

UNIVERSIDADE DE LISBOA
FACULDADE DE CIÊNCIAS
DEPARTAMENTO DE INFORMÁTICA



Ciências
ULisboa

**SaveDForest.v2 – a serious game to forge pro-environmental
behaviour change via empathy with the native people of the
Amazon**

Ângela Maria Almeida da Silva Saraiva

Mestrado em Informática

Trabalho de Projeto orientado por:
Prof.^a Doutora Ana Paula Boler Cláudio
Prof.^a Doutora Maria Augusta Duarte Gaspar

Acknowledgments

It is with immense gratitude that I want to acknowledge all those who helped me and this project in its progression. First, I am truly grateful to my advisors, Ana Paula Boler Cláudio and Maria Augusta Duarte Gaspar, for their extensive support and guidance. I also want to express my sincere gratitude to Leoni Vogelbacher for her help and insights for the game, together with her thorough research about the game's themes and creativity for the storyboarding of various scenarios for the game's forest narrative. The unconditional support of my family in me and in my work means so much to me that it can not be put into words. I am always grateful to my friends for creating a safe space to express and forget my worries for some time. Finally, I want to thank everyone who participated in this project's user testing period and gave their time and feedback for the game's success.

Resumo

Este projeto descreve a concepção e desenvolvimento de um jogo sério, SaveDForest.v2, focado em apresentar as consequências que determinadas decisões do nosso dia-a-dia podem ter em relação a vários problemas ambientais que ocorrem em territórios geograficamente longínquos e o negativo impacto que causam na vida dos seus habitantes. Como caso de estudo, foi escolhida a Floresta Amazónica e uma das tribos de indígenas que nela habitam, os Yanomami.

O projeto é uma continuação de tese que usa a mesma base da tese anterior, de ser um jogo sério que utiliza a empatia para promover comportamentos sustentáveis, mas executado num formato diferente, aplicado com um novo conceito e uma narrativa focada noutra floresta.

O jogo foi criado no motor de jogo Unity, junto de um servidor simples que lida com dados e informações necessárias para o funcionamento do jogo. Estes encontram-se disponíveis online, estando o jogo hospedado na plataforma itch.io e o servidor na plataforma Render. Os elementos visuais como imagens de fundo, das personagens, e gerais da interface foram criados através do editor de imagens GIMP, da ferramenta de desenho Krita e do editor para prototipagem Figma, respectivamente.

A Amazónia continua a sofrer devido à desflorestação, o maior fator de ameaça à floresta, para criação de agricultura, de gado e para exploração mineira ilegal. Estes métodos são usados devido à procura em crescimento por madeira, metais preciosos, e espaços para a criação de gado e plantações. Muitos destes recursos são extraídos em massa por causa do alto consumo de produtos que os utilizam. Uma maneira de amenizar este fator pode ser feita através da compra de produtos provenientes de fontes responsáveis e da redução do consumo de carne. Assim, a procura desenfreada por estes recursos será diminuída e haverá um incentivo no mercado para o uso de práticas mais sustentáveis. Sendo esta floresta um pulmão do nosso planeta, os seus problemas têm efetivamente uma influência global, e não apenas localizada geograficamente.

Para criar uma conexão positiva com os jogadores em relação aos temas de sustentabilidade que afetam a Amazónia, foram usadas estratégias para a indução de empatia no jogo. Ao seguir a história de Yani, um nativo Yanomami que vive na Amazónia, é criada uma ligação de compreensão em relação aos seus pensamentos e estilo de vida, e de preocupação pelas dificuldades que ele e as pessoas próximas dele passam. A empatia pelos animais é também explorada através de Camu, um animal de estimação da família de Yani. Para avaliar a resposta de empatia apresentada, foi escolhido usar o teste de empatia SAM. Este teste mede as emoções que o indivíduo está a sentir como reação a um certo estímulo, através dos domínios da valência, estimulação e dominância.

Ele usa uma escala visual com imagens que representam, para cada um dos domínios, diferentes caras expressivas, e pede ao indivíduo para escolher aquela que mais se parece com o que está a sentir no momento. A primeira etapa do projeto consistiu em fazer o levantamento de jogos com temas similares a SaveDForest.v2, com foco em jogos que tenham artigos científicos sobre estes. As características observadas foram: gêneros, público-alvo, tipos de gráficos, temas de sustentabilidade explorados, personagens, tipos de cenários, tecnologias usadas, plataformas e línguas disponíveis, se são pagos ou grátis, e informações sobre as suas equipas de desenvolvimento. Os jogos escolhidos para trabalho relacionado deste projeto foram separados em temas baseado nos assuntos de sustentabilidade que estes jogos exploram.

A etapa seguinte envolveu o levantamento de requisitos que o trabalho teria junto com o planeamento das várias etapas necessárias para completar o projeto. Os requisitos foram divididos em requisitos necessários para o jogo e para o servidor e foram definidas algumas restrições e detalhes sobre algumas das funcionalidades. Cada um dos requisitos foi também caracterizado como funcional ou não funcional.

Na próxima fase do desenvolvimento do jogo foi realizado e detalhado o conceito e narrativa de SaveDForest.v2. O jogo é dividido em duas narrativas principais, cada uma com uma personagem principal. Uma das narrativas segue o ponto de vista de um estudante de uma faculdade de Artes, a estudar num país europeu, Callum, que, no seu quotidiano, faz escolhas de consumo que têm consequências na Amazónia. Ao longo desta narrativa, o jogador é desafiado a fazer escolhas informadas de consumo, com ou sem impacto negativo na referida floresta. As escolhas ambientalmente corretas são premiadas. Para demonstrar as consequências sentidas na floresta, o jogador acompanha também a segunda narrativa, o desenrolar de cenas do quotidiano de um jovem indígena, Yani, e da sua família, que vivem nesta floresta, e têm de lidar diariamente com os danos causados nela. A ideia do jogo é apresentar cenários que seguem a vida de Callum, fazer a transição para a floresta e demonstrar uma série de cenários relativos a Yani e o seu quotidiano. Estas duas personagens foram conceptualizadas para serem parecidas para criar uma relação de identificação entre os dois, e, conseqüentemente, entre o jogador. Ao longo do jogo, diversos conhecimentos e informações são desbloqueados, sendo estes relacionados aos impactos que afetam a floresta, à vivência dos Yanomami, e a escolhas sustentáveis que podem ser implementadas facilmente no quotidiano. Depois de uma certa quantidade de cenas serem apresentadas, os testes SAM são apresentados aos jogadores para medir a sua resposta emocional aos cenários do Yani. Depois da apresentação dos testes, ocorrem questionários sobre os temas mencionados no jogo onde, para cada resposta certa, é atribuída ao jogador uma pequena quantidade de pontos. No final, baseado nos pontos do jogador, o jogo atribui um de três finais que representam o desenlace final da narrativa de Yani.

Para criar uma transição coesiva entre as duas narrativas, foram desenhadas três animações para serem apresentadas durante essas transições. A primeira animação mostra uma tela de arte onde é desenhado um ramo de árvore, e representa o lado artístico de Callum. A segunda animação exhibe um portal entrelaçado em ramos e folhas de plantas, e representa a mudança de espaço da

cidade para a floresta, como se o jogador fosse transportado realmente para outro local. A terceira e última animação apresenta uma espiral de folhas, e representa também esta mudança para outro local, de uma maneira que pode retratar a transição da floresta para a cidade como vice-versa.

Após a conclusão da implementação, o jogo foi avaliado através de testes com utilizadores. Nestes testes, foi pedido aos jogadores a realização de cinco tarefas e, no final, respondido a uma série de perguntas sobre a demografia, usabilidade e animações do jogo. As perguntas sobre a demografia tiveram um foco em hábitos em relação a jogos. A usabilidade foi medida através do uso do PSSUQ, um questionário validado cientificamente. No final, a preferência dos utilizadores em relação a cada animação foi avaliada.

Neste trabalho foram também descritas possíveis melhorias para o jogo, como a utilização de fuzzy logic para a determinação do final do jogo e a receção de feedback sobre o domínio da empatia através de testes com especialistas na área de Psicologia. Por fim, SaveDForest.v2 mostra potencial para o sucesso de jogos sérios que usam a empatia para ensinar e mudar os comportamentos de grupos de pessoas em relação a problemas relacionados com a preservação de florestas tropicais e dos seus habitantes.

Palavras-chave: jogo sério, empatia, mudança de comportamento, comunidades Yanomami, Floresta Amazónica

Abstract

Deforestation continues to be a serious issue globally and is still currently a major contributing factor to the harm of several forests. One of the forests that are massively impacted by this is the Amazon rainforest and its communities that live in harmony with the forest and its resources. These issues are mostly still ongoing due to a lack of knowledge about the continuous clearing of land in the forest. To help reduce this impact, individuals can make environmentally sustainable decisions that will hinder the exploitation of the Amazon forest.

This project conceived and developed a serious decision-based game that fosters empathy towards the people and animals of the Amazon forest, motivating behaviour change such as choosing eco-friendly alternatives to everyday habits and actions.

The game was conceived through the cooperation of a multidisciplinary team in the areas of Informatics and Psychology. The results of an analysis of the game's concept show the potential for this type of approach in the mitigation of deforestation in tropical forests. The results of the user tests showed the game's user-friendliness and ability to evoke empathy. These results are promising for a future validation of the game as an elicitor of empathy and booster of consumer behaviour change.

Keywords: serious game, empathy, behavior change, Yanomami communities, Amazon rainforest

Contents

List of Figures	xvi
List of Tables	xviii
List of Acronyms	xx
1 Introduction	1
1.1 Motivation	1
1.2 Goals	1
1.3 Contribution	2
1.4 Structure of the document	2
2 Background	5
2.1 Yanomami people	5
2.2 Threats to the Amazon rainforest and to its native communities	6
2.3 Empathy	6
2.3.1 Empathy towards animals	7
2.3.2 Behaviour change	7
2.3.3 Use in games	8
2.3.4 Empathy tests	8
2.4 Game traits and genres	9
2.5 Serious games and environmental games	10
2.6 Conclusion	11
3 Related work	13
3.1 Living with nature	13
3.2 Impacts of environmental degradation	16
3.3 Environmental restoration	18
4 Procedures and technologies	23
4.1 Requirements	23
4.1.1 Server	23
4.1.2 Game	25

4.2	Planning	25
4.2.1	Concept definition	25
4.2.2	Technologies and platform	26
4.2.3	Prototype creation	27
4.2.4	Game assets	27
4.2.5	Game implementation and testing	28
4.2.6	Testing inside the team	28
4.2.7	User testing	28
4.2.8	Refinements and updates	28
5	Conceptualization	30
5.1	Story and concept	30
5.1.1	Parallel narratives	30
5.1.2	Empathy and changing the players' behaviours	31
5.2	Characters	31
5.2.1	Main characters	32
5.2.2	Side characters	33
5.3	Main mechanics	34
5.3.1	Decisions	34
5.3.2	SAM tests	34
5.3.3	Quizzes	34
5.3.4	Endings	35
6	Implementation of the game SaveDForest.v2	37
6.1	Figma prototype	37
6.2	Game's architecture	38
6.3	Unity game	39
6.3.1	Scene's structure	39
6.3.2	Types of scenes	40
6.3.3	Adding new scenes	45
6.3.4	Animations that identify transitions	46
6.3.5	Sounds and music	47
6.4	Node.js server	48
6.5	Web hosting	48
6.6	Cross-platform playability	48
6.7	Security	49
6.8	Visual guide	49

7	Evaluation	52
7.1	User tests	52
7.1.1	Methodology	52
7.1.2	Results	53
7.1.3	Discussion	56
8	Conclusions and future work	59
8.1	Conclusions	59
8.2	Future work	59
	Bibliography	67
A	Visual guide	69

List of Figures

3.1	Depiction of Stardew Valley’s fishing mechanic	14
3.2	Stardew Valley’s menu in the main page, displaying the current funds	14
3.3	Depiction of the pond at dusk in Walden, a game	15
3.4	Early stage of the cabin’s construction in Walden, a game	15
3.5	Point where the fox can dig in The First Tree	15
3.6	Major obstacle represented by long vines in The First Tree	15
3.7	Nuna using her bola to clear an obstacle in Never Alone	16
3.8	Depiction of one of the spirits blocking the path in Never Alone	16
3.9	Depiction of the steam-powered vehicle used in FAR: Lone Sails	17
3.10	Depiction of an explosion happening the background in FAR: Lone Sails	17
3.11	Depiction of a city with its water full of plastic in Plasticity	17
3.12	Noa appreciating the recovering world in the good ending of Plasticity	17
3.13	Depiction of Eco’s UI with its various components displayed	18
3.14	Complex construction made by a community of Eco	18
3.15	Depiction of an early stage of a Terra Nil’s level	19
3.16	Depiction of a restored ambient in a Terra Nil’s level	19
3.17	Depiction of Cloud Gardens’s UI and the progress of a level	20
3.18	Depiction of an environment of a completed level in Cloud Gardens	20
5.1	Portrait of Callum	33
5.2	Portrait of Yani	33
5.3	Portrait of Romi	33
5.4	Portrait of Yani’s son	33
5.5	Portrait of Yani’s wife	33
6.1	Visualization of the prototype’s flow in Figma	38
6.2	Visualization of the project’s architecture	39
6.3	Visualization of an example of narration in the game	40
6.4	Visualization of an example of a thinking dialogue in the game	41
6.5	Visualization of an example of speaking dialogue in the game	41
6.6	Visualization of an example of an ”on the phone” dialogue in the game	41

6.7	Visualization of an example of a simple decision in the game, displaying the buttons for both choices	42
6.8	Visualization of an example of a decision where you can "get data" before making a decision	42
6.9	Visualization of a panel that displays the points earned after making a decision, at the top right	42
6.10	Visualization of an example of a question with several options on a quiz in the game	42
6.11	Visualization of an example of an answer after choosing the correct answer to a question	42
6.12	Visualization of an example of a SAM test on the question about valence	43
6.13	Visualization of an example of a SAM test on the question about arousal	43
6.14	Visualization of the first lines of the good ending in the game	44
6.15	Visualization of the display of the game's ending, done at the end of the scene . .	44
6.16	Visualization of the game's menu, Resources, displaying the icons for the Memories and Knowledge scenes	44
6.17	Visualization of the Memories' tutorial, on the right and the plant with the decision leaves, on the left	45
6.18	Visualization of the Memories page, displaying the decision about meat consumption	45
6.19	Visualization of the Knowledge scene with some topics unlocked on the side . . .	45
6.20	Visualization of the Knowledge scene with information about the first topic . . .	45
6.21	Frames displaying the stages of the artsy animation	46
6.22	Frames displaying the stages of the portal animation	46
6.23	Frames displaying the stages of the spiral animation	47
7.1	Bar chart of the number of users that needed help or not during the execution tasks from SaveDForest.v2's user tests	54
7.2	Bar chart of the averages of each PSSUQ's questions from SaveDForest.v2's user tests	55
7.3	Bar chart of the user's answers to their preference regarding the animations displayed in SaveDForest.v2	56
A.1	Depiction of the game's fonts and where they are used	69
A.2	Depiction of the sizing and spacing of the elements of a dialogue scene	69
A.3	Visualization of the types and subtypes of scenes the game has	70
A.4	Depiction of the details of a speaking dialogue scene	70
A.5	Depiction of the details of a thinking dialogue scene	71
A.6	Depiction of the details of a narration dialogue scene	71
A.7	Depiction of the details of a quiz scene	72
A.8	Depiction of the details of a SAM test scene	72
A.9	Depiction of the details of a decision scene	73

A.10 Visualization of the colours used for Romi scenes	73
A.11 Visualization of the colours used for Callum scenes	74
A.12 Visualization of the colours used for Yani scenes	74
A.13 Visualization of the colours used for the start menu	75
A.14 Visualization of the colours used for the login/register scenes	75
A.15 Visualization of the colours used for the main menu	76
A.16 Visualization of the colours used for the Memories scene	76
A.17 Visualization of the colours used for the Memories scene	77
A.18 Visualization of the colours used for the Knowledge scene	77

List of Tables

3.1	Summary of the games analyzed in the Related Work, with their characteristics as rows and their names as columns	21
7.1	PSSUQ's average score per question, overall and for each subscale	55
7.2	PSSUQ's average score per question together with the benchmark values	57

List of Acronyms

CPUs Central Processing Units. 38

INFOQUAL Information Quality. 53, 54, 56, 57

INTERQUAL Interface Quality. 53, 54, 56, 57

JSON JavaScript Object Notation. 39

POV Point of View. 30–32, 40

PSSUQ Post-Study System Usability Questionnaire. vi, xv, xviii, 53–57, 59

RPG Role-playing game. 8, 9, 13

SAM Self-Assessment Manikin. iv, v, xv, 8, 9, 11, 24, 32, 34, 37, 42, 43, 48, 53

SUS System Usability Scale. 53

SYSUSE System Usefulness. 53, 54, 56, 57

UI User interface. xiv, 18–20, 26, 27, 40, 49

UXE User experience evaluation. 28

Chapter 1

Introduction

In recent years, scientists have continuously informed and warned about the damage caused by human impact on our planet and uphold that this damage could turn irreparable if there was not a significant effort to mitigate it [1]. To minimize this impact, some environmentally conscious countries and individuals have made an effort to safeguard the environment through the implementation of laws and a change of habits. However, these efforts are far from being enough [2]. Many forests and their populations have been suffering and this information is not generally talked about enough for significant change to be seen.

1.1 Motivation

One of the major forests in the world is the Amazon rainforest [3], the lungs of the planet Earth and home of various native tribes such as the Yanomami. Even after creating many safeguarded areas, there are still several threats influencing the well-being of the rainforest which shows that not even the most famous forests are safe [4]. With this in mind, it is essential to inform the general population and teach about ways to help decrease the effect of human impact on these forests.

Within the realm of serious games, there has been a rise in contents that explore environmental themes and issues such as the impact of overuse of resources and promotion of recycling [5] [6]. Trying to foster empathy in games is also rising [7], as is its research, especially in the context of serious games, for the purpose of generating a lasting impression on its players related to meaningful topics such as bullying [8] [9] and prejudice [10].

1.2 Goals

The serious game conceived and developed in this project aims to teach which and how our daily decisions can affect the environment of the largest rainforest in the planet, by implementing a decision-based serious game where the player's actions impact the characters' environments. The game switches between focusing on the stories of two main characters: one being a university student living in the city and the other being an Amazon native, a Yanomami tribe member. The city side will follow the daily life of the student and the player will have a selection of choices that

will directly impact the Amazon's ecosystem (e.g. skip reading labels that display if certain foods or other products were sustainably sourced, to ensure that production of these items was not done by destructive means to the Amazon forest). The forest side will also follow the daily life of the native and his family, and will mainly be narrative-driven with the story being influenced by the previous player's decisions. The game will show how individual decisions can directly impact a forest's ecosystem that exists far away, in another continent.

1.3 Contribution

The main contribution of this project is a serious game, conceived from scratch, involving a multi-disciplinary team of psychologists and informatics. The game, SaveDForest.v2, acts as a compact guide and engaging tool to learn relevant information about making environmentally friendly decisions that impact the Amazon rainforest. The component of decision-making encourages critical thinking about the consequences of various actions and presents the outcome of choosing environmentally conscious vs. destructive decisions, fostering awareness of sustainable practices.

To generate engagement, the player is immersed in a narrative of the Yanomami character's day-to-day life, starting with a dream about a forest fire. This is expected to trigger thereon empathy towards this native young man and his community, and engagement to diminish the negative impact of our consumption choices in their lives. The information presented in the game is about the Amazon rainforest itself, its native communities, its animal and plant life, the struggles the forest is facing and how every person can contribute in small ways to alleviate the harm being done to the rainforest. The game can also help disseminate information about the culture of Yanomami people, promoting respect and creating empathy for indigenous communities.

The game was implemented as a web application [11] and it can be freely used after registration. The illustrations made of the characters' portraits also act as an intellectual contribution to the project.

1.4 Structure of the document

This document is organised as follows:

- **Chapter 2 - Background:** contextualizes important concepts needed to understand and develop the project.
- **Chapter 3 - Related work:** introduces various games that have similar or related themes to SaveDForest.v2 and a summary of their characteristics.
- **Chapter 4 - Procedures and technologies:** discloses the project's requirements and how the workflow for the game's creation will occur by explaining the several steps that it entails.
- **Chapter 5 - Conceptualization:** details the concept designed for SaveDForest.v2 before its implementation, including its story, characters and main mechanics.

- **Chapter 6 - Implementation of the game SaveDForest.v2:** outlines the implementation of the game SaveDForest.v2, starting by its concept and going to the prototype's design, and the game's overall production.
- **Chapter 7 - Evaluation:** depicts the tests done on the game to ensure its usability and ability to elicit empathy onto its players. The chapter presents the tests' results and the discusses the meaning of said results in the context of SaveDForest.v2.
- **Chapter 8 - Conclusions and future work:** provides the leading conclusions of the project and presents suggestions for future work.

Chapter 2

Background

To design and create the game, there are essential concepts and background data that are important to understand, namely the culture of Yanomami people, the current leading causes that threaten the Amazon rainforest and its communities, the concept of empathy and its use in game design, the depiction of usual game traits and context on game genres explored in this document, and, finally, the concept of serious games and environmental games.

2.1 Yanomami people

The Yanomami are a group of indigenous communities who populate part of the Amazon forest with most territories on both the Brazilian and Venezuelan side of the forest. Currently, their population is estimated to be around at least 30 000 native people [12]. The Yanomami people live in large communal houses named shabonos, in Yanomami language. Shabono and maloca are both terms used to represent these communal houses. These houses are typically circular structures made out of wood, vines and palm leaves. Being usually open in the center, they reveal a communal area that is used for rituals and feasts, and are divided into smaller areas where each family lives, each with hammocks and a fireplace [13]. The Yanomami culture is heavily driven and influenced by family and their villages are usually composed of their extended family. Marriages occur at young ages, and are sometimes used to create political bonds and stabilize relationships between villages [14]. In terms of horticulture, the Yanomami people use the slash-and-burn practice where gardens are cleared from the forest in order to grow different crops. They also hunt small animals and fish. Spirituality also plays a huge role in their culture as they often perform ceremonies and other spiritual practices.

Their personal names hold deep cultural significance to them as they are unique and are not to be directly said in conversation, since the name of a person is seen as a verbal representation of one's ghost. An individual's name is given to them when they are a child and only children's names are accepted to be said out loud. When they are considered adults, their real names are no longer used and should be forgotten. In those cases, to refer to each other, the Yanomami people use their second name, nicknames or other descriptors of someone [15].

David Good, a young man, who is the son of a Yanomami mother and an American father, has

a Youtube channel [16] with videos that are dedicated to preserving and sharing his heritage and culture.

2.2 Threats to the Amazon rainforest and to its native communities

The main threat to the Amazon rainforest continues to be deforestation through the means of illegal logging and human-caused forest fires that deplete the quality of life of indigenous people living in the forest [17]. The balance between the forest ecosystem and its indigenous and animal population becomes irreparably corrupted, influencing their overall welfare. Climate change also can have a more indirect impact on the forest since it causes an increase in the frequency of extreme weather conditions which can destabilize the balance in its environment [18] [19]. While these threats can mostly be helped through stricter conservation measures and laws brought by international cooperation [20], individual people can contribute to the forest's betterment. Some contributions can be, for example, buying sustainable products with certifications that indicate that they were sustainably sourced. Eating less meat also mitigates the impact of deforestation since one of the primary reasons for the Amazon's deforestation is the expansion of cattle ranches [2]. Not buying palm oil or buying sustainable palm oil also helps the forest's conservation since palm oil production is heavily linked with deforestation [21]. Reducing energy consumption or utilizing renewable energies can indirectly impact the Amazon by lessening the impact of climate change.

The forest's native communities, including the Yanomami, have also suffered from the deforestation and illegal mining happening. The Yanomami rely on the forest's resources for their daily lives and the disruptions created by these threats have destroyed the trees, animal lives, plants used for medicinal purposes and their plantations. Their territories are invaded and taken to be used to raise cattle farms, to cultivate massive plantations and to create mines to extract precious ores [22]. Their culture is also effectively changing and eroding with time, which has increased the vulnerability of the native communities [23] [24].

2.3 Empathy

Empathy is normally seen as a vast term that is related to many concepts such as understanding someone's actions by knowing their thoughts and feelings (cognitive empathy), being affected by their emotional experiences or even mirroring them (affective empathy), automatically mimicking their facial or body expressive behavior (motor empathy), among other related concepts such as perspective taking, empathic concern and empathic distress [25] [26]. Perspective taking consists of the effort to step from one's own perspective and try to adopt the point of view of another person. Empathic concern is seen as an emotional response of compassion towards another individual that is in distress, which motivates the one experiencing empathy to help the person in need. Empathic distress, on the other hand, refers to the experience of overwhelming negative emotions one person can go through when empathizing with another person's pain and suffering, which can leave the individual feeling trapped and helpless. The general idea of empathy is shown to intertwine both

cognitive and affective components and vary among individuals and triggering contexts. The possible emotions displayed by the person experiencing empathy are alike but not equal to the ones felt by the empathy's target subject. It is mostly an automatic reaction but is complex and thought provoking [27].

2.3.1 Empathy towards animals

Empathy is often mentioned in the context of humans experiencing empathy towards other humans but the concept of empathy actually transcends into other species as well. While humans may sometimes overlook animal suffering [28], the topic of empathy towards other species has had an increase in importance in order to discover if it can be a factor in environmental conservation. Currently, the major contact that modern people have with animals is through pets, usually cats and dogs, as smaller animals are more suited to live in small apartments. Institutions such as shelters, sanctuaries and other nature centers also aim to develop human connections to other types of animals. Several studies have shown that empathy is critical for individuals to comprehend animals' feelings and experiences by relating and seeing them as a complex being with emotions and needs [29] [30] [31].

2.3.2 Behaviour change

In the context of environmental awareness, an important point is not just to educate and provide resources so that others understand that the environment is struggling and needs help, but to actually provoke behavioral change in people in order to influence others to actively make more environmentally friendly decisions. Changing certain behaviours can be challenging and the decisions that this project aims to nudge are already formed habits that have become part of a routine, such as choosing to drive over using public transportation, buying specific brands (some brands have products that are not responsibly sourced or do not have such indications), and having a specific diet (most people consume meat, sometimes in excess). All these behaviours are hard to unlearn since they are habits, which means that an individual must make a conscious decision in order to correct said behaviours [32]. Also, these behaviours can have a significant impact on the environment, specifically in this context, on the Amazon rainforest.

The COM-B model of behaviour change [33] is one of the many behaviour change models and it proposes three components that are needed for any behaviour to happen: capability, opportunity and motivation. Capability is referred to as being an individual's ability to engage in the behaviour. There are two types of capability: physical which includes strength and balance, and psychological which includes memory and knowledge. Opportunity is referred to as external factors that make the behaviour possible. There are two types of opportunity: physical which includes financial and material resources, and social which includes social influences and cultural norms. Finally, motivation is referred to as the processes that energize and direct behaviour. Motivation can be reflective which encompasses all conscious thought processes, and automatic which include habits and impulses. This model is widely used in health interventions, policy design,

and behaviour change programs to identify where interventions can be targeted so as to encourage desired behaviours.

2.3.3 Use in games

Empathy is often applied in games to keep the player engaged and interested. For example, games that focus heavily on storytelling may make profound and relatable characters that the player attaches to and wishes to see where their story leads to. In another case, Role-playing game (RPG)'s genre often have magnificent and unique landscapes, enveloping and profound world building with a well thought out story and characters [34].

There are four design principles proposed to create a game that successfully fosters empathy in its players [35]. The 1st principle mentions that these games should induce players to try to empathize with its characters, situations and story, even before they start playing the game, since, in doing so, players are less likely to detach themselves from what they are seeing and be indifferent to the characters' experiences. This situation can happen prominently in the context of games, seeing as how it is more usual for people to be more apathetic towards virtual stories and characters than real experiences because they do not acknowledge that they exist or see them as real. The 2nd principle refers that the game should lay out ways so that the players are able to help those whom they empathize with, both inside the game and in real life. The 3rd principle mentions that employing both emotional and cognitive empathy is important but there should be a grander emphasis in the cognitive part. This is because cognitive empathy creates long-time changes in behaviours for most individuals while emotional empathy alone mostly provides a reaction in the moment, leading to the players' behaviour towards the aspects displayed in the game to remain the same as it was before. Employing affective empathy in combination with cognitive empathy has better cover on different types of empathy responses that people have, leading to better fostering of empathy in its players. The 4th and last principle brings up the importance of having the game point out similarities between the player and the people they are expected to empathize with, which in turn can create more easily a sense of relatability onto the players and improve the chances that the players develop empathy towards the characters.

These related concepts of empathy, specifically perspective taking and empathic concern, are placed in various games to make players understand different situations and nuances by placing them in another's shoes. The element of empathic concern goes hand in hand with prosocial behaviours, generating an urge to help the other who's distressing and in need [36]. When the players empathize with the story and characters, they are more likely to change behaviours that they know (or learnt) can negatively impact the situations depicted in the games they consume.

2.3.4 Empathy tests

The immediate experience of empathy can be measured through the usage of tests. The Self-Assessment Manikin (SAM) is an image-based scale that measures emotional responses across three dimensions [37]. The dimensions are valence, arousal and dominance. In this test, each di-

mension is estimated by having a scale with a series of human-like figures that visually represents intensity degrees of emotional states. The figures can range from miserable to happy in terms of valence, calm to excited in terms of arousal, and a change in size, ranging from small to big, in terms of dominance and control. The SAM test's scores can be seen as a proxy of empathic responses, as they reflect how individuals respond emotionally to specific scenarios.

2.4 Game traits and genres

Games are truly diverse in nature and they cater to a plethora of player bases that seek different types of entertainment, which leads to the formation of the various game types. Although these games are fundamentally different, they still derive from shared core elements that distinguish them from movies, music and other types of media. Designing the game so that players actively interact and partake in the experience, having depicted actions and resources that help in achieving the game's goals, and limiting the player through implementing sets of rules that set boundaries on what can be done, are all major components that are utilized in game design [38]. These components work together to produce different outcomes in a single game so they do not end up stale after a few playthroughs.

Typical game design uses elements such as giving points, progress bars and/or badges as a reward for players for completing certain tasks and progressing the game. Having the option of choosing the difficulty through difficulty levels is also generally done to appeal to players that have different skill sets and provide a greater challenge to experienced players in those games. The game's difficulty needs to be balanced as to not be impossible to complete but still provide an interesting challenge. There are also progression mechanisms that are represented by levers and/or switches which lock and unlock specific areas depending on the player's progress [39]. The use of different combinations of game mechanisms lead to the creation of different game genres. Some of the most popular ones are simulation, strategy, RPG, adventure, puzzle and platform games [40].

Simulation games display several features of real life and allow the player to interact with them virtually. Strategy games utilize simulated worlds where the emphasis lies in the player's decisions and planning which have a great significance towards the outcome of said world. They are usually more challenging games that require lots of thought to achieve success.

RPG games are set in imaginary worlds where the main objective is to explore a vast world, interact with and befriend the game's characters. Adventure games focus mostly on a story that is portrayed in-game. The story drives the gameplay by providing missions to be completed, often called quests. Games with heavy focus on their narrative usually provide different dialog and choices that influence the gameplay and its outcome. The aforementioned game type is called decision-based.

Puzzle games focus on solving puzzles that are represented by obstacles and challenges that impede the game's progress. Platformers are a type of game where the objective is to have the character move between points in the environment by jumping to and running on platforms. Most

platform games are also side-scrolling, a game type where action is viewed through a side camera angle and the characters move only horizontally.

A niche type of game will also be mentioned further into this document since it is one of SaveDForest.v2's genres, namely visual novel games. Visual novel games are a type of narrative-driven games, mainly made in Japan, with elements of decision-making embedded that influence the outcome of the plot. They are often structured like a novel, with the players reading through a story, but distinguish themselves by combining storytelling with visual elements. These visual elements typically consist of 2D character sprites, backgrounds and other artworks. Visual novel games have been rising in popularity internationally through the translation of those games into English, enabling them to reach a larger audience. Using visual novel games as a media for education has also been researched and discussed as a valid way for students to learn [41].

2.5 Serious games and environmental games

Serious games focus on having the player learn a certain topic, theme or idea through playing the game, making use of game design and dynamics [42]. Thus, they bring a fresh approach to learning by having the player control the learning instead of a traditional learning experience, which is often more passive. These games balance knowledge with entertainment and aim to be impactful or have a lasting impression on the player. Recently, these types of games are mostly applied in the fields of simulation training, research and advertising and mostly in the industries of education, healthcare and Non-For-Profit (NFP) organizations [43].

Serious games have a unique space in the teaching field as a result of the increase in the popularization of digital games for all target audiences. Almost everyone plays games to enjoy a full adventure in a new world with new people, new ideas and concepts, while entertainment is only a bonus to the game experience. With this in mind, it seems only natural to start incorporating various types of knowledge into game experiences and introduce them in a lasting and fun way to a greater market.

These types of games are often used because they can quickly capture their users' attention, can have a more permanent impression and can disseminate information on different platforms and to a variety of people easier than traditional education.

Environmental games are often described as a sub-group of serious games which focus on teaching about sustainability and other environmental themes such as climate change, pollution, and conservation of wildlife, renewable energy and the impacts of these issues on mostly marginalized communities [44]. Recent research has shown the effectiveness of exploring environmental issues through the media of environmental games, namely by simplifying the intricacies of its themes through visualization and interaction with the game's world, and by emphasizing the players' impacts on all aspects of the game [45] [46]. Continuous exposure to environmental games is also found to better the odds of individuals engaging in more pro-environmental actions in real life [47].

2.6 Conclusion

Summing up, the Yanomami people and their culture have been in danger by threats that are outside of their control and are damaging their home, lifestyle and the lives of those around them. A serious game revolving around environmental themes can be implemented and utilized in order to educate more people about these topics. The game can make use of important concepts of empathy, namely perspective change and empathic concern, to initiate a behaviour change in its players, causing them to slowly break harmful habits. The players' reaction to the game can be assessed through a measure of their self-perception of emotional response, namely the Self-Assessment Manikin (SAM) [37]. Scores on SAM's subscales of emotional arousal and valence provide valuable indications that empathic responses may be taking place, if arousal is high and valence is aligned with the emotional content of the scene and experience of the characters.

Chapter 3

Related work

This chapter summarizes the set of games that were chosen and further analyzed. The target of the research were games that fall on the broad category of environmental games or deal with topics related to the environment's well-being. Their analysis was done in order to understand what genres are most prevalent, the games' target audience, types of graphics, types of sustainability explored, what types of characters are featured, the scenarios displayed, in what ways they award points and/or badges, what technologies were used to develop them, in which platforms these games are usually on, if they are free or paid, what languages they are available in, and information about their development team. The research was focused on finding generally popular games with good reviews and with scientific background or articles about said games. By researching the state of the art of these games and knowing their characteristics, it is possible to comprehend what parts of theirs are compelling and what parts could be improved, which contributed significantly to the development of SaveDForest.v2.

3.1 Living with nature

The following games have a focus on exploring and living in harmony with nature with some underlying themes of sustainability.

Stardew Valley [48] focuses on the life of a new farmer who just inherited the farm from their grandfather. The character moves to the new town and learns about the basics of their new life from the locals such as farming, exploration and mining, fishing (as shown in Figure 3.1) and how to build tools and machines to aid these tasks. The character can also befriend the town's characters and actively participate in its community by purchasing from local stores and joining festivals. It is a popular simulation RPG that uses the themes of farming, mining and resource management to introduce and raise awareness of issues such as sustainable farming and over-exploiting resources. The game does not have an explicit difficulty level, although some types of farm terrain are easier to manage than others and certain tasks are more difficult than others. In Stardew Valley, progress is viewed in terms of money earned from the various tasks and hearts earned from building relationships with the other characters, and both of these resources can be seen in the game's menu, as shown in Figure 3.2. This game has a scientific article that analyzes

how the game portrays environment restoration where it emphasizes that, while some immersion leads to the players ignoring some behaviours that can indirectly harm the environment, *Stardew Valley* has many ways to "provide opportunities for the player to choose critical engagement" and "The role of critical engagement with these potentially imperfect media can help to bridge the gap between academic perspectives and the everyday video gamer and community member" [49]. It was developed using MonoGame [50], a free and open source C# framework mostly used for the development of cross-platform games, by a development team consisting of 1 person. The game is paid and available for PC, most consoles, Android and iOS. It is available in 12 languages.



Figure 3.1: Depiction of *Stardew Valley*'s fishing mechanic



Figure 3.2: *Stardew Valley*'s menu in the main page, displaying the current funds

Walden, a game [51] provides an outlook to living in the forest in a tiny cabin near a pond (which can be seen in Figure 3.3, and being surrounded by a serene atmosphere. The players are expected to explore the wilderness, appreciate the vegetation, and do several outdoor activities such as fishing, planting, and building their own cabin. An example of the progress of building the cabin is shown in Figure 3.4. It was inspired by the book "Walden; or, Life in the Woods." [52] by Henry David Thoreau, a philosopher and naturalist. The game functions as an interactive simulation of the written story and its focus lies on a thought-provoking adventure that promotes simple and sustainable living and encourages its players to reflect on their impact on the environment, leading to a greater empathy towards it. The game is not difficult since it concentrates on a narrative experience and does not focus on the survival aspect. It also does not have a standard system of points since the progress of the game is shown through learning more and more about living in resonance with nature. The game was created using Unity, a cross-platform game engine that uses mostly C# language, by a small team from the University of Southern California Game Innovation Lab Research. It is paid and available on PC, Xbox One and PlayStation 4 in English.

In *The First Tree* [53], there are two explored narratives: a fox searching for their missing family and a couple dealing with personal challenges. The player controls mostly the fox, navigating a breathtaking forest and solving nearby puzzles that will clear the path to the main objective: the tree known as *The First Tree*. The game's main mechanics are shown through the fox, such as jumping, digging (as seen in Figure 3.5), and tracking specific areas of interest. During the fox's journey, elements from the couple's narrative will be exposed through the fox's progress. This game uses nature and wildlife as symbols for emotional and psychological subjects. The

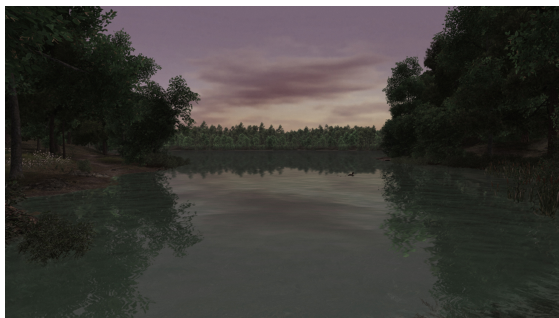


Figure 3.3: Depiction of the pond at dusk in Walden, a game



Figure 3.4: Early stage of the cabin's construction in Walden, a game

main feeling explored is empathy since it has the fox as the main character, leading to the player empathizing with them, and utilizing them as a parallel to the couples' story. This game also does not have a standard system of points so the game's progress is done through learning about the story and completing the puzzles that clear obstacles (an example of an obstacle can be seen in Figure 3.6), which also advances the narrative. It was created using Unity by mostly a 1-person developer team. The game is paid and available on Windows, Mac, PS4, Xbox, Nintendo Switch, Android and iOS in 11 different languages.



Figure 3.5: Point where the fox can dig in The First Tree



Figure 3.6: Major obstacle represented by long vines in The First Tree

Never Alone (Kisima Ingitchuna) [54] takes place in the Arctic tundra of Alaska and dives into the life of Nuna, an Iñupiaq young girl, and her Arctic fox companion and their quest to set out in search of the source of a powerful blizzard that is threatening their community for quite some time which hindered their ability to hunt, leading them towards starvation. Both the fox and Nuna are playable characters and the game has 2 options: to be played in cooperation by 2 players or played in single-player mode where a single player switches between playing the fox and the girl. The game is based on a traditional Iñupiaq tale named "Kunuksaayuka" whose moral is that our actions can greatly affect others [55]. In both game styles, the characters have unique skills to them that make their cooperation necessary. Nuna is capable of climbing, moving heavy objects and throwing a bola (a type of weapon, shown in Figure 3.7) and the fox can pass through small areas and jump high. In their journey, the characters will find puzzles they need to solve to progress which will lead to unlocking a game mechanism called "Cultural insights". The players

will usually need the skills from both characters to solve the puzzles and the latter tend to get more challenging as the story progresses by adding other interferences (one of them is the appearance of spirits, as shown in Figure 3.8, that can block platforms). The game was developed using Unity by a smaller development studio that worked directly with Alaskan Native people in its production. It is paid and available on PC, consoles, Android and iOS in 16 languages.



Figure 3.7: Nuna using her bola to clear an obstacle in Never Alone



Figure 3.8: Depiction of one of the spirits blocking the path in Never Alone

3.2 Impacts of environmental degradation

The next games display how the impacts of environmental degradation express themselves, either by showing a desolate and dead environment and how it can be difficult to recover it, or by showing the process that can lead to that same fate.

FAR: Lone Sails [56] features a bleak post-apocalyptic world where the player is following the travel of a red-cloaked nameless character. The character finds a unique transportation which has the features of a ship and a steam-powered train which they will use to journey through these sceneries (an inside-view of the vehicle can be seen in Figure 3.9). Through it, the player will have to manage and upgrade the vehicle, collect fuel, add it to the ship, and unblock the passage by solving different puzzle-like obstacles, clearing their path forward. The game encourages players to reflect on the environment through the story-telling of an abandoned world that has remains of a past thriving world through managing the few resources that can be found to power the vehicle, which visualizes environmental degradation. In terms of the game's difficulty, the fuel management and the puzzles are expected to become more difficult and complex as the game progresses. Various dangerous events (such as explosions, as seen in Figure 3.10) can also happen throughout the game which can damage the vehicle. This game does not have a traditional system of points so the game's progress can be seen through the ship's upgrading and through solving the various challenges that interrupt the travel. This game was also created using Unity by a small team, the core team being a 2-person team. It is paid and available on PC, PlayStation 4, Xbox One, Nintendo Switch, Android and iOS in 14 languages.

Plasticity [57] follows the life of Noa, a young girl who is exploring a plastic-filled world while surpassing several obstacles on the way. An example is seen in Figure 3.11 which displays



Figure 3.9: Depiction of the steam-powered vehicle used in FAR: Lone Sails



Figure 3.10: Depiction of an explosion happening the background in FAR: Lone Sails

a city with its water sources full of plastic. In her adventure, there are different choices to be made such as picking or not picking up the trash and helping or not helping animals that are stuck in different types of plastic. These choices will heavily impact the outcome and the gameplay itself (a scene of the good ending can be seen in Figure 3.12). This game is a puzzle platformer whose main objective is to keep moving the character through solving puzzle-like obstacles that impede the course. It focuses on the impact of the overuse of plastic in the world as it shows various scenes of a seemingly lost and over-polluted world. The puzzles in the game tend to get more difficult as the game progresses. The game does not have a standard system of points so it rewards the player with new wholesome interactions and a good ending when they perform behaviours that lead to the betterment of the planet. This game has a scientific article that analyzes how Plasticity successfully represents the overconsumption of plastics in real life and makes players consider their own consumption decisions. It also praises the game's ability to shine light on the consequences of waste disposal that are rarely mentioned [58]. The game was also made using Unity, the 3D models were created using 3DS Max and the effect sounds were created using FMOD. Plasticity is free and available on PC. It is currently only in English and its developer team started with a 2-person team and was established as a 30-person team by the end of its development.



Figure 3.11: Depiction of a city with its water full of plastic in Plasticity



Figure 3.12: Noa appreciating the recovering world in the good ending of Plasticity

In Eco [59], the player explores different ecosystems with different wildlife and can utilize their resources to devise basic tools and shelter. It is also important to collaborate with the other

players, creating communities that have a specific role for every player in it. The focal point of the game is maintaining the balance in the surrounding environments and the newly created civilizations. Harming the environment by taking too much and causing pollution can lead to several environmental issues that will impact every player so it is important to be mindful about resource usage and use sustainable sources. Eco is challenging since its difficulty depends on the types of environments generated and on the players' decisions and their consequences. The game has various mechanisms that display game progress such as player's skill points earned through gathering, building and other tasks, the technology tree that shows unlocked and locked skills and technologies and metrics about environmental impact such as air and water quality, to name a few. A depiction of the game's User interface (UI) can be seen in Figure 3.13 where it displays, for example, a nutrition graph, inventory bar, and a mini map at the top left, center and right, respectively. An example of a construction made by its players can also be seen in Figure 3.14. In terms of a scientific background, an article was published delving into how Eco can provide an educational way of advocating for environmental awareness [60]. This game is paid and available on Windows, Mac and Linux in 10 different languages. It was made using Unity by a small team of indie developers.



Figure 3.13: Depiction of Eco's UI with its various components displayed



Figure 3.14: Complex construction made by a community of Eco

3.3 Environmental restoration

The last two games focus on environmental restoration where the terrains seem irreparable, but, through the players' progress, the surroundings become more alive. They touch on the themes of pollution, recycling and nature's ability to thrive against all odds.

Terra Nil [61] is a strategy simulation game that falls on the subgenre of city-building where the player constructs and manages a city or community, with a heavy focus on resource management. In the game, the player travels through different desolate territories and turns them into thriving habitats using reusable energy powered technology. The main objectives of the game are to recover the infertile land, introduce simple lifeforms, recycle the instruments used and reintroduce animal life to the restored environment. The player starts by building wind turbines to generate electric energy, constructing machines that remove the soil toxins and building sprinklers to irrigate the

land. From then, vegetation starts growing and the first step is concluded. Then, it is possible to restore the flora by increasing humidity and reducing toxicity levels. Next, various animal species can be chosen and placed in their adequate environments. In the end, the machines used are recycled and the restoration is completed. Figure 3.15 displays an early stage of a level where the land is still mostly infertile but with some progress near the water. In Figure 3.16, it is displayed a typical scenario of the latter stages of a Terra Nil's level with a restored environment and built structures such as an Irrigator, for example. It also has other mechanics such as humidity where certain ranges of values lead to changes in weather. It has 3 difficulty levels to choose from at the start: the Gardener, which makes the strategy aspect not that important and focuses on entertainment and relaxation; the Ecologist, which is described to be for players with experience in strategy games; and the Environmental engineer, which is not recommended for beginners as it uses difficult mechanics and doesn't provide tutorials. The game also becomes more difficult with each level. The game uses leaves as currency and the different machines are bought with said leaves. The leaves are limited for each level but some can be restored through recycling already placed machines. In the game, players can earn different badges by completing levels and other challenges. The technology used to develop Terra Nil was Unity. Terra Nil is paid, available on PC and Android with 17 languages to choose from, and was developed by a small team of indie developers. This game focuses on the themes of ecosystem restoration, biodiversity through the reintroduction of various species, sustainability through the usage of eco-friendly technologies, resource management and pollution remediation.



Figure 3.15: Depiction of an early stage of a Terra Nil's level



Figure 3.16: Depiction of a restored ambient in a Terra Nil's level

Cloud Gardens [62] starts in abandoned urban ambiances and, to recover its environments, the player needs to utilize these structures to aid flora thriving and growth by moving the plants to more favorable spots. For example, moving vines from a small, not cared-for pot to street signs so they have access to more light and space. In the end, the bare environments turn into flourishing landscapes, promoting the potential for urban spaces to coexist with and support plant life. Regarding difficulty levels, Cloud Gardens does not meaningfully increase the difficulty as it focuses more on the game's ambience and relaxation of the player. The game is divided into levels and the level's progress is measured mostly through plant growth and, after completing, stars are won based on the previous metric. The Figure 3.17 displays the UI and current progress of a level

and Figure 3.18 displays a completed level. This game was developed using Unity by a small team of indie developers. It is paid and available for Windows, Mac, Xbox and Nintendo Switch in 9 languages.



Figure 3.17: Depiction of Cloud Gardens's UI and the progress of a level



Figure 3.18: Depiction of an environment of a completed level in Cloud Gardens

The Table 3.1 offers a summary of the analysis made of game's characteristics discussed previously in this chapter, providing an easier visualization of their comparisons.

To sum up, the game's characteristics that were chosen to be analyzed were: the game's genres, their target audience, types of graphics, types of sustainability themes discussed, characters, scenarios, scientific background, technologies used, available platforms, cost, available languages and development team. The aspects that were focused on in this analysis were, especially, the genres, types of graphics, scientific background, technologies, platforms and development team. Most of these games are simulation or adventure-focused games since they are some of the most popular game genres currently. But SaveDForest.v2 aims to emphasize the livelihood of native communities in the Amazon forest which pairs better with the narrative-driven genre. It also explores a less known genre, which is a visual novel game, which often uses the characters' point of view to develop the game's narrative. In terms of graphics, there is a balance of types in this collection of games, so the decision for the types of graphics used in SaveDForest.v2 was chosen mostly to create a unique style for the game, for its lower developmental costs, and for performance optimization. In terms of scientific background, some of the chosen games have scientific articles made about them but were not indicated to have a specific scientific basis. The technology used to develop the games was majoritarily Unity, so it was chosen for this project's game engine as well, since it is free, open-source, popular and easy to use. Regarding the game's available platforms, they are all available to download for computers, but not all are ready to play on other popular platforms. SaveDForest.v2 aims to be available for most platforms by being hosted in an online hosting platform, itch.io. Finally, the chosen games' development teams are smaller since this project is also working with a small team compared to a full development team that is usually seen in most gaming companies.

Table 3.1: Summary of the games analyzed in the Related Work, with their characteristics as rows and their names as columns

	Terra Nil	Plasticity	Stardew Valley	Eco
Genres	Strategy, simulation	Narrative, adventure, puzzle	Simulation, RPG	Simulation, sandbox
Target audience	More suited to Teens+	Everyone	Everyone	Teens+
Types of graphics	2D (pixel art style)	Mostly 3D	2D (pixel art)	3D
Type of sustainability	Ecosystem restoration, resource management and pollution	Impact of overuse of plastic in the world	Farming, resource management	Environmental and social sustainability
Characters	The player; animals are also displayed but not controlled	Young girl named Noa	Customizable player character	Customizable player character
Scenarios	Various (landscapes)	Various (city)	Various (farm, cave, marketplace)	Various (open world; forests, cities, etc)
Scientific background	Not found	Scientific paper about waste/plastic disposal	Scientific article about environment conservation	Has a scientific article of the game
Technologies	Unity (C#)	Unity (C#), Maya, 3DS Max, Fmod	MonoGame (C#)	Unity (C#)
Platform	PC and Android	PC	PC, consoles, Android and iOS	PC
Paid/free	Paid	Free	Paid	Paid
Languages	17	1 (English)	12	10
Developer team	Small team of indie developers	Started 2, 30-person team in the end	1 person team	Small team of indie developers

	Walden, a game	FAR: Lone Sails	Cloud Gardens	The First Tree	Never Alone
Genres	Exploration, simulation	Adventure, puzzle	Puzzle, sandbox	Adventure, exploration	Puzzle, platformer
Target audience	Teens+	Everyone	Everyone	Teens+	Teens+
Types of graphics	3D (realistic)	2.5 (side scrolling with depth)	2D	3D	2.5 (Side scrolling with depth)
Type of sustainability	Sustainable living, ethical considerations (hunting)	Recycling, eco-friendly transportation, preservation of the environment	Restoration of nature in damaged urban spaces	Impact of human intervention in nature and interconnected of species	Cultural sustainability, living in harmony with nature
Characters	Player assuming the role of the character	Nameless protagonist	The player; plants	2 main characters	2 main characters
Scenarios	Various (cabin, forest, changing of seasons)	Various (hazardous terrain)	Various (abandoned factory, wasteland, urban overpass)	Various (forest – fox, open wilderness, memories – human)	Various (icy plains, forests and underwater)
Scientific background	Not found	Not found	Not found	Not found	Has a scientific article of the game
Technologies	Unity (C#)	Unity (C#)	Unity (C#)	Unity (C#)	Unity (C#)
Platform	PC, Xbox, PS4	PC, consoles, Android and iOS	PC and consoles	PC, consoles, Android and iOS	PC, consoles and iOS
Paid/free	Paid	Paid	Paid	Paid	Paid
Languages	1 (English)	14	9	11	16
Developer team	Small team (7 people from USC)	Small team (core team of 2 people)	Small team of indie developers	1 person	Small development studio (worked directly with Inupiaq people)

Chapter 4

Procedures and technologies

Through the conception and development phases of SaveDForest.v2, a recursive approach was adopted where the necessary steps for the game's development was mostly done before the teams' meetings and, during the meetings, the current progress was evaluated and discussed. After the team's discussion, the game implementation was adjusted according to feedback. The next subsections will detail each step involved in the conception and development of SaveDForest.v2.

4.1 Requirements

The gathering of requirements was detailed in order to help better visualize what the implementation of the game wants to achieve. The requirements are separated into server requirements and game requirements and also split into subsections of functional, which detail tasks that the game should be able to perform, and non-functional, which specify the system's qualities when performing the functions specified in the functional requirements.

4.1.1 Server

Functional requirements

1. Register user
 - (a) Utilizes the player's email and password to create a user;
 - (b) The email used can not be in use in another created account.
2. Login user
 - (a) Utilizes the player's email and password to login in a user;
 - (b) The user needs to exist beforehand.
3. Get user's data
 - (a) Utilizes the user's id to get the user's data.
4. Add a new decision to a user's data

- (a) Accesses the user's data and adds a new decision to its collection of decisions;
 - (b) Utilizes the user's id to get the user's data;
 - (c) The general name, the chosen option and the type of the decision need to be provided as well.
5. Add a new SAM test results to a user's data
- (a) Creates a new result of a SAM test;
 - (b) Utilizes the user's id to connect the result to a specific user;
 - (c) The test's number, the valence number, and the arousal number need to be provided as well;
 - (d) The test's number can go from 1 to 4;
 - (e) The valence number can go from 1 to 5, where 1 represents feeling unhappy and 5 represents feeling happy;
 - (f) The arousal number can also go from 1 to 5, where 1 represents feeling calm and 5 represents feeling excited.
6. Update a player's score
- (a) Accesses the user's data and changes the score;
 - (b) Utilizes the user's id to get the user's data;
 - (c) The new score needs to be provided as well.
7. Delete all decisions from a specific user
- (a) Utilizes the user's id to get the user's data;
 - (b) Empties the collection of decisions of the user's data.
8. Delete all SAM test results from a specific user
- (a) Utilizes the user's id to delete all the SAM results that are from a specific user.

Non-functional requirements

1. Data security;
2. Performance;
3. Reliability;
4. Maintainability;
5. Availability.

4.1.2 Game

Functional requirements

1. Hosted online
2. Game components
 - (a) Characters: personas and portraits;
 - (b) Objectives;
 - (c) Resources: points and knowledge.
3. Register a user
4. Login user
5. Show narration/dialogue
6. Make a decision
 - (a) The player chooses to press one of the options displayed and the decision is made.
7. Show information about previous decisions
 - (a) Displays the chosen option, the other option that was not chosen, and information of the player's choice and ways to minimize harmful behaviours related to this theme.
8. Show additional information to gain more knowledge about the game's explored themes
9. Game's endings: have different outcomes that represent a good, neutral, and bad endings

Non-functional requirements

1. Data security;
2. Portability;
3. Usability;
4. Availability;
5. Performance.

4.2 Planning

4.2.1 Concept definition

To create a game, the first step is to design a compelling concept by outlining the type of game, genre, gameplay mechanics, art style, scope and tone of the game.

Through analysis of previous research discussed in Chapter 3, it was noted that many of the games that are seen as environmental tackle different environmental themes but do not always teach their players about environmental issues and how to make a difference in minimizing their impact.

SaveDForest.v2 is a visual novel decision-based game that utilizes 2 main art styles which are 2D cartoon style for its characters' design and other minor UI elements, and watercolor style for the scenes' background images. It focuses on teaching the impact of everyday decisions on the environment of the Amazon forest and its population, utilizing empathy to solidify the behaviour changes. The game's tone heavily depends on the type of decisions the player makes, since some endings can lead to feelings of happiness and accomplishment while others can lead to more sorrowful and regretful feelings.

4.2.2 Technologies and platform

After crafting the game's concept, technologies needed to plan the game were chosen.

The technologies used to put together this project were:

- Unity for the game's development;
- GIMP for editing images;
- Figma for the prototype's development and design of the game's UI elements;
- Krita for the creation of the characters' portraits.

Based on the previous research, it was observed that the game engine used the most is Unity [63], that utilizes the programming language C#. This mostly stems from the popularity of the engine and its usage in most popular modern games. It is also free for non-commercial purposes and has a user-friendly design, making it easy for new game developers to learn how to use it to create games.

For the creation of some UI designs and for the background images' editing, GIMP [64], a free and open-source application for image editing and graphic design, was used. This software is often a great alternative to the more popular tool, Adobe Photoshop, since it does not require a paid subscription, has a variety of tutorials and user-made plugins and, in specific for this project, most of the functionalities that were needed were basic and available to use in GIMP.

To create the 2D designs, the tool that was used is Krita, a free and open-source painting program [65]. This tool is also a popular alternative to similar paid software such as Procreate and Adobe Photoshop, which are popular applications between digital artists. Krita was chosen because of its higher flexibility and constant updates, being a cross-platform software, and having extensive documentation available for new users. The alternatives are either paid or only available for iOS or macOS systems and, while Procreate has a larger user base and thus more resources and works available, the main drawings that were to be made with the tool were ones made either using real photos as references for the Yanomami natives or inspirations from cartoons, which

makes the gathering inspiration or collecting specific brushes and elements from others artists that use these tools inefficient.

Figma [66] was used to develop an initial iteration of the game's prototype. Figma is a web application tool utilized for designing and prototyping interfaces. This tool has seen a significant increase in usage, especially by designers and developers. The decision to utilize this tool stems from being easy to learn and start using, being a vector-based design tool which ensures the designs do not lose quality and are scalable, and finally, its interactive prototyping that can be used to simulate and test user interactions.

In terms of platforms, the game is available for PC and mobile through the usage of WebGL, a JavaScript API used to render complex graphics directly in a web page. It is a commonly used technology to run games on a web environment. To build the game in this way through Unity, the build settings need to be set to WebGL which is one of the options that Unity provides [67].

4.2.3 Prototype creation

To better visualize the mechanics and gameplay of SaveDForest.v2, a non-functional digital prototype was created and served as the base for the subsequent implementation of the game. This first prototype focused on developing the core mechanics and worked to test initial ideas in terms of functionality, and aimed to have a design close to the idea for the finished product in terms of design. Thus, the prototype can be characterized as being low-functional and high-fidelity, respectively. It was designed using Figma through the usage of connected frames through user interactions, creating a controlled game flow.

4.2.4 Game assets

The sound effects and music were sourced from Unity's Asset Store [68]. To utilize the assets in the Unity project, they first need to be added into the package "My Assets". Then, they can be imported through Unity's Package Manager into the project.

The creation of 2D models for the characters was done using Krita. Their models were made as layered digital drawings of the characters' faces to be included in the game as Unity sprites.

The scenes' background images were edited using GIMP. The images used were photographs taken of real places that were modified to look like watercolour paintings. To create this effect, the pictures were smoothed out and the overall number of colours was reduced to 24. In GIMP, several filters were used such as Filter - Enhance - Despeckle (with the parameter Adaptive unticked) and Filter - Blur - Selective Gaussian Blur, in this order. After that, the option used was Image - Mode - Indexed - Generate optimized palette with 24 colours.

Most of the UI elements were created in Figma and then exported to utilize as Unity sprites. To export an image or element in Figma, it needs to be selected, and, in the Design tab, utilize the option "Export" that makes the picture downloadable in various extensions. These images can then be utilized in Unity by assigning them as sprites.

4.2.5 Game implementation and testing

The initial game's implementation focused on developing the core mechanics and controls of the game. The general mechanics are advancing to the next dialogue or returning to the previous dialogue, picking an option that indicates a player's decision, and accessing new summarized information related to the game's themes. Then, the different environments such as the student's bedroom, the maloca's inside view, forest views, rivers and water streams were designed, followed by the creation of the different scenes in the city and forest along with the transitions between the two sides, in order to create a continued flow. The next part was to create a menu page that will display the points, past decisions made by the player, and general information needed for the story's context. After that, the start menu, register and login pages were created along with a simple server to store important user data such as e-mails, passwords and the history of the user's previous decisions. In the end, the three different endings were created.

The testing was done regularly in parallel to development and focused on specific scenes or mechanics that were implemented recently. After verifying the behaviour of the new or updated scripts, further testing was done of the game as a whole in order to confirm that other parts of the game were not compromised in the update. The inclusion of game assets such as sounds was done at a later stage of the game's development and was equally tested to provide a seamless experience.

Factors such as performance on the target platform were tested on different devices, namely computers and smartphones, and optimized to ensure that it runs correctly and smoothly. In the end, thorough testing of the game's behaviour as a whole was done to find and fix possible bugs.

4.2.6 Testing inside the team

Weekly or every 2 weeks, the team scheduled a meeting to present and discuss the game's progress. After consideration and feedback, the game was refined accordingly and SaveDForest.v2's implementation continued, either to improve parts that already exist or to design new scenes and/or mechanics.

4.2.7 User testing

When the game was deemed ready for user testing, the game's implementation was used in an User experience evaluation (UXE) where the users' game experience was reported and their opinions of the game were noted in order to improve the game's usability [69].

4.2.8 Refinements and updates

After the users' feedback, the game had its final refinements and updates to ensure it was easy to use and navigate and that it led to its expected results, such as teaching users the impact of everyday life decisions in the Amazon and how to have more environmentally-friendly attitudes.

Chapter 5

Conceptualization

The game development process in SaveDForest.v2 started by the formulation of the game's concept, its story, characters, and main mechanics needed. These ideas created for the game will be further explained and detailed in the following sections.

5.1 Story and concept

The purpose of SaveDForest.v2 is to create a game that gives feedback to the player's in-game decisions by demonstrating how seemingly inoffensive choices can impact the environment, and consequently, the forests such as the Amazon. The concept of the game is to have an environmental decision-based game with 2 main characters: a university student and a Yanomami native, representing 2 different sides, the city and the forest. The city side has a simple narrative, focusing mostly on the university and the decision-based gameplay, while the forest side focuses on detailed narration, meaning no choices are included. User decisions that bring no harm to the forest are rewarded with a significant amount of points while unsustainable decisions have no assigned points. The city side's decisions will directly create effects in the forest side's narrative but only the decisions that are related to the damage on the Amazon forest. These effects will be portrayed through the native's perspective and will display the impact on him, his community and the forest's plants and animals. Based on the points, the player will achieve one of three distinct endings: good, neutral or bad ending. The outcome of the forest will be reflected through the player's decisions and be displayed in the ending received.

5.1.1 Parallel narratives

SaveDForest.v2 focuses its narrative on two main personas, two young men around their 20's, and alternates between their Point of View (POV) frequently. Callum's POV aims to describe the daily life of a young man who is an university student and comes from Scotland to study in an English art university. The story has scenes where the character is working on a digital drawing project for an art class, watching a football game with his friends and, more importantly, making simple and ordinary decisions throughout the day. Callum's narrative is presented this way to bring about a sense of relatability, security and routine to the players, since the experience of a

student life is a common experience for many, either through a direct experience or through its depiction in popular visual media. Yani's POV aims to detail the daily life of a young man from a Yanomami community, his family and the struggles they face from the harm that is done to the Amazon rainforest.

The narratives make a direct comparison of the routine of the two personas while highlighting their similarities and differences. The personas were conceived to have some similarities, such as being the same age and gender, to create a deeper connection between them, but they still lead distinct lives related to their backgrounds. Callum has a standard routine of a contemporary college student that lives away from home, goes to classes, hangs out with friends that are also students and works on assignments. This way of life contrasts with that of Yani, a Yanomami young man who has a wife and children, who hunts and cares for his community, and who constantly worries about their wellbeing regarding the deterioration of the forest they live in.

5.1.2 Empathy and changing the players' behaviours

With the narrative following Yani's daily life, the game aims to create proximity, identification and empathic concern in its players. Empathic concern, which is a dimension of empathy, triggers motivation through emotion, persuading players to want to help Yani and other natives both in game and in real life.

Progress in SaveDForest.v2 is mostly measured by points, gained through quizzes and decisions, which reinforces the want to acquire knowledge, and, with this approach, empathizes the player's engagement and encourages the experience of cognitive empathy.

One of the topics the game also focuses on is in providing ways to gradually make more environmentally conscious decisions in day-to-day life, which can help in persuading players to slowly turn some destructive habits into others that are friendlier towards the environment.

5.2 Characters

SaveDForest.v2 tells its story mostly through the characters' perspectives in order to focus on the characters' thoughts, feelings and motivations, thus allowing the players to connect with them more easily. This attachment can lead to changes into preconceived bias and internalize information and context that are related to the characters they feel empathy towards [70]. In this game, main characters are defined by their importance to the story's plot and, visually, they are the only ones that have a character portrait. Side characters, on the other hand, have a lesser significance but are still important to the story's overall flow since they directly interact with the main characters. The next subsections will explore the personas and other characters' direction designed for the characters of SaveDForest.v2, together with the characters' illustrations that were drawn for the project.

5.2.1 Main characters

The main characters are Callum, Yani, Yani's son, Yani's wife, and Romi (a macaw). Although the five characters are considered as main characters, the game focuses heavily on Callum and Yani since the story is told from their perspective, in their respective narrative's side.

Starting from Callum's persona (drawing shown in Figure 5.1), he is a 21-year-old arts college student living in the UK. He is carefree, open-minded, impulsive and can be insensitive to certain topics. He is living in a student residence and does not work while studying. Callum's general idea is to represent a person that does not know a lot about the environment's struggles, especially on the Amazon forest, meaning he is supposed to be regarded as someone who does not always care to make environmentally friendly decisions. Although the character is thought of to have a more neutral approach to sustainability practices, his perceived traits can be changed depending on the players' decisions since the players are in control of Callum's decisions in the storyline.

Regarding Yani's persona (drawing shown in Figure 5.2), he is also 21 years old and is from a Yanomami community living in the Amazon rainforest, in the Brazilian side. He handles the trade agreements with the other villages and hunts. He is idealistic, adaptable, logical and rebellious. In terms of family, Yani has a partner, a son, and a daughter. Yani's general idea is to represent the average young man who is an Amazon native, living with the damage that has been and is still being caused to the forest. The threats impacting the Amazon forest directly influence his life and the lives of those around him, so the players can glimpse the effects that linger directly from his POV.

Yani's son and Yani's wife are characters that contribute to the development of Yani and consequently, the representation of Yanomami culture. Romi also helps in connecting and advancing the story by giving the players a space to assimilate their feelings about the situations and the information distributed through the game.

Romi (drawing shown in Figure 5.3) is a macaw from the Amazon forest and she acts as a mysterious entity that guides and checks in with the player throughout the gameplay. She appears mostly to gauge the player's experience with the game by providing the SAM tests, quizzes, and general questions about the player's knowledge. Details about these scenes will be further explained in the subsection "Types of scenes" of Chapter 6.

Yani's son (drawing shown in Figure 5.4) is 4 years old and is the oldest child of the family. He is curious, imaginative and patient. His role is mainly to generate a means to tell the looming threats affecting the Amazon forest in an accessible and universal way. Yani's son asks questions about what he sees (e.g. an area of the forest destroyed through massive deforestation) and Yani responds in an age-appropriate way for him to understand. Then, the information becomes easy to grasp and internalize for everyone.

Yani's wife (drawing shown in Figure 5.5) is 20 years old and lives with her family of 4. She is cheerful, resourceful and perceptive. Her role is to show more sides of the Yanomami's culture, specifically customs regarding women.



Figure 5.1: Portrait of Callum

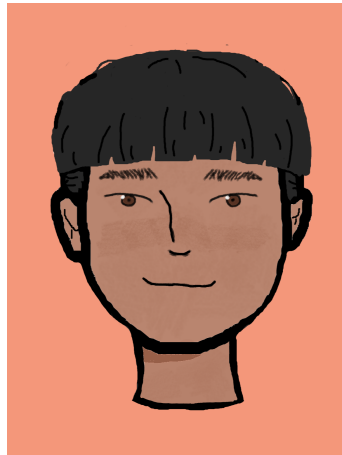


Figure 5.2: Portrait of Yani



Figure 5.3: Portrait of Romi

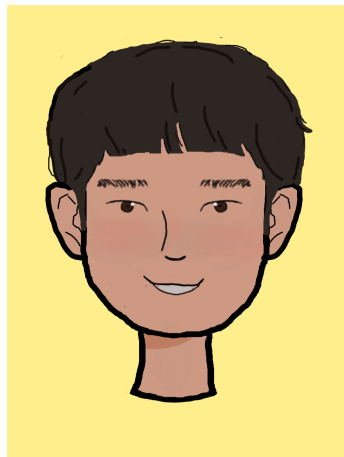


Figure 5.4: Portrait of Yani's son

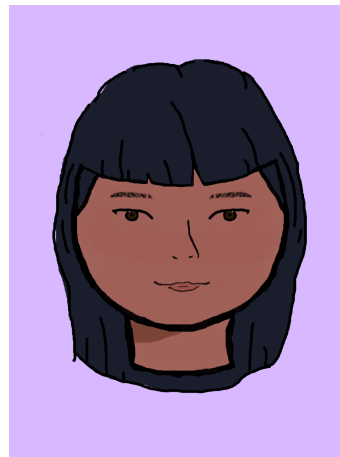


Figure 5.5: Portrait of Yani's wife

5.2.2 Side characters

The side characters are Callum's friends and Camu. Callum's friends appear in one specific part of the story where Callum invites them to watch a football game and have dinner at his house. This part was included to be the context to a specific decision that the player has, which is to influence whether or not his friends choose a vegan alternative over a meat one.

Camu is the family's pet, a young female monkey that was rescued by Yani's family. She is the family's pet and often follows and accompanies Yani on his morning walks. Camu's role is to elicit an empathy response from the players. Her character aims to establish an emotional connection of care and attachment between the players and her, as they observe Camu's endearing behaviours and interactions with Yani.

There are other characters that are mentioned briefly, however they do not engage with the main characters and only exist in the background and, as such, do not need character portraits or dialogue lines.

5.3 Main mechanics

5.3.1 Decisions

Throughout the game's narrative, specifically in Callum's scenes, the player will be asked to choose between 2 options. These decisions are the most important in the game and thus reward the player with the most points if they choose the "correct" choice. The choices are related to ways that every person can impact the Amazon rainforest, either directly or indirectly, and either positively or negatively. Hence why it was mentioned as a "correct" choice; the option that is the most environmentally friendly is seen as correct and is awarded with 100 points, and the option that is less environmentally friendly is seen as incorrect and no points are earned.

Decisions can be easier or harder depending on the players' prior knowledge in environmental sustainability and its related themes. Some decisions have a possibility for the player to learn more about each option before making a decision which enables more informed outcomes. For example, one of the decisions is to buy a gold ring, having two possibilities to choose from. The options are connected to the production of gold articles from sustainable sources. At this section of the game, the rings are displayed above and the player has an additional option to pick from that reads as "¿ Before choosing your option, get data". After choosing this "get data option", a panel appears with information about each one of the rings. In this case, it will clarify that just one of the two rings was produced with gold that was proven to be ethically sourced by an international trade association named London Bullion Market Association.

5.3.2 SAM tests

After a set of specific Yani's scenes are revealed, the game will present a SAM test to assess the players' reaction, especially to emotionally charged scenes such as Yani's nightmare and Yani and his son's reaction to the appearance of a deforestation scene, where a section of the forest is full of severed trunks. For the questions of valence and arousal, these scenes will display the visual scale with each option as a possible answer, and the player can choose by clicking the image that best suits their feelings at the current moment. The SAM tests are expected to appear every time the narrative is about to switch back into the city side.

5.3.3 Quizzes

After experiencing a series of Yani's scenes, a quiz will sometimes appear in order to test the players about the information that was displayed in the context of the Yanomami culture, forest, and the threats impacting the forest and the Yanomami people. A quiz consists of a set of questions related to a specific theme that was addressed previously in the game. These questions are multiple choice with two to four options to choose from, but only one correct answer. Correct answers will award points to the player while wrong answers do not give out any points.

5.3.4 Endings

In the end of the story, each player will experience an ending scene that will be based on the points the players received until the final narrative scene. SaveDForest.v2 has 3 different endings: a bad ending which happens when the player gained too little points, a neutral ending which happens when the player gained some points but not enough to guarantee a good ending and, finally, a good ending which happens when the player gained enough points. This is a straightforward approach to a decision-based game but it works since the only way players are awarded points are through major decisions that can alleviate or aggravate the impacts on the Amazon rainforest and by answering the quizzes that have questions also related to the forest. These mechanics make receiving points meaningful to the well-being of the environment since receiving points is directly correlated to the player making environmentally friendly decisions and answering the quizzes' questions correctly.

Chapter 6

Implementation of the game SaveDForest.v2

The implementation of the game SaveDForest.v2 started after its conception and planning. An initial prototype formed the basis of the game's implementation in Unity. While the game was being completed, a visual guide was designed to record information about colour, fonts and other measures that are fundamental for the game's visual coherency.

6.1 Figma prototype

One of the first iterations of the game development process was to design a prototype using Figma [71]. The Figma project is separated through frames and connected through interactions.

It presents a flow that commences from the start menu of the game, goes to an initial scene with Romi who asks introductory questions for the player, and then goes to a short mysterious encounter in the forest between unknown characters. The scene goes to Callum's bedroom, the first major decision is made by the player, and the Memories scene is unlocked (More about this scene and others will be further explained in the subsection "Types of scenes" in the next chapter). Then, the scene transitions into a series of Yani's scenes and, at the end of them, a SAM test is displayed. Next, it goes to one of Callum's scenes again, followed by a series of Yani's scenes. In the end, a SAM test is again presented, followed by a simple quiz.

All the user interactions in this prototype are made by clicking anywhere to change to the next scene or to the next dialogue. The decisions or quizzes are done through clicking one of the presented buttons, chosen by the player.

This flow is the intended flow for the final product of the game and, when the prototype was finished, it served as a guide on how to start developing the game in Unity. Some of the scenes in the Figma prototype were already changed since any changes and new designs are made there, but the general flow of the game, with various frames in groups to represent the scenes, is displayed in Figure 6.1.

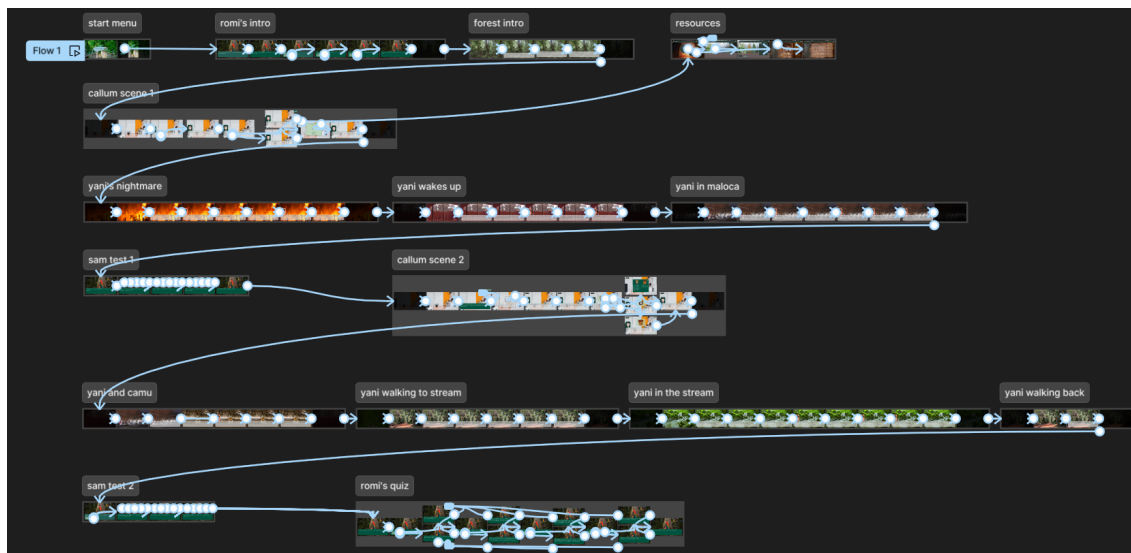


Figure 6.1: Visualization of the prototype's flow in Figma

6.2 Game's architecture

In order to produce a WebGL game that is hosted on a website which needs to interact with a database, a client-server architecture was chosen. In a client-server architecture, clients, which usually represent the devices used by the users such as personal computers and smartphones, initiate requests for specific resources to the server. The server processes the requests of various clients and delivers the necessary information back to the clients, respectively. In this case, the game itself acts as a client that interacts with a server when it needs to get or store data related to the users, for example, when registering or logging in a user. The server is the only component that interacts directly with the database; therefore, it stores and sends responses to the clients' requests. This project only has a server, and it acts as a web service hosted online on Render. The server has limited Central Processing Units (CPUs) and available memory resources, which means that it is not equipped to handle a high demand of requests. However, since the project is not expected to have a high amount of users playing the game at the same time, the server should have no problems fulfilling the clients' requests. Although SaveDForest.v2 was made to be a low traffic application, it could also be upgraded by increasing the server's capabilities. Render offers many paid instances with more CPUs and memory with new features, meaning that the game is highly scalable through the server. A simplified diagram of the project's architecture is shown in Figure 6.2. The part highlighted in green corresponds to the accessible elements for the game's users. The one highlighted in blue corresponds to the project's back-end, such as the server and database. The other elements represent how each part was developed and is deployed, such as the game's build, technologies used, and others.

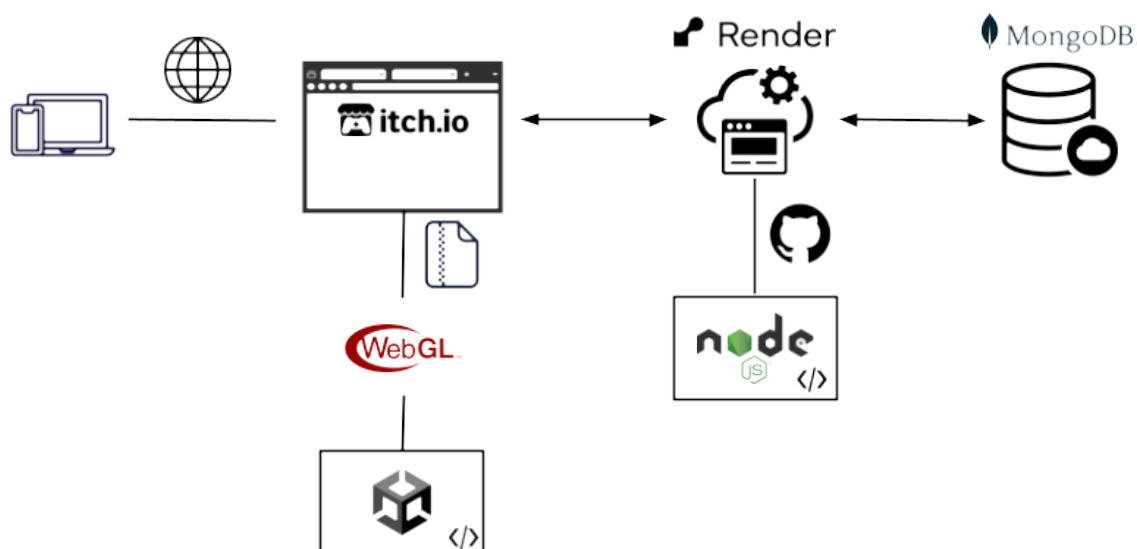


Figure 6.2: Visualization of the project's architecture

6.3 Unity game

Using the prototype as a base, the game development process moved into Unity where the parts that were not functional would be implemented, namely the mechanics of gaining knowledge and viewing previous decisions.

6.3.1 Scene's structure

A new scene usually happens when there is a location change, which means a Unity scene represents a specific scenario that happens in a single setting from the character's point of view. When a scenario ends and a location change ensues, it changes into a new Unity scene and the scene's background image changes. The scenes' order is maintained through a JavaScript Object Notation (JSON) file that lists every scene in their correct order, not including the game's early scenes, such as the game's opening scene, login, register, start menu and the menu's items, or general scenes such as the main menu, the menu's options (the Memories and Knowledge scenes) and the 3 endings of the game. The JSON file, named `scenes.json`, stores an object that has various names of the scenes mentioned before in order. This approach was used in favor of utilizing the order that is in the Build Settings of Unity because it brings greater flexibility and control when adding new scenes, deleting or changing current scenes.

Each scene has a canvas that is separated by layers in order to maintain the elements organized and to avoid elements from hiding others. All the scripts needed for a scene are aggregated on a separate Empty Object, away from the canvas, named `[Scripts]`. The animations used to switch between narratives are also separated from the main canvas in an Empty Object named `[Transitions]`. This object is working as a Prefab, a game object that can be shared between scenes and when changes are made in it, all the changes are also made in all the other scenes the Prefab exists in.

6.3.2 Types of scenes

Narrations

Narration parts appear in all the main scenes, namely Callum, Romi and Yani's scenes. The narration happens when the lines from the story do not come from any characters' POV so they are presented by an unseen narrator. The narrator normally describes the environments, characters' movements, including facial expressions and analysis of their behaviours, and other context needed for the scenes. These parts have as its main visual points the background and dialogue box. Since narration normally is within the first parts of a scene, the appearance of fewer UI elements helps to promote the immersion of the players into the new environment and to focus on the context provided by the narrator. Figure 6.3 displays an example of a narration line in the game.

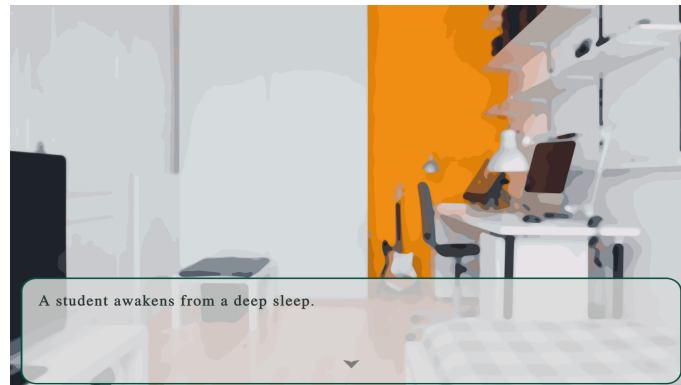


Figure 6.3: Visualization of an example of narration in the game

Dialogues

Dialogue parts also appear in all the main scenes; however each piece of dialogue can be a subtype inside this category, namely thinking (shown in Figure 6.4), speaking (shown in Figure 6.5), and being on the phone (shown in Figure 6.6). In Romi's scenes, the main character only speaks, since the players' do not see through Romi's POV and rather are talking with them. In Callum's scenes, there are segments of thinking, speaking and being on the phone, although Callum only speaks and is on the phone when he is directly interacting with his friends. Yani's scenes include thinking and talking parts, and the talking sections also only appear when he is interacting with his family. When dialogue is happening, the main visual points that are presented are the dialogue box that displays the current line and the character's portrait above that box which displays the face of the character who is talking/thinking that dialogue line.

Decisions

Decisions appear only in Callum's scenes. These parts are marked, in the story, by having Callum considering (thinking) between 2 options and, then, the decision is reflected on to the players for them to choose from the displayed options (shown in Figure 6.7). The main visual points that

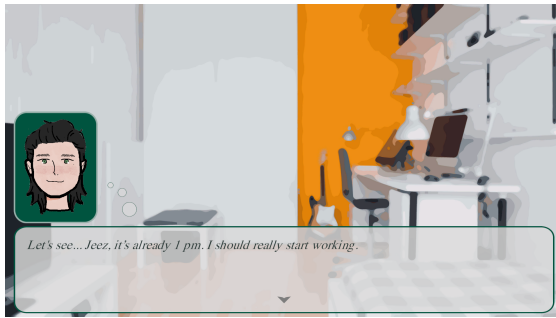


Figure 6.4: Visualization of an example of a thinking dialogue in the game

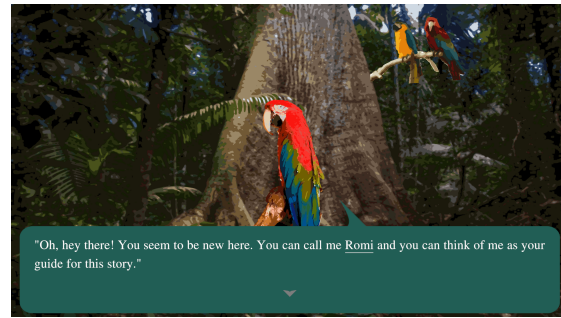


Figure 6.5: Visualization of an example of speaking dialogue in the game



Figure 6.6: Visualization of an example of an "on the phone" dialogue in the game

distinguish Decisions from other similar types (such as Dialogue and Quizzes) are the display of buttons and/or of a panel that shows figures of the 2 options provided. After making a decision, the points earned are also displayed at the top right of the screen (shown in Figure 6.9). The panel displaying the figures is usually used when observing the options before making a final decision is crucial to discern which is better towards the well-being of the environment. An example of this can be when choosing between two products where one has a sustainability label on it and other does not (shown in Figure 6.8). If in one of the products there is a clear sustainability label that the player recognizes, they can easily pinpoint it visually without having to read a description of the products.

Quizzes

Quizzes appear only on Romi's scenes. These scenes appear usually after a series of scenes depicting the life of Yani and act as a way to check if the players retained the knowledge provided by the game, either by the Knowledge scene or by the dialogues themselves. The quizzes ask simple multiple-choice questions about focal topics related to the Amazon rainforest such as wildfires, floods, deforestation and illegal logging, and illegal mining. Each question only has a correct answer and, while correct answers earn the player 10 points, incorrect ones give 0 points. The points awarded are displayed in the same fashion as the one on the Decisions scenes. Figure 6.10 displays

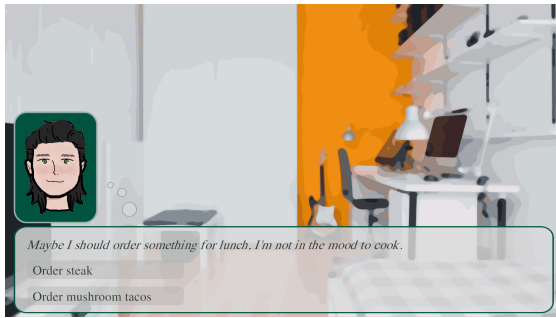


Figure 6.7: Visualization of an example of a simple decision in the game, displaying the buttons for both choices

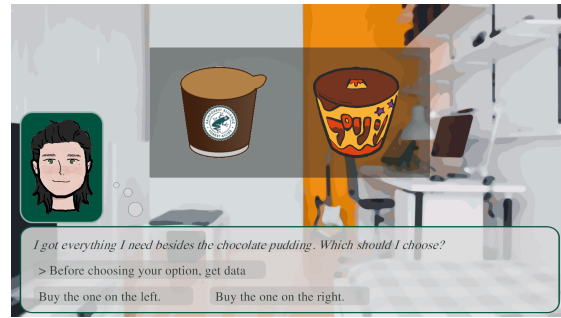


Figure 6.8: Visualization of an example of a decision where you can "get data" before making a decision

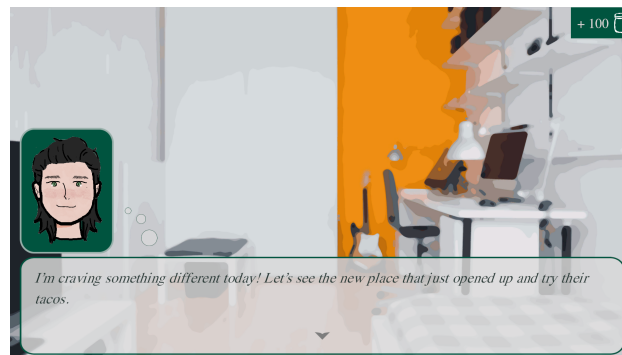


Figure 6.9: Visualization of a panel that displays the points earned after making a decision, at the top right

an example of a question that can appear on a Quiz scene and Figure 6.11 shows the outcome of a correct answer to the question displayed in the figure on its left.



Figure 6.10: Visualization of an example of a question with several options on a quiz in the game



Figure 6.11: Visualization of an example of an answer after choosing the correct answer to a question

SAM tests

SAM tests also appear only on Romi's scenes. These scenes also appear after a series of Yani's scenes and usually before a Quiz scene. These scenes integrate two inquiries about the valence

and arousal of the player, questions that derive from the actual SAM test. The question related to dominance was excluded in the case of this game because it was not relevant to the context of this game in specific. Both questions display a panel that has a visual representation of a scale of 5 for the players to choose from, depending on what they are feeling at the moment after experiencing a series of scenes that are intended to spark empathy, which are Yani's scenes. The first question is about valence (shown in Figure 6.12) and it presents a visual scale of 5 from unhappy to happy, with unhappy being 1 and happy being 5. The second question is about arousal (shown in Figure 6.13) and it presents another visual scale of 5 from calm to excited, with calm being 1 and excited being 5.

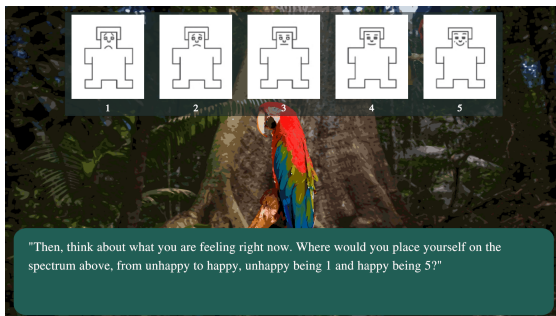


Figure 6.12: Visualization of an example of a SAM test on the question about valence

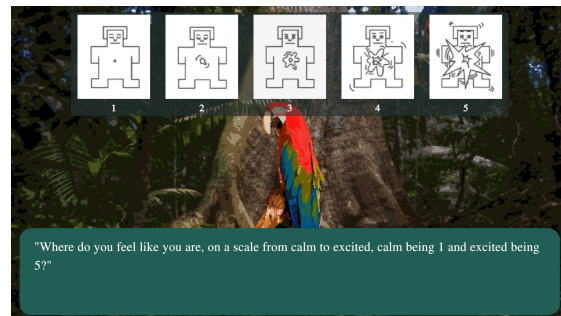


Figure 6.13: Visualization of an example of a SAM test on the question about arousal

Endings

The endings are done through the narrator and have as background the image from the start menu. It depicts a wooden bridge that leads to a path in the Amazon rainforest and this figure is used to symbolize a path into the game's story, either its entrance or exit, as a way to connect the end and start coherently. The endings have a brief narration of what the forest's outcome was (the first line of one of the endings is shown in Figure 6.14), followed by a screen that displays what ending they reached (shown in Figure 6.15). After that, the player is sent to the game's start menu. The game has 3 different endings: a good, neutral and bad ending. To reach the good ending, the player needs to have gained more than 200 points at the game's final scene (which is the Quiz 3). For the neutral ending, the player's points need to be more than or equal to 100 but less than or equal to 200. For the bad ending, the player needs to have earned less than 100 points.

Resources

The Resources scene acts as the game's menu. This name was chosen since it is a gateway to various sorts of information and resources that educate on topics such as simple ways to start making more environmentally friendly decisions and various data about sustainability, Yanomami culture and the threats currently endangering the Amazon forest. This scene displays the points the player has earned thus far on the top right page, and the icons to two other scenes, Memories and Knowledge, in the middle (shown in Figure 6.16).



Figure 6.14: Visualization of the first lines of the good ending in the game



Figure 6.15: Visualization of the display of the game's ending, done at the end of the scene



Figure 6.16: Visualization of the game's menu, Resources, displaying the icons for the Memories and Knowledge scenes

Memories

The Memories scene acts as a history of the previous decisions that players have made and provides information about the option that they chose, together with several ways to minimize behaviours that are less environmentally conscious. The plant that is displayed has leaves and each leaf represents a decision made. After clicking the leaf, two panels will appear. The panel in the middle has the environmental theme as its title, and two different colored leaves which represent the two options given for this particular decision. The leaf that is fully opaque corresponds to the option that the player picked while the leaf that is semi-transparent corresponds to the other option that was not chosen. The panel on the right displays information about ways to minimize the consequences of a less environmentally friendly decision. This data is shown in default or if the button “minimize consequences” is pressed. If the button “about your choice” is clicked, the panel's text will change into information about the player's decision, specifically mentioning if the option chosen was the more or less environmentally conscious option out of the two provided at the time. Figure 6.17 displays how the Memories scene looks like the first time it is accessed by the player and Figure 6.18 displays the information about a specific previous decision.

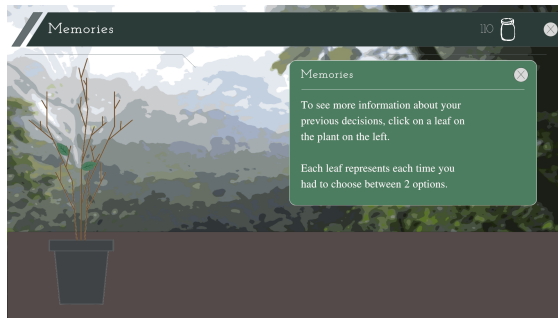


Figure 6.17: Visualization of the Memories' tutorial, on the right and the plant with the decision leaves, on the left

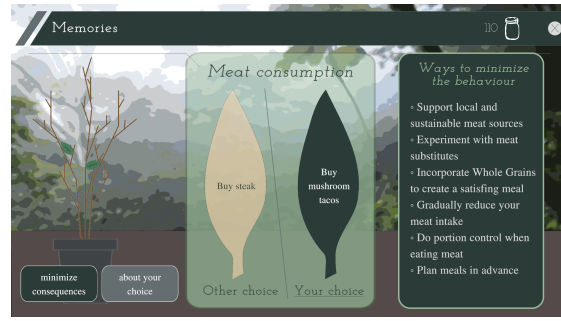


Figure 6.18: Visualization of the Memories page, displaying the decision about meat consumption

Knowledge

The Knowledge scene acts as an archive with various data about the game's themes: environmental practices, the Amazon rainforest's current threats and Yanomami's culture. Some of the information presented here will intersect with topics and questions in the quizzes, which is mentioned to the players and turns the scene crucial to gain knowledge and points easily. The buttons on the left side are named after topics (e.g. Sustainability labels) and, when clicked, a panel is displayed with some information related to the topic that was clicked. The topics are unlocked through story progression, meaning that not all of them are available at the start of the game and more will be added with each new Callum's scene. Figure 6.19 displays how the Memories scene looks like it is opened, only having the buttons with the topics displayed on the side. The information panel is displayed in Figure 6.20.

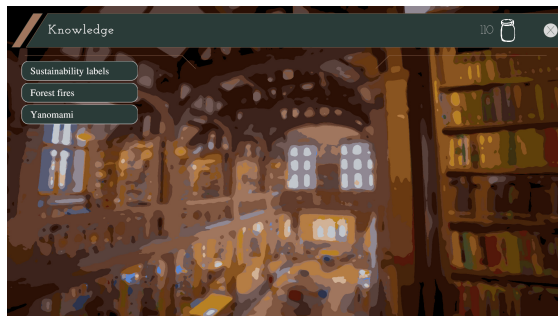


Figure 6.19: Visualization of the Knowledge scene with some topics unlocked on the side



Figure 6.20: Visualization of the Knowledge scene with information about the first topic

6.3.3 Adding new scenes

In this project, the method used to add new scenes was to duplicate scenes by clicking the option "Duplicate" on a scene file. This practice was chosen because many of SaveDForest.v2's scenes have a similar structure to each other. For example, Yani and Callum's scenes have a layout that is alike, with the major differences being that the character portrait, dialogue box and speech details'

sprites change, and the points' display and choice buttons can be removed from Yani's scenes. This can be done since decisions and, thus, points are not present in Yani's side. Other types of scenes also followed the same logic: when adding a new scene, a scene that was similar in layout was duplicated and minor changed if necessary.

6.3.4 Animations that identify transitions

The game has 3 different animations that were created to highlight the transitions between Callum and Yani's narratives. They appear when a Callum scene ends and a Yani scene starts and vice-versa.

The first animation is named "Artsy transition" and it consists of a painting canvas divided in its center by two different tones of green. A brush appears and draws the branch of a plant. This transition is meant to represent Callum working on his art project.



Figure 6.21: Frames displaying the stages of the artsy animation

The second animation is named "Forest portal" and it consists of a portal decorated with leaves and branches appearing and teleporting the player to the next scene. This transition is meant to represent the act of transporting the player from the city into the forest, by going from a Callum scene into a Yani scene.

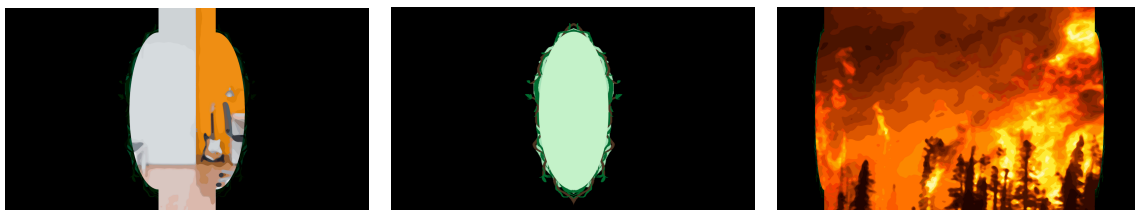


Figure 6.22: Frames displaying the stages of the portal animation

The third and final animation is named "Leaves" and it consists of a rotating spiral of leaves that creates a central circular focal point. This transition has the same purpose of the one before, but it is more universal and can represent both transportations, either from forest to city or city to forest.

Other simpler animations were designed to make the transitions between scenes more seamless, such as a crossfade and a loading screen. The crossfade is used to transition any scene that is not directly Callum to Yani. The loading screen is only used on the login and register scenes since it can take a while to get a response when the server becomes inactive.

Since each animation has its own canvas, a new animation can be added by adding a new

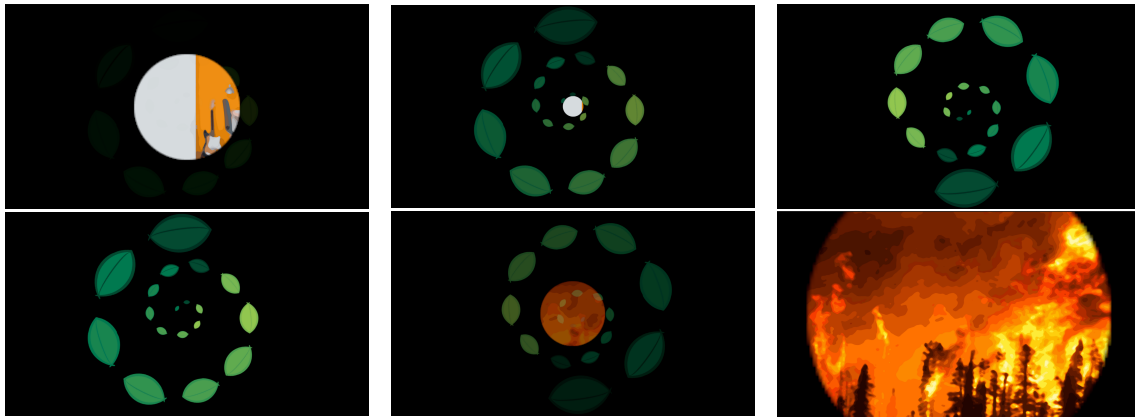


Figure 6.23: Frames displaying the stages of the spiral animation

canvas to the [Transitions] object and then, adding the necessary images or components to said canvas. After that, by opening the “Animation” tab and clicking on “Create”, a new Animation clip is generated. Then, separate animations for the start and end of the animation need to be done. In the end, to make them have the correct structure, an Animator Controller Override needs to be created and the 2 new animations need to be assigned in the Inspector of the Animator Controller Override to the correct spots, those being the start and end of the animation.

6.3.5 Sounds and music

Different sounds were used to promote the game’s immersion. The main music played in most scenes is named “The Night Sky” by Olan [72]. The music is calm, soulful and seems to belong in a serene adventure setting. This sound was chosen to be the background music playing on the game in the general scenes that do not have specific sounds assigned to them.

The following scenes have particular sounds playing to add to the scenery and feel of the scenes. In the scene where Yani has a nightmare related to a forest fire, the sound played is of the crackling of a big fire close by. The volume is set high as to add to the closeness of the fire and to the feelings of desperation and anguish of the moment. In Callum’s scenes, since he lives in a more urban area, the sound played is of muffled car traffic, trams and other street noises. The other sounds are more simple: the scene next to a waterstream has a tranquil sound of a stream that is nearby; the scene near the firecamp has a sound of a smaller fire crackling; the general scenes in the forest has a sound of birds singing; Romi’s scenes has a greater variety of birds singing in a more open space; and the scene where Yani goes fishing, the sound is of a faster river with its water flowing.

The sounds are looped and have a transition of crossfade, with the duration of a second, between them when the scene changes to remove abrupt variations in audio.

6.4 Node.js server

In order to store user data from the players of SaveDForest.v2, a simple server that receives requests from several clients was created. The server connects to the database, and stores and retrieves important data needed for the game's functionality.

The server is an Express application with several defined endpoints. It has the basic routes needed such as login and register, adding the SAM test's results to its corresponding user when the test is done, adding a decision to its corresponding user right after it is made, and updating the user's score when they gain points. It also has an endpoint for getting all the user's data by their id, made to get all the previous decisions for a specific user and then display them on the Memories page. There are also routes to delete data when the user chooses to start a new game instead of continuing, namely deleting their previous decisions and SAM results.

6.5 Web hosting

The Unity game is hosted in a web page on itch.io [73], a popular site that provides free web hosting for indie games. To configure the game correctly, a .zip of the game's Unity's WebGL build needs to be uploaded to the itch.io project. Then, the option "This file will be played in the browser" was checked and a frame option that offers optimizations for smaller resolutions and touch support named "Mobile friendly" was also turned on.

The server is also hosted online as a web service on Render [74], a cloud hosting platform used for hosting web services, databases, static sites and other types of services. Render is a common alternative to similar paid platforms while maintaining most of their features. It only requires a simple file named render.yaml to configure the necessary parameters for the deployment to be successful. The file has information about the type of service, the name of the project, the environment used (Node.js), Render's payment plan (free), and commands to build and start the application. Since this platform supports automatic deployments through GitHub repositories, the web service is connected to the server's repository¹ and, when any changes are pushed, the service is updated shortly after. But Render does have a noticeable downside which is that, in the free tier, the services stop running after 15 minutes of inactivity. After the service becomes inactive, it will take a while (around 1 minute) to start back up again when a new request is received.

6.6 Cross-platform playability

One of the main reasons that SaveDForest.v2 was designed to be able to be hosted through a website was so the game could be played on most devices that had access to the Internet. In order to ensure that the game could be run on multiple devices, some measures were implemented, specifically for mobiles and tablets. One measure was adding a script that manages the behaviour of input fields when the device has a virtual keyboard. This script makes sure that the virtual

¹<https://github.com/angelasaraiva/SaveDForest.v2-server>

keyboard appears to the player when they click an input field and also that the input field is updated based on what is being written through the virtual keyboard. Another simple implemented measure was to make the game's orientation be in landscape view, because the project's proportions would not translate well to a portrait view, specifically the scenes' background images since most of them are panoramic or landscape photos.

6.7 Security

The main priority in terms of the security was the users' passwords since it is the most sensitive information that the game collects. The method used to ensure integrity was BCrypt, a library for password hashing that provides a .NET implementation of the bcrypt password hashing algorithm. In the Unity project, the package used was BCrypt.Net-Next on version 4.0.3, added through VS Code option - NuGet Package Manager: Add Package. In the Node.js server, the package is named bcrypt on version 5.1.1, added through the command `npm install` from the package manager NPM. The different packages and versions are not a problem since bcrypt is not language-specific so the packages follow the same cryptographic standard. The hashing logic works as such: when a player registration happens in the game, the password is directly hashed before being sent, together with the email provided, to the server to be handled. The server receives the email and hashed password and stores them in the database. When a player is logging in to the game, the password is sent in plain text with the user's email to the server. On the server side, it verifies, in the database, if a user exists with the received email, and, if it exists, retrieves the data of said user. Then, the server compares the password received from the client in plain text with the user's hashed password from the database, fetched using the email also received.

The security of the database's keys is also crucial since the keys have to be known by the server so it can respond automatically to the game's requests. But keeping them in plain text in the server's code is severely unsafe so they are maintained as environment variables, which are pairs of keys and values that are separated from the source code but can be accessed from it. These environment variables are directly set in the server's Render configuration.

6.8 Visual guide

Through the process of the game's implementation, in order to keep track of the different visual elements used in SaveDForest.v2, a visual guide was created (available in Appendix A). It details information about fonts used, the main UI's sizing and spacing, each character scene's type and their respective colours, and, finally, the colours of the game's general scenes, such as the start menu, main menu, register/login, and the Memories and Knowledge scenes.

Regarding the fonts, the guide specifies the name and styles of each font used, and their specific uses throughout the game. In terms of the UI's sizing and spacing, it refers the most used measurements of dialogue scenes, namely the spacing of the dialogue box in relation to the scene's background, the spacing of the dialogue box's text box in relation to the dialogue box itself, and

the size of the dialogue box. Then, the types and subtypes of character scenes are mentioned and explained, including their visual similarities and differences. Finally, the guide displays the main colours used in the most important scenes of SaveDForest.v2, including the colours of each character scene.

The main colours used in the game, dark green and brown, are inspired by the forest's colours. Each main character has an assigned colour that represents them, and it is the colour utilized for their dialogue box's outline, the speech detail's outline, and the background of their character portrait.

Chapter 7

Evaluation

The evaluation of SaveDForest.v2 was done through user testing to measure the game's engagement and ability to educate their players on the themes explored. This chapter will review the methodology used, the results and discussion of the user tests performed, as well as provide insights into the overall success of the project.

7.1 User tests

The game was assessed through user testing, a process where users are invited to interact with a system to evaluate various aspects that were specified beforehand, by the system's development team, through performing tasks and, then, answering questions about the overall game experience.

7.1.1 Methodology

The main objectives for conducting user tests on SaveDForest.v2 were: to verify the game's usability, to gather input regarding the animations made for the transitions, and to verify the game's ability to evoke empathy.

Five users participated in the tests, aged 20 through 80, mostly around the 20 to 29 age bracket. Most of them play games with a frequency of 1 to 3 hours per day, and while some of the users rarely play games, most of them have a preference for FPS and simulation games. Only one person reported to having any visual impairments.

The testing was performed remotely and was unmoderated, meaning it was done without direct supervision from the team. This decision was made because it made it possible to gather more participants by giving them more freedom to choose when and where they would do the test, and it guaranteed results that are more natural and less influenced by external forces since the users would be experiencing the game in a more realistic environment. Thus, the tests were done through any phone or computer that had internet access, considering SaveDForest.v2 is available through any browser. The duration of the testing session depended on the users themselves but was estimated as lasting 40 to 55 minutes.

The participants were guided and answered questions through a form. In the form, the users were first asked to complete a set of 6 tasks. In certain tasks, there was an option to get help or

more instructions if a user had difficulties completing them. These tasks were centered on specific mechanics from the game, and were, in this order, the following:

1. Registering into the game;
2. Making a decision;
3. View data about the decision that was just made;
4. Learn more context and information about a specific decision before making a choice;
5. View obtained Knowledge;
6. Reach one of the game's endings.

After the tasks were completed, the users were asked to answer a few questions regarding demographic data, usability and the game's animations. For the demographic data, the inquiries made were about age bracket, gender, gaming frequency, preferred game genres, and visual impairments or conditions (including but not limited to colour blindness and poor vision).

After these inquiries, the form provided a section with a Post-Study System Usability Questionnaire (PSSUQ), an alternative to System Usability Scale (SUS), to test the game's usability. The questionnaire has 16 questions with 7 different answers, ranging from 1 as strongly agree to 7 as strongly disagree. The answers can be measured by averaging the scores of each question. Usability can be measured overall by regarding all of PSSUQ's questions, but it can also be divided into 3 sub-areas of usability, namely System Usefulness (SYSUSE), Information Quality (INFOQUAL) and Interface Quality (INTERQUAL), which can help in making an in-depth analysis of specific factors regarding the game's functionality.

After the usability's inquiries, the users were asked about the animations used to transition between Callum and Yani's narratives. The questions made were about the user's preference over the three animations, opinions on having only one of the animations or multiple appear throughout the game, and whether the transition using the animations was seamless or not. At the end of the form, there was an open question where the users can give suggestions, other opinions or simply mention sections of the game that were not included in the questionnaire part of the form.

The SAM tests were an integrated test in the game and, thus, were not included in the user test's form. However, their results were collected and discussed in the following sections.

7.1.2 Results

Questions about tasks

In some of the 6 tasks that the users performed, there were specific inquiries that could be answered during the progression of the task or after the task was concluded and the user needed to get to the next one.

Most of the questions were related to providing further instructions or help to complete a task or to get to the next task, but only if they needed it. Since the tests were unmoderated, this sections

were crucial for more complex tasks, in case a user became stuck and could not continue the test. The tasks that had this inquiry were task 1, 3, 4 and 5 (see the previous subsection 7.1.1 for the tasks' descriptors). The results to these inquiries are shown in Figure 7.1.

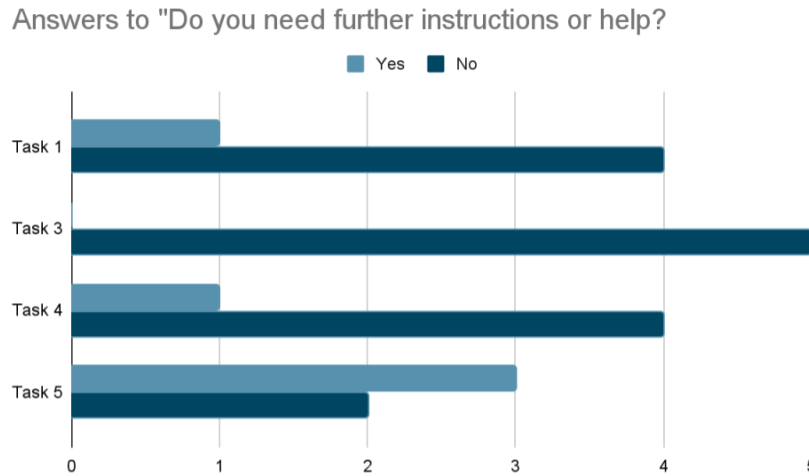


Figure 7.1: Bar chart of the number of users that needed help or not during the execution tasks from SaveDForest.v2's user tests

The other two questions posed were related to the visualization of points being earned (which can be seen in Figure 6.9) and to determine what one of the 3 endings the users achieved. 3 (60%) users noticed the points after making a decision, while 2 (40%) did not. 4 (80%) users got the good ending, 1 (20%) got the bad ending, and none got the neutral ending.

PSSUQ

In terms of PSSUQ, the user tests' results that were measured were the overall score and the subscales' scores for SYSUSE, INFOQUAL and INTERQUAL. Their scores and averages per question are displayed in Table 7.1.

Firstly, the overall score measures the general satisfaction of the users towards a system and is calculated by averaging all the responses for all the questions. In this case, the 5 users' responses for the 16 questions were averaged and the obtained result was an average of around 2.7 per question. For the SYSUSE dimension, the final score measures the ease of use of a system and is calculated by averaging the scores of the first 6 questions (questions 1 to 6). The obtained result was an average of around 2.8 per question. For the INFOQUAL dimension, the final score measures the clarity and relevance of the information the system provides according to the users, and is calculated by averaging the scores of the questions 7 to 12. The obtained result was an average of around 2.5 per question. Finally, the dimension of INTERQUAL measures the user's satisfaction towards a system's interface, including its design and functionalities, and is calculated by averaging the scores of the questions 13 to 15. The obtained results for INTERQUAL was an average of around 3.1 per question.

Table 7.1: PSSUQ's average score per question, overall and for each subscale

Category	Average per question
Overall	2.7
System Usefulness	2.8
Information Quality	2.5
Interface Quality	3.1

All the averages for each individual question were also calculated for further analysis. The description of each question answered by the users and its respective average score are displayed in Figure 7.2. The highest, thus worse, scores correspond to the scores of questions 1, 7 and 13, and the lowest, thus better, scores correspond to the score of questions 8, 9 and 12.

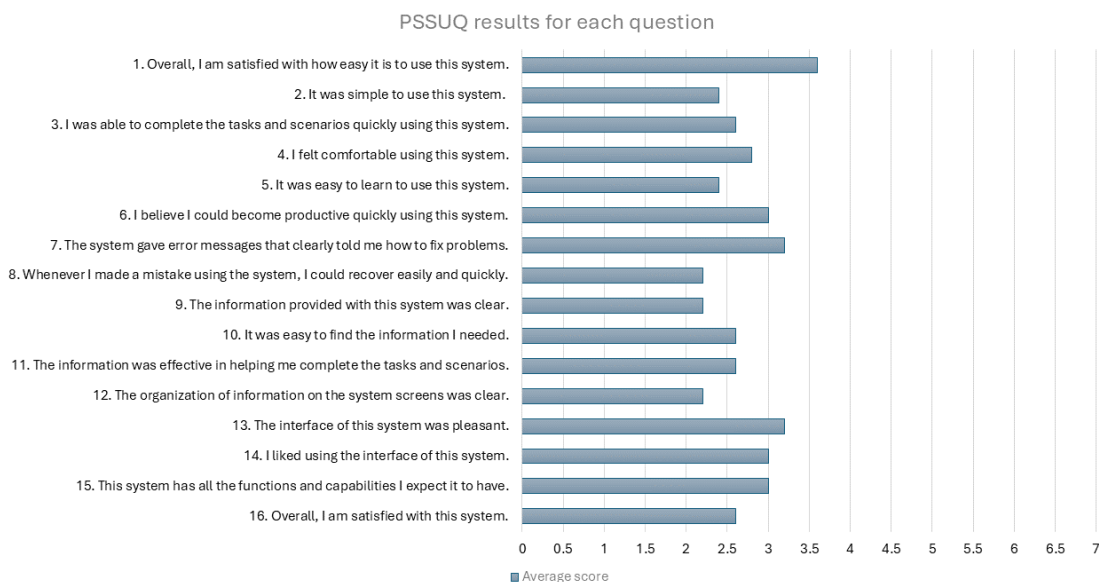


Figure 7.2: Bar chart of the averages of each PSSUQ's questions from SaveDForest.v2's user tests

Animations

In terms of the animations that were utilized as transitions between the game's two narratives, the users also answered questions regarding them. One of them was their preference between each of the 3 animations, where they were asked to choose which animation(s) they thought worked better in the game's context. The results of this inquiry are shown in Figure 7.3.

Most of the users signaled that using multiple animations throughout the game could be more beneficial than only using one. The users also confirmed that the animations provided a smooth transition between the 2 narratives.

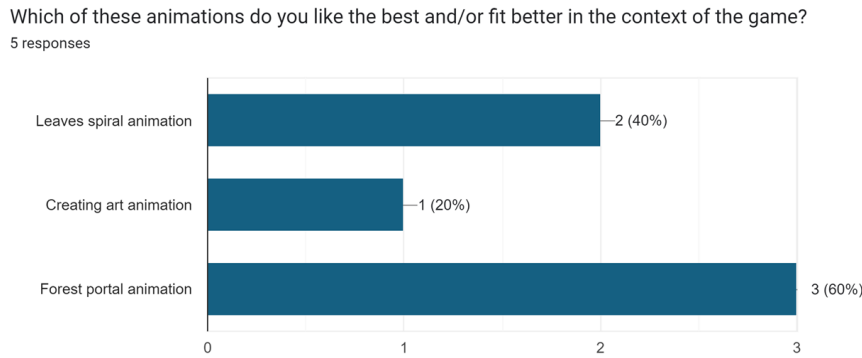


Figure 7.3: Bar chart of the user's answers to their preference regarding the animations displayed in SaveDForest.v2

7.1.3 Discussion

In terms of the results regarding the tasks themselves, the users seem to have had more problems in completing Task 5, which can be seen by its higher percentage in the inquiry related to needing further instructions. Task 3 seems to be the easiest since no one needed help to complete it, followed by Task 1 and 4. One of the reason why Task 5 might have required more help is because, in the Knowledge scene, there is no visual tutorial (similar to the one on the Memories scene) to inform the users that they need to click on the buttons on the side to open a new panel to view data about a certain topic. Regarding the visualization of the points earned after making a decision, it seems that some users did not notice the points at the top right of the screen, which could mean that it should be reworked to be more noticeable. For example, creating a simple animation that slightly shakes the points panel so that it is more likely to be caught in one's peripheral vision.

Regarding the PSSUQ's results, it is important to compare them with benchmark values from other studies in order to interpret their meanings. The means calculated for other systems from 21 studies evaluated using PSSUQ [75] are as follows:

- Overall score of 2.82;
- SYSUSE score of 2.80;
- INFOQUAL score of 3.02;
- INTERQUAL score of 2.49.

It is important to know that, when comparing results obtained from PSSUQ, lower values are in line with better system performance and user satisfaction, while higher values signify the opposite. The values obtained in the user tests together with the corresponding benchmark values can be seen in Table 7.2

With these values in mind, SaveDForest.v2's Overall score of 2.7 is slightly below the normal value, meaning that the game is above average in terms of user satisfaction and usability. The

Table 7.2: PSSUQ's average score per question together with the benchmark values

Category	Average per question	Benchmark values
Overall	2.7	2.82
System Usefulness	2.8	2.80
Information Quality	2.5	3.02
Interface Quality	3.1	2.49

SYSUSE score of 2.8 is exactly on the mean, which implies that the game is on par with the average ease of use and effectiveness, but could also be improved. The game's INFOQUAL score of 2.5 is significantly below the benchmark value, which means the information is well presented and the additional documentation and help provided is clear and easy to understand. The INTERQUAL score of 3.1 shows that the game's interface should be improved as it is noticeably higher than the average value, which means that the users found the game's interface harder to use or it did not meet their expectations.

Finally, while the forest portal animation stood out above the others, the game's animations were well-received and most of the users confirmed that having multiple animations throughout the game could be beneficial, either for variety or because some animations fit better in different contexts of transitions.

It is important to highlight that, while 5 users' responses can provide valuable insights, it is still a small sample size, which can lead to inconclusive results. There is a necessity to realize more user tests to ensure that the data collected is reliable and better reflects the thoughts of the majority of the user base.

Chapter 8

Conclusions and future work

8.1 Conclusions

This project implemented the development of an environmental game focusing on the narrative of a Yanomami person and their daily life and struggles. Its goal is to evoke an empathy response from its players in order for them to actively want to understand and help the character, and, consequently, the native communities and their home. The game teaches about every individual's place in alleviating the impacts on the Amazon rainforest by providing information about how simple habits, such as buying products from brands that do not disclose if they are sourcing their products responsibly, can be incredibly damaging for the forest.

The game's usability was tested through PSSUQ and found that the users' opinion towards its overall ease of use was positive while the game's interface could be worked on, especially with the help of more detailed insights about what could be improved.

The game's development was accomplished with all its expected features and functionalities by creating the needed scenes in Unity to display the culture and struggles of the Yanomami people and their loved ones, by showing the point of view of Yani and his interactions with his environment and others.

8.2 Future work

In terms of future work for SaveDForest.v2, a few suggestions are presented ahead. The story could be expanded to include other daily decisions that can impact the Amazon rainforest and the environment as a whole on Callum's scenes and other aspects of Yanomami people's life on Yani's scenes.

Regarding the game's endings, they were simplified in this version of the game but the scenes can be changed to be similar to Yani's scenes and be told from his point of view, as to better convey how the players' decisions could affect his well-being and the ones he cares about.

The endings could be determined through fuzzy logic [55], an approach that utilizes approximations to determine where a value should belong, rather than binary logic. For example, a player could have a final score of 99 points and get the bad ending, while another player could have a

score of 100 points and get the neutral ending. Their scores are too similar and the outcomes are completely different. If fuzzy logic was implemented, these two players would receive the same ending, which would be the neutral one.

For the game's testing, having more users participating in the user tests is crucial since the results and, consequently, the discussion and changes made based on them, may not be accurate, and specific problems related to usability can be missed.

Specialized user tests could also be beneficial, specifically with psychologists or other specialists in psychology, since they can provide helpful insights into capability of the game's empathy generation.

Bibliography

- [1] William J. Ripple, Christopher Wolf, Thomas M. Newsome, Mauro Galetti, Mohammed Alamgir, Eileen Crist, Mahmoud I. Mahmoud, William F. Laurance, and 364 scientist signatories from 184 countries 15. World Scientists' Warning to Humanity: A Second Notice. *BioScience*, 67(12):1026–1028, 11 2017.
- [2] Samuel A. Levy, Federico Cammelli, Jacob Munger, Holly K. Gibbs, and Rachael D. Garrett. Deforestation in the brazilian amazon could be halved by scaling up the implementation of zero-deforestation cattle commitments. *Global Environmental Change*, 80:102671, 2023.
- [3] Laura Otero Pedraza, Joanna Maria Lesna, Andrea Terceros Barron, and Kasper Martlev. Vernacular eco-lodges for the protection of the bolivian amazon rainforest. In Sandi Hilal, Merve Bedir, Mette Ramsgaard Thomsen, and Martin Tamke, editors, *Design for Partnerships for Change*, pages 429–445, Cham, 2023. Springer International Publishing.
- [4] David M. Lapola et al. The drivers and impacts of amazon forest degradation. *Science*, 379(6630):eabp8622, 2023.
- [5] Ștefan Boncu, Octav-Sorin Candela, and Nicoleta Laura Popa. Gameful green: A systematic review on the use of serious computer games and gamified mobile apps to foster pro-environmental information, attitudes and behaviors. *Sustainability*, 14(16), 2022.
- [6] Manuel Carabantes Lopes Soares. A gamified platform to encourage sustainable behaviours. Master's thesis, NOVA School of Science and Technology, NOVA University, Lisbon, Portugal, September 2023.
- [7] Karen Schrier and Matthew Farber. A systematic literature review of 'empathy' and 'games'. *Journal of Gaming & Virtual Worlds*, 13(2):195–214, 2021.
- [8] Paula C. Ferreira, Ana Margarida Veiga Simão, Ana Paiva, Carlos Martinho, Rui Prada, Aristides Ferreira, and Francisco Santos. Exploring empathy in cyberbullying with serious games. *Computers & Education*, 166:104155, 2021.
- [9] Cátia Sofia Campos Raminhos. *STOPBULLY: jogo sério para prevenir o bullying e promover a empatia*. Master's project thesis in informatics engineering, Universidade de Lisboa, 2015.

- [10] Paula Sterkenburg, Linda Olivier, and Esmé Van Rensburg. The effect of a serious game on empathy and prejudice of psychology students towards persons with disabilities. *African journal of disability*, 8(1):1–10, 2019.
- [11] Ângela Saraiva. Savedforest.v2 by brightcry. Available on: <https://brightcry.itch.io/savedforest2>, 2024. Last accessed 28 September 2024.
- [12] International Work Group for Indigenous Affairs. The indigenous world 2024: Brazil - iwgia - international work group for indigenous affairs. Available on: <https://www.iwgia.org/en/brazil/5378-iw-2024-brazil.html>, 2024. Last accessed 22 September 2024.
- [13] Survival International. Yanomami. Available on: <https://www.survivalinternational.org/tribes/yanomami>, 2024. Last accessed 22 September 2024.
- [14] Napoleon A. Chagnon. *Yanomamo, the fierce people*. Holt, Rinehart and Winston, 1968.
- [15] Catherine Alès. Systems of naming and creolization: Authentic acculturation and/or authentic tradition? the yanomami case. *Tipití: Journal of the Society for the Anthropology of Lowland South America*, 11(1):35–51, 2013.
- [16] Shabono Media. Shabono media - youtube. Available on: <https://www.youtube.com/@shabonomediamedia>, 2023. Accessed: 2024-09-28.
- [17] Silva-Junior, C.H.L, Silva, F.B., Arisi, and B.M. et al. Brazilian amazon indigenous territories under deforestation pressure. *Scientific Reports*, 13(1):5851, 2023.
- [18] Edward W. Butt, Jessica C. A. Baker, Francisco G. Silva Bezerra, Celso von Randow, Ana P. D. Aguiar, and Dominick V. Spracklen. Amazon deforestation causes strong regional warming. *Proceedings of the National Academy of Sciences*, 120(45):e2309123120, 2023.
- [19] BBC News. Is unprecedented drought pushing the amazon to the brink? — bbc news. Available on: https://www.youtube.com/watch?v=rrA_MazD_WA, 2023. Accessed: 2024-09-28.
- [20] Daniel Nepstad, David McGrath, Claudia Stickler, Ane Alencar, Andrea Azevedo, Briana Swette, Tathiana Bezerra, Maria DiGiano, João Shimada, Ronaldo Seroa da Motta, Eric Armijo, Leandro Castello, Paulo Brando, Matt C. Hansen, Max McGrath-Horn, Oswaldo Carvalho, and Laura Hess. Slowing amazon deforestation through public policy and interventions in beef and soy supply chains. *Science*, 344(6188):1118–1123, 2014.
- [21] Lacour M. Ayompe, M. Schaafsma, and Benis N. Egoh. Towards sustainable palm oil production: The positive and negative impacts on ecosystem services and human wellbeing. *Journal of Cleaner Production*, 278:123914, 2021.

- [22] Ehuana Yaira Yanomami and Ana Maria Machado. “we yanomami want to continue living in our forest”. *NACLA Report on the Americas*, 55(2):198–201, 2023.
- [23] Marcelo G. Lima and Thiago M. Fidalgo. Yanomami humanitarian tragedy: an urgent colonial heritage issue. *Brazilian Journal of Psychiatry*, 45(5):459–460, Sep 2023.
- [24] Público. Mini-doc. a guardiã da amazônia — público. Available on: <https://www.publico.pt/multimedia/interactivo/mini-doc-a-guardia-da-amazonia>, 2024. Last accessed 22 September 2024.
- [25] C. Daniel Batson. These Things Called Empathy: Eight Related but Distinct Phenomena. In *The Social Neuroscience of Empathy*. The MIT Press, 03 2009.
- [26] Jean Decety and Jason M. Cowell. Friends or foes: Is empathy necessary for moral behavior? *Perspectives on Psychological Science*, 9(5):525–537, 2014. PMID: 25429304.
- [27] Benjamin M.P. Cuff, Sarah J. Brown, Laura Taylor, and Douglas J. Howat. Empathy: A review of the concept. *Emotion Review*, 8(2):144–153, 2016.
- [28] Thomas Köllen and Doris Schneeberger. Avoiding unnecessary suffering: Towards a moral minimum standard for humans’ responsibility for animal welfare. *Business Ethics, the Environment & Responsibility*, 32(4):1139–1149, 2023.
- [29] Elizabeth S. Paul. Empathy with animals and with humans: Are they linked? *Anthrozoös*, 13(4):194–202, 2000.
- [30] Ana Emauz, Augusta Gaspar, and Francisco Esteves. Preditores da empatia dirigida a humanos e outros animais em portuguesas e anglo-saxónicas. *Psicologia*, 32(1):15–28, May 2018.
- [31] Ashley Young, Kathayoon A Khalil, and Jim Wharton. Empathy for animals: A review of the existing literature. *Curator: The Museum Journal*, 61(2):327–343, 2018.
- [32] Joe E. Heimlich and Nicole M. Ardoin. Understanding behavior to understand behavior change: a literature review. *Environmental Education Research*, 14(3):215–237, 2008.
- [33] Susan Michie, Maartje M Van Stralen, and Robert West. The behaviour change wheel: a new method for characterising and designing behaviour change interventions. *Implementation science*, 6:1–12, 2011.
- [34] Adam Jerrett, Peter Howell, and Neil Dansey. Developing an empathy spectrum for games. *Games and Culture*, 16(6):635–659, 2021.
- [35] Jonathan Belman and Mary Flanagan. Designing games to foster empathy. *International Journal of Cognitive Technology*, 15(1):11, 2010.

- [36] Jean Decety, Inbal Ben-Ami Bartal, Florina Uzefovsky, and Ariel Knafo-Noam. Empathy as a driver of prosocial behaviour: highly conserved neurobehavioural mechanisms across species. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 371(1686):20150077, 2016.
- [37] Margaret M. Bradley and Peter J. Lang. Measuring emotion: The self-assessment manikin and the semantic differential. *Journal of Behavior Therapy and Experimental Psychiatry*, 25(1):49–59, 1994.
- [38] Tracy Fullerton and E Zimmerman. A playcentric approach to creating innovative games. In *Game Design Workshop*. CRC Press New York, 2019.
- [39] Ernest Adams and Joris Dormans. *Game mechanics: advanced game design*. New Riders, 2012.
- [40] Alaa A. Qaffas. An operational study of video games’ genres. *International Journal of Interactive Mobile Technologies (IJIM)*, 14(15):pp. 175–194, Sep. 2020.
- [41] Kristine Øygardslia, Charlotte Lærke Weitze, and Juhyung Shin. The educational potential of visual novel games: Principles for design. *Replaying Japan*, 2020.
- [42] Phil Wilkinson. *A Brief History of Serious Games*, pages 17–41. Springer International Publishing, Cham, 2016.
- [43] Fedwa Laamarti, Mohamad Eid, and Abdulmotaleb El Saddik. An overview of serious games. *Int. J. Comput. Games Technol.*, 2014, jan 2014.
- [44] Kaveh Madani, Tyler W. Pierce, and Ali Mirchi. Serious games on environmental management. *Sustainable Cities and Society*, 29:1–11, 2017.
- [45] Kristoffer S. Fjællingsdal and Christian A. Klöckner. Green across the board: Board games as tools for dialogue and simplified environmental communication. *Simulation & Gaming*, 51(5):632–652, 2020.
- [46] Cedric K. W. Tan and Hidayah Nurul-Asna. Serious games for environmental education. *Integrative Conservation*, 2(1):19–42, 2023.
- [47] Xi Hu, Meigang Li, Miao Gu, and Bin Zhang. How online pro-environmental games affect users’ pro-environmental behavioural intentions? — insights from ant forest. *Journal of Environmental Management*, 368:122182, 2024.
- [48] ConcernedApe. Stardew valley. Available on: https://store.steampowered.com/app/413150/Stardew_Valley/ for PC and <https://www.stardewvalley.net/> for other platforms, 2016.

- [49] Sydney Crowley. Playing farmer: At the intersections of neo-liberal capitalism and ecocriticism in stardew valley. *Journal of Gaming & Virtual Worlds*, 15(1):21–37, 2023.
- [50] Inc. MonoGame Foundation. Monogame — monogame. Available on: <https://monogame.net/>, 2024. Last accessed 22 September 2024.
- [51] USC Game Innovation Lab. Walden, a game. Available on: https://store.steampowered.com/app/1011700/Walden_a_game/ for PC and <https://www.waldengame.com/> for other platforms, 2017.
- [52] Henry David Thoreau and James Cloyd Bowman. *Walden, or, life in the woods*. Scott, Foresman, 1917.
- [53] David Wehle. The first tree. Available on: https://store.steampowered.com/app/555150/The_First_Tree/ for PC and <https://www.thefirsttree.com/> for other platforms, 2017.
- [54] Upper One Games and E-Line Media. Never alone (kisima ingitchuna). Available on: https://store.steampowered.com/app/295790/Never_Alone_Kisima_Ingitchuna/ for PC, 2014.
- [55] Natalie Neill. Teaching the inupiaq video game never alone and/as literature. *Teaching Games and Game Studies in the Literature Classroom*, page 133, 2022.
- [56] Okomotive. Far: Lone sails. Available on: https://store.steampowered.com/app/609320/FAR_Lone_Sails/ for PC and <https://www.far-game.com/> for other platforms, 2018.
- [57] Plasticity Games. Plasticity. Available on: <https://store.steampowered.com/app/1069360/Plasticity/>, 2019.
- [58] Neylan Ogutveren Aular. Plastic waste (in) visibility in plasticity. *Tahiti*, 14(1):76–92, 2024.
- [59] Strange Loop Games. Eco. Available on: <https://store.steampowered.com/app/382310/Eco/>, 2018.
- [60] Kristoffer S. Fjællingsdal and Christian A. Klöckner. Gaming green: The educational potential of eco – a digital simulated ecosystem. *Frontiers in Psychology*, 10, 2019.
- [61] Free Lives. Terra nil. Available on: https://store.steampowered.com/app/1593030/Terra_Nil/ for PC and on: <https://www.terranyl.com/> for other platforms, 2023.
- [62] Noio. Cloud gardens. Available on: https://store.steampowered.com/app/1372320/Cloud_Gardens/, 2021.

- [63] Unity Technologies. Unity real-time development platform — 3d, 2d, vr & ar engine. Available on: <https://unity.com/>, 2024. Last accessed 16 September 2024.
- [64] GIMP's Team. Gimp - gnu image manipulation program. Available on: <https://www.gimp.org/>, 2024. Last accessed 16 September 2024.
- [65] KDE. Krita — digital painting. creative freedom. Available on: <https://krita.org/>, 2024. Last accessed 16 September 2024.
- [66] Inc. Figma. Figma: The collaborative interface design tool. Available on: <https://www.figma.com/>, 2024. Last accessed 16 September 2024.
- [67] Unity Technologies. Unity - manual: Build your webgl. Available on: <https://docs.unity3d.com/Manual/webgl-building.html>, 2024. Last accessed 16 September 2024.
- [68] Unity Technologies. Unity asset store - the best assets for game making. Available on: <https://assetstore.unity.com/>, 2024. Last accessed 16 September 2024.
- [69] Bill Albert and Tom Tullis. *Measuring the User Experience: Collecting, Analyzing, and Presenting UX Metrics*. Morgan Kaufmann, 2022.
- [70] Christoph Klimmt, Dorothée Hefner, Peter Vorderer, Christian Roth, and Christopher Blake. Identification with video game characters as automatic shift of self-perceptions. *Media Psychology*, 13(4):323–338, 2010.
- [71] Ângela Saraiva. Savedforest 2 prototype - figma. Available on: <https://www.figma.com/proto/tICs73u4HCPYC116ppgzZU/SaveDForest-2-prototype?node-id=0-1&t=sW04y1XfS69X3uIo-1>, 2024. Last accessed 16 September 2024.
- [72] Olan. The night sky — orchestral music — unity asset store. Available on: <https://assetstore.unity.com/packages/audio/music/orchestral/the-night-sky-35720>, 2024. Last accessed 16 September 2024.
- [73] itch corp. Download the latest indie games - itch.io. Available on: <https://itch.io/>, 2024. Last accessed 19 September 2024.
- [74] Render. Render: Cloud application hosting for developers. Available on: <https://render.com/>, 2024. Last accessed 19 September 2024.
- [75] Jeff Sauro and James R Lewis. *Quantifying the user experience: Practical statistics for user research*. Morgan Kaufmann, 2016.
- [76] Utku Kose. Developing a fuzzy logic based game system. *Computer Technology and Application*, 3(7):510–517, 2012.

Appendix A

Visual guide

The visual guide acts a compendium of the game’s colours, spacing and sizing, but it also serves as the game’s user manual, since it has pages detailing each scene, their purposes and how to navigate them.

The following images displays each part of the visual guide made for SaveDForest.v2.

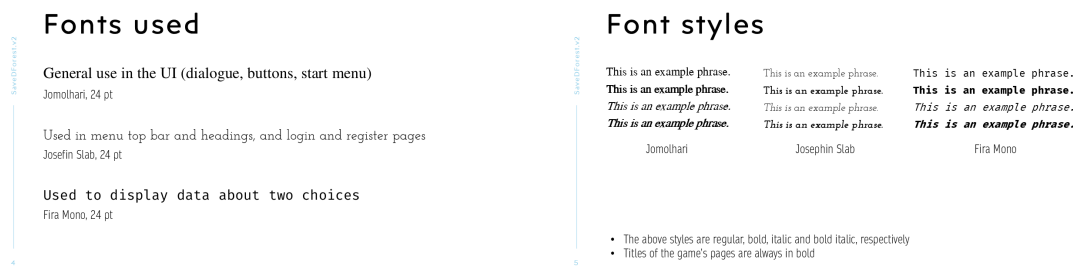


Figure A.1: Depiction of the game’s fonts and where they are used

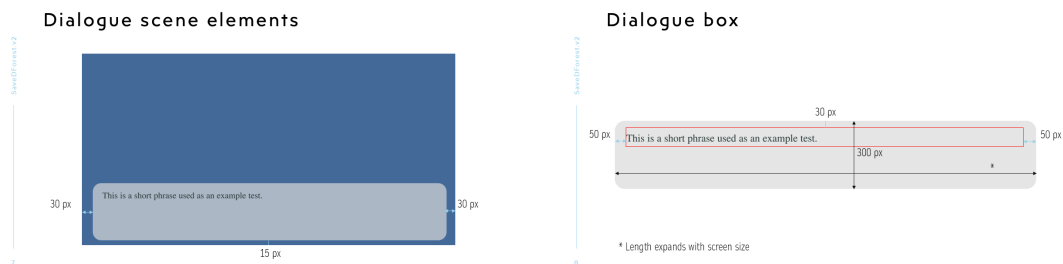


Figure A.2: Depiction of the sizing and spacing of the elements of a dialogue scene

Types of scenes and their subtypes

1. Romi's scenes
 - i. Speaking
 - ii. Quizzes
 - iii. SAM tests
2. Callum's scenes
 - i. Thinking
 - ii. Decisions
 - iii. Narration
3. Yani's scenes
 - i. Thinking
 - ii. Speaking
 - iii. Narration

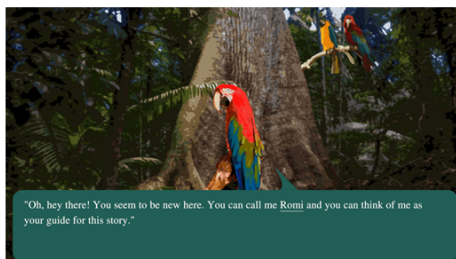
Figure A.3: Visualization of the types and subtypes of scenes the game has

Speaking

Romi, Yani, Callum

- Appears on Romi, Yani and Callum's scenes
- Is distinguished by displaying a **speech arrow** pointing to the character portrait, and by having the line in **quotation marks**
- The character is displayed through a character portrait, either on the middle (Romi) or on the left close to the dialogue box (Callum, Yani)

Example on a Romi scene:



Example on a Yani scene:



Figure A.4: Depiction of the details of a speaking dialogue scene

Thinking

Callum, Yani

- Appears on both Callum and Yani's scenes
- Is distinguished by displaying **thinking bubbles** on the right, close to the character portrait, and by having lines in *italic*
- The character is displayed in the same way as "Speaking" (see Slide 12)

Example on a [Callum](#) scene:



Example on a [Yani](#) scene:



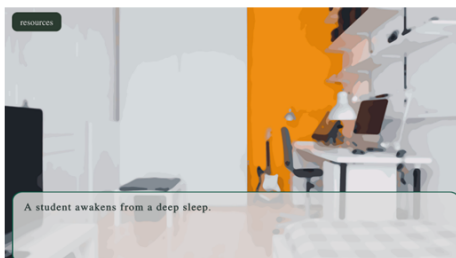
Figure A.5: Depiction of the details of a thinking dialogue scene

Narration

Callum, Yani

- Appears on both Callum and Yani's scenes
- Is distinguished by having lines in **bold** and no character portrait above the dialogue box
- Maintains the colours of the current displayed scene

Example on a [Callum](#) scene:



Example on a [Yani](#) scene:



Figure A.6: Depiction of the details of a narration dialogue scene

Quizzes

Romi

- Appear on Romi's scenes
- Are distinguished by having a dialogue line that is posed as a **question**, followed by buttons that represent the **options** to choose from, and after choosing, the player may earn 10 points for a correct answer and 0 points for an incorrect one
- The questions are based on information that is in the "Knowledge" page before the start of the quiz
- Each question only has **1 correct answer**



Figure A.7: Depiction of the details of a quiz scene

SAM tests

Romi

- Appear on Romi's scenes
- Are distinguished by having a **panel** on top of the character portrait that **displays the SAM test**
- The SAM test is used to **measure the players' emotional reaction** after playing through a scene of the game (specially Yani's)
- The test has 2 questions, each with 5 images
- The 1st question has the player select the image that best represents their feelings (from unhappy to happy), and the 2nd one relates to the player's level of excitement (from calm to excited)



Figure A.8: Depiction of the details of a SAM test scene

Decisions

Callum

SaveDForest.v2

- Appear on Callum's scenes
- Are distinguished by posing a choice and displaying 2 buttons that represent 2 different options to choose from
- After choosing, the points earned will be displayed in the top right corner
- Each decision can earn 100 points for a choice that is better environmentally for the Amazon rainforest, or 0 points for one that can have an impact on the well-being of the forest

17

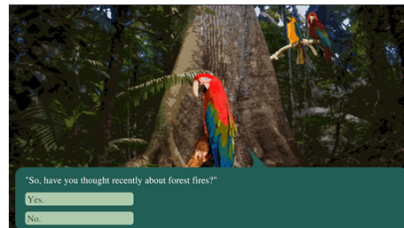


Figure A.9: Depiction of the details of a decision scene



Romi

Example of a Romi scene:



SaveDForest.v2

Dialogue box colour



19 Hex
RGB

#215E55
R 33, G 94, B 85

Buttons colour

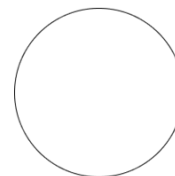


#AFCBAE
R 175, G 203, B 174

Text colours depending on contrast



#2A3B38
R 42, G 59, B 56



#FFFFFF
R 255, G 255, B 255

Figure A.10: Visualization of the colours used for Romi scenes

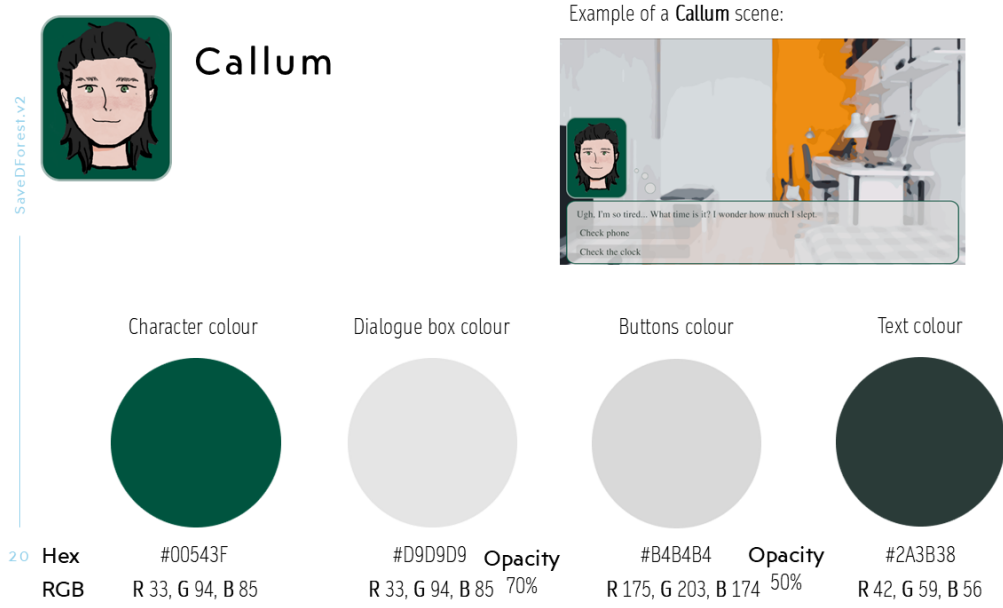


Figure A.11: Visualization of the colours used for Callum scenes

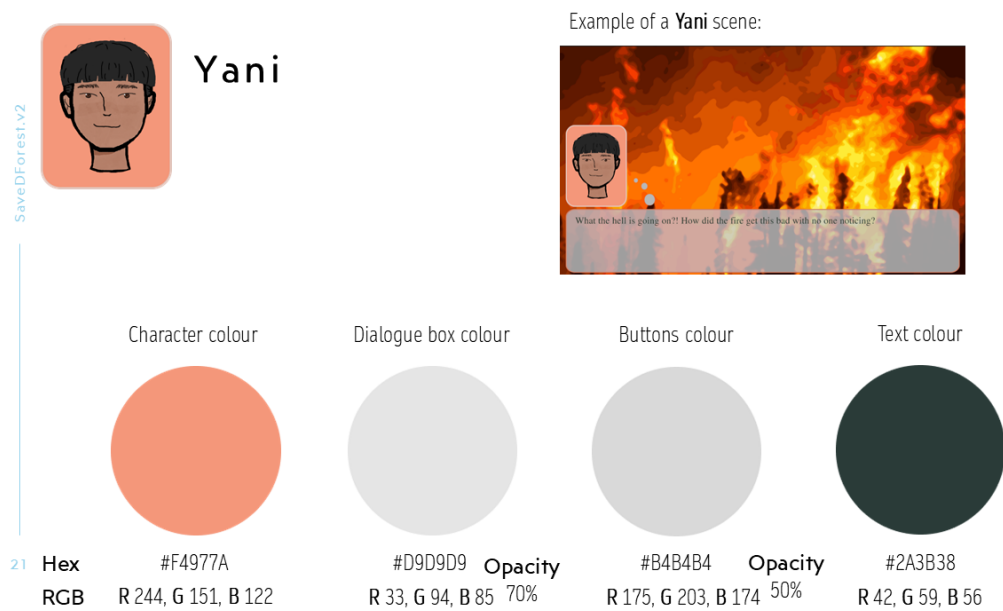


Figure A.12: Visualization of the colours used for Yani scenes

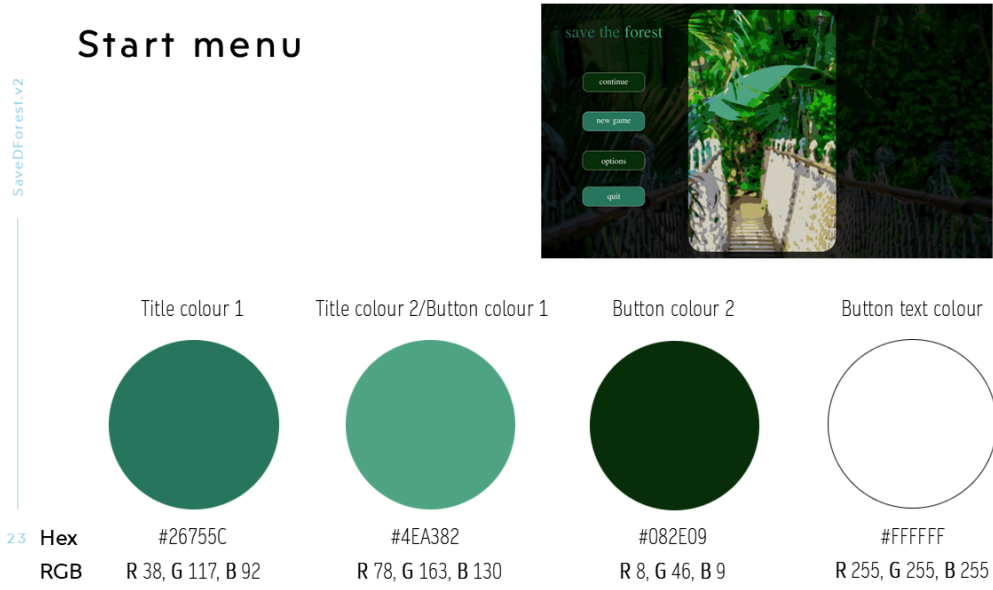


Figure A.13: Visualization of the colours used for the start menu

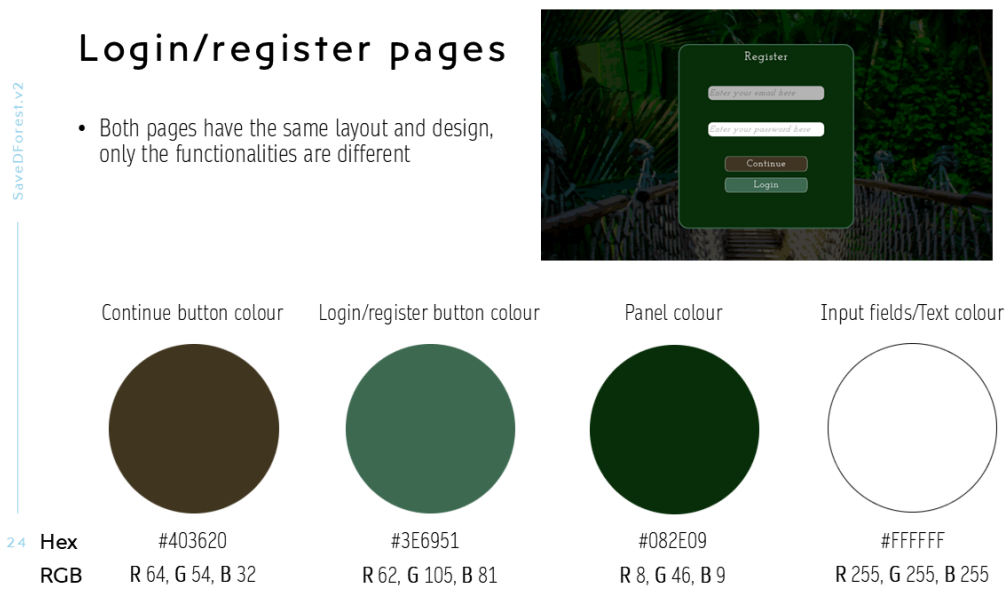


Figure A.14: Visualization of the colours used for the login/register scenes

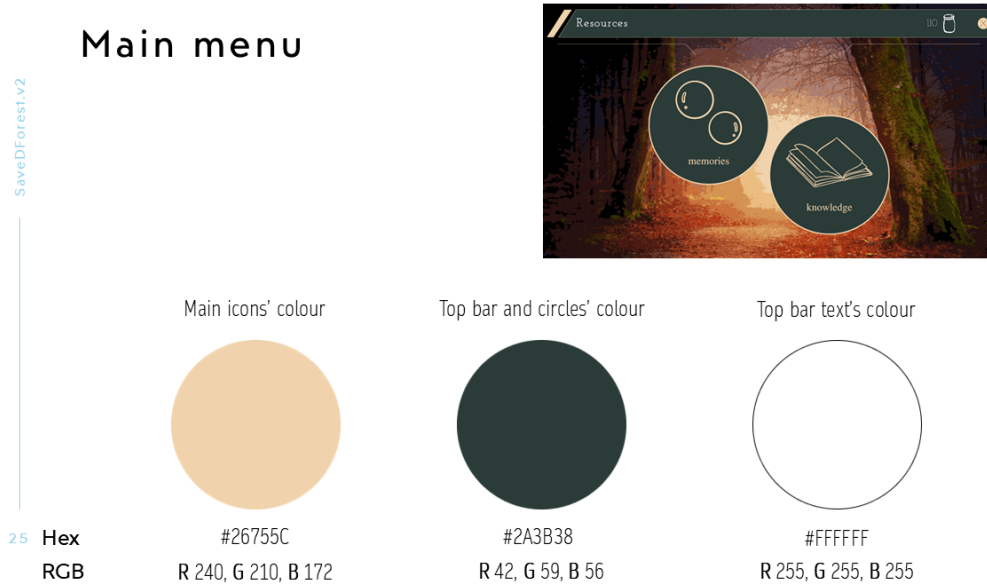


Figure A.15: Visualization of the colours used for the main menu

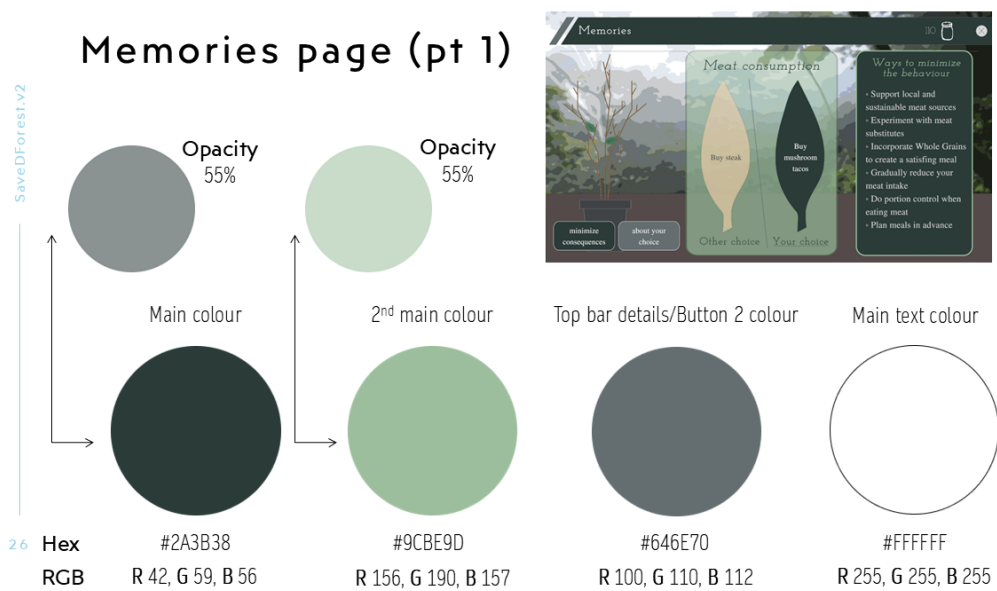


Figure A.16: Visualization of the colours used for the Memories scene

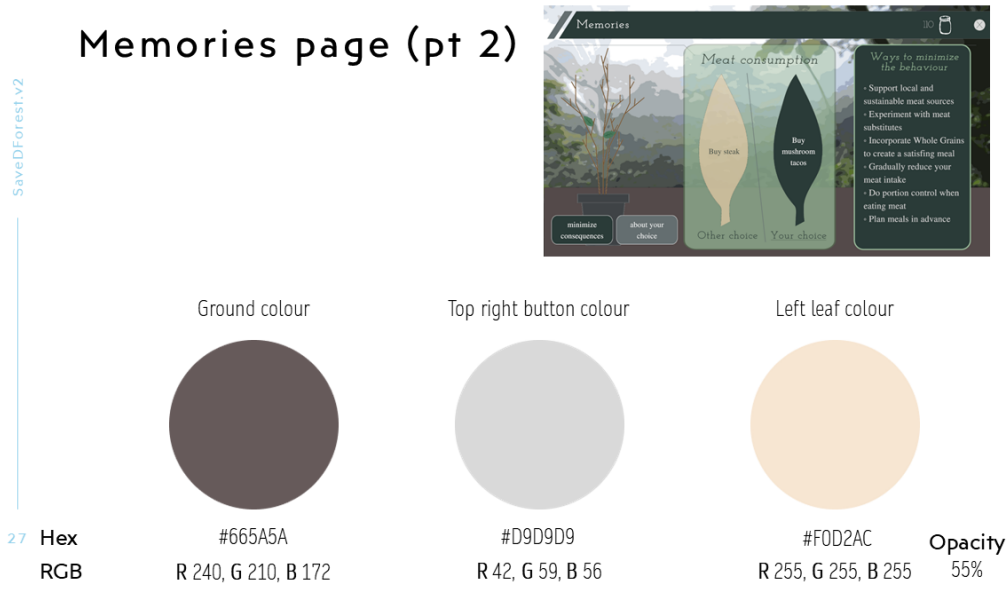


Figure A.17: Visualization of the colours used for the Memories scene

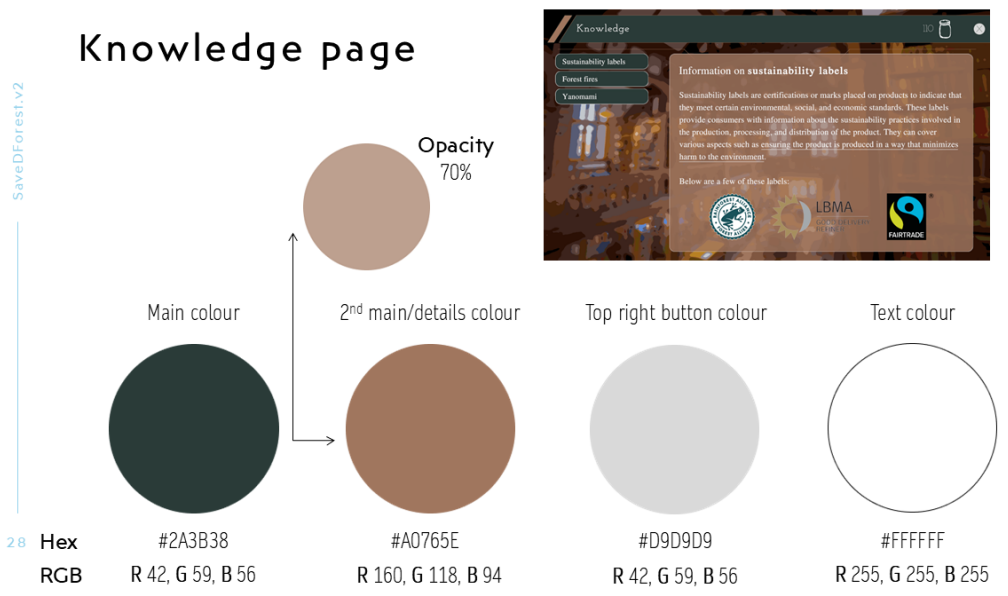


Figure A.18: Visualization of the colours used for the Knowledge scene