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Leveraging Facebook's Open Graph to develop an Environmental Persuasive Application

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*To my grandfather for teaching me that a diploma only
means knowledge if one complements it with practice.*

Acknowledgements

“If one says Red (the name of a color) and there are 50 people listening, it can be expected that there will be 50 reds in their minds. And one can be very sure that all these reds will be very different.” [2] This quote while not incredibly intense tells a lot about my work during these last months. I had the unique opportunity to work with so many different people (far more than 50), among designers, writers, developers, teachers, activists, chairmen, psychologists, students and many others. All of them had their single conception of red, and all of these visions differed from my own. Probably because I am colorblind. However, the truth is that all these shades of red were brought together to be discussed, analyzed, questioned and challenged. From an insignificant portion of the palette, we succeeded to create many variants and soon we had pigments of Blue and thin traces of Green from which we were able to create all the remaining colors and our possibilities came to be endless. This being stated, I would like to express my gratitude for those who contributed in some way to the success of this project whether through an opinion, an action, or simply a suggestion. In the top of my list are my parents who gave me the stencils to paint with and risking to state the obvious without their help I would certainly lack the right tools and methodology needed to get this far. Moreover, in order to bring an idea to reality an artist needs to express it. In that sense, my MSc’s supervisor, Professor Teresa Romão promptly offered me a white canvas together with guidance, continuous help and encouragement towards our goals. Furthermore, my words would not be enough to thank Bárbara Teixeira, the only one in this text who indeed masters the use of color for her amazing work giving life to our prototype. Last but surely not the least, a special thank to the one who kept me motivated at all times, and had always a kind word to share. I believe her passion for butterflies and the way they spread joy with their colorful wings have inspired me to give my own contribution to this field.

Abstract

Social networking sites persuade millions of users each day to adopt specific behaviors. Using the persuasive principles inherent to these sites to increase environmental awareness and reduce our ecological footprint can be challenging but certainly worthy. The DEAP project has already invested time and resources to address persuasion through different devices for a broad audience. However, there are still many obstacles when it comes to such a delicate subject as people's routines. For many years, social factors have prevented people from adopting a way of living friendlier to our Environment. Whether it is due to lack of proper knowledge about this topic or simply because they are not willing to change, the truth is that we are eventually reaching a point where it will be too late to keep our planet as we know it. Consequently, the time has arrived when there is great need for a platform to bring existing efforts together no matter where they come from but the goal they share: change incorrect behaviors towards environmental sustainability. Towards this ambitious goal a board game was developed and integrated in Facebook capable of merging third-party applications and an important and valuable basis for future research in the field of persuasion.

Keywords: Connectivity, Persuasive Technology, Facebook, Serious Games, Social Recognition, Environment, Peer Pressure, Mass Interpersonal Persuasion

Resumo

Atualmente, as redes sociais persuadem diariamente milhões de utilizadores a adotarem rotinas específicas. A utilização dos princípios persuasivos inerentes a estas redes para aumentar a consciência ambiental dos cidadãos e reduzir a nossa pegada ecológica além de desafiante é certamente uma mais valia. O projeto DEAP investiu já tempo e recursos para enfrentar este problema através de diferentes dispositivos focados num público-alvo abrangente. Contudo, por tratar-se dum tema tão delicado como é a rotina pessoal de cada indivíduo existem ainda diversos obstáculos que têm de ser superados. Por muitos anos, fatores sociais condicionaram a população a adotar maneiras de estar amigas do ambiente. Seja por falta de conhecimento na área ou simplesmente porque não estão dispostos a mudar, é preciso intervir e consciencializar os cidadãos antes que a situação se torne irreversível. Chegou o momento em que existe grande necessidade de uma plataforma que junte todos os protótipos existentes, independentemente da sua origem, mas com uma missão em comum: alterar comportamentos errados por um ambiente melhor. Para atingir este objetivo ambicioso, foi desenvolvido e integrado um jogo de tabuleiro no Facebook capaz de juntar aplicações externas e de servir de base para investigação futura na área da persuasão.

Palavras-chave: Conetividade, Tecnologia Persuasiva, Facebook, Jogos Sérios, Reconhecimento Social, Meio Ambiente, Pressão Social, Persuasão em Massa

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Introduction

This thesis aims to reduce environmental apathy through a recreational approach which will leverage the services provided by the largest social network at the time of this writing as a mean to reach a broader audience than ordinary web games. Assuming our intent to affect specific citizen's practices which arm our planet, we shall make use of several persuasive principles and rely on proved conclusions in related projects world wide under this matter. This research is supported by the DEAP project¹ (Developing Environmental Awareness with Persuasive systems) which in turn is funded by the Foundation for Science and Technology.

1.1 Motivation

We live in a special period in history. In the late twentieth century, human population reached 5 billion. It took almost all human history for this number to reach 1 billion about 175 years ago. Since then, each new billion has been gained at rapidly decreasing time intervals - 115 years, 35 years, 15 years and 11 years. Even if growth rates decline as predicted, earth's population will double to 10 billion by 2050 and so will the demands upon nature. The ability of our species to change landscapes or physical environments at local and regional scales isn't true anymore. As a matter of fact, the human role in changing the face of the Earth was never so clear as with the development of a fossil-fuel-based society [42].

¹PTDC/AAC-AMB/104834/2008

With the advent of modern agricultural techniques and the beginning of industrialization, societies lost their historical connection with the Environment. People could live in cities and still depend on a constant supply of food and material goods, but this break up with our land has allowed environmental problems to go unattended, as the industrialized nations of the world continue to increase economic development and the consumption of natural resources. In fact, humans have impacted our planet more deeply in the twentieth century than in all previous history combined [38] and now environmental problems run rampant across the globe. The more serious issues include: ozone deterioration; deforestation; global warming; suburban sprawl and other human causes that disrupt ecosystems; urban air pollution; soil erosion; and species extinction [30].

Moreover, industrialized nations are either unaware of these problems or not sufficiently concerned about this state of affairs to address these issues. Ignorance and apathy exist at every level of society, from the everyday consumer who fail to recycle, to governments that don't encourage stricter laws in order to prevent such dramatic threats to our environment [30]. The outcome is visible: our societies, especially in the industrialized world, underestimate the importance of a healthy environment and its relation to the overall welfare and health of human beings. Despite some scattered efforts to the contrary, industrialized nations have still a long way to go in order to reverse this disturbing scenario.

Education plays a key role when the challenge is to create an environmentally-conscious society and can be the first step to address some of the environmental problems we are facing today. It is not by chance, that in both high schools and universities, Environmental Science is a growing branch of studies with degrees on Social and Environmental Psychology becoming increasingly common but, in the overall, some misguided concepts and high-level ideas are still far from having an impact on students [6]. Classroom education has not overcome the disconnection between humans and their natural home, leaving much to do yet in order to raise awareness towards people's carbon footprint [5]. The challenge then, is to find a more creative way than the traditional textbook to reach people from all over the world.



There are almost 4 million Facebook users in a country with less than 11 million citizens. That's what statistics [3] reveal about our small country at the far

West limit of Europe. Just last year, Facebook announced that over one billion users were registered in their social network and nearly half of this number use it on a daily basis. If we think globally we reach the astonishing conclusion that, a notable percentage, namely 7.4% of all human beings, have used, at least once, Mark Zuckerberg's social network [45]. As increasingly more people engage in these websites and spend time using the services that they provide, one can hardly find a more suitable way to promote a message over a huge audience.

Due to our intrinsically social nature, we are constantly seeking for an equilibrium, between what we learn from our role models (parents, teachers, friends) and the way we act. To keep this balance, we trigger psychological responses such as *securing utilitarian outcomes, ego defense, value expression and social adjustment* [46]. Cognitive dissonance, for example, arises from the psychological inconsistency between what we believe in and what we actually do. Several studies [46] support the conclusion that dissonance motivation can emerge in contexts devoid of negative consequence, that threaten the consistency, stability, predictability, competence or moral goodness of a thought or an action.

With the proper persuasive concepts in mind and the right computing tools, there is a great chance that we can raise environmental awareness among computer users. In terms of ecological preservation, for example, surveys show that even when citizens don't behave as they should, they are still willing to help the Environment [21]. In other words, despite their beliefs there are reasons, such as, lack of motivation to change their incorrect attitudes towards the Environment, ignorance of such environmental threats, shortage of confidence to take the first step, misleading advices from peers, among others reasons [26]) that prevent people from rethinking their habits and giving their own contribute.

The challenge to overcome these barriers and motivate people through competition, social recognition, self-awareness and even economic savings in the family's budget, while providing them with an interactive and fun way that will keep them engaged and satisfied, was the strongest driver behind this study. We believe that, at this pace, changing one person at a time is not enough anymore.

"Change will not come if we wait for some other person or some other time. We are the ones we've been waiting for. We are the change that we seek." – Barack Obama

1.2 Description and Context

*“...environmental problems occur due to our erroneous and exaggerated use of Earth resources. Unfortunately, citizens still have habits that contribute to environmental destruction when sometimes a slight behavior change can make a difference. That change can be achieved by demonstrating **them** the consequences of **their** actions to the Environment.”* This is the motivation behind the DEAP² project, which seeks to leverage a new computer paradigm in order to raise environmental awareness among users, by teaching them how to become more environmentally responsible in their life. For the last years, DEAP has already conducted studies on mobile persuasive interfaces for public ambient displays, on smartphone-based augmented experiences, on real-time feedback systems to improve our energy consumption awareness, to name just a few. These projects were submitted and accepted in well ranked conferences and have already proved their value to the international community. In the next paragraphs we will describe the aforementioned prototypes since they were the ones chosen to be merged and promoted on Facebook.

1.2.1 Gaea

The work developed by Pedro Centieiro relies on the rapid growing of the mobile phone market and its innovation. He describes them as “the most personal and most loved technology in the world”, since they advise and entertain us anywhere and at anytime. He also believes that public ambient displays are the way to obtain high success rates and earn the attention of the global community.

“(...) by applying persuasive technology concepts to mobile phones, and through innovative forms of interaction between these and public ambient displays, we can stimulate citizens to become more aware of our planet environmental problems (...)” [9]

In practice, virtual waste is addressed to geographical coordinates around the user position (through the mobile’s GPS), so that, to pick it up, the user has to walk to the referred location and bring it back to the correct recycle bin (virtually displayed in the iPhone when pointed at the public ambient display). By doing this, and succeeding in his/her task, the user is rewarded with points and ecological tips which serve as virtual motivators. At the same time, the public ambient display is monitoring all information going back and forth between the mobile device and the server. The PAD is also responsible for listing the scores

²<http://www.deaproject.com>

on a leader board, time statistics, as well as players' coordinates. Furthermore, in order to urge users to recycle and inform them about the scarcity of our planet's resources, images and videos of Earth landscapes being depleted are continuously playing. This emotional involvement can have a very important role in shaping users' beliefs, values, and attitudes towards the Environment since it has already been proved that vivid and provocative images are more likely to produce an emotional reaction than inflaming speeches about climate change or alarming mathematical models [26]. As more waste materials are being recycled, the images and/or videos switch to a healthier planet, until there are only images of a beautiful planet where everything is reused and a natural equilibrium is finally achieved. The last activity is a social quiz which can be answered from the tips given during the game. When users finish playing, they may opt to share their achievements online. Lastly, team collaboration is also encouraged. While some teams can be in charge of picking up paper, others can focus on plastic or metal waste and then alternate during game flow. Even though they are not directly helping the Environment, since they are collecting *virtual* waste instead of real one, they are learning better ways of recycling and, more importantly, being informed about the consequences of their actions thus increasing their internal locus of control. A higher locus means that an individual perceives himself as capable of bringing about change through his own behavior.

1.2.2 eVision

With the same concern about fair consumption of non-renewable resources but with a different approach, Bruno Santos decided to focus on environmental threats from our everyday life and their ecological alternatives, such as traveling by bike to work or building green areas and leisure parks instead of polluting facilities. In fact, his research has allowed:

"(...) to test if persuasive technologies on mobile devices in conjunction with augmented reality techniques are an efficient way to provide new and amusing ways of interaction to a broad audience, stimulating and driving them to become increasingly aware of the sustainability problems which our planet is facing, while persuading them to adopt pro-environmental behaviors in favor of a better future." [39]

As stated before, his solution allows users to use their mobile phone's camera to receive direct feedback, through augmented reality, of the consequences which arise from environmental threats in their surroundings. While scanning

around, the system automatically detects environmental threats, which the user is encouraged to “clean” by rubbing the screen surface over them. Such hazards may be either places or vehicles. After interaction, menaces are replaced by cartoonish environmentally friendly alternatives and a virtual character rewards the user with points and moral boosts (positive reinforcement). Lastly, logged info with the history of all cleaned places can be explored and shared online for other users to mirror. Lastly, customization, another important persuasive tool [14], was also applied, and it is possible to humanize eVision’s host, a white panda, with colorful assets and funny clothes bought with earned points.

1.2.3 Ley

Yet another ongoing research under the supervision of the DEAP project’s team regards power consumption habits in residential homes. To enhance awareness of citizens’ electricity usage, including common bad habits such as leaving gadgets on stand-by, turning lamps on even when away, buying uncertified kitchen equipment, among others, a team of researchers from New University of Lisbon have joined forces with Setúbal’s Technical School of Technology to create a persuasive pervasive-based game called LEY (Less Energy empowers You). Excited about the optimistic results achieved by a similar application in the market, the Power Explorer [19], this team took one step forward and implemented a mobile, context-aware, java-based application running on Android OS. Their goal was:

“(...) to provide a simple, reliable and funny system so that any user can get and analyze their domestic energy consumption over day by day.” [28]

Grasping the details, the application allows two distinct game modes: single and multiplayer. In the former, users are able to visualize their power consumption in real time, realizing if their daily rate is within the average one by watching the cartoonish house in their profile. If the house displays a green, happy face, it means that adequate power usage is being consumed, while a sad and reddish face shows that little care has been given to this matter. An exciting alternative is to challenge a friend to consume less energy for a fixed period of time.

LEY’s architecture relies on a game server and a support website where users must register in order to fill in details about their household, number of rooms, type of appliances, frequent activities so that the application can have a basis for comparison. Upon completion of this process, an electrical category is assigned

to each player. This prototype is not yet integrated in Facebook though it would greatly benefit from Facebook Connect[©] to become global.

The aforementioned prototypes, are just some examples of DEAP's extensive portfolio and were the ones chosen to be merged in a larger, cross-browser, online platform. Being aware that many other research centers over Europe and North America are also investing their time and resources in the persuasion field, we thought that a robust, versatile, and innovative prototype capable of joining together existing approaches would be a significant contribution. We also expect to draw solid ground for future investigation, by creating the tools to test whether multiple persuasive applications have greater impact on players when acting as a group than when applied separately.

1.3 Main Contributions

The main contributions expected from this thesis are:

- Create a platform within Facebook to integrate pro-environmental games provided an existing communication channel with this social network;
- Provide the tools to understand if the persuasive power of applications that foment behavioral change are more powerful as a group than isolated;
- Test if users are specially motivated to play when competition factors are at stake and whether or not they are willing to share their results (privacy issues) and improve their performance stimulated by their virtual friends;
- Study the potential impact of social recommendation inherent to social networks as a mean to promote existent applications inside the DEAP project;
- Provide a way to associate *credibility*, an important factor when it comes to persuasion, to the platform itself enhancing mini-games developed by external companies that want to present themselves as "Green";
- Create a bridge from the academic domain to real projects conducted by private institutions and non-governmental organizations. Leveraging the expertise of these groups to create content and understanding their own methods to reach a broad audience can only be advantageous to our work;
- Allow future surveys about citizens' behaviors and pro-environmental attitudes to a broader target, through it's viral distribution throughout the Web.

1.4 Document Organization

To make it easier for the reader to consult information as needed we decided to split the contents of this thesis in subject-specific chapters organized in a sequential manner, expressing the evolutionary path taken by our team during research:

Chapter 2 - The next chapter describes the state of the art in the fields that directly relate to persuasion, such as the study of computers as persuasive tools stimulated by professor Fogg³ with examples of applications which implement these mechanisms with altruistic goals (e.g. aid elderly people to take medication in time, help people to stay fit and keep a healthy diet, promote environmental habits at home and in the office). Psychological concepts, such as locus of control, verbal commitment, cognitive dissonance, among others, that are important to understand how people react are also considered although they do not have a straight connection with persuasive technology. Other internal and external factors will be briefly covered since they can help us understand our target, namely, their educational level, demographic distribution, environmental knowledge and economic priorities;

Chapter 3 - The third chapter of this thesis details the design process of our game, including a thoroughly explanation of each conducted stage, from the initial idea to use the popular board game, Monopoly, as an inspiration and how it was adapted to our specific context to the final prototype's deployment. Moreover, we shall characterize our target, through a user analysis, identify the main tasks that our users should be able to complete in Greenpoly, as well as, the primary and secondary goals we want to accomplish with the release. Several details on how we structured the interface, the importance of using an affective pedagogical agent and the creation of the wrapping scenario were also included in this chapter;

Chapter 4 - Opting for an iterative approach, we created a low-fidelity prototype of the final product. Aimed with a cardboard representation of our idea, we tested this paper prototype with a test group composed by twenty users, from which only six were experienced users. Participants were asked to fill out a survey regarding Greenpoly's usability and comment on the relevance of its underlying purpose. Without any programming skills involved and with very much at stake we managed to bring the idea to judgement by

³<http://www.bjfogg.com>

both inexperienced and expert users of computer systems. The results of the conducted observations are covered in this chapter;

Chapter 5 - Chapter five includes an exhaustive analysis of the implemented prototype without sparing details about the technical decisions which we went through during the development process. Firstly, a brief but elucidative comparison on the different game engines available. Secondly, the choice between Flash and third-party plugins, including technological limitations and target suitability. Following, Greenpoly's architecture, database model, localization, data interchange protocols and other technical specificities are disclosed. An interface description focusing on Greenpoly's main scenes, included puzzles and plugins, as well as, important game dynamics makes up the third part of this chapter. Finally, partnerships with popular organizations are discussed covering some of the most interesting benefits we leveraged from their expertise in the matter, such as free advertisement, volunteering initiatives and rewards;

Chapter 6 - In this chapter we present and discuss the usability surveys conducted, under six different categories: users' profile, perceived credibility, interface evaluation, our partners, Greenpoly's social features and impact on players' everyday life. Some of the results are followed by brief explanations which are subject to our personal interpretation. The social buzz which preceded Greenpoly's release is also covered in this chapter, as well as, some preliminary conclusions drawn from the results obtained by both surveys and generated metrics;

Chapter 7 - We finish this document by revisiting each of the main contributions we expected to achieve with Greenpoly's deployment. As it was vital to follow the scope defined for this thesis we took some time here to outline key recommendations for future work. This, includes revealing some minor pitfalls present in the latest version, suggesting, for each, a possible solution;



Finally, in order to speed up the understanding of our prototype we opted to include, as an appendix, the installation instructions on Windows and Mac operating systems. There isn't a version of Unity's plugin for Linux at the time of this writing thus a guide for this OS was not included. In addition, a copy of the letter sent to WWE, asking for their help, was also appended to this document.



Related Work

This chapter details some of the scientific research that has been done all over the world in the domain of *persuasive computing*. It aims to give an overview of the latest advances in this field by inspecting some of the most recent academic achievements. In order to fully understand the base concepts, we will, in the following chapters, cover the ground work and theoretical principles underlying the theme of persuasion, including a thoroughgoing definition of the term *captology* coined in 1996 by the researcher and professor B. J. Fogg who used it to describe the overlap between persuasion and computers. First of all, however, we shall scrape the ethical issues that naturally arise when talking about changing people's behaviors and interfering with human psychic.

2.1 The Ethics of Persuasive Technology

In human history there have always been human persuaders in society, masters of rhetoric, men capable of changing others' minds and shape their behavior. Until recently, technology was just a tool often used by persuaders to achieve their intents although not persuasive on its own. In a document entitled "Charismatic Computing" handled by a PhD student in 1997, experimental psychology was used for the first time to demonstrate that computers can indeed change people's thoughts and attitudes in predictable ways. Ten years later, the author of this

study, created a Stanford course about what he calls “Mass Interpersonal Persuasion” where he teaches about the role that social networks have in modeling users’ choices by making them part of a larger, virtual community with similar social rules than its real counterpart. In his book, professor B. J. Fogg states that by examining the intentions of those who create persuasive technology, the methods used to persuade and the foreseen outcome, it is possible to assess whether it is ethic or not. He also states that some intentions are almost always good, such as promoting an healthy lifestyle and, not surprisingly, raising awareness towards environmental issues which is the ultimate driver of this thesis.

Moreover, Daniel Berdichevsky and Erik Neuenschwander suggest, in their paper, eight rules to follow during persuasive technology design [4]. While these rules fall out of the scope of this thesis and can be consulted in the aforementioned study we would like to draw the attention of the reader to two of the principles referred by Erik and Daniel, which have special importance to our case:

The Disclosure Principle - Some persuasive methods depend on persuaded parties not realizing they are being persuaded, or, more often, not realizing how they are being persuaded. It has been proved that knowledge of the presence of persuasive mechanisms in a technology may sensitize users to them and decrease their efficacy. As creators of a persuasive system we have disclosed our motivations, methods and intended outcomes thus holding ourselves responsible for all reasonably predictable outcomes of our work;

The Accuracy Principle - Persuaders often tweak the truth or ignore it entirely. Computers, in particular, can lie with equanimity, showing information that appears to be trustworthy and taking advantage of the natural trust that people tend to have on these devices [41]. Furthermore, people do not expect dishonesty from technology, nor do they have any instinctive aptitude for detecting it. To ensure that our information was as reliable as possible, we asked external organizations, without any economical interest in our prototype, to provide the contents used in the application. As a consequence, we could not only leverage their expertise on the field, but also guarantee that the information being passed was truthful and unbiased.

Although important in the higher level field of psychology, as creators of a computer prototype we are particularly concerned with unethical behavior directly related to technology itself. As a result we based the early design of our product on the following key issues [14] suggested and reviewed by BJ Fogg:

The Novelty of the Technology Can Mask Its Persuasive Intent - Ethical issues are especially prominent when computer technology uses novelty as a distraction to increase persuasion. When dealing with a novel experience, people not only lack expertise but they are distracted by the experience, which impedes their ability to focus on the content presented. As a result, people may be unaware of the ways in which interactive computer technology can be designed to influence them, and they may not know how to identify or respond to persuasion tactics applied by the technology;

Persuasive Technology Can Exploit the Positive Reputation of Computers - Another fact to take into consideration is that when it comes to persuasion, computers also benefit from their traditional reputation of being intelligent and fair, making them seem credible sources of information and advice. While this reputation isn't always warranted it can lead people to accept information and advice too readily from technology systems. Ethical concerns arise when persuasive technologies leverage the traditional reputation of computers as being credible in cases where that reputation isn't deserved;

Computers Can Be Proactively Persistent - Yet another advantage of computers is persistence. Unlike human persuaders computers don't get tired. In fact, they can implement their persuasive strategies over and over and keep persuading, even if users are not using the application (e.g. spamming a user's email box). Such proactive attempts to persuade can have a greater impact than other persistent media and turn unethically rather quickly;

Computers Control the Interactive Possibilities - When dealing with human persuaders, you can stop the persuasion process and ask for clarification, argue, debate and even negotiate. By contrast, when you interact with computing technology, the technology ultimately controls how the interaction unfolds. You can choose either to continue or stop the interaction, but you can't go down a path the computer hasn't been programmed to accept;

Computers Can Affect Emotions but Can't Be Affected by Them - Computing products don't read subtle cues from people, but they do offer emotional cues, which can be applied to persuade. When dealing with someone who is trying to influence us, we expect ethical persuasion to include elements of empathy and reciprocity. But when dealing with interactive technology, there is no emotional reciprocity;

Computer Cannot Shoulder Responsibility - The final ethical issue unique to interactive technology involves taking responsibility for errors. On one hand to be an ethical agent of persuasion, one must be able to take responsibility for those who he persuades. On the other hand, in cases where they lead people down the wrong path, computers can't shoulder the blame.

Alone, or combined, the six factors previously outlined give interactive computing technology an advantage when it comes to persuasion. Before closing this section we feel that it's important to briefly cover the intended *versus* unintended outcome flowchart [4] and its implications in our study.

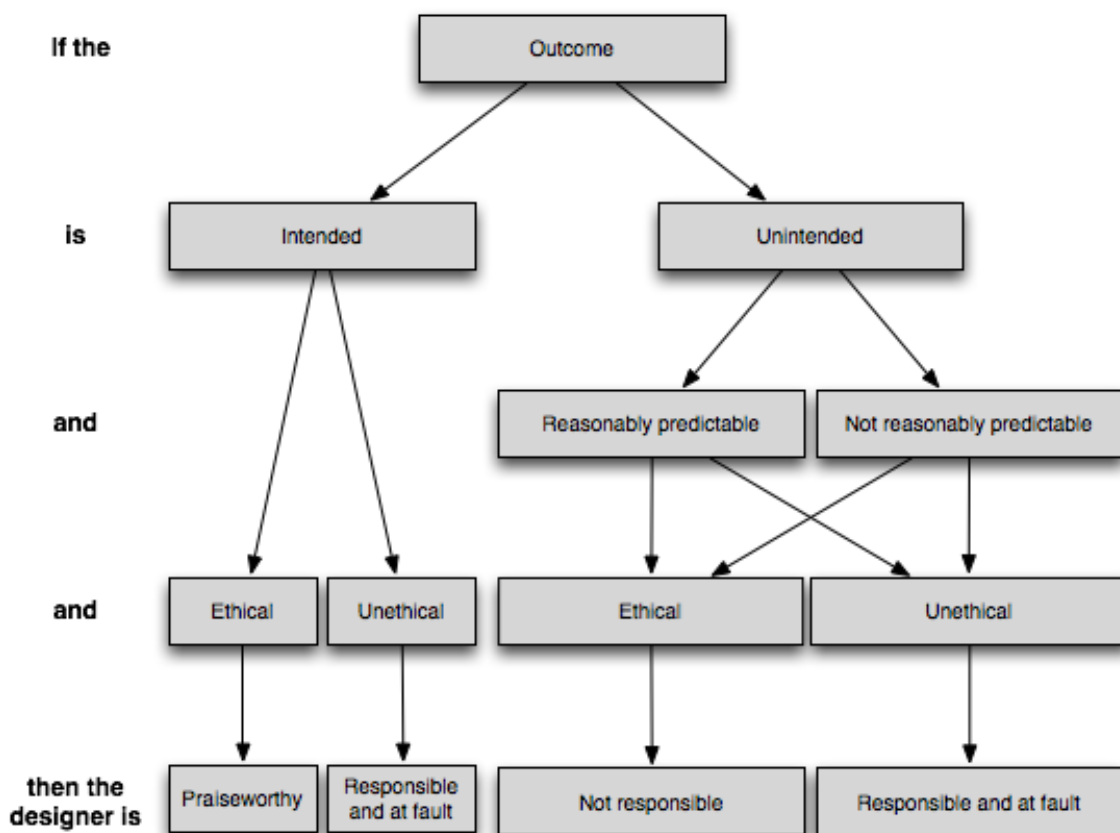


Figure 2.1: The ethics of a persuasive technology based on its perceived outcome

If we agree to classify environmental awareness as a benign intended outcome, we shall expect to have a final prototype which complies with the aforementioned rules. However, if the current fragile climatic situation that we live in was not value-laden we would be incurring in a faulty research, compelling users to something that they don't believe in. As such, we have put together, in the following section, a fair number of studies that aim to prove that environmental

threats are a pressing and high-priority problem.

2.2 Environmental Awareness

Our demand on the Earth, as represented by our *ecological footprint*, is growing, whereas Earth's capacity for sustainable production and its ability to absorb CO₂ emissions [47] are diminishing. At our current rate of consumption, our planet needs one and a half years to produce and replenish the natural resources that we consume in a single year. This is alarming because Earth provides for all our basic needs, such as food, water and energy. In the last four decades humanity's global ecological footprint has more than doubled as people started consuming non renewable resources at a faster rate than they could regenerate and releasing more CO₂ than ecosystems could absorb (see figure 2.2).

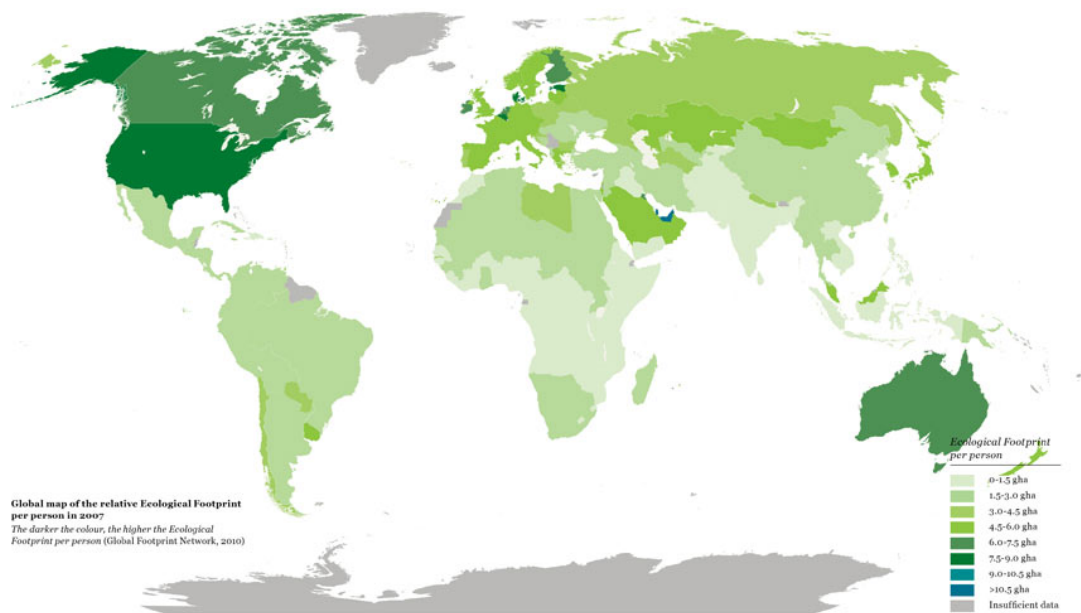


Figure 2.2: Global map with the relative ecological footprint per person [47]

2.2.1 The Need for Pro-Environmental Behaviors

As we can read in Wikipedia's definition of biocapacity, it is "the capacity of an area to provide resources and absorb wastes". Unfortunately, natural resources are not evenly distributed throughout the world, which becomes clear if we think that only three countries (Brazil, China and the United States) account for over 60 per cent of all of the productive land on Earth [47]. All the remaining countries,

Portugal included, depend, for a significant part of their consumption, on imported resources sourced from elsewhere around the world. On top of this, it is known, that not everybody has the same standard of living, which means that humanity's use of resources is unevenly distributed. It has been proved that first-world countries are the ones responsible for disproportionate demands on the available supplies. As a consequence, changes in land cause significant losses in biodiversity. Whilst everyone depends on their surrounding ecosystem and its natural assets, and hence biodiversity, the impact of environmental degradation is felt most directly by the world's poorest and most vulnerable people.

Water, in particular, is both the source of life and a scarce resource. Water covers around 70 per cent of the Earth's surface, yet only 3 per cent of it is freshwater. With less than 1 per cent of the Earth's water currently accessible for direct human use, experts stress that there won't be enough water available to meet both human and environmental needs if it isn't well managed. Moreover, freshwater is poorly distributed over the globe, and within river systems there are limits to how much water can be used. Although a large water footprint is not necessarily bad, the same can't be said about the destruction of the ecosystems from which we take our water supplies to such a degree that is irreversible.

Equally important to us, humans, are the forests. They provide us building materials, wood, fuel, oxygen, food and medicinal plants. Furthermore, they store carbon, help regulate the climate, mitigate the impact of floods, landslides, and other natural hazards, and purify water. They also contain nearly 90 per cent of the world's terrestrial biodiversity, including the pollinators and wild relatives of many agricultural crops. Regarding the previous topic, it is known that forests are vitally important as watersheds. Because of the thick humus layer, loose soil, and soil-retaining powers of the trees' long roots, forests are capable of preserving adequate water supplies. It is also worth noting, that, almost all water ultimately comes from forest rivers, lakes and forest-derived water sources. In addition, forests provide shelter for wildlife, recreation and aesthetic renewal for people, and are irreplaceable supplies of oxygen and soil nutrients. Deforestation, particularly in the tropical rain forests, has become a major environmental concern, as it can destabilize the earth's temperature, humidity, and carbon dioxide levels. Efforts to control deforestation, including those at the 1992 United Nations Conference on Environment and Development, remain ineffective.

Fortunately there are a number of things that everyone can do to change the direction towards which our planet is going. First of all, our definition and measurement of prosperity and success needs to change. In recent history, income and consumption have become important facets of development instead of personal and societal well-being. Truth is that above a certain income level, more consumption does not dramatically increase social benefits, and further increases in income per capita do not significantly increase human satisfaction. There is also a growing recognition that, in addition to income, well-being includes social and personal elements that together allow people to lead lives they value.

Additionally, in order to live in harmony with nature we also need to invest in it and not take it for granted. A building block of this has to be the adequate protection of representative areas of our forests, freshwater areas and oceans. Moreover, we should strive as citizens to guarantee an equitable distribution of energy, water and food across nations by managing our own demands on such resources.

2.2.2 Barriers to Pro-Environmental Behavior

The oldest and simplest models of pro-environmental behavior were based on a linear progression of environmental knowledge leading to a pro-environmental attitude and concern, which in turn was thought to lead to pro-environmental behavior (Figure 2.3). However, these rationalist models were soon proved to be wrong [26]. Yet today, most environmental Non-Governmental Organizations still base their communication campaigns and strategies on the naive assumption that more knowledge will lead to more enlightened behavior. To increase our chances of changing people lifestyle to a more ecological one we shall analyze some of the factors that have been found to have some influence, positive or negative, on pro-environmental behavior such as demographic factors, external factors (e.g. institutional, economic, social and cultural) and internal factors (e.g. motivation, environmental knowledge, values, responsibilities and priorities).

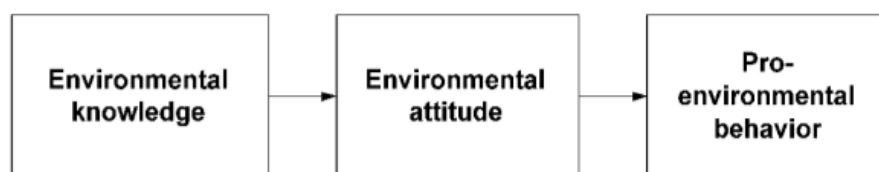


Figure 2.3: Early model of pro-environmental behaviors

2.2.2.1 Demographic barriers

Two demographic factors that have been found to influence environmental attitude and pro-environmental behavior are gender and years of education. Women usually have a less extensive environmental knowledge than men but they are more emotionally engaged, show more concern about environmental destruction, believe less in technological solutions, and are more willing to change [26].

2.2.2.2 External barriers

Even if people want to take action and make their own contribution towards the Environment, it can only be possible if the necessary infrastructures are provided (e.g. recycling bins, public transportation). The poorer such services are, the less likely people are to use them. These institutional barriers can be overcome mainly through people's actions as citizens (indirect environmental actions).

Economic factors have a strong influence on people's decisions and behavior. When faced with the decision between two possible products, one energy-efficient and one that it's not, people tend to choose the energy-efficient one only if the payback time for the energy-saved is very short. The economic factors that play into people's decision are very complex and only poorly understood. Yet people can be influenced by economic incentives and they should not be forgotten when designing new policies and strategies that are meant to influence and change people's behavior. Later on this document we will explain how such economic influence have been taken into account during the design process.

Last but not the least, social norms, cultural traditions, and family customs all play an important role in shaping people's beliefs. As a consequence, if the dominant culture propagates a lifestyle that is unsustainable, pro-environmental behavior is less likely to occur and the gap between attitude and action will widen.

2.2.2.3 Internal barriers

Even though demographic and external factors may influence people's likelihood to behave pro-environmentally, ultimately, it's their own decision to make. For such judgment, a person should be familiar with the existing environmental problems and their causes. To such extent *knowledge of issues* is important but not enough *per se*. Moreover, one must know how to act to lower his or her impact on the environmental problem thus gaining *knowledge of actions' strategies*.

Locus of control represents an individual's perception of whether he or she has the ability to bring about change through his or her own behavior. People with a strong internal locus of control believe that their actions can have significant impact while those with an external locus of control, feel that their actions are insignificant and that change can only be brought about by powerful others. Two other factors regarding attitude change are *commitment* and *individual sense of responsibility*. People with a greater sense of personal responsibility are more likely to engage in environmentally responsible behavior as are the ones who communicate willingness to take action through verbal or written commitment.

Finally, to overcome the previous barriers one must be motivated. *Motivation* can be defined as the reason for a behavior or a strong internal stimulus around which behavior is organized. It is shaped by intensity and direction and can be overt or hidden, conscious or unconscious. People may have an abstract willingness to act but usually they are easily restrained by the more immediate, selective needs (e.g. being comfortable, saving money and time). Motivation can be achieved by positive reinforcement which can be intrinsic (e.g. satisfaction for doing "the right thing"), or extrinsic (e.g. recycling can be a socially desirable action). In figure 2.4 there is a more evolved model than the one presented before (fig. 2.3). Although it adds more factors that explain the *Value-Action* gap, it still misses some psychological reasons that prevent us humans to change our attitudes, such as apathy, resignation, selfishness, and, naturally, priorities.

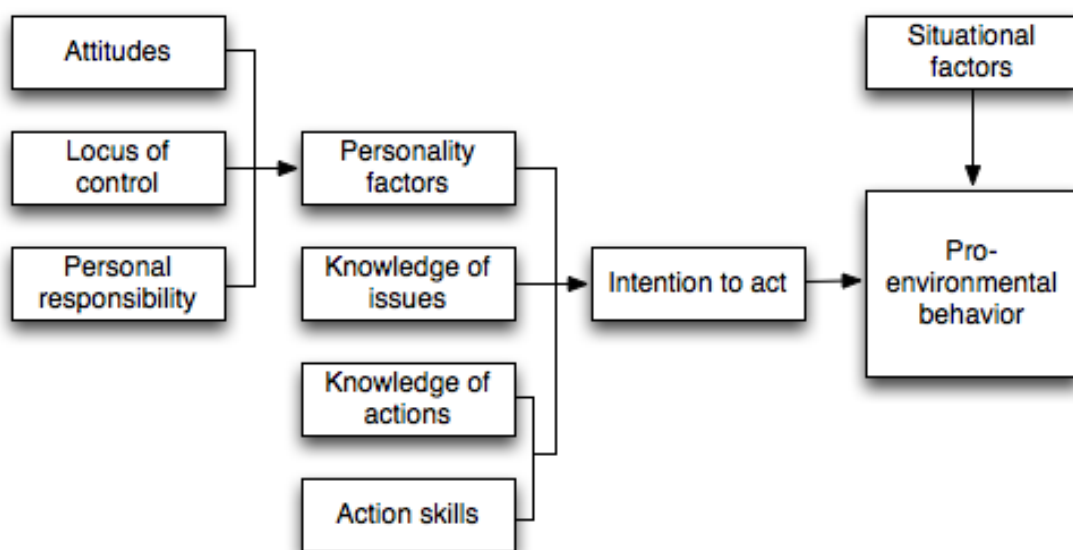


Figure 2.4: Model of predictors of environmental behavior

Provoking the stimulus to change and keeping people motivated can be very challenging. Persuasive techniques, through technological means, have already succeeded in several case studies around the world (some examples are provided in the end of this chapter). In the next sections of this chapter we shall cover the theoretical background behind those attempts as well as the emerging field of mass persuasion, where social networks play a major role.

2.3 Persuasion

The term persuasion is defined as non-coercively changing one's attitudes or behaviors but has been subject of great controversy and kept changing over the years [7]. Social psychology, the first scientific area to address this topic, assigns a number of variables to persuasion, which in turn can be divided into the broad categories of source, recipient, message and context. As persuasion tries to alter the way others think, feel, or act, it is a form of attempted influence, but not the only one (see figure 2.5). In fact, there are at least two other forms of attempted influence: material inducements and coercion. For being ethically dubious we shall ignore the latter ones and focus on sending a persuasive message to an audience with the intention of changing specific viewpoints but ultimately leaving the decision to the receiver.

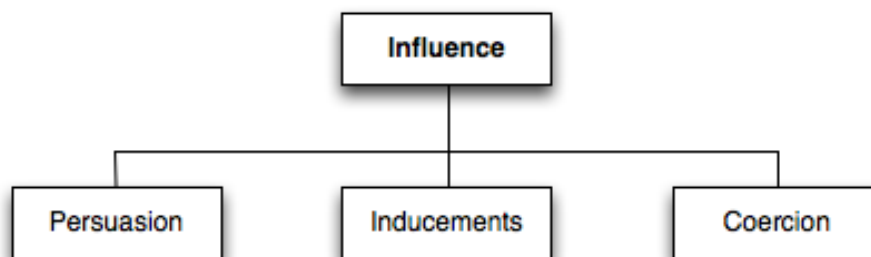


Figure 2.5: Forms of influence

Types of persuasion

Influencing others through persuasion began with interpersonal communication and consisted of verbal and non-verbal forms of behavior, personal feedback, coherence of actions and an intent to change the persuadee. With the proliferation of technology in the early 90's, persuaders took advantage of, increasingly easier to access, computer products to reach a broader audience and leverage their unique features (see computers as tools), giving place to computer-mediated persuasion.

Recently, a third type of persuasion has been rising (Figure 2.6) and focus on how people are persuaded when interacting with computer technology, or, in other words, in human-computer persuasion.

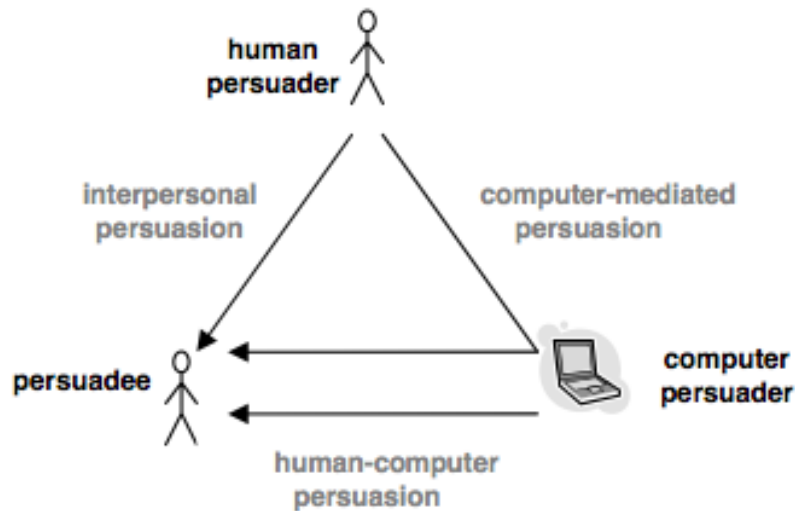


Figure 2.6: Three types of persuasion

Common approaches

Marja Harjumaa and Harri Oinas-Kukkonen have synthesized four main theories that try to explain the persuasive communication process: information processing theory, consistency theory, the Elaboration Likelihood Model and Cialdini's functional approach [20]. As the authors describe, information processing theory treats the individual being persuaded as an information processor, who in order to be persuaded, must both receive and understand the message and accept or yield to it. Alternatively, the key idea of cognitive consistency is that people want their views about the world to be organized and consistent, while psychological inconsistency (also called cognitive dissonance) disturbs people leading them to reorganize their thinking as a driver to restore consistency. In addition to these two theories, there are also two other, more recent and more common approaches. The Elaboration Likelihood Model (ELM) is a general theory of attitude change which relies on two routes to persuasion, a central and a peripheral one. An individual who carefully evaluates the content of the persuasive message may be persuaded by the central route, while an individual who is less thoughtful and uses a simple cue (e.g. the source or length of the message) or a rule of thumb (e.g. "more is better", "experts can be trusted", "consensus implies correctness") for evaluating the information may be persuaded through the peripheral route.

Lastly, Cialdini identifies six influence techniques that explain people's tendencies to comply with a request: reciprocity, commitment and consistency, social proof, liking, authority and scarcity [10].

All these approaches share the assumption that true persuasion implies an intent to change attitudes or behaviors, or, in other words, persuasion requires *intentionality*. As such, since machines do not have intentions, a computer qualifies as a persuasive technology only when those who create, distribute, or adopt the technology do so with an intent to affect human beliefs [13].

2.3.1 Persuasive Technology

While the study of persuasion in psychology remotes back to the ancient Greece, the study of computers as persuasive technologies is relatively new. Fogg coined the term "captology" to describe the emerging area which focuses on the design, research, and analysis of interactive computing products created for the purpose of changing people's attitudes or behaviors. Fogg also identified two levels of persuasion: macro and micro. Apart from failing to have an overall intent to persuade, "microsuasion" elements can be designed into dialogue boxes, icons, or interaction patterns between the computer and the user to enhance behavioral change. Video games, for example, are exceptionally rich in this form of persuasion. This is because their overall goal is to provide entertainment, not to persuade.

2.3.1.1 Computers as Persuasive Agents

In order to explain the roles that computers can play as persuasive agents, a framework known as the functional triad was defined [13]. It shows that interactive and computing technologies have three possible roles: tool, media and social actor, which help capturing how people use or respond to any computer device.

First Role: Tool

Computers are essential tools that help us fulfill our needs. When acting as tools, computers can make a target behavior easier to achieve, influence and motivate people in specific ways, leading them through processes and performing measurements that show their results in real time. But before we specify the potential of these machines, let us first define *what* is a persuasive technology tool exactly:

“A persuasive technology tool is an interactive product designed to change attitudes or behaviors, or both, by making desired outcomes easier to achieve.” [14]

For purposes of captology, there are seven types of such persuasive tools: *Reduction*, *Tunneling*, *Tailoring*, *Suggestion*, *Self-Monitoring*, *Surveillance* and *Conditioning*. Any of them may be applied into a product separately or in combination. Given their importance during the design process we felt that a brief but enlightening definition of each of them should be included.

Reduction's main goal is to simplify complex behavior thus improving the user's confidence to overcome challenges on his own;

Tunneling intends to guide users, through a process or experience, which provides opportunities to persuade along the way;

Tailoring is usually used when designers plan to persuade through customization. By providing information which fits the user's needs, interests or opinions, designers aim to lower their resistance to external influence;

Suggestion regards intervening at the right time with recommendations for specific actions. Suggestion takes advantage of the right or opportune moment to enhance the persuasive power of the given advice;

Self-Monitoring allows people to monitor themselves in order to change their attitudes or achieve predetermined goals. When subject to positive *feedback* about their performance or status, users are less likely to give up trying;

Surveillance comprises *observing* and sometimes even accessing other people's information. Several studies show that people have a tendency to copy or act in such a way that conforms with their close friends, family or role models. Surveillance is at the moment, the most common persuasive technology in the market, mainly due to the power and extension of social networks;

Conditioning makes use of positive reinforcement to shape complex behaviors. It states that seldom acts may turn into habits by frequent repetition.

In many cases, effective persuasion requires using more than a single tool or strategy, but there should always be a natural synergy between the proposed set of actions and the intended outcome in order to minimize unintended effects.

Second Role: Medium

When computers act as a media, persuasion can be achieved by allowing people to explore cause-effect relationships, providing new and different outcomes that may help them understand the consequences of their acts in a quick, graphical and representative way. Through simulations of the real world, it is possible to imitate experiences and create non-real scenarios that could be felt as real. Three classes of computer-based simulations can be considered:

Cause-and-effect explores the philosophical concept of causality. By compressing time, a computer simulation can immediately show the link between cause and effect, which can lead people to reconsider their behaviors. Some popular applications that adopt this type of simulation are games and information systems that help people to learn about specific topics, like cancer spreading, sexually transmitted diseases or long-term lung consequences from smoking habits;

Environment is often based on computer generated scenarios that provide immersive surroundings within artificial worlds. By providing a motivating simulated environment where users can rehearse a behavior, chances are that they will adjust their actions in the real world (virtual rehearsal);

Objects are the opposite of environment simulations, because they are implemented in a real world setting (e.g. augmented reality). This makes the simulation less dependent on imagination, fitting into the context of a person's everyday life and making clear the impact of certain actions.

As it has been stated, there are several ways for computers to play as media or simulations, but all of them use experience as a basis to persuade the user.

Third Role: Social Actor

Computers are usually treated as living beings, because people get very attached to them, creating a special bond with the computer device. Consequently, computers may take this as an advantage to apply the same persuasion techniques that humans use to influence others, either by returning positive feedback, shaping a target behavior or attitude or even providing social support. The computing products as persuasive social actors, act by giving users a range of social cues in order to extract social responses from them, such as:

Physical refers to computing products that can convey physical cues through face, eyes, body, among others, which enables them to transmit a social presence. It is believed that the use of visually attractive elements in a computer product has a higher chance to cause an emotional reaction;

Psychological encloses all the properties which emulate human emotions, motivations, interests and ultimately a personality. Through these characteristics the intent is to make the product a friendly figure that the user can have a nice time with. Furthermore, it has been proved that people are less resistant to suggestions from software products that are similar to themselves;

Language regards the way computer products “talk” with users. Language style can lead them to be more receptive or, on the contrary, provoke or cause distress. Language should have no mistakes, fit the target group and if reasonable apply positive reinforcement as it eases people response;

Social Dynamics comprises the unwritten rules for interacting with others. In this context, the main concept is reciprocity, which means that people feel the need to give back when they believe they have been given a favor;

Social Roles are easily simulated by computers, and can, through the principle of authority, enhance the power of persuasion.

To sum up, each corner of the functional triad (figure 2.7) comes with its own set of persuasion techniques which can be applied to evaluate existing computer products or help designing new ones, by drafting scenarios where the product acts as a tool, a medium, a social actor or some combination of the three.

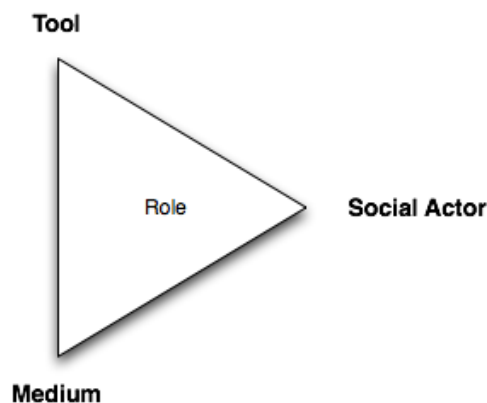


Figure 2.7: Functional triad of persuasive technology

Besides being the most accepted framework for analyzing persuasive technology, Fogg's functional triad is not the only approach to the subject. In fact, there is already a modified theory which identifies two conceptual uses of technology (rather than Fogg's triad), namely *active* and *passive* persuasion [40]. The author perceives persuasive technology as a nested Venn diagram (see figure 2.8) where all technology acts as a tool. When we go deeper towards the center of the diagram we reach passive design, which can be programmed or designed into the technology. This level of persuasive design seeks to elicit a response from the target that is largely conditioned and requires a low level of cognitive process, perhaps triggered by the perceived expertise of the technology sending the message (credibility), attractiveness and likability of the technology (anthropomorphic design), and directed cues that suggest the best decision to make. Finally, the innermost circle, active design, is the one where the target takes a direct, cognitive route to deciphering the argument and making a judgment on it.

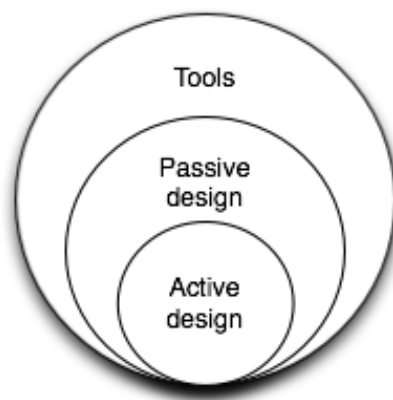


Figure 2.8: Progressive design concept

We believe that both approaches have drawbacks and should be applied cautiously. On the one hand the functional triad was a huge contribute to the field by filling many of the conceptual gaps and leveraging existing persuasive tools from sociology to adapt and implement new ones in computing products. On the other hand it may be too general to be consistently executed in such a wide range of possibilities that persuasive technology can take. Shearer's study, besides requiring a great deal of revision and refinement is probably too narrow and overly focused on the Elaboration Likelihood Model to replace Fogg's framework but is certainly a reminder that a consensus has yet to be reached and the use of persuasive elements through technology is live and open for further improvements.

2.3.2 Credibility and Persuasion

Regardless of which approach designers adopt or the goal they aim to persuade people into, when the goal is to change people's behaviors, credibility matters. For most of computers' brief history, users have held these machines in high regard, mainly because computer-based information have been marketed as better, more reliable and more credible than its human counterpart. Recently, however, with Internet's popularization and the proliferation of less than credible websites the cultural myth of highly credible computing machines is fading [41]. Experts in the field agree that credibility is a perceived quality, which means that it doesn't reside in an object, a person, or a piece of information, but in the mind of the viewer. Academic literature dating back from the 50's have already addressed several dimensions which, when combined, allow for the evaluation of credibility. From where we stand, two of these dimensions are specially relevant: *trustworthiness* and *expertise*. The trustworthiness dimension of credibility captures the perceived goodness or morality while the expertise dimension captures the perceived knowledge and skill of the source [4].



Figure 2.9: The two key dimensions of credibility

One of the first conceptual frameworks for identifying credibility sources was suggested by Fogg and Tseng in the late 1990s [41] and consisted of:

Presumed credibility rates how much the perceiver believes someone or something because of *general assumptions* in the perceiver's mind. Presumed credibility may be based on existing stereotypes or pre-conceived ideas;

Reputed credibility rates how much the perceiver believes someone or something because of what *third parties have reported*;

Surface credibility rates how much the perceiver believes someone or something based on *simple inspection*. Commonly referred as "first impression";

Experienced credibility rates how much the perceiver believes someone or something based on *first-hand experience*, which should happen for a significant amount of time.

We have confirmed (chapter 6) that our prototype is perceived as highly credible since it fits in all previous categories. Being an educational, non-profitable prototype we guarantee that, to our best knowledge, the information provided is unbiased and trustworthy. Further, in order to play, users must be invited by their friends or online peers thus reputed credibility is achieved by means of recommendation. Additionally, the fact that this research was funded by a *respected* organization - Fundação para a Ciência e Tecnologia - was also disclosed. Color use, layout, navigation, icons, writing style, fonts along with other visual properties were carefully weighted to create a positive first impact and are the subject of the next chapter. Finally, all factual data supplied in the game was provided by non-governmental organizations leveraging their expertise in the field.

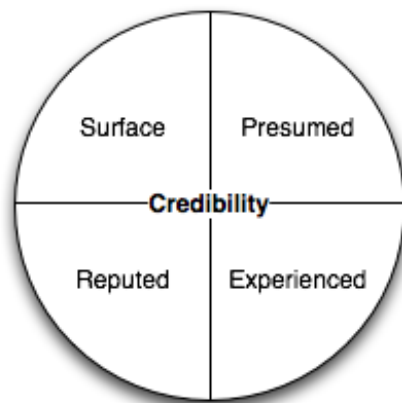


Figure 2.10: Conceptual framework with four types of computer credibility

We end this section with a reference to Hovland’s experience [22] on the influence of source credibility. Despite showing no significant difference in the amount of factual information acquired by subjects when the material came from a high credibility source as compared to the amount learned when the same material was attributed to a low credibility one, the same wasn’t true for user beliefs. As a matter of fact, meaningful variations exist in the extent to which opinion on an issue depends on the credibility of the source. In this study, subjects changed their opinion in the direction advocated by the communicator in a significantly greater number of cases when the material was attributed to a high credibility source than when attributed to a low credibility one. Moreover, the existence of what is known by “the sleeper effect”, which describes a situation where people are more likely to change their opinion in the direction of the communicator’s position after a lapse of time than immediately after the communication, was also confirmed.

2.3.3 Mass Interpersonal Persuasion

“When Facebook came along I was one of the developers at the launch and what struck me was how there was this new form of persuasion. This mass interpersonal persuasion.” was the answer given by professor Fogg in an interview for BBC News¹. *“I believe this new way to change attitudes and behavior is the most significant advance in persuasion since radio was invented in the 1890s.”* he adds in his keynote address for the Persuasive Technology 2008 Conference [15]. For the first time in history Facebook has brought together six dynamics of persuasion in one place². In the following subsections we will develop further on each of these dynamics so that we understand how they can be combined and massively used.

Persuasive experience Besides their differences, both MIP and viral adoption focus on changing people’s thoughts and behaviors instead of simply amusing or informing them. In fact, Fogg argues that *“without a successful persuasive experience creators cannot achieve MIP”* [15]. In order to achieve this persuasive experience MIP may rely on existing social influence strategies, such as: compliance (e.g. direct request, moral appeal, deceit), ingratiation (e.g. giving compliments, conforming to others, presenting self, and rendering favors) and group-level intrinsic motivators (e.g. recognition, competition, and cooperation). Whether created by individuals or big companies, when using MIP, a creator always intends to make impact on people’s lives.

Automated structure Next, MIP relies on computers to automate the persuasive experience. If it’s valid that software can deliver a persuasive experience over and over, it’s not any less true that the same experience may be replicated endlessly to new users. The simpler it is to reach and persuade a large target the most appealing it is for developers to create applications.

Social distribution Although online social distribution was possible before any of today’s major social networks come into play, for the purposes of MIP, distribution within a structured social website like Facebook seems important if not vital [15]. Provided that every action in a social network like Facebook is attached to a real user which adds to the easiness of inviting and accepting invitations (sometimes just a couple of clicks away) there is just the right environment for social distribution to happen.

¹<http://news.bbc.co.uk/2/hi/technology/7357934.stm>

²<http://thesocietypages.org/thickculture/2008/11/07/facebook-mass-interpersonal-persuasion-and-the-public-sphere/>

Rapid cycle For social apps to achieve rapid cycle, the time between invitation, acceptance, and a subsequent invitation needs to be small, because not only does the level of involvement grow quickly with a rapid cycle, but the rate of involvement also goes up. High adherence and buzz around a topic helps forming momentum which is responsible for sweeping many people into a movement who could otherwise not get involved. For this reason apps that are designed to be easily shared among peers, usually achieve a greater audience than when the cycle for adoption and social distribution is slow.

Huge social graph An important component of MIP is having a huge social graph, or, in other words, a network of millions of people connected to one another. Facebook offers a huge social graph, about one billion monthly active users at the time of this writing³. In the context of MIP, more than companies and brands, what matters is the fact that millions of people now share an online bond and form potential distribution paths.

Measured impact The final component of MIP is measured impact. By providing basic statistics on an app's distribution and use, a social network, like Facebook, facilitates MIP in three ways. First, those who share the persuasive experience with their friends can get feedback on the success of their efforts. On the receiving side, visibility creates more pressure for the person who is invited since his social capital is at stake. Secondly, as stated earlier, when an experience gains momentum, people take notice and are more likely to join in, even without an explicit invitation from friends. Lastly, creators of social applications can test various approaches and see which option works best thus creating a constant cycle of testing and improving.

We have decided to describe the phenomenon of mass interpersonal persuasion because we agree with Fogg's statement that "*this new phenomenon gives ordinary individuals the ability to reach and influence millions of people*". As the power to persuade continues to become less centralized, with individuals having increased impact with personal blogs and home made videos we are walking towards a full democratization of persuasion which will certainly have an impact on how individuals and cultures make decisions and take action. Examples of such change can already be seen in social experiments to promote healthy habits, volunteerism or an eco-friendly lifestyle, to name a few. We finish this chapter with some of these studies so that we can bridge their conclusions to our own investigation.

³<http://newsroom.fb.com/Key-Facts>

2.4 Online Social Networks

The concept of online social networks (OSNs) such as Facebook emerged with the advent of Web 2.0. From that moment on, the focus of the Web moved from being centered on content, such as photographs or videos to the identity and the relationships between people [25]. Together with Web 2.0 technologies came the opportunity for users to establish social links between peers and share with them their private info, interests, home made content, aspirations and late breaking news at any time. Such services have engaged many people who now spend most of their online time in OSNs⁴, strengthening what is called in sociology by *social capital*. Generally speaking, social capital is the benefit derived from one's position in a social network, the number and character of the ties one maintains, and the resources those ties themselves possess. A few studies on how OSNs can enhance social capital, users' self-esteem and self-perception have already been conducted [8, 12, 43]. In this case, however, we are concerned about (1) whether people will use our application and how much impact will it have on their social capital and (2) whether players will share game based content with their peers or refrain from publicly post such information on their news feed.

OSNs can play an important role in environmental behavior change interventions. First, they may activate and enhance social support for the behavior change itself [37]. Second, they can contribute to increased adherence to the intervention and hence increase its potency to attract and hold the interest of users over time [37] and third they can reach a great audience in a very short period of time [35]. It has been proved that for users of these services what makes OSNs so attractive are their dynamic and social properties [37]. When subject to a pilot study on how consumers perceive OSNs it was consensual that the fast rate at which new information becomes visible is a major plus. "It has always happened something new since the last log-in" as one participant described and "The possibility to constantly click on something and discover something new makes it easy to spend more time on the sites than planned" as another added. Furthermore, OSNs are viewed as entertaining and an easy way to keep in touch with friends about their last whereabouts. In fact, features that facilitate social relations like the possibility to chat, comment on other people's walls, status fields, and pictures emerged as the most attractive aspects of OSNs.

⁴<http://thesocialskinny.com/100-social-media-statistics-for-2012/>

2.4.1 User Engagement

When designing a new social networking site, key behavioral goals for the service depend on users creating content, inviting others to join, and directly contributing to its value. Although users are not expected to contribute in the same way, there are specific influence strategies which encourage users to participate and return frequently to these sites. Fogg and Eckles suggest a generic behavior chain (Figure 2.11) which users often go through from the moment they learn about a new OSN to creating the very content that makes the service valuable [16].

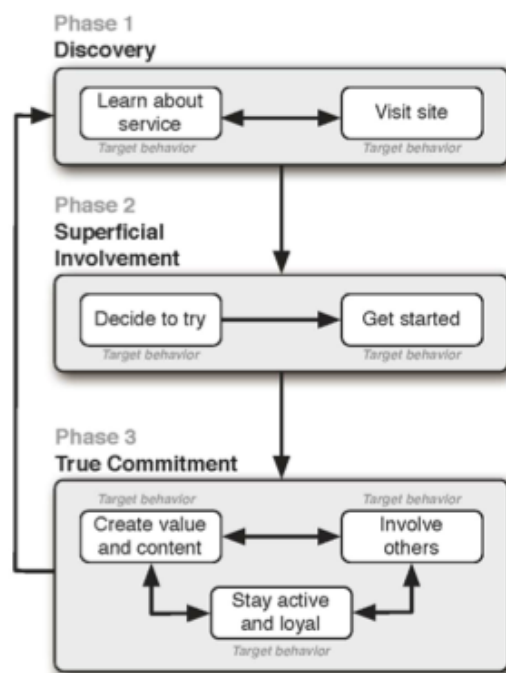


Figure 2.11: Behavior chain for online participation

Phase 1 - Discovery In the first phase of the behavior chain for OSNs, users become aware of a new web service either by learning about it or by visiting the site. Email from a friend, word-of-mouth, by traditional media or through a reference from other site are all possible sources of information for new users to learn about a particular service. At the same time, value created by existing users can stimulate new ones to explore the site;

Phase 2 - Superficial Involvement Successful OSNs are masters in getting users to try out their service usually by creating an account and completing their profile. Reduction is common at this stage since newcomers will be more likely to complete registration if its quick and easily accomplished;

Phase 3 - True Commitment In the previous phases, users become involved in the service but generally without making a large or permanent investment in using the site. Deeper investments come only when a user becomes loyal to the service by providing valuable content, involving others are returning often. To achieve true commitment web services try to create habits in users (e.g. persuading users to frequently comment in response to videos). The target behaviors of this phase contribute to a service's success in introducing and moving other users through the chain thus the path from Phase 3 to 1.

The behavior chain described above has two key implications for us, as designers of an application which is meant to be engaging. If on the one hand we want users to stay active and encourage repeated visits to our game, on the other hand, it is important that each user feels compelled to invite his friends in order to share the persuasive experience among a large audience. In their study Fogg and Eckles anticipate the development of new methods for evaluating successful patterns of behavior change online which can very well be applied in domains like health, gaming, or political action. Identifying the design implications that lead to a behavioral chain for our own purposes is the subject of the next chapter.

To sum up, social software has characteristics that make it suitable for use as a persuasive technology platform: it can cater to any interest, its content can be rapidly modified, and its members engage with its content [24]. Unlike many other persuasive technologies, it is collective, therefore calling into effect group dynamics that impact upon persuasion. Because people join voluntarily, those who affiliate to an online community are likely to be engaged with the thoughts and activities of other community members and consequently feel motivated to carry out actions of their own. Moreover, social networks generally allow members to access each other's contributions, whether these take the form of ideas, opinions, or perhaps experiences thus enabling *social comparison* as an important stimulus to change. This access also facilitates *social learning*, where people learn and are persuaded by the experiences of others. Finally, active participation in OSNs elicits a variety of other motivators, such as *social approval*, *group reputation*, *inter-group comparison*, *co-operation* and *self-regulation*.

2.5 Facebook

Facebook is a fine example of how OSNs can succeed. Launched in 2004 by the hands of Mark Zuckerberg and four other college roommates, this social networking service has seen a rapid growth since then. Although it's membership was initially limited to Harvard students, it gradually added support for students at various other universities before opening to high school students, and eventually to anyone aged 13 and over. As a curiosity, the name of the service stems from the colloquial name for the book given to students at the start of the academic year by some university administrations to help students get to know each other⁵.

Facebook in Portugal

Social networking statistics show that Facebook penetration in Portugal is 43.22% compared to the country's population and 89.77% in relation to number of Internet users. The total number of FB users in Portugal is approximately 5 million users and grew by more than 272 500 in the last 6 months⁶. The largest age group is currently between 25 and 34 followed by the users in the of age 18 and 24 (Figure 2.12). There is also 1% more male users than female ones (Figure 2.13).

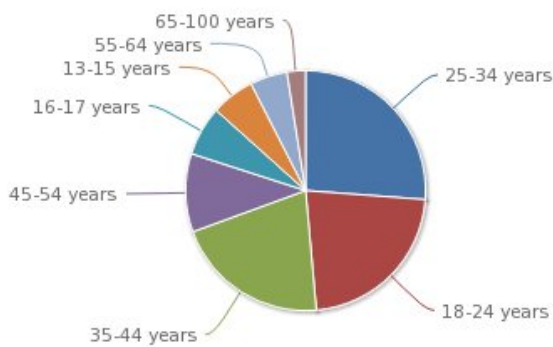


Figure 2.12: Distribution by age

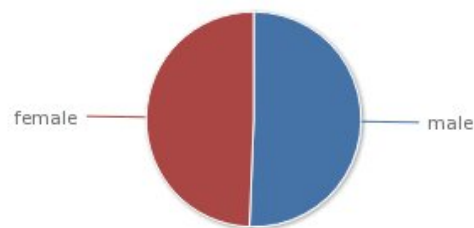


Figure 2.13: Distribution by gender

The aforementioned statistics did not happen by chance. In fact, the successful user persuasion in Facebook can be decomposed into community elements and persuasive factors as identified by one of Fogg's students back in Stanford University [27]. As he describes there are three fundamental online community elements, *content*, *community* and *activity* that when connected will keep users engaged.

⁵<http://en.wikipedia.org/wiki/Facebook>

⁶<http://www.socialbakers.com/facebook-statistics/portugal> (21/11/2012)

2.5.1 Facebook Persuasive Model

With the individual user in the center, Facebook makes use of three elements (represented in Figure 2.14 by its vertices) to enhance both self-perception and *social capital*. The former is facilitated through connections between users and those elements (e.g. completing their profile, playing apps, adding new friends, joining a community, fighting for a cause) while social capital is valorized through connections between elements and elements (e.g. posting in the Wall, joining social events, providing valuable content to the News Feed).

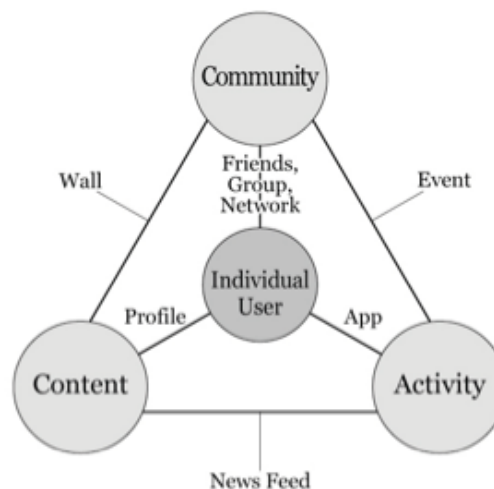


Figure 2.14: The persuasive model of the Triangle User Lock

Until now, traditional internet services have only focused on one or two vertices, failing to build up a persuasive model that can tightly lock users inside.

2.5.2 Facebook Developer Platform

In a successful attempt to improve user experience and increase the site's appeal, in May 2007, Facebook made a key innovation: they opened their platform to third-party developers⁷ which led to a 30% increase in this social network's traffic in just one week. Since then, developers are able to create social apps that augment Facebook's functionality or act as front-end to third party web-based services. This new paradigm is unique, because the risk of development and promotion investment in third party applications is much smaller than the risk of investing in stand-alone web applications [18]. This is mainly due to the simplicity of FB developer's API and for the advantages⁸ over other services.

⁷<http://developers.facebook.com>

⁸<http://tinyurl.com/yjxojx9>

Facebook is where the users are: An obvious reason for Facebook games' success is simply that Facebook has a lot of users. One billion monthly active users⁹ as of October 2012. If we compare that with the 63.9 million Playstation 2 units sold, or Microsoft's sale of 70 million Xbox 360 units or even Nintendo's greatest success Nintendo Wii which sold around 97 million consoles¹⁰ it becomes clear the dimension of Facebook;

Facebook apps market themselves The tight integration with a social graph gives Facebook applications great possibilities for viral growth since the platform automatically exposes application usage to friends and acquaintances, offering an implicit recommendation for the application by the players;

Facebook apps are free: For our purposes this is one of the most tempting aspects of Facebook. Having the chance to deploy a persuasive application, study its use by the selected target and extrapolate the results for academic purposes at virtually no cost makes this platform even more appealing;

Facebook apps are trackable: A Facebook game can be endlessly tweaked. The possibility to study the average number of users at a monthly basis as well as their opinion can determine the success and evolution path of the game;

Facebook apps are prototypes: Another huge advantage of Facebook games regards the short development time that is needed before deployment. Unlike traditional offline games which must be finished in order to be released, most Facebook games are only 20% complete at launch. As a consequence, the developer gets to test the product with its target, its adoption and major failures while in the early stages of the process;

Facebook apps leave Facebook: One of the most interesting developments at Facebook was Facebook Connect. Connect allows developers to use Facebook credentials and a user's social graph outside the core Facebook site.

However, social games also have some disadvantages. For example, having been developed specifically for OSNs, social games rely on HTTP/TCP traffic, whereas other online games employ UDP to cater the bursty nature of simultaneous multiplayer gameplay. Furthermore, traffic on social games is pull-based (the clients initiate the change, "pulling" the data from the server), whereas other online multiplayer games (e.g. CounterStrike and Half-Life) use a push-based

⁹<http://newsroom.fb.com/content/default.aspx?NewsAreaId=22>

¹⁰http://en.wikipedia.org/wiki/List_of_best-selling_game_consoles

(the server actively seeks to make updates to its clients) virtual broadcasting approach to disseminate information to players. This clearly limits social games to non-realtime gameplay [35]. Yet another disadvantage is the complexity affordable by social games. Running in Facebook's iFrame, these applications entirely rely on server's response delay, as well as, the loading time for the advertisement bar visible in the right side of Facebook's application page.

Even if deploying a new application into Facebook is tempting, getting people to use it in a daily basis, keep having fun, and perhaps recommending it to their friends is a completely different issue. Perhaps due to over 550 000 active applications on Facebook¹¹ some patterns have emerged in the way these apps attract and engage new users. Some of these patterns involve novel combinations of psychological dynamics that appear to be native to online social networks, whereas others are adapted patterns from other contexts [44]. In the following paragraphs we shall briefly describe each of the patterns presented below (Fig. 2.15):

	I. Native Patterns		II. Adapted Patterns
	1. Individually Directed	2. Group Directed	
A. Take Action	1A. Provoke and Retaliate <i>X Me, Bless you, Kiss Me</i>	2A. Reveal and Compare <i>Likeness, Send HOTNESS</i>	IIA. Competition <i>Scrabulous, Jetman, achievement "levels"</i>
B. Create Object	1B. Self-expression <i>Graffiti, Hatching Eggs</i>	2B. Group Exchange <i>SuperWall, BumperSticker</i>	IIB. Deceive <i>Fake Facebook buttons & install tabs</i>

Figure 2.15: Six patterns of persuasion typical to OSNs' built-in applications

Native Patterns

Native Patterns of persuasion rely heavily on functionality that OSNs provide. In Facebook, for example, users can call native functions to take actions or create objects that are either individually directed or group directed. In the following paragraphs, we will briefly explain each of these patterns.

Provoke and Retaliate Social applications that apply this pattern allow users to

¹¹<http://www.facebook.com/press/info.php?statistics>

interact based on the norm of reciprocity. Reciprocity can be either positive (e.g. hugging, blessing or kissing a friend) or negative, by means of revenge. Through Facebook's social graph (the term used to describe the social links between users), for example, this pattern can easily become a powerful persuader. Moreover, having no clear purpose, if a friend referred the user to a Provoke and Retaliate type of application, she freely installed it, and she even invited others to install it, a user concludes that it must be fun and is tempted to try it himself.

Expression As social beings we have a natural drive to create artifacts that express identity, opinions, and affiliations. Many of the applications in this genre, encourage people to share movies, songs, interests and often require large databases of content. The ability to express themselves in a consistent way leads users to return frequently after their first-time expressions.

Reveal and Compare Another common persuasive pattern is comparison. Reveal and Compare type of applications allow users to take group-directed actions thus enhancing mechanisms such as reciprocity, cognitive dissonance, the need to belong and social validation. Comparing friends to find out who shares which hobbies, reveal who is more attractive or to match single friends are some examples of this pattern's usage.

Group Exchange Like Expression applications, Group Exchange applications allow users to create artifacts. But unlike Expression applications, these artifacts are created collectively. Its success is mainly due to the confluence of several powerful factors: impression management, reciprocity, social validation, and context variables like feedback and applause.

Adapted Patterns

While previous patterns are tightly bond to social networks there is a second class of persuasive strategies that were created for other contexts (e.g. desktop software, web sites, video games) and then adapted to fit in OSNs.

Competition Competition is a persuasive pattern which appeared long before any of today's popular social networks. Games like Scrabble, Battleships or Poker conquered the crowd for the pleasure of winning. Competition motivates engagement in two ways: (1) internally, by tapping a user's need for cognition, and (2) externally, by tapping a user's need for social status.

Deception Deception exploits and undermines credibility and unlike other patterns, no application is based purely on this strategy. Deception applications use simple navigation paths to escalate commitment and often resort to visual similarities in order to fool users to unintended outcomes.

2.5.3 Case Studies

What role can OSNs play to support large-scale group action and change? In this section we hope to answer this question by covering some successful uses of persuasive applications in combination with social networking sites. Even though there is a plethora of environmental sites throughout the web, research suggests that including environmental information in content-agnostic social networks can be advantageous [29]. Wattsup is an innovative Facebook application which displays live data from a commercial energy monitor and also a fine example of how this kind of approach may succeed [17].



Figure 2.16: Screenshot of the Watts Up application

Energy meters were deployed and trialled in eight homes over an eighteen day period alternating between personal and social energy data view modes. Despite the fact that numerous studies had already demonstrated that energy usage falls when people know it is being monitored [17] these researchers wanted to prove that social networks could make it more enjoyable and less intrusive. According to them, after being interviewed, all participants said they had enjoyed

participating in the social condition which already proves a change of attitude towards surveillance. On top of that, several participants even mentioned the competitive attribute of the experience as being a motivating factor in reducing their energy usage, which combined with a significant reduction in household energy during the social condition makes these results very encouraging.

Another compelling case study, this time conducted by a research team in the university of Michigan have shown the importance of keeping users privacy when deploying group-directed applications[33]. Their experiment consisted on a Facebook application (3GT) that could support the *Three Good Things* intervention in which participants are stimulated to publish three situations that made them happy at a daily, or weekly basis. They included features that would enable people to write their positive experiences and decide whether to share them with other group members or with the general public. The answers obtained in this study showed that participants generally did not seek to share their good things with their entire Facebook network. When asked about this topic, they would raise concerns about not wanting to add to the “stuff” on Facebook or to “spam the rest of the world”. Despite their reluctance to post too many good things publicly, some participants were very positive about social interactions prompted by 3GT and most of them wanted the 3GT application to make others’ activity more salient. Also in this study, interviews showed that viewing others’ activity in 3GT could sometimes lead to decreased activity as realizing that other participants are posting less frequently also decreases one’s motivation to contribute. Finally, the designers of the 3GT application concluded that integrating such an intervention into Facebook is a viable option, showing an inferior dropout rate than other “open access” websites. This lends support to the idea that Facebook-based interventions may assist adherence by facilitating easier access to the exercise materials. Moreover, although social aspects of the intervention, i.e., sharing with others and viewing others’ posts, were employed and deemed valuable by users, audience issues were seen as a great concern for 3GT participants, and should be taken into consideration for our prototype as well.

The last case study that we think is relevant for our research has a particularly challenging goal: to promote volunteerism. Volunteering is an important activity that brings great benefits to societies. Nevertheless, encouraging volunteerism is difficult due to the altruistic nature of volunteer activities and the high resource demand in carrying them out [23]. Similar to our approach, the

creators of *Farmer's tale* have modeled their game after an existing popular one, in their case, *Farmville*. They added persuasive elements to the game by having a quest system which links virtual tasks to real world volunteer activities and higher rewards to those who complete the latter. Further, by deploying the game in Facebook, they could create a social environment which in combination with game incentives, social influence, and the mixture of virtual and physical world reinforcement would encourage non-volunteers to take action.

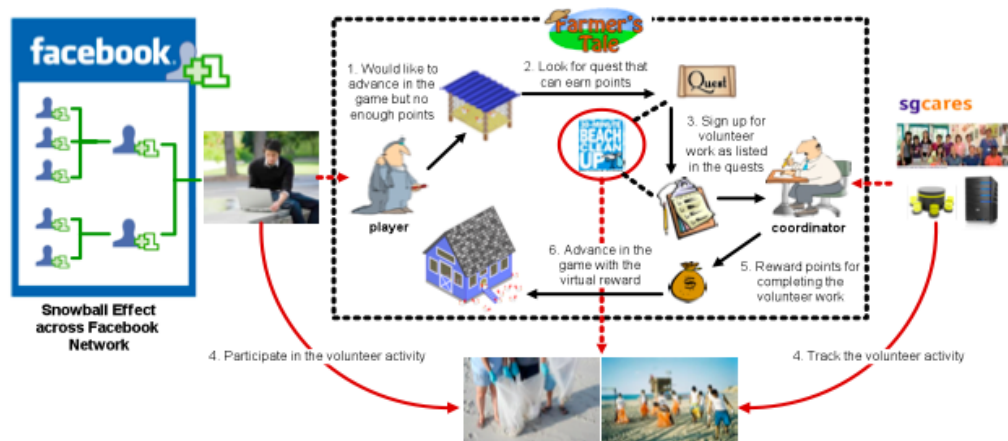


Figure 2.17: Farmer's Tale interaction between virtual and real world

After carrying out an exploratory evaluation, the authors of this study have concluded that the player's overall (89.3%) felt that the game had the potential to influence their willingness to volunteer and that first-time volunteer greatly depended on the availability of volunteer activities that match personal interests, accessibility of information on volunteering opportunities and involvement of friends. All in all, we may state that by adopting after *Farmville*, their game inherited a number of key contributors to the popularity of successful games: simplistic tasks with high rewards, social enjoyment, invitation rebate, and personalization. As we later came to find out, the design of such persuasive reward systems must achieve a fine balance between encouraging practice of target behavior and maintaining the fairness of the game or will otherwise dissuade players from playing. In the end *in order to make a persuasive game successful, its perceived benefit needs to out-weigh its perceived cost* [23]. Currently, many persuasive games are not as engaging compared to other popular games, because most of them emphasize on the target behavior, which often significantly compromises the entertainment value. The true challenge with *Greenpoly* is then to create a serious application capable of having an impact on its players and at the same time let them have a good time.

3

Design Process

This chapter aims to describe the creative process behind Greenpoly. We start by describing our requirements and goals, then the design methodology inspired by the classic board game, Monopoly, and finally a thoroughgoing analysis of our target and the main tasks which users should successfully complete.

3.1 Description and Objectives

As stated before, we wanted Greenpoly to have an environmental focus, namely to raise people's awareness towards the dangers of their current attitudes, encourage them to rethink their habits and offer opportunities for them to take action. Following DEAP's philosophy it was important to keep the entertainment approach of the earlier prototypes, but, unlike them, it should be capable of merging several persuasive applications rather than aiming at a single behavior (e.g. recycling, saving energy, sparing water, planting trees). In order to succeed, we needed a common link, or, in other words, something that all applications would share so that we could uniquely identify each user, independently of the application they logged into. This connection was achieved by Facebook's identification number. When a new Facebook account is created, its owner is assigned an exclusive ID which can be used to access his social profile, recent activity and list of acquaintances. At this point of reasoning, we were faced with the decision of whether to integrate with or into Facebook. Naturally, we could use this identifier

without effectively deploying the prototype inside Facebook, but given the pressure to reach a broad audience, in such short time and make it happen through Facebook's built-in mechanisms, we went through with the latter approach.

Having established the underlying theme, medium and intent, our challenge was to come up with an idea for a game which would:

- Inform users about actions which threaten the Environment (e.g. throwing trash to the street, leaving the lights on, leaving the water running while brushing teeth) and encourage them to avoid such behaviors;
- Provide positive feedback each time a player accomplishes a pro-environmental goal through virtual or real rewards;
- Create an environment that would enhance intra and intergroup dynamics (e.g. social facilitation, ingroup bias, supportive context);
- Suggest programs for which users could volunteer and take an active role to protect the Environment. Recognize their efforts with virtual trophies;
- Be fun and engage users in a positive and helpful experience.

To address such requirements we searched for games that had already conquered the crowd and at the same time would allow us to apply the theoretical principles underlying this research. While popular games proliferate both on and offline, we had very specific needs: it had to be simple enough for people to understand it and successfully manage to play it (two of the participants who took the first survey had never played a computer game before), it had to be flexible, since most rules would probably have to change to fit the environmental theme and it should allow for several players. After giving careful thought about it (and several brainstorm sessions) we finally agreed that a potential solution could be the popular game of our childhood: Monopoly. The initial concept which still continues to prove its success¹ and the fact of being spread out all over the world, makes it the "right tool for the job". Despite this prosaic play on words, the truth is that the design of the classic Monopoly set has hardly changed since it was conceived by Charles B. Darrow in 1933 and as its popularity has grown, thousands of localized versions and special editions of Monopoly have been produced, turning it into the world's best selling board game².

¹<http://www.patricktaylor.com/game-monopoly>

²http://www.ehow.com/about_5378612_monopoly-game.html

3.1.1 Greenopoly

Monopoly is a game designed for 2 to 8 players, though most games work best with a minimum of 3 players³. This satisfies our multiplayer requirement. For each set of eight opponents a new room is to be created and players should be encouraged to invite their friends. The objective of the Monopoly game is to have the most money at the end of gameplay through property rental and trading. To achieve this goal, each player is assigned an initial amount of money, namely 1500 dollars of either \$500, \$100, \$50, \$20, \$10 and \$5 notes. Unfortunately, the pleasure of handling such paper notes cannot be fulfilled in a computer game so we kept things simple with a single amount of coins which we named *greenies*. The rest of the necessary equipment to play Monopoly consists of a board, 2 dice and a set of tokens for players to choose from. The board is divided into 40 different tiles, where corners play a special role in the game's flow: *Go*, *Go to Jail*, *Jail* and *Free Parking*. For their importance we opted to replace them with environmental consequences of people's detachment with the Environment. Phenomenons such as global warming, melting of the polar caps, smog, the greenhouse effect, acid rains or ocean acidification should be used to either alert players or provoke an emotional reaction. To the initial tile from where all action takes place we simply added the "Green" suffix turning it into a *Go Green* fresh start.

"Whenever you land on an unowned property you may buy that property from the Bank at its printed price", taken from Monopoly official rules⁴, this was the biggest change we made to the classic version. In Greenopoly (to facilitate the portuguese pronunciation of the word we eventually dropped out the first 'o') whenever a player lands on an unowned and *conquerable* tile, he/she must play an environmental game and beat its current high-score, earning the right to collect a pre-defined amount of greenies from those who fail. We have underlined the word "conquerable" to stress the distinction between these and the community tiles. While the former can be taken and made profit with other players' rent, the latter are built-in activities such as tax fees, environmental quizzes or volunteering suggestions. We now describe our motivation for each community tile:

Water, Light and Gas bills Paying for their commodities is part of every family's budget. Helping them understand how they can reduce their bills with more efficient assets, like a dual-flush toilet, double glazed windows to keep

³<http://www.mahalo.com/how-to-play-monopoly/>

⁴http://richard_wilding.tripod.com/monorules.html

the heat inside, compact fluorescent lamps, low flow shower heads, among other more ecological alternatives, is the purpose of these tiles;

Luxury tax Despite the fact that SUVs and sports cars are known to pollute more than the common ones⁵, as they consume more gas, in Greenpoly the luxury penalty serves only to avoid great fortune discrepancies. Whenever obliged to pay a luxury tax, a fixed percentage is deducted from the player's amount of greenies, so that richer players pay more than the poorer ones;

Eco Quiz We want our players to take in new information about the Environment but we want them to keep it over time and not just forget the moment they close their browsers. To do so, we thought about using a quiz, which could help players retain the information even if they fail a couple of times before getting the right answer. Some of the answers would be provided in other informative tiles to reward users who took the time to read them.

Chance We didn't want to interfere with the enjoyment of drawing such random cards, yet always with a funny message. We chose to modify the original punishments and prizes for environmental equivalents (e.g. "Very well! You agreed to share your car with your colleagues so you can go to work together thus spending less oil. For doing your part in reducing carbon emissions you shall receive 200 greenies.");

Eco Tips Eco Tips, eventually renamed to "Did you know?", may include current campaigns from our partners, suggestions for people to become more eco-friendly or even interesting facts about the Environment;

Have you heard about <name_of_NGO>? Presenting information about environmental organizations as well as some of their active programs seemed too valuable to pass by. To this account we felt that the traditional railroads, which can be found as the middle property on each row of the game board, should be replaced by a NGO, whether it contained its general description or specific actions which the player could take or learn more about; In the computer prototype the tile is simply named NGO.

Finally, in order to focus on other implementation aspects, we have used only one dice in both prototypes and colored tokens similar to the ones used in Ludo.

⁵http://www.evscroll.com/Car_pollution_facts.html

3.1.2 Fairness

Allowing for several players to play a turn-based game online entails a serious problem: time. How much time should be given to each player to complete their moves? or, as we prefer, How many moves should be allowed before the player is interrupted for some time? In both cases we have two variables which are difficult to predict accurately. What we do know, is that several free-to-play and browser games make extensive use of *waiting times*⁶ to both limit content consumption, and help with monetization: Players can usually pay real money to skip waiting periods. In real life, friends can play Monopoly simultaneously, with every player benefitting from the same opportunities as his opponents. However, in social games, bandwidth consumption (application usage time) rises around the start of working hours and falls sharply at the end of working hours [35]. In fact, it is impossible to predict accurately when someone is going to play and for how much time. A popular solution adopted by other Massive Multiplayer Online Role-Playing Games (MMOs) is Rest⁷. *“Rest is a device that allows more casual gamers to stay somewhat on par with other players, as to character level. It’s also a clever device to encourage less-active players to keep their accounts, making players want to come back and play some more after some time away from the game.”*. To formulate an hypothesis about possible values for both the time break and number of moves, we have asked players’ opinion. Although no ideal values were found, we present a discussion of the results in the next chapter.

3.1.3 Modularity

To make something modular is to *employ or involve a singular or multiple modules as the basis of design or construction* (quoted from Thesaurus English Dictionary). Now, a powerful strength of this prototype is the possibility to integrate a wide range of third-party applications, in a two-way manner. Recurring to Facebook’s unique identifier, external applications, running in different platforms can send each player’s score to our database through one of the developed APIs. They could then receive an HTTP response provided by our server with statistical data or trophies earned. To fully merge such applications with our game, it is necessary that they share the same platform and are compatible with Unity’s plugin (see more about Greenpoly’s game engine in chapter 6), so that we can call the correspondent methods seamlessly from the Unity Player. At the time of this

⁶<http://tobolds.blogspot.pt/2011/10/real-time-waiting-in-games.html>

⁷<http://www.wowwiki.com/Rest>

writing only games developed in Unity can be used inside Greenpoly since support is not yet available, for, as an example, flash-based apps. In the end, we expect to have prefab tiles, which act as individual modules and can be disposed in different ways to create a dynamic and live gaming environment.

3.1.4 Host

Rich Uncle Pennybags or, as some prefer to call him, Mr. Monopoly has been the host of Monopoly since its release. His appearance resembles a wealthy banker though historians affirm that this character was designed to remind the dress and style of mogul J.P. Morgan. Appealing to people's intimate desire for wealth and power is not by far our goal thus a charismatic and meaningful host had to be chosen. We have based our decision in the proven facts that (1) animated agents are believed to have advantages in the context of learning environments and (2) integrating emotional traits into these agents may result in more effective and motivating instruction [36]. If we combine that with today's over 40% of all living species being at risk of extinction⁸, which shows an alarming and pressing situation, the replacing host should appeal for people's natural empathy for endangered animals thus facilitating an emotional bond from the first moment.



Figure 3.1: Rich Uncle Pennybags (aka Mr. Monopoly)

For this study, we designed an emotional pedagogical agent called "Poly" that delivers the training. Poly exhibits verbal and facial expressions in response to users actions and progress during game flow. The character is designed to appear as caring and concerned about player's awareness towards the Environment expressed in their performance and progress throughout the game.

⁸http://ecos.fws.gov/tess_public/pub/Boxscore.do

Toucans are members of the *Ramphastidae* family of near passerine birds from the Neotropics. The family includes five genera and about forty different species. Toucans are native to Southern Mexico, Central and South America, and the Caribbean region. They generally live in tropical and sub-tropical regions. They make their nests in tree hollows and holes excavated by other animals such as woodpeckers. The colorful and large bill, which in some large species measures more than half the length of the body, is the hallmark of toucans was recently discovered that it a highly efficient thermo regulator keeping the toucan cool⁹.



Figure 3.2: Keel-billed toucan



Figure 3.3: Greenpoly's host: Poly

The name of this bird's group is derived from the Tupi word *tukana*, which in turn came from the portuguese word *tucano*. We thought it would be interesting to leave this subtle cue given the nationality of Greenpoly's researchers.

3.1.5 Scenario

We felt that a tropical environment, free of human intervention, where our host could fit would greatly benefit our mission. Although post-apocalyptic or polluted scenarios are common in environmental games like the popular *Machinarium*¹⁰ we wanted people to idealize a clean and natural stronghold tapping into feelings such as serenity and happiness. To make it more realistic we also added some tribal songs that vary according to gameplay. Carved wood is the main element of our environment, surrounded by large extensions of blue. Different tones of blue were used to fill the surrounding ocean and the sky above the island since colors on the blue side of the spectrum are often described as calm and reflective¹¹. Some pirate resembling objects were also scattered around our game such as a rusty treasure chest, a pirate's cross and a small treasure map icon.

⁹<http://en.wikipedia.org/wiki/Toucan>

¹⁰<http://machinarium.net/demo/>

¹¹<http://www.precisionintermedia.com/color.html>

3.2 Design Methodology

Any innovation always includes a risk of failure. This is the motto behind prototyping. By deploying a tangible, low cost, but expressive version of a product, their creators can test its usability, the extent of its capabilities and above all solve early conflicts that may jeopardize the success of the final release gathering additional requirements and backup scenarios along the way [34].

Bearing in mind that prototyping techniques reach from easy-to-make, cheap paper prototypes to highly interactive computer-based ones that might not be distinguishable from the final product, we had to consider the trade-offs between speed and accuracy. While a deep understanding of all options for prototyping falls out of this thesis' scope we felt responsible for browsing the most commonly adopted prototyping methods, for identifying their singularities and circumstances they are best suited for in order to choose the most appropriate one.

3.2.1 Prototyping Methods

Two main approaches to prototyping are called *throw-away* and *evolutionary* prototyping¹². Throw-away prototyping includes, as the name suggests, prototypes which are to be discarded after use so that the final product is built from scratch. Alternatively, in evolutionary prototyping, the prototype evolves into the final product. Most low-fidelity prototypes are the throw-away type as are naturally all prototypes that use a different medium than the final product. Through its evolution, intermediate versions can be completely disregarded or suffer profound modifications (see Figure 3.4).

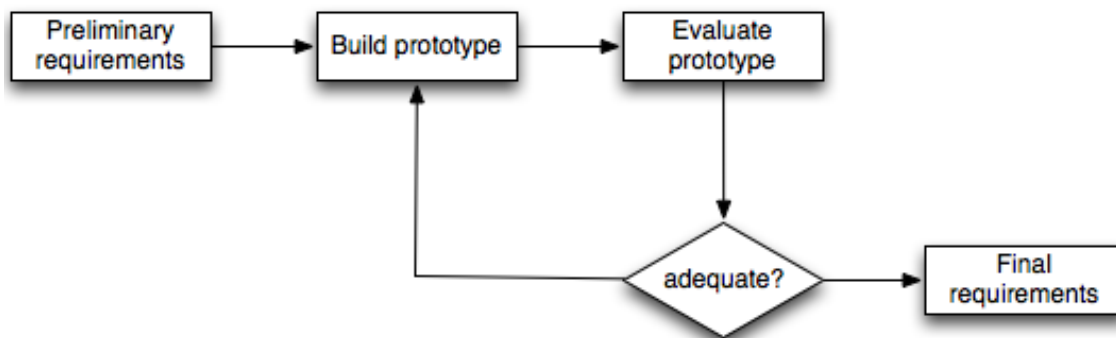


Figure 3.4: Throw-away prototyping

¹²http://en.wikipedia.org/wiki/Paper_prototyping

In contrast, the challenge in evolutionary prototyping is to adequately test it for characteristics such as robustness and error-free operation along the development process to ensure that the final product is not only user-evaluated but also tested on all other software-related issues. Recently a third approach to prototyping has been introduced [11] which is called *incremental* prototyping. In this case, the product is split into separate components that are developed one at a time. The final product is then composed by a succession of releases, each one with better, improved features. This approach could as well be understood as a type of evolutionary prototyping.

Our choice for one of the available prototyping methods was now depending on the model of software engineering that we would choose. In order to do so we enumerated our project's conditions:

1. Small group of stakeholders (a developer, a designer and one supervisor);
2. User-centered, medium size project;
3. Six months time frame to achieve measurable results;
4. The emphasis is both in the final solution and the midterm ones;
5. All midterm prototypes should be scalable;
6. Requirements were carefully defined from the early stages;
7. If necessary initial requirements may receive minor adjustments;

Although requirements were well-defined from the beginning and would probably suffer minor corrections during development which could appeal for a waterfall model all other constraints excluded this approach. In order to provide fast results, receive feedback from users often and have greater flexibility we have followed an iterative design methodology (Fig. 3.5), deploying two prototypes: a low-fidelity, horizontal prototype (low level of functionality but high coverage of the entire user interface [11]) and the second a high-fidelity, evolutionary one.

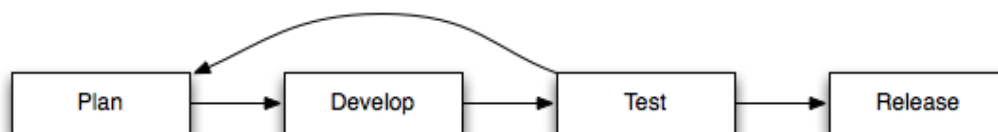


Figure 3.5: Iterative design methodology

3.3 Visual Elements

Elegance in design can be defined as an approach that solves a problem completely *yet* in a highly economical way [32]. Elegant solutions not only reveal an intimate understanding of the problem but also an ability to ensure that its essence is grasped by the consumer as well. Simplicity, in turn, plays a central role in all timeless designs and is frequently seen as the ability to cut directly to the heart of the matter. We put our efforts to create a minimal yet meaningful interface, highly approachable and above all capable of making an impact. In order to achieve this, we opted to follow some of the best practices in the design field, which we describe through this section.

3.3.1 Reduction

An elegant design must be reduced to its essential elements and each element reduced to its essential form. In fact, good design is simple, bold and direct. To achieve this, all visual details except those needed to identify the object's category should be removed so we began to critically examine each element in Greenpoly's paper prototype (described in chapter 4), asked ourselves how it related to the essence of the design, and how the interface's functionality would suffer without it. From this analysis we reached the following results:

Invite We noticed during the first interviews that participants often forgot to invite other people to join their room, which gave us a clue that the "Invite a friend" button was probably not as appealing as we wanted to. We confirmed this hypothesis when one of the participants replied "I thought that I was just supposed to wait for other players to join and forgot that I could invite them to" when asked about this topic. We intervened at this point and asked "What would you suggest to keep one aware that he/she can invite a friend at anytime during the game?" but, unfortunately, a suggestion didn't cross our participant's mind. After a while (and making the same question to several other players) we finally came by a better solution: to use the available slots as buttons which would be immediately perceptible each time a player would check his/her score and rank (no. 1 in figure 3.6);

Rank Defining an explicit ranking enumeration seemed overkill to us and there was certainly a better way to organize players, so we gave this topic careful thought. A better approach was suggested by one member of our team and consisted of using a player's score to identify his/her rank. In the computer

prototype this was easily achievable by including the number of greenies below players' profile picture and took us one step closer to an elegant and simple design. Designed mainly for occidental cultures, we assume left-right orientation in ascending order (no. 2 in figure 3.6);



Figure 3.6: Redundant elements in Greenpoly

Quit After evaluating the first prototype a redundancy between the “Quit” button and the red “Cross” on the top right corner of the screen (button no. 3), became clear to us. Not only were they meant for the exact same thing, *to allow players to leave the game*, they were also obsolete, since Facebook players often, if not always, simply close the browser when they are done playing. Simply enough we discarded them in the second release.

3.3.2 Regularization

Establishing a pattern simplifies the design by moving the viewer's experience to a higher level of abstraction. We applied this quite successfully to Greenpoly's iconicity by making all buttons similar, but the ones used in the quiz, with a wooden square as their background with a black, plain logo carved in it.

Although, some of the icons were not used in the prototype, we decided to include them here as a reference (see table 3.1). Symbols which are indeed part of Greenopoly's interface are marked with a tick under the "Active" column:



















Icon	Hover	Usage	Active
		Turn on the sound	✓
		Turn off the sound	✓
		Return to play screen (version with one dice)	✓
		Return to play screen (version with two dice)	
		Change to map screen	✓
		Check other players' positions	
		Customize Greenopoly's settings	
		Resign	✓
		Close window	

Table 3.1: Wooden icons used in Greenopoly

Typography

Typography can play an important role when it comes to regularization. Limiting the number of font families to one or two with a couple to five different sizes, adds some rhythm to the whole interface and significantly diminishes its visual noise and distracting motion. As such, we chose only to employ Gotham's font family with three variations: book, light and bold (see Figure 3.7).

3.3.3 Leverage

The last and most challenging means of simplification involves finding points of leverage at which design elements play multiple roles. Moreover, when one part does the work of two, the elegance of the solution is always enhanced. In order

Greenpoly _____ Gotham Bold
 Greenpoly _____ Gotham Book
 Greenpoly _____ Gotham Light

Figure 3.7: Examples of Gotham’s font family

to utilize every component in Greenpoly to its fullest we decided to merge the “One Dice” button with the “Map” one, because the only difference in their goal (change the current screen) was the surrounding context. As such we came up with a single wooden square button, which symbol would be a black dice or a treasure map whether the screen is the board or the map one, accordingly.



Figure 3.8: Map button in play screen Figure 3.9: Dice button in options screen

We also reduced labeling overhead by trying to make all icons as straightforward as possible. We describe image metaphors in “Image and Representation”.

Image and Representation

Imagery is essential for communication throughout the product user interface [31]. Images are particularly important in three areas:

Identification When serving as representations of concrete real-world objects, images make identification easy. we have put a fair amount of effort to create easily identifiable buttons. As examples, consider the dice button, the golden coin in the upper right corner or the speaker in the down left one;

Expression Imagery offers great latitude for expression and personalization in the designed artifact. Through Poly’s impersonation of expressions, such as, joy, tedium or shame we want players not just to sympathize with it, but also, to share feelings with our host;

Communication Pictorial representations cross social and linguistic boundaries with ease, when the objects being represented are kept the same. We leveraged cultural metaphors in several signs throughout Greenpoly’s interface. Turning one of the quiz’s options, green (commonly used to express approval) we make it easy for players to identify the correct answer and the red (which usually means problems) option as the wrong one.

3.3.4 3D Models

Greenpoly’s game production pipeline can be divided in three main stages (see figure 3.10), each of them suited for a different set of development skills:

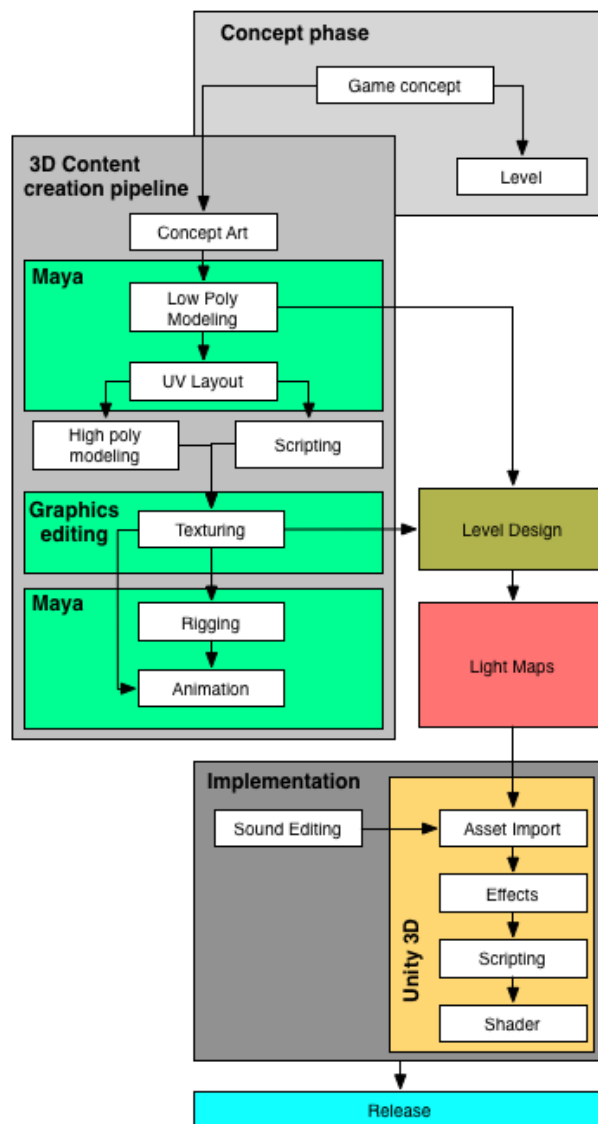


Figure 3.10: Greenpoly production pipeline overview

Concept Phase

During the concept phase all team members were gathered together to establish the game's setting and mechanics. From this moment on the main path for the game was outlined and some of the resulting dynamics are described below. The game's environment was chosen to be a wild, tropical island still untouched by human hand. A comic style was preferred over a photorealistic one and the goal of the game was set to conquering all game tiles hence reaching "green(o)poly".

3D Content Pipeline

Unity3D lack of integrated modeling abilities, led us to use Maya as external modeling tool. Since none of the developers had previous experience in this design software we outsourced the modeling stage, including low and high polygon modeling, UV maps, rigging and three-dimensional movement. The resulting objects were then textured by our team's lead designer, Bárbara Teixeira, who had the hard task of bringing color and life to Greenpoly. Poly, is a fine example of an asset which went through the whole 3D content pipeline. From the concept phase, where it was decided to include a funny animated toucan, through sketching and polygon modeling (see figure 3.11) to its actual implementation in Unity as a prefab, Poly is the result of several talented people.

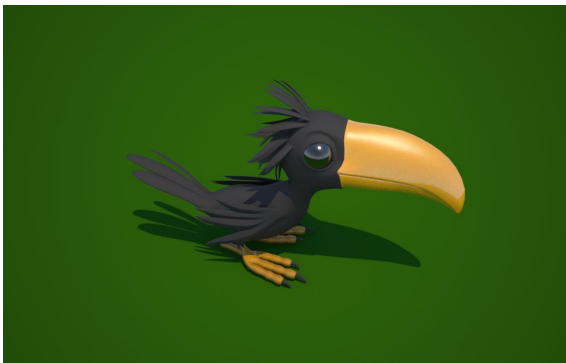


Figure 3.11: Poly before texturing



Figure 3.12: Poly's UV map

Implementation

During the implementation phase, intensive work with the game engine started, as all the models had to be imported into Unity. All Maya files were directly imported into Unity to avoid problems with animated objects exported by Maya as *.fbx and to skip an additional step in the workflow. The files were then converted into *.fbx by Unity. This procedure makes it easy to re-import changed

Maya files but it takes more time for Unity to convert them. Only then, layering, lighting, sound editing, shading and, of course, programming could be done.



Figure 3.13: Token asset being included in the scenario

3.3.5 Release

The final result of the whole production process was a game prototype with four levels. Overall, it took about 700 hours to develop Greenpoly. A detailed overview of the working time spent on this project can be found below:

Task	Time in person hours
Concept and references	80
Low polygon modeling	30
UV Layout	16
High polygon modeling	10
Texturing	20
Rigging	20
Animation	50
Level design	20
Lighting	14
Implementation	240
Miscellaneous (Presentation)	40
Organization and feedback	160
Total	700

For the sake of simplicity, time spent while getting used to Unity's development platform, idealizing assets, preparing user surveys, designing the database's model, rendering scenarios, providing Facebook integration and programming the API for third-party connectivity was not considered at this point.

3.4 Game Dynamics

We have included in this section some of the dynamics which make up Greenpoly.

3.4.1 Chance

Chance is an important part of Monopoly since it increases players' expectations whether they will receive a tempting bonus or pay a considerable fee. Examples of chance messages in the traditional board version include *"Advance token to nearest Utility. If unowned, you may buy it from the Bank. If owned, throw dice and pay owner a total ten times the amount thrown"* or a more fortunate one *"You have won a crossword competition - collect \$100"*. In Greenpoly, we wanted to leave an implicit message in each chance message so that players would unconsciously link their day-to-day actions as good or bad towards the Environment. Consequently, we have given an environmental tone and created chance cards as follows:

- *"It seems that you have been recycling at your place. For being such an active citizen for the protection of the environment you receive 100 greenies."*
- *"You continue to believe that recycling is not your responsibility? For not helping the environment where you live in, you must pay 100 greenies."*
- *"Very well, you agreed to share your car with your colleagues so you can go to work together thus spending less oil. For doing your part in reducing gas emission you shall receive 200 greenies."*
- *"Great, you went walking and did not leave trash traces of your passage. Protecting the Nature is very important! You win 50 greenies."*
- *"You organized a picnic and after a pleasant afternoon you left empty bottles around the place. For being irresponsible you shall pay 150 greenies."*
- *"Instead of hose, you wash your car with a bucket filled with water and a sponge. Impressive! You are saving water and money, so take 150 greenies."*
- *"While you wash your teeth, water keeps running from the tap. That's a lot of water being wasted, so 200 greenies will be taken from your account."*

All values used in chance descriptions and other places where greenies are involved can be edited directly in the .xml files (see subsection 5.2.3). By adding this layer it is possible to use a trial and error approach with different amounts without having to recompile and export the all game.

Wildcards

Still regarding chance tiles we opted to distinguish our game from the board version and created what we called chance wildcards. We have included three of these in the released prototype, namely: a horseshoe, a four-leaves clover and a rabbit's paw (see more in subsection 3.4.6). Wildcards allow players to increase their bonus in case of getting a lucky card or minimize their loss otherwise. At the moment, a horseshoe increases the chance bonus by 100 greenies and the prize is two or three times the card's amount whether the player has a rabbit's paw or a four-leaves clover, accordingly.

Finally, chance tiles are represented by one of the wildcards: the four-leaves clover (see figures 3.14 and 3.15) and their title depends on the selected idiom:



Figure 3.14: Chance Tile (Eng)



Figure 3.15: Chance Tile (Pt)

3.4.2 Corners

Corner tiles in traditional Monopoly are the ones which add more joy to the game. Whether its for seeing an opponent go directly to jail or by receiving all the money in the parking lot or even by collecting 200 Monopoly dollars for free, all four corners were designed with a single purpose: to create an impact. In Greenpoly, while the underlying goal remains, we strategically decided that all but the classic "GO" tile should illustrate the consequences of citizens' threats towards the Environment. Moreover, we had to think of a way to include examples of several threats in just three tiles, which means, that corner tiles would have to be reusable. To achieve this we came up with the idea of using a visual metaphor for danger (see more in subsection 3.3.4): a pirate's flag (figure 3.13).



Figure 3.16: Visual metaphor for danger used in Greenpoly's corner tiles

In our second prototype we had to choose some of the environmental catastrophes that affect our World having come up with the following:

Acid Rain¹³ is a rain or any other form of precipitation that is unusually acidic, meaning that it possesses elevated levels of hydrogen ions (low pH). It can have harmful effects on plants, aquatic animals, and infrastructure. Acid rain is caused by emissions of sulfur dioxide and nitrogen oxide, which react with the water molecules in the atmosphere to produce acids;

Stratospheric Ozone Layer¹⁴ is a layer in Earth's atmosphere containing relatively high concentrations of ozone (O₃). The ozone layer absorbs 97–99% of the Sun's medium-frequency ultraviolet light which potentially damages exposed life forms on Earth;

Melting of Polar Ice¹⁵ Polar ice packs are large areas of pack ice formed from seawater in the Earth's polar regions, known as polar ice caps. Polar packs significantly change their size during seasonal changes of the year. However, despite this seasonal variation, there is an underlying trend of melting as part of a more general process of Arctic shrinkage;

Ultraviolet¹⁶ light is an electromagnetic radiation invisible to the human eye. UV light is found in sunlight and is emitted by electric arcs and specialized lights such as mercury lamps and black lights. In addition to short wave UV blocked by oxygen, a great deal of mid-range ultraviolet is blocked by the ozone layer, and can cause much damage to living organisms.

¹³See reference at http://en.wikipedia.org/wiki/Acid_rain

¹⁴See reference at http://en.wikipedia.org/wiki/Ozone_layer

¹⁵See reference at http://en.wikipedia.org/wiki/Polar_ice_packs

¹⁶See reference at <http://en.wikipedia.org/wiki/Ultraviolet>

3.4.3 Quiz

Quizzes are an excellent way of testing our general knowledge. From pub quizzes to international mastermind competitions, the goal is the same: to pick our brain and stimulate our need for information. We thought that having a quiz in Greenpoly would be a great addition since we could not only evaluate our player's environmental expertise but also reward them for being informed. As such, we used quizzes with four questions each and a total of 16 possible answers from which players must choose the correct one from. We list below some examples:


- *"The fifth of June was chosen to be the World's Environmental Day (WED) to celebrate which of the following events?"*
- *"Which of these countries has invested more in renewable sources of energy?"*
- *"What does the three-letter acronym EEA stand for?"*
- *"How many countries belong to the European organization EEA?"*
- *"Who coined the term Ecology?"*
- *"What are the three R's of the Environment?"*
- *"Which one of the following energy sources is not renewable?"*

Each time a player answers correctly, he/she is rewarded with 100 greenies and Poly shows his contentment by laughing loudly. If, however, the player fails to give the right answer, Poly hides his face in shame and 50 greenies are deducted to the player's amount of greenies. Furthermore, to emphasize which of the options was correct it is shown in green (see figure 3.14) once the player hits the submit button so that he/she can learn and succeed next time.

3.4.4 Trophies

Still regarding awards we felt that trophies would be a nice recompense for players who really put their effort in Greenpoly. This way, they would stay motivated while playing and at the same time play longer. We have selected a set of actions deserving this type of rewards, as well as a ranking scheme from copper to gold for some of them. Since trophies' icons were set aside from the core model, they can be modified at anytime without the need to recompile the whole game.

We list below all trophies available in Greenpoly's computer prototype:

Icon	Name	Rank	Description
	Action	Copper Silver Gold	Completed 1 eco action Completed 2 eco actions Completed 3 eco actions
	Conquistador	Copper Silver Gold	Conquered 3 tile Conquered 9 tiles Conquered 27 tiles
	#1 Fan	Copper Silver Gold	Played 5 sessions Played 25 sessions Played 50 sessions
	Luck	Copper Silver Gold	Got 3 lucky cards in a row Got 6 lucky cards in a row Got 9 lucky cards in a row
	Quiz	Copper Silver Gold	Answered 8 times correctly Answered 16 times correctly Answered 24 times correctly
	Racer	Copper Silver Gold	Crossed "Go" 3 times Crossed "Go" 6 times Crossed "Go" 9 times
	Eco Pro	Gold	Completed 4 quizzes in a row
	Puzzle	Gold	Conquered all Puzzle tiles
	DEAP	Gold	Conquered all DEAP tiles
	Activist	Gold	Completed 4 ecological actions
	Tutorial	Gold	Completed the tutorial

3.4.5 Ending

“One common criticism of Monopoly is that it has carefully defined, yet almost unreachable, termination conditions.” While this seems ideal to keep players around it comes with the hard challenge of keeping players engaged at all times. Regular Monopoly reaches its end either from (1) a time limit¹⁷ or (2) one of the players owning all the properties, leaving no chance to his opponents to take his place. In Greenpoly, however, even if one owns all conquerable tiles there is always an opportunity for other player to steal them by beating the owner’s high score. Moreover, setting a deadline for each Greenpoly’s instance would have two main drawbacks, namely:

- All players would have to start at the same time in order to have the same opportunities;
- Since there is no system to equalize each player’s number of plays, the ones who could play less (e.g at the beginning and end of the day) would be at a serious disadvantage.

This being stated, there was still another option to consider: finish the game when one of the players reached a predetermined amount of greenies. Even though this could make sense in the traditional board version where the ultimate drive is to collect rents and pile up monopoly money, in our case, we want people to use the money to use their greenies to buy ecologic appliances as they would in real life, pay their taxes but above all focus on the didactic quizzes and mini games scattered among Greenpoly’s board. Forcing the number of greenies to be the game’s final goal would spoil our objective of raising people’s awareness about their current behaviors towards the environment, the impact of those behaviors and, above all, their role to reduce environmental threats. All in all, there is yet to be found a suitable end to Greenpoly hence this topic is open for further discussion.

3.4.6 Eco Store

While money is the ultimate drive for Monopoly players, the same isn’t exactly true for Greenpoly’s currency: *greenies*. However, having a fair amount of these can significantly increase one’s odds of winning the game. This is due to Greenpoly’s Eco Store where players can find and buy the following ecological items:

¹⁷[en.wikipedia.org/wiki/Monopoly_\(game\)](https://en.wikipedia.org/wiki/Monopoly_(game))














Icon	Item	Category	Price	Permanent
	Water Tap	Water	100	✓
	Toilet Flush	Water	100	✓
	Shower Head	Water	100	✓
	Compact Fluorescent Lamp	Energy	100	✓
	Double-glass Window	Energy	100	✓
	Switched Electric Cord	Energy	100	✓
	Bus Tickets	Fuel	100	✓
	Biofuel	Fuel	100	✓
	Bicycle	Fuel	100	✓
	Rabbit's Paw	Chance	250	
	Four-leaves Clover	Chance	350	
	Horseshoe	Chance	150	
	Inflatable Boat	Corner	180	
	Sunscreen	Corner	180	
	Ultra-Resistant Umbrella	Corner	180	
	Reduced idle time	Custom	1500	✓
	One extra play	Custom	1500	✓
	Plane token	Custom	2500	✓

Table 3.3: List of ecological items in Greenpoly

Price Range

Price Range was also taken into account so that a natural hierarchy would evolve where the cheapest items (and the ones we expect players to buy first) are related to people's day-to-day utilities. On the flip side, custom items which purpose is to enhance gameplay and do not relate directly to environmental awareness are more expensive and require more playing time. It is also worth noting that all items marked with a ✓ are permanent and may only be bought once while the remaining (in the "Chance" and "Corner" categories) expire after the first use.

3.4.7 Conquerable Tiles

Conquerable tiles are the corner-stone of Greenpoly as they provide interaction, amusement and healthy competition between players. In this prototype we created two groups: Puzzle and Deap tiles. When a player falls in a Puzzle tile he/she must play one of the following mini-games:

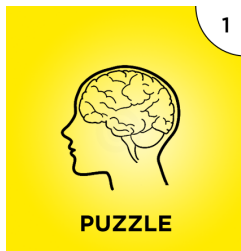


Figure 3.17: Memory

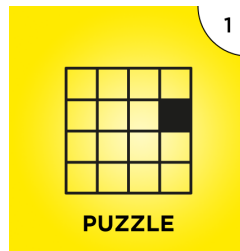


Figure 3.18: Sliding

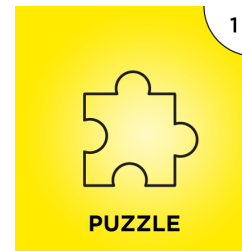


Figure 3.19: Jigsaw

Memory A memory puzzle, or matching puzzle is a puzzle usually used to improve memory as players have to find pairs in a set of hidden cards. To reveal what's behind a player may turn two cards at a time and then wait a small fraction of time to keep trying. In Greenpoly, each pair is formed by a recyclable item. A possible alternative would be to associate a recyclable item with the corresponding ecological trash bin, but was put aside as that would be less intuitive for players;

Sliding A sliding tile puzzle is a puzzle that challenges a player to slide flat pieces along certain routes (usually on a board) to establish a certain end-configuration. When finished, sliding puzzles in Greenpoly show players

current endangered species as well as some examples of Earth's rich fauna;

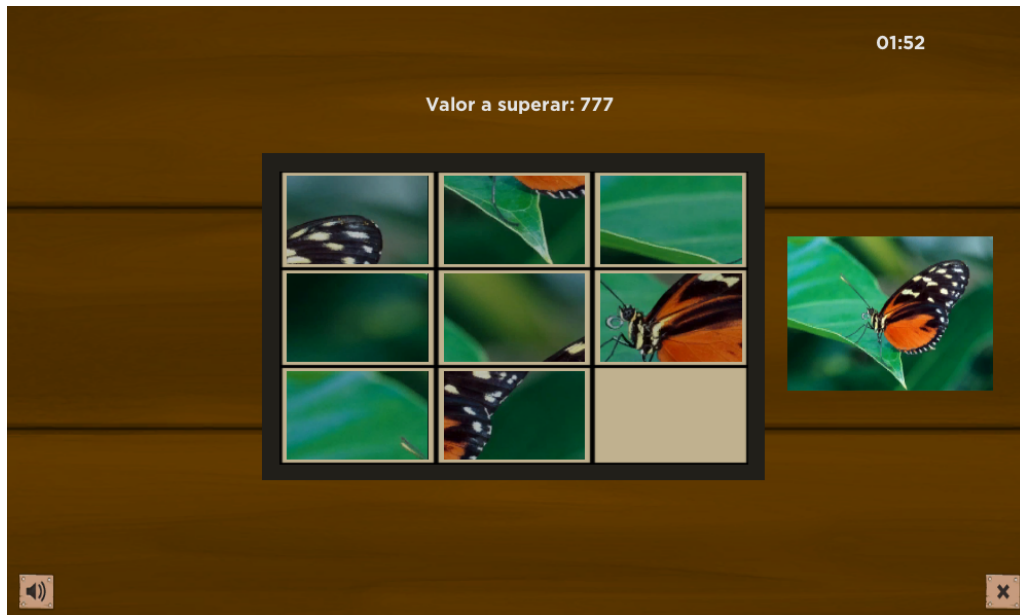


Figure 3.20: Sliding Puzzle

Jigsaw A jigsaw puzzle is a tiling puzzle that requires the assembly of numerous small, often oddly-shaped, interlocking pieces. Each piece has a small part of a picture on it, so that, when complete, a jigsaw puzzle produces a complete picture. Jigsaw puzzles were originally created by painting a picture on a flat, rectangular piece of wood, and then cutting that picture into small pieces with a jigsaw, hence the name. In Greenpoly, the jigsaw puzzle puts together images of polluted scenarios where human footprint is evident.

In addition, Greenpoly may include external games acting a merging platform. Furthermore, if a player falls over one of the DEAP tiles he/she will be briefed about the game and where to play it, but will only be able to conquer the tile through it's native platform. We have included three of our project's previous releases, namely: *ley*, *gaea* and *eVision* (figures 3.21, 3.22 and 3.23).

3.5 User and Task Analysis

Along this section we detail some of the idiosyncrasies which distinguish the audience we want to reach and study possible scenarios by enumerating tasks and subtasks which users must go through in order to complete predefined goals [11]. Exceptions to the regular flow of each action will also be considered.



Figure 3.21: Ley



Figure 3.22: Gaea



Figure 3.23: eVision

3.5.1 User Analysis

Based on the Trans-Theoretical Model of Health Behavior Change [1] we hope to intervene at the second stage of the behavioral change process: **contemplation**. We shall focus on people who intend to make an effort towards a better environment within the foreseeable future, but are not ready to take action yet. This is usually because they have doubts about the effectiveness of action and the costs and benefits of their individual change. Naturally, people who intend to take action in the immediate future or have already made specific overt modifications to their behaviors will also be considered since it is important to keep their levels of confidence about their efficacy thus preventing a relapse to the previous behaviors. Due to the particular requirements of this project we do not expect people who aren't concerned about their ecological footprint, who have never considered their actions as a threat to the environment or do not recognize environmental problems as an issue at all, to change their attitude based solely on their experience in Greenpoly.

Concerning our target facts are that (1) the majority of Facebook users are women and (2) teenagers and young adults form 40% of Facebook's general audience¹⁸. Since the difference between male and female users is around 14% we expect that emotional response will be relevant during data analysis. Even if more than half of Facebook users are older than 45 we have followed an informal and direct language style as the one used by Facebook's Help Center¹⁹. This was also due to the fact that teenagers and young adults to whom such style is expected are the closest target to the author's peer group which is critical for testing. All in all, despite the adoption of brighter tones and colorful themes targeted to a younger public, like in Monopoly, everyone is free to join.

¹⁸<http://mashable.com/2012/03/09/social-media-demographics/>

¹⁹<http://www.facebook.com/help/parents>

3.5.2 Task Analysis

We have identified ten main tasks which users should be aware of in order to take full advantage of Greenpoly's experience. For each task, we establish the goal, pre-conditions, mandatory system subtasks and possible exceptions.

Task 1: Read the tutorial

Goal A player have the opportunity to learn Greenpoly's main rules in order to fully understand the game basics;

Pre-condition 1 Player is at Greenpoly's splash screen;

Subtask 1 Player must left-click wooden sign with "Learn" tag;

Subtask 2 After reading each learning tip, player must left-click the right-pointed arrow to move forward through the tutorial;

Exception Players may skip the tutorial at any time, by pressing "Skip tutorial" at the top left corner of the screen; If it is the first time and a color has yet to be picked, all available colors shall be displayed, otherwise, only previously selected color should appear; Player has also the option to revisit previous tips by left-clicking the left-pointed arrow.

Task 2: Change idiom

Goal A player can choose one of the available idioms (Portuguese and English in the prototype version);

Pre-condition 1 Player is at Greenpoly's splash screen;

Pre-condition 2 Player must recognize each idiom by its country's flag;

Subtask In order to select a different idiom (Portuguese is selected *by default*), players must left click the corresponding country's flag;

Exception In order to reduce in-game buttons and keep the interface to a minimum, this option has been deliberately limited to the beginning of each session, namely, at Greenpoly's splash screen.

Task 3: Invite friends

Goal A player can invite their friends to play Greenpoly;

Pre-condition 1 Player is at Greenpoly's play screen;

Pre-condition 2 There is at least one free slot (empty frame) in the bottom bar;

Subtask Player must left-click an empty frame in players' bar; In Facebook's friend picker, select one or more friends to join; Press "Save";

Exception When a room is full and there aren't any free slots (empty frames), players can only share Greenpoly through the social network itself, by choosing "Share" under Greenpoly in the Application Center.

Task 3: Throw the dice

Goal A player can move through the board by throwing the dice;

Pre-condition 1 Player is at Greenpoly's play screen;

Pre-condition 2 Player has at least one play left;

Pre-condition 3 Player's amount of greenies is greater or equal to zero;

Subtask Player must left click the dice button on the right side of the screen (both dice rolling and token movement are done automatically);

Exception If any of the pre-conditions fail, the dice button won't be displayed.

Task 5: Turn music on/off

Goal A player can turn music on/off and this state is consistent among all screens;

Pre-condition There are no pre-conditions to this task;

Subtask Player must left-click the sound button on left-down corner (button works in binary mode: on/off without any intermediate states);

Exception Introductory song in splash screen cannot be disabled.

Task 6: Navigate between screens

Goal A player can change between play and options screens;

Pre-condition Player must be at either play or options screen;

Subtask Player must left-click the travel button in the down-right corner of the screen;

Exception If the game is loading an intermediate scene or playing an animation, the travel button won't be displayed.

Task 7: Shop in the eco-store

Goal A player can spend his/her greenies in the eco-store to buy eco-friendly products that will enhance game's entertainment;

Pre-condition 1 Player is at Greenpoly's options screen;

Pre-condition 2 Player's amount of greenies is greater or equal than zero;

Subtask 1 Player must left-click the mill with the "Shop" tag on the right side of the screen;

Subtask 2 Player may browse through available items and press "Buy" if item is available;

Exception 1 If the player's amount of greenies is lower than the item's value the option to buy it won't be displayed.

Exception 2 Some items can be temporarily *out of stock* because they are season items which means that they are only available for a limited period of time.

Task 8: Check previously bought items

Goal Players should be able to check what they have bought from the eco-store in previous sessions;

Pre-condition Player is at Greenpoly's options screen;

Subtask Player must left-click the wooden box in order to open it; Players may browse twelve items at a time and move forward or backwards by clicking the right and left-pointed arrows, accordingly;

Exceptions Only items that have not expired will be displayed inside the box.

Task 9: Consult earned trophies

Goal Players should be able to check which trophies they have earned already;

Pre-condition Player is at Greenpoly's options screen;

Subtask Player must left-click the treasure chest in the left-side of the screen in order to open the trophies panel;

Exception 1 While a nice-to-have feature would be to include instructions in the trophies panel on how to get new awards, it was overlooked in this prototype for the sake of simplicity.

Exception 2 Regarding progressive trophies (copper, silver and gold) for the same category only the most valuable one is shown at the trophies' panel (e.g if a player earns the quiz copper trophy for answering 10 questions correctly and then makes it to 30 answers, beating the silver trophy's baseline only the latter is displayed).

Task 10: Resign

Goal Players may choose to resign from the current game and start over.

Pre-condition Player must be already playing in one room;

Subtask Player must left-click the resign button in the left-hand corner

Exception There are no exceptions to this task.

Whether used on their own or in combination we expect these tasks to fully support the persuasive goal of Greenpoly.

4

Paper Prototype

In order to identify problems and inconsistencies as soon as possible as well as to test user acceptance, we started by creating a low-fidelity, paper-prototype in the early design of Greenpoly (Figure 4.1). It was mainly horizontal with low virtual depth since only a limited number of underlying functions could be tested.



Figure 4.1: Paper prototype used in the first iteration

4.1 Prototype Evolution

Throughout preliminary design we have followed the assumption that the game's layout should fit a single A3 cardboard (420 x 297 mm), making it easy for users to recognize it as their desktop/laptop's screen.

4.1.1 Game board

Structuring layout was our first concern since Greenpoly's board should be the immediate focus for players. As such, two independent layers were considered where:

- A centered, highly-perceptible board as well as peripheral n-tier options would make up the base layer;
- Individual windows which would open upon player's actions during game flow could overlay the first layer and then disappear when not in use.

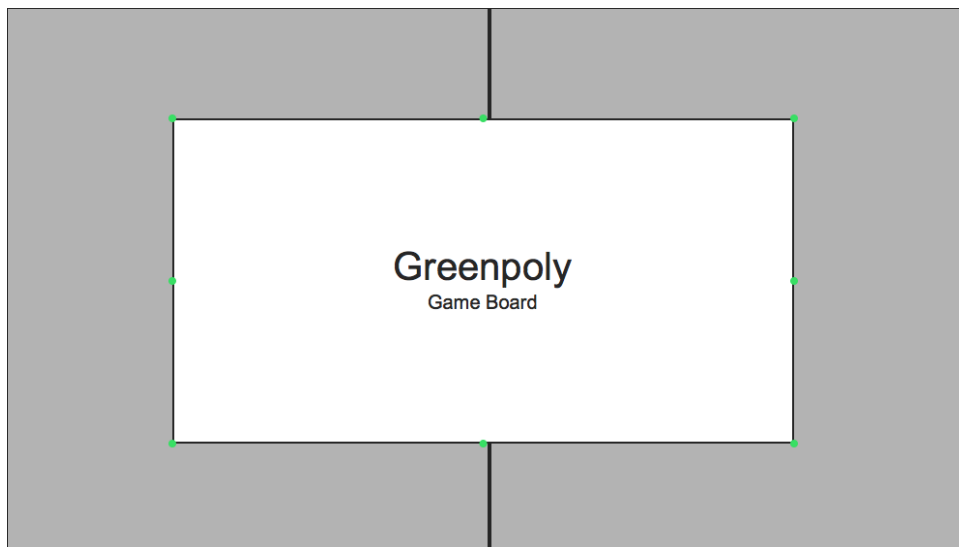


Figure 4.2: Centered layout

Besides its fixed viewport the board itself could have different sizes (small, medium and large in the current version) with the corresponding number of tiles placed around (24, 32 and 40, accordingly) the enclosing area. The game's logo should be displayed in the center, but tolerance was given to this space as an embedding environment could be set afterwards (eolic wings were added later). Rules were also defined for each tile, in terms of composition, design and purpose, which served as a blueprint for our team's designer to follow.

Individual tile requirements

Regarding tile construction and bearing in mind our previously defined topology for these structures (conquerable and community tiles), we have recognized the need to make a visual distinction between them by adding an header bar to the conquerable ones. This simple yet meaningful addition would allow for players to immediately distinguish between the two types and at the same time by changing this new bar to a player's color could mean that he/she have beaten its high score earning the right to collect rents from his/her opponents.

Among community tiles, a consistent layout was planned where a visual logo would take a great share of the available place with a label attached. Tiles' hierarchy as well as each predefined layout is presented below (Figure 4.3).

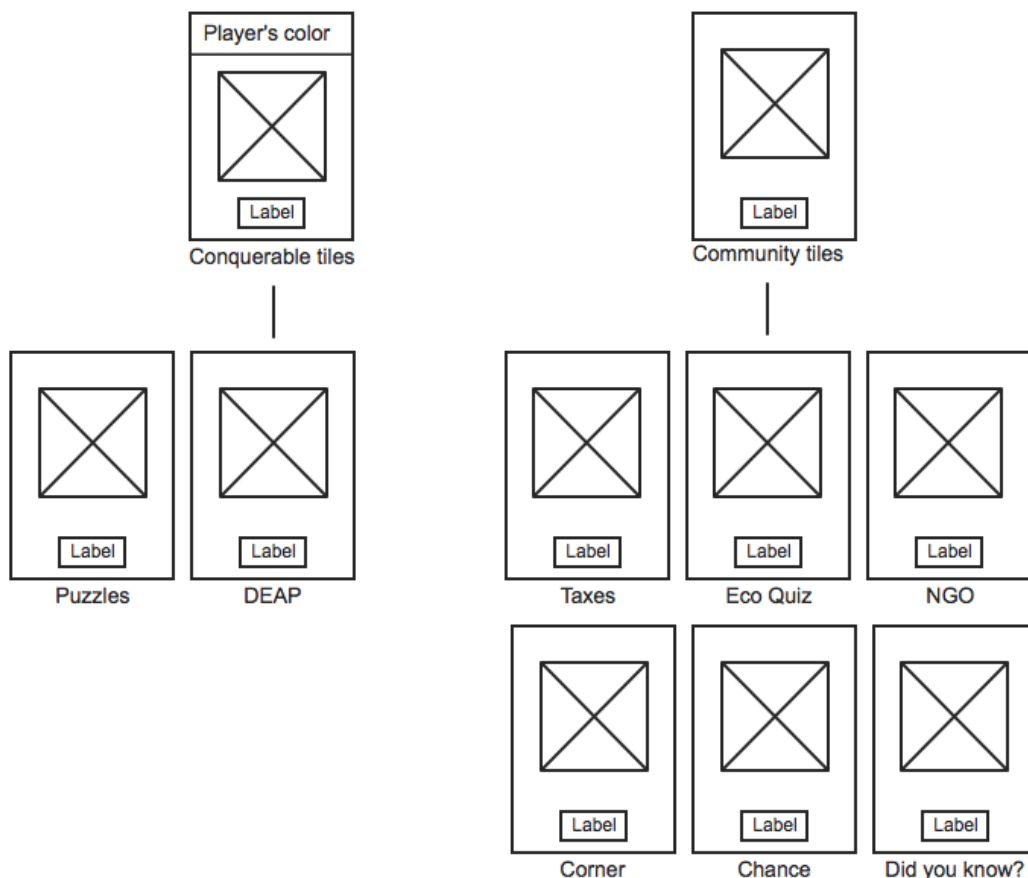


Figure 4.3: Tile structure and hierarchy

From this moment on, the choice for the corresponding logos and filling colors were left to our team's lead designer Bárbara Teixeira and the output can be seen in chapter 6 (Computer Prototype) in the interface description.

4.1.2 Core Settings

Having established the main focus of Greenpoly it was now necessary to add a set of nuclear options that would ensure, on their own, playability, such as:

1. Enable player's movement around board;
2. Generate a random number of jumps in order to move forward;
3. Check amount of greenies achieved until that moment;
4. Check number of available plays;
5. Invite other players to join a Greenpoly's instance;
6. Check own status among his/her opponents;
7. Turn background music on/off.

Because of their high usage frequency, we have established that actions one to four should be placed on top of the screen. A vertical list with all room players' name and score (this was subject of debate since we were not sure that being aware of other players' number of greenies would act as a motivator, or, on the contrary, make a player less eager to play) would occupy the majority of the right side. Finally the option to invite one's friends stressing the multiplayer component of Greenpoly was placed alone in the left side (Figure 4.4).

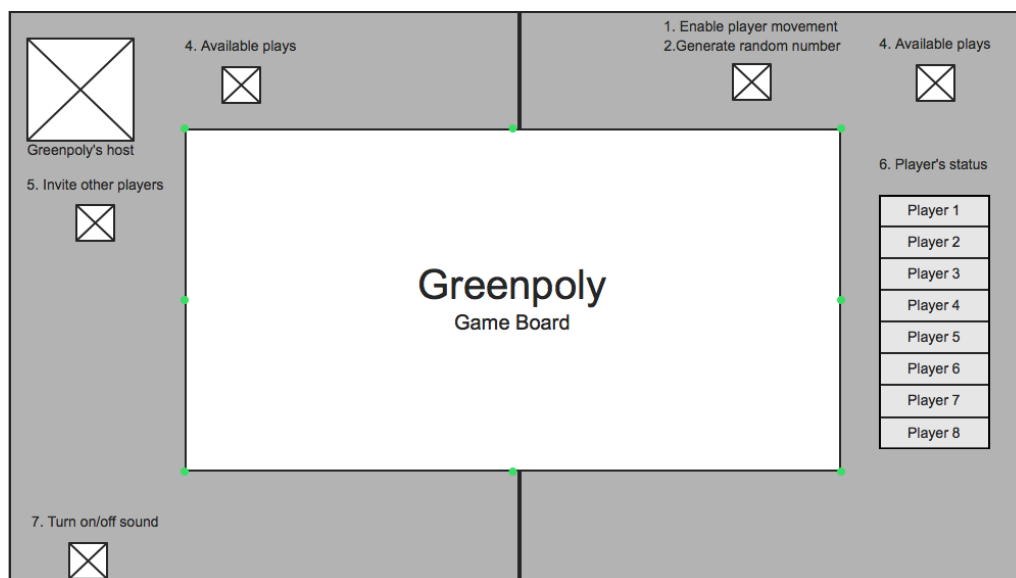


Figure 4.4: Mandatory actions to ensure playability

4.1.3 Additional Settings

In addition to the former actions, all elements defined in game dynamics had yet to be positioned, namely:

8. Buy assets in the eco-store;
9. Check previously bought assets;
10. Check earned trophies until that moment;
11. Check already conquered tiles;
12. Resign from current Greenpoly's instance;

All but action twelve were placed in the left side under the invite friends button. For its less frequent usage, the resign option was left alone in the bottom right corner of the screen (Figure 4.5).

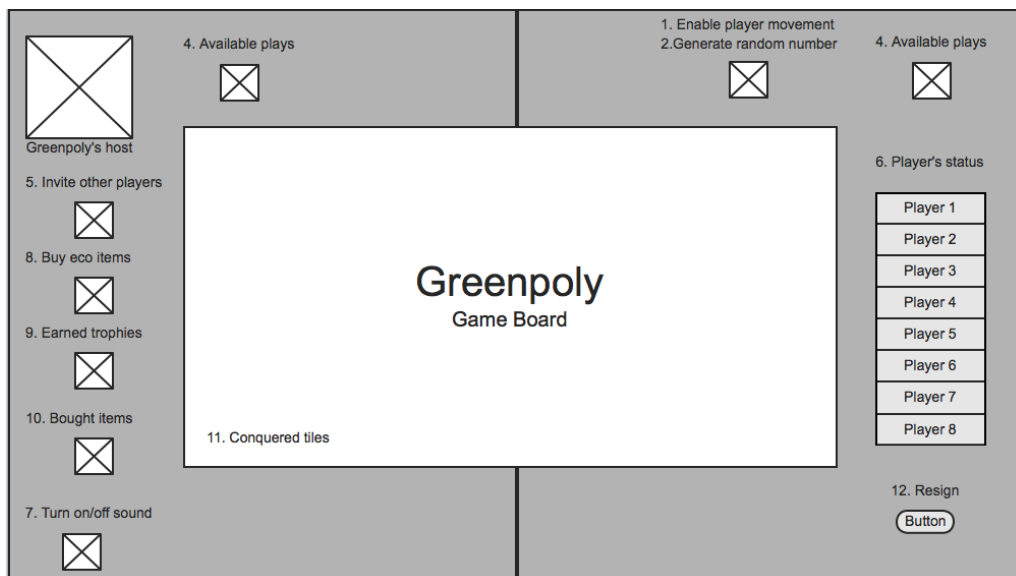


Figure 4.5: Additional actions to enhance gameplay

While other design faults were made visible throughout the first iteration, it was already apparent from these sketches that actions five and six should be physically near since both belong to the same group (multiplayer options) and much of the available space to place Greenpoly's host was already taken by the board which meant that we had to find a way to isolate it in the left side of the screen to avoid it from passing unnoticed. Despite these hints we refrained ourselves from making hurried conclusions and proceeded to collect unbiased input.

4.2 Evaluation Methodology

The first iteration undertaken by Greenpoly consisted on an interactive mock-up where participants performed a rigid scenario (see below). Initially, special care was given to avoid long and exhaustive instructions as we expected the interface to be intuitive and self-explanatory. Still, whenever a user struggled to complete a certain task or looked confused, additional explanations were given. Participants used their fingers to interact with several hand-drawn interface elements and were always encouraged to think aloud, enabling a better judgment towards interface's stumbling blocks.

4.2.1 Test Case Scenario

Before each test, an explanation of what Greenpoly was and its purpose was given to participants, along with some instructions to carry out the proposed scenario. While some participants were in couples, the great majority of our subjects performed the scenario individually so that we could get the most of their attention. In both evaluation phases our test groups received the following briefing:

“We are currently developing a computer game aimed at raising an environmental consciousness among players. To achieve this we have redesigned the popular board game, Monopoly, and changed some rules which you will become aware during gameplay. The major change that you will find is that in Greenpoly there is no longer the possibility to buy tiles but to earn them. You can earn tiles by playing an environmental game and scoring higher than the current owner. Another major difference between Greenpoly and its predecessor is that there is only one dice and each player can throw it a limited number of times after which he/she must wait for a period of time in order to play again. Further on, with this paper prototype, we expect to find out early problems, features that would be nice to have and evaluate the overall user experience. For such reasons, we kindly ask you to speak aloud when in doubt about the next step and give feedback whenever you find yourself lost. This being stated we hope that you have fun and from this moment on, we will refrain from commenting your experience and act as closely as the computer would, except background music (laughs) ...”

When the introduction was over and participants fully understood the purpose of the application, they were presented with the paper made Greenpoly.

Even though the scenario itself was quiet straightforward, we were more concerned with to what extension users were at ease with the overall interface organization. We have compiled below the card flow presented to the test group:

1. With the board (Figure 4.1) on the table, several messages were overlapped in order to simulate pop up windows. The first of them was the welcoming message (Figure 4.6) where Poly would introduce himself as an endangered specimen and explain its mission to raise environmental awareness among people through a competition where each player must prove his/her consciousness towards the Environment.

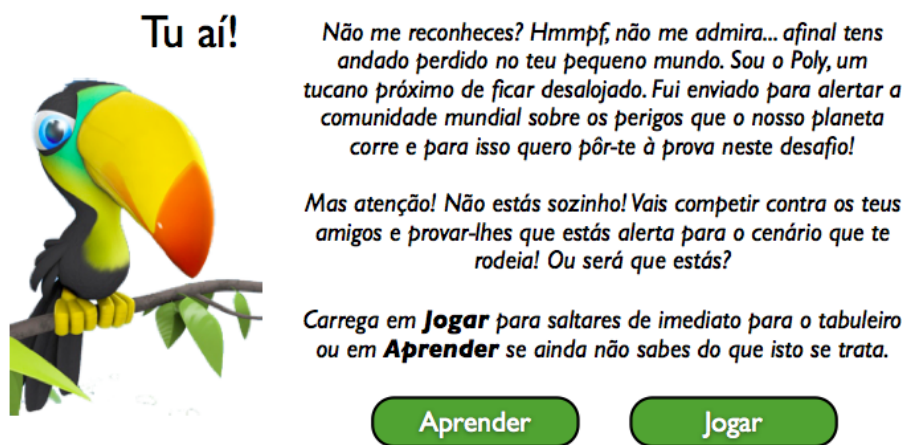


Figure 4.6: Welcoming message

Giving players the option to choose whether to “Learn” or “Play” gave us the chance to evaluate Greenpoly’s learning curve (time to complete the scenario). We have divided this flow in two parts respective to each option, and decided to begin with Learn’s unfolding events.

- 1.1. The tutorial started with a brief description of Greenpoly followed by an introduction to the game’s board;
- 1.2. Basic explanation of how to conquer tiles, the advantages of acquiring these and the dangers behind the corner ones;
- 1.3. Information about the number of players allowed per room (to this point we had established a minimum of two players), number of available plays per session and Greenpoly’s currency: greenies.
- 1.4. Guidance on Greenpoly buttons’ disposal, their function and importance in game flow (Poly was also introduced as part of the interface).

2. Once the tutorial was finished (or the participant chose to skip it) he/she would be prompted with all the available colors to choose from (four in the paper prototype and eight in the computer one).



Figure 4.7: Color picker

3. Participants were then encouraged to press the dice even if the outcome was already set (the interviewer was responsible to show a pre-determined sequence of values allowing players to try each one of Greenpoly's tiles). In the following lines we shall describe this sequence by identifying each of the tiles where players would fall during the test case scenario. All in all, players had the opportunity to play nine times in three successions of three moves each.

Quiz Besides being just a preliminary prototype there were already four sequential questions to answer in the quiz. As an example, the first question to be shown was: *Which of these species is not in risk of becoming extinct?* with the options¹ being: *American Giant Runt, Iberian Lynx, American Eskimo Dog and Crowned Eagle*. If a player failed to state the Iberian Lynx as the endangered breed he/she would see 50 greenies deducted from his/her amount of greenies. If, on the other hand, he/she picked the correct answer the same amount would be added to his/her fortune. Later on we decided to increase the prize to 100 greenies, so that two correct and two wrong answers would still grant profit of one hundred greenies;

¹Options differ from the ones used in portuguese to keep a sensible approximation of the difficulty's level

Did you know? In this tile, as mentioned before we wanted to include general trivia about the Environment to raise players' curiosity. We included two different messages, one of them being: *Did you know that according to a study from ONU there will be around 9 billion people in our planet in 2050. How will we manage resources then if we don't take care of them now?* Did you know kind of tiles are not only about passing on knowledge but is also about sharing. Players are encouraged to share this new information with their friends, showing their interest about the theme and, naturally, promoting Greenpoly;

Acid Rain Acid rain is the first of the couple of climate change effects present in Greenpoly's paper prototype. If a player happened to buy an ultra resistant umbrella (before falling into this tile) he/she would escape unharmed, or disburse 250 greenies, otherwise.

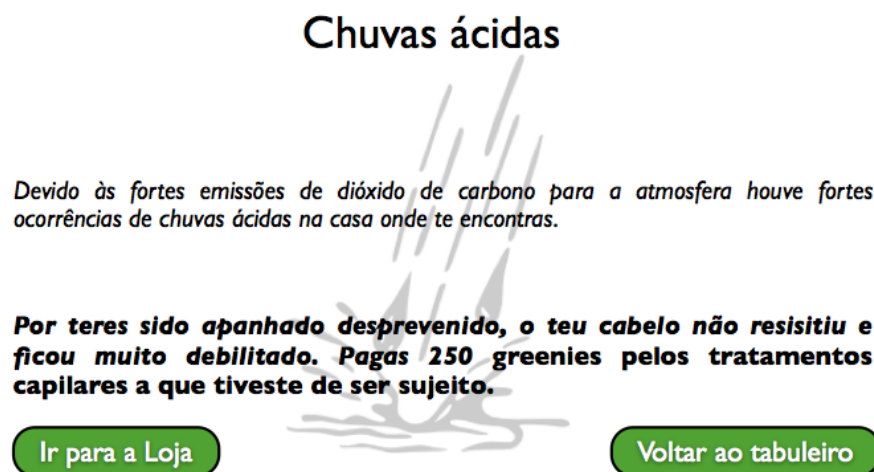


Figure 4.8: Acid rains's card in Greenpoly's paper prototype

4. Immediately after the three first moves were completed, players had to wait for 2 minutes to play again. This delay was explained to users as a way of raising expectations and giving the chance to return at a later time.

NGO At this point of development we had already decided to include popular NGOs in the creation of Greenpoly (see more about this topic in chapter 5). As such, it was important to divulge them through a brief introduction to its history, its goals and activities. We also added the url to their official website as well as their facebook page (players who "like" the NGO's Facebook are rewarded with extra greenies the next time they stop at a NGO tile);

Utilities Large bills can be avoided by buying eco-friendly items in the eco-store. In this test case scenario, we hoped participants to become aware of their water waste at home. Whenever a player fell in this tile there were two possible outcomes. In case he/she had previously bought one of the available assets for saving water (double toilet flush, head shower or water tap) the following message would appear: *The water's bill has arrived. It seems that you already have eco-friendly equipment at your place so you aren't only helping the Environment but also spared half of the water's expense..* On the flip side, if they aren't aware of this kind of measures yet, the message *Save up some money and help the Environment by buying eco-friendly equipment. Simply by changing your toilet flush for one with distinct discharges can make you spare a significant amount of money. Visit the eco-store and see what you can find!* would inform them;

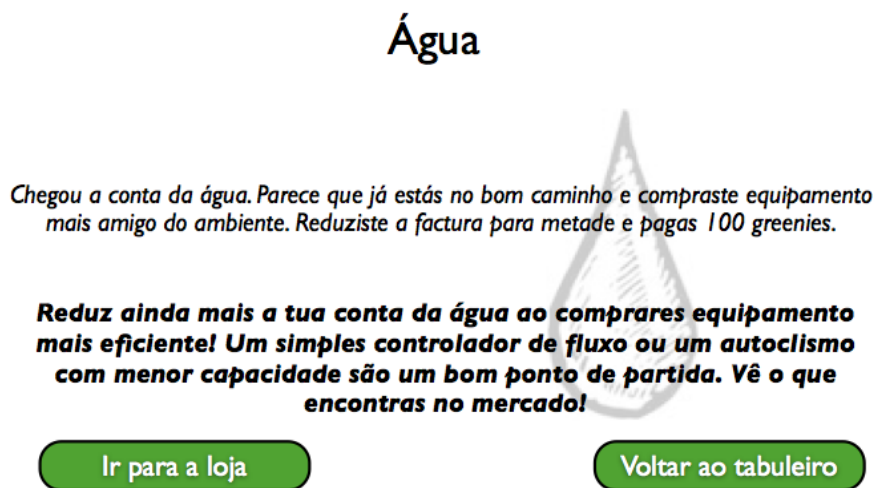


Figure 4.9: Water tax's card in Greenpoly's paper prototype

Mini-game We figured that there wasn't a better way to explain participants the dynamics behind third-party integration than to actually let them play a virtual mini-game. For this purpose we used WWF's Earth Hour Game² where players have two minutes to switch off as many lights as possible just by running and jumping an intrepid little man.

5. During this interruption players were asked about the tiles they were sent to. We felt that it was important to receive feedback at this time since the scenario was still fresh in their heads and they were already sorting out a strategy for the remaining of the test case.

²http://wwf.panda.org/how_you_can_help/games/earth_hour_game

Melting of polar ice caps This is other possible outcome of human irresponsible use of Earth’s resources. For its severity and potential impact³ on Today’s living conditions this Environmental catastrophe was a must-have in this prototype.

Chance Our participants’ luck was put at stake in this tile. To add a pinch of delight to the test we included only luck cards in this prototype. As an example consider the message *We found out that you have been recycling at home and for that you deserve 100 greenies!* (Figure 4.10). This prize would increase up to three times its value depending on the amulet that the player is carrying (if any).

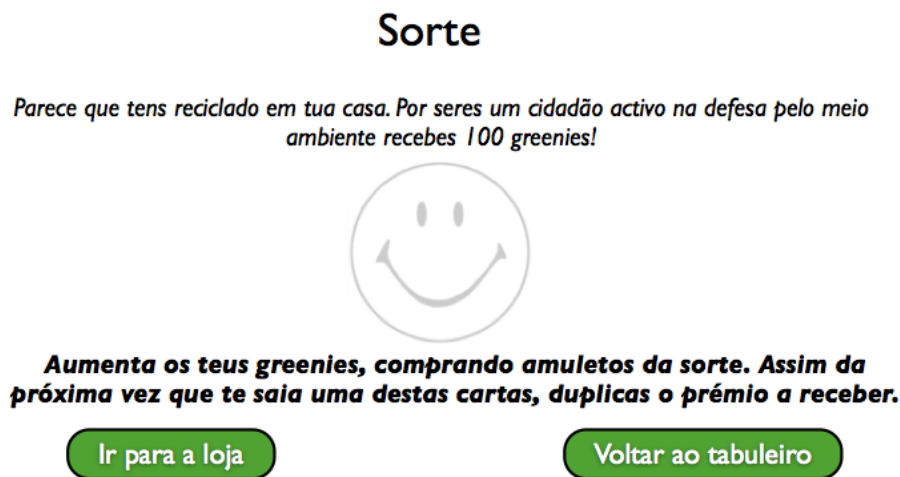


Figure 4.10: Chance’s card in Greenpoly’s paper prototype

GO Known as the classic tile of Monopoly, we decided to leave it unchanged. By this means and in order to finish gracefully, all players received 200 additional greenies for crossing “GO”. Even if it is our responsibility to keep answers to our survey unbiased, there’s nowhere stated that we shouldn’t build up our participants’ mood.

- Once finished, players were given a short survey where they should evaluate Greenpoly’s usability and only then we would finish with a brief interview about the overall gaming experience.

³<http://www.dw.de/polar-ice-sheets-melting-faster-than-ever/a-16432199>

4.2.2 Interviews

The evaluation tests for the paper prototype were conducted in two phases: the first was executed with a freshly finished sketch (Figure 4.1) with fourteen users with none or little gaming experience while the second received feedback from six users familiar to online gaming. We present below gender and age statistics of all participants in the paper survey:

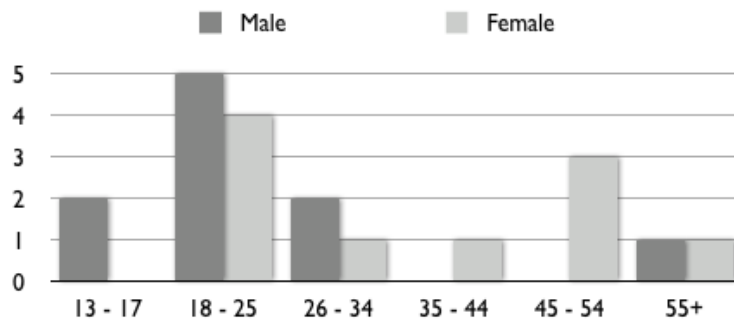


Figure 4.11: Age and gender distribution of participants

Even though the majority of the participants were under 25, we sought feedback from all age ranges. Not surprisingly, the ones most familiar with online gaming were the two teenagers and four of the young adults interviewed.

4.3 Discussion and Results

In this section we present a graphic resume of the answers to our survey followed by a discussion of each research topic:

The game uses a light written style with terms which are easy to understand.

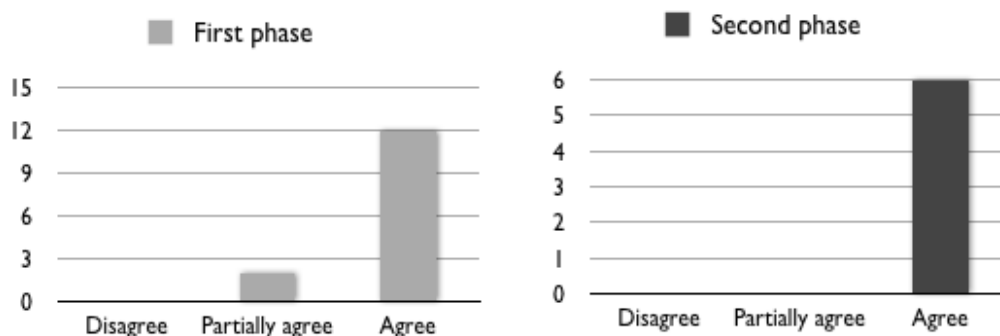


Figure 4.12: Participants' answers regarding Greenpoly's written style.

These results arrive from the fact that the eldest couple found some of the terms ambiguous and was confused about whether to press or not some buttons because of their label (e.g. when asked about their answer they admitted to feel intimidated by the label “Subscribe” as they thought it would oblige them to some type of contract or fee).

The game’s language is too childish.

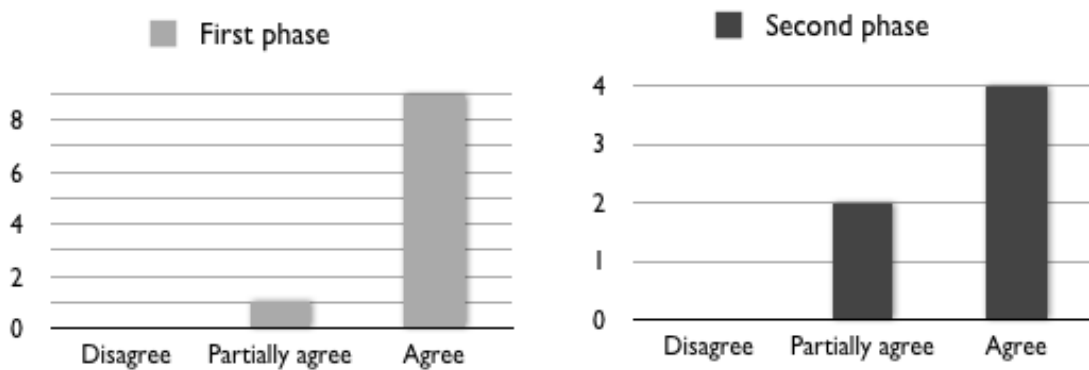


Figure 4.13: Participants’ answers regarding game language.

Three participants found the game’s language quite childish and would rather see a more serious communication style, mainly during the tutorial.

The game’s vocabulary is difficult to understand.

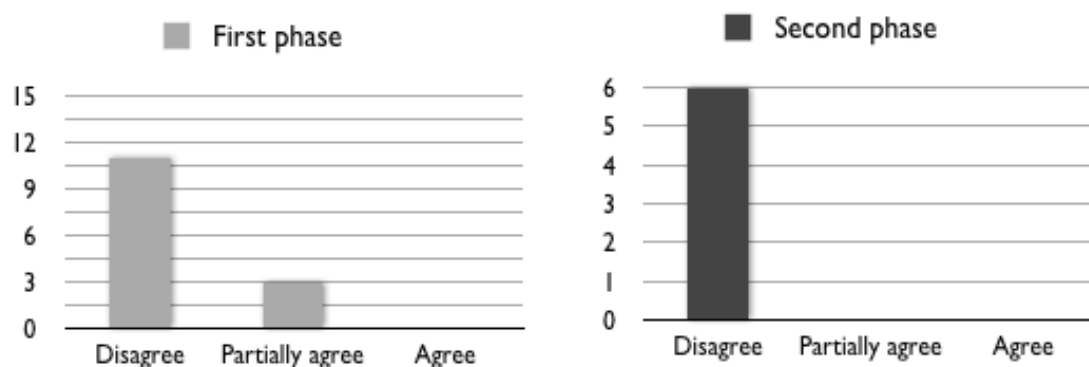


Figure 4.14: Participants’ answers regarding Greenpoly’s vocabulary.

This statement was included to track false positives in the first research topic. Surprisingly, one of the first phase’s participants changed his opinion towards Greenpoly’s written style, agreeing that, sometimes, the game’s vocabulary was difficult to understand.

It requires a great effort to learn the game.

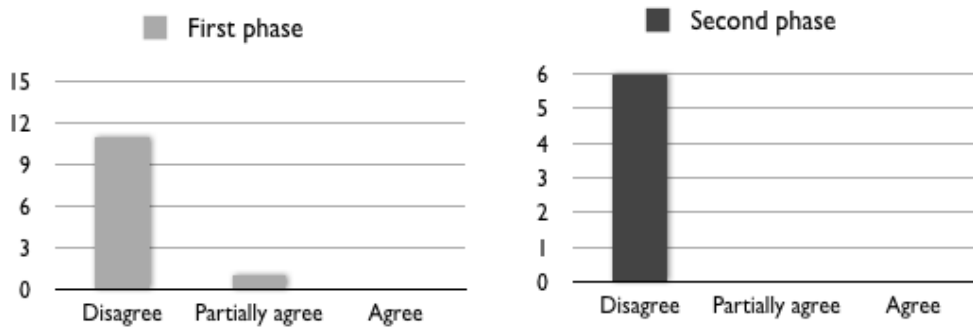


Figure 4.15: Participants' answers regarding Greenpoly's learning curve.

Although the great majority disagreed, one participant found the learning curve lightly steep and partially agreed with the statement.

Greenpoly's tile covers are straightforward and easy to understand.

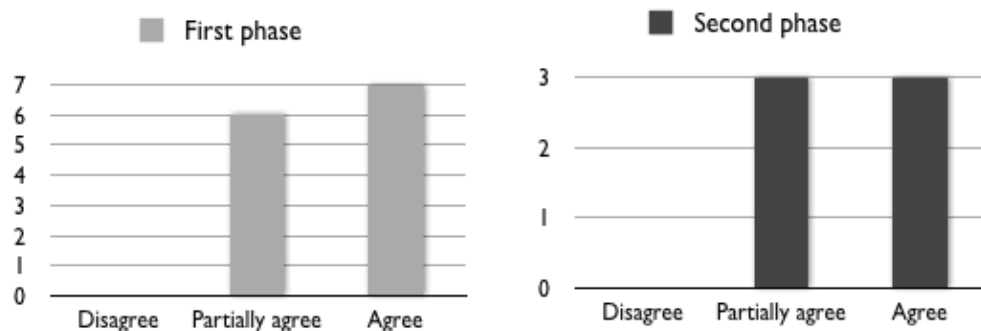


Figure 4.16: Participants' answers regarding Greenpoly's tile covers.

The answers to this topic raised the first discussion regarding the overall interface of Greenpoly, which in part is our fault for having merged together two distinct adjectives (straightforwardness and easiness). While 55% of the participants completely agreed with the statement, a meaningful group of users (nine to be exact) only partially agreed with it. When asked about this, one of the participants answered that even if he could immediately recognize that a tile cover with an umbrella and a dark cloud (in the context of Environmental threats) was probably related to acid rains, he had no clue about what would happen if he moved there (it was definitely not straightforward). Another participant went even further by stating that a black cat with a question mark reminded her of something mystical and was surprised to find out that it was meant to be a chance tile.

There is great need for labeling in order to understand Greenpoly’s tile covers.

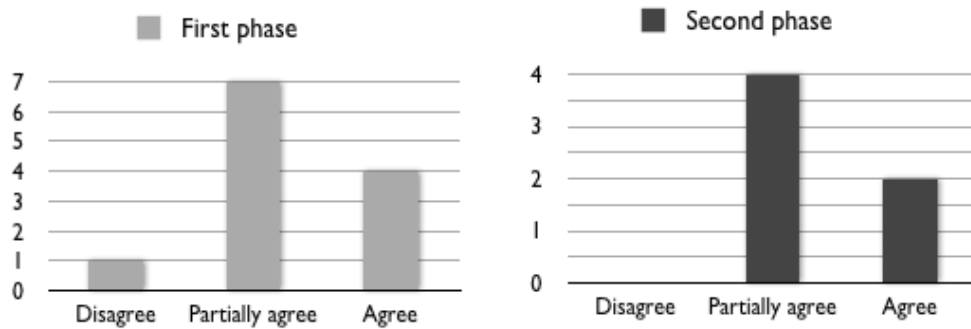


Figure 4.17: Participants’ answers regarding the need for labeling.

Only one participant found Greenpoly’s tile covers to be self-explanatory. Once again this question was used to detect false positives, and it indeed confirmed that the majority of people were not happy with our tiles’ covers. As you can see in figure 4.18 there were some tiles which had to be improved. As a matter of fact, it seems that a black cat with a question mark doesn’t represent very well a chance tile or, even if, a floating polar bear or a sweating earth gave some players a clue that something bad was about to happen, others thought they were about to play some sort of mini-game to face those Environmental threats.



Figure 4.18: Low fidelity prototype of Greenpoly

Game messages are clear and helpful.

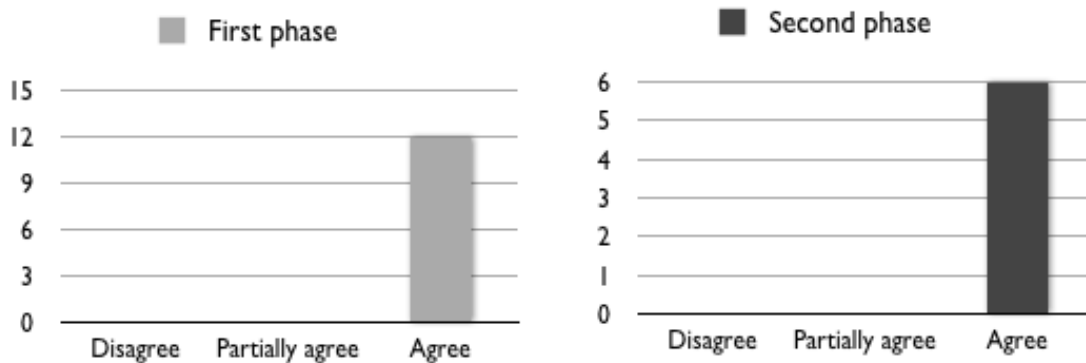


Figure 4.19: Participants' answers regarding Greenpoly's in-game messages.

There was a consensus about game messages being helpful and well-written.

The tutorial explains game rules thoroughly.

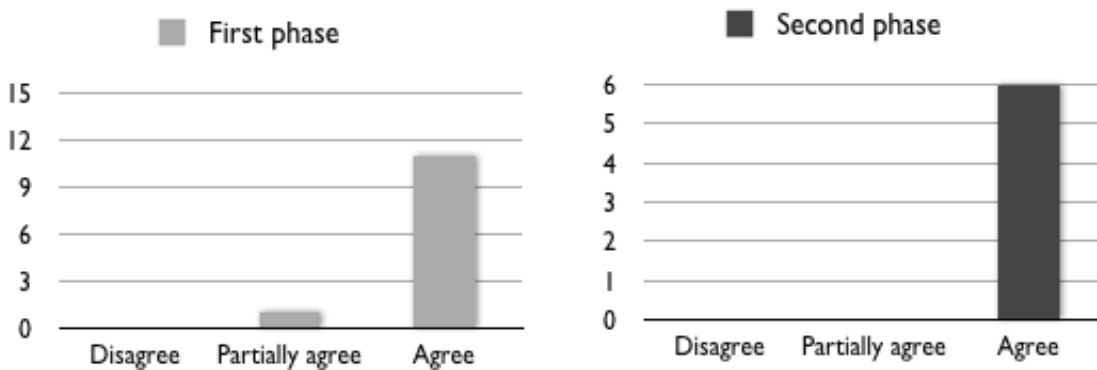


Figure 4.20: Participants' answers regarding Greenpoly's tutorial.

It is important to add a note here about the average time consumed by players who went through the tutorial vs the ones who didn't. In order to clock players we divided the session in three rounds. The tutorial plus the three first moves made up the first round whereas the remaining ones corresponded to each trio of successive moves. By choosing to read the instructions on how to play Greenpoly, participants spent an average of 14.25 minutes in the first session. On the other hand, players who opted to play immediately, took about 7.34 minutes to complete this stage. As one would expect, participants who learned beforehand, spent, in the worst case, 7.9 minutes to complete the rest of the test (4.2 + 3.7). The latter group, however, took some additional time with a worst case count of 12.6 minutes (9.1 + 3.5) to complete the tutorial.

Greenpoly's buttons are visible and match their underlying function.

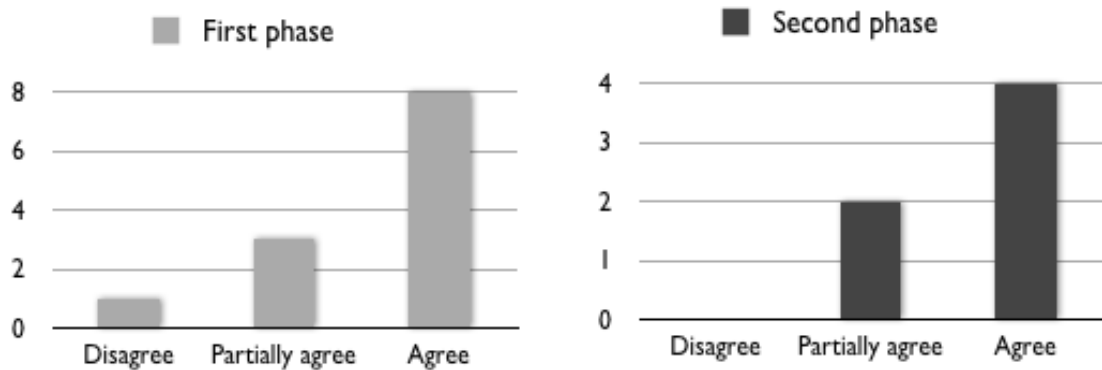


Figure 4.21: Participants' answers regarding Greenpoly's buttons.

Three participants weren't one hundred percent happy about the expressiveness of Greenpoly's buttons, namely the "Invite a friend" button which icon gave them no clue about its function (more on this topic in subsection 4.3.2).

During the test case scenario I knew always what was the next move.

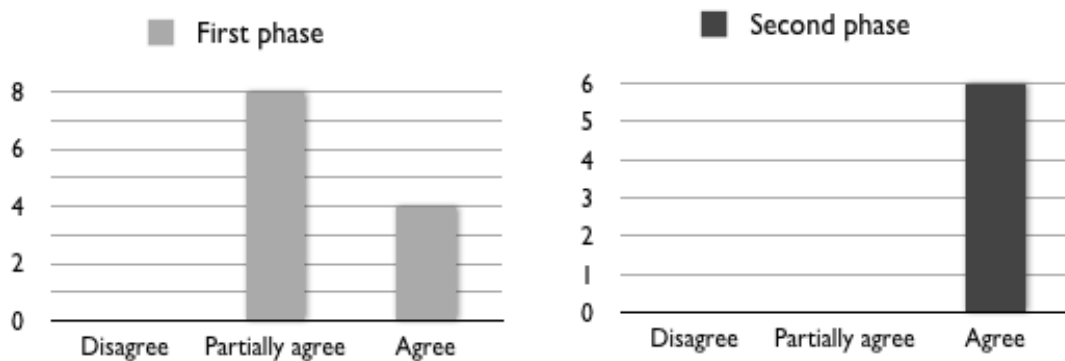


Figure 4.22: Participants' answers regarding the test case scenario.

Almost half of the participants were lost at some point of the test case scenario and asked at least once for help. We believe that to some extent the reason for this was due to them feeling uncomfortable to try several alternatives and look bad in front of the interviewer. It is also worth noting here that from this results, a gap between non-experienced and practiced players becomes evident, with the latter showing more confidence during the whole experience.

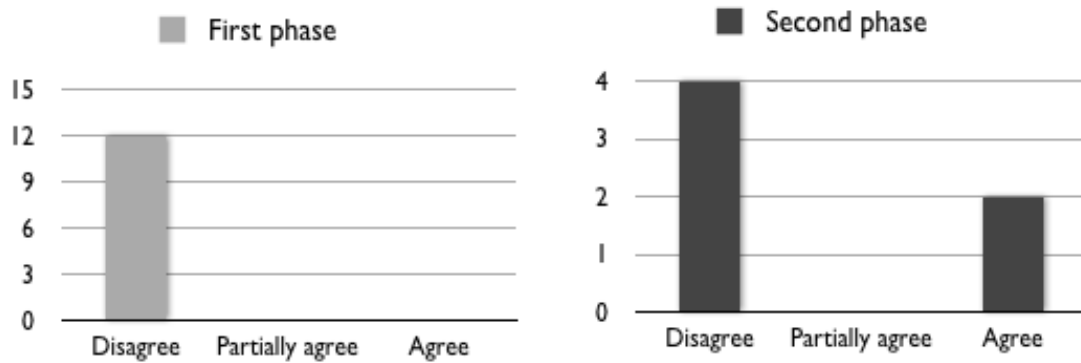


Figure 4.23: Participants' answers regarding Greenpoly's board.

Greenpoly's board is too colorful.

One percent of the participants felt that considering the seriousness of the topic (Environment), the game should be more provocative and aim to create a greater impact on its players. Indeed, one of the players, despite having disagreed with the statement, shown concern about our approach being too lightly.

The questions in the quiz are too hard.

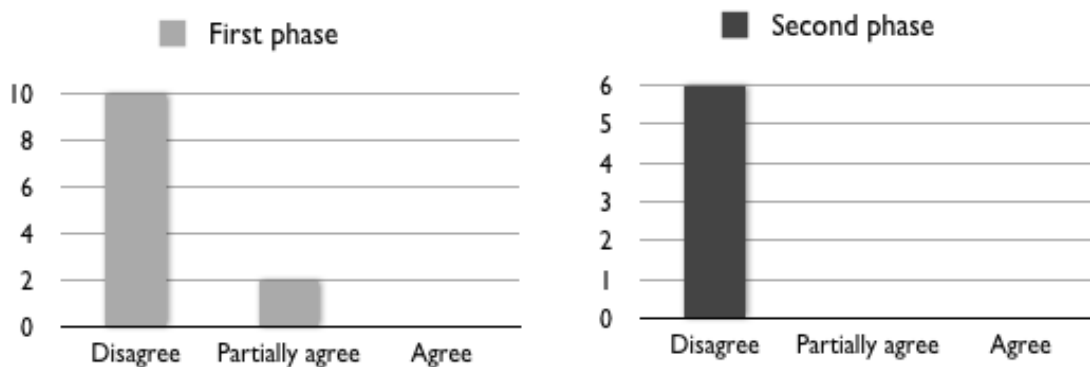


Figure 4.24: Participants' answers regarding the difficulty of Greenpoly's quiz.

From the twenty participants who accepted to test our game, a meaningful percentage answered correctly to all four questions in the quiz (90%). The eldest couple didn't feel so comfortable with some of the questions and was quite disappointed after. Further, the idea to add difficulty levels, with higher rewards, came from one of the adults who got none of the answers wrong.

There is low interaction with the game.

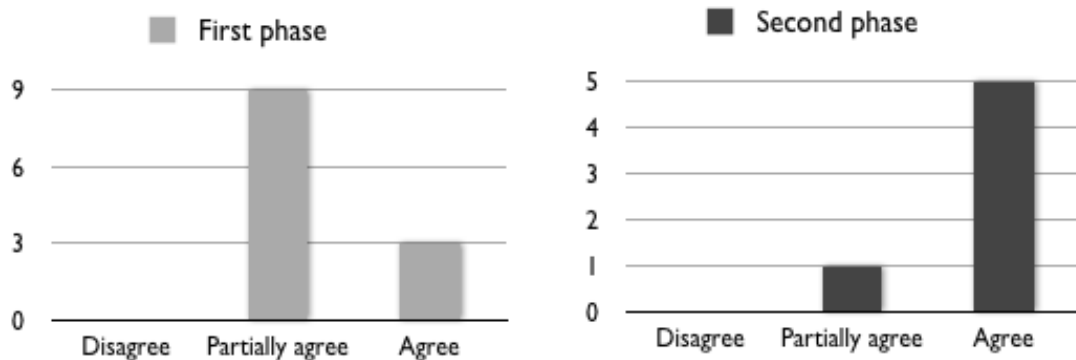


Figure 4.25: Participants' answers regarding their interaction with the game.

Almost all of the participants thought this statement as a tricky one, since they didn't know a-priori if it was a bad thing or not. These results confirmed our fear that besides the quiz and the "Earth Hour" game, Greenpoly lacked interactivity. We agreed that it was time to focus less on design issues and focus more on what really matters in a game: playing.

It is easy to understand how to conquer a tile.

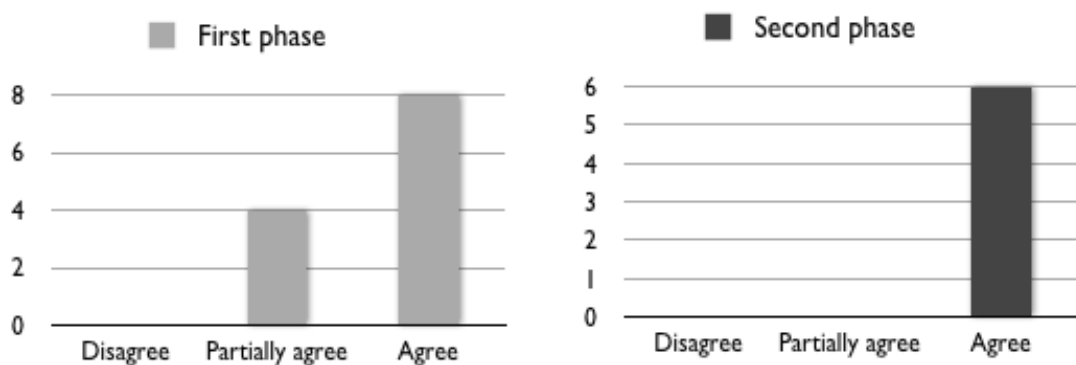


Figure 4.26: Participants' answers regarding Greenpoly's conquerable tiles.

One of the problems that arise from using a popular conceptual model (in this case, Monopoly), is that, players tend to assume everything to be the same but the underlying theme. As a consequence, it was quite common for them to ask, at some point, how to buy a certain tile. We believe that this is normal due to the impact that Monopoly had on our childhood and that they would naturally adapt to Greenpoly's rules as they continue to play it. Curiously, after nearly one

year dealing with conquerable tiles and individual high scores, we are the ones to feel unfamiliar with those Saturday nights' Monopoly sessions.

Greenpoly's theme is current and of great significance.

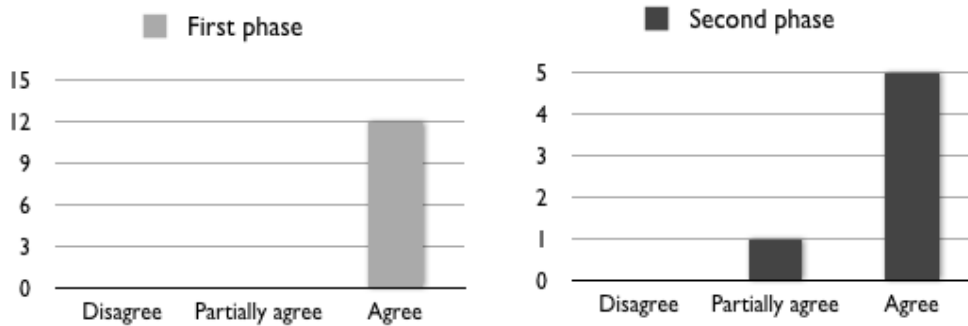


Figure 4.27: Participants' answers regarding Greenpoly's underlying theme.

Close to all participants found this statement to be true with one of them even adding that with the proliferation of online games it was, from his point of view, the best time to invest in different approaches to raise environmental awareness among current generations.

Have you ever played a social game online?

- Never played a social game online
- Tried one or more social games online



Figure 4.28: Participants who had already played social games online

Regarding familiarity with online gaming, results were quiet even with eleven (11) participants stating they had already tried at least once a social game (results varied between Sims Social and FarmVille) while the remaining nine hadn't had the chance or just weren't curious about this kind of entertainment.

4.3.1 Most Welcomed Features

In addition to the aforementioned statements, there were two open-answer questions to find out participants' opinion about Greenpoly's underlying theme and what they thought about using a gaming approach to raise environmental awareness among players. We were very happy to know that all players felt the Environment to be of major importance nowadays and that every way of getting people to feel responsible for their actions towards a more sustainable lifestyle is greatly welcomed. We also received recognition regarding the eco-store for its relevance in players' day-to-day life and how they could really relate the virtual assets included in the prototype (see figure 4.29) to the ones they are used to find at the supermarket. Another feature highlighted by participants was Poly. Even if our host didn't fulfill the supporting role we wanted it to, players thought it was funny to read Poly's interventions during the tutorial and felt that we could really leverage this hallmark to improve Greenpoly's gaming experience.

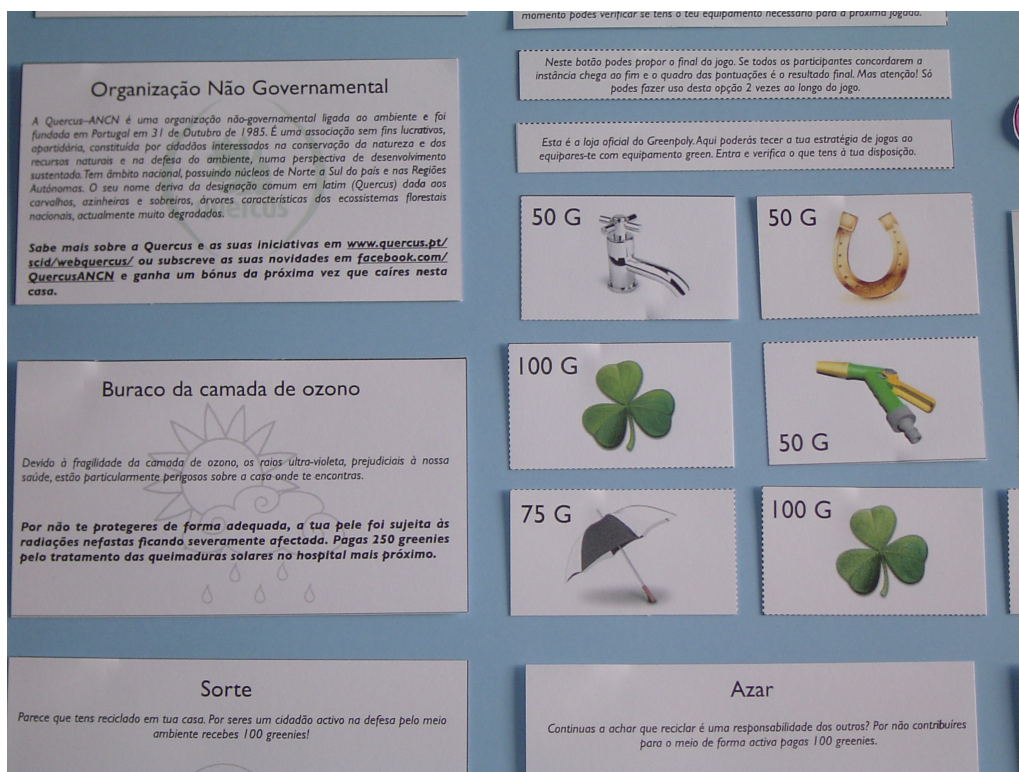


Figure 4.29: Examples of assets included in the paper prototype

Other less consensual reviews, pointed out that using one's skills for beating an opponent's high score and conquering his/her tile was a valuable variation of the classic buy and sell paradigm of Monopoly.

4.3.2 Suggestions to Improve

Curiously enough, participants were keen to give their recommendations in order to improve Greenpoly. Some of these, listed below, were carried out, others, mainly because they would drive us away from our purpose, were postponed.

More plays The most emphasized nice-to-have feature concerned the number of players with suggestions varying from a modest improve of one play per round up to unlimited plays without breaks;

More mini-games Close, in votes, to the first position, the desire to have more mini-games didn't pass unnoticed. It was also suggested that we grouped similar tiles together and offered bonus for conquering these groups;

Chance's tile cover A precious and one of the first adopted suggestions was the one to use symbols commonly associated with good luck not only in the chance cards but also in the cover itself.

Shorten the tutorial Some people showed concern about the length of the tutorial and felt that it should be more straight to the point. A possible amendment could pass by explaining the main options in the interface and some of the less intuitive game dynamics leaving more for "on-the-job" learning;

Game-specific assets One of the younger participants advised us to include a set of game-specific assets in the eco-store. One that he could think of at that time was to have less waiting time between rounds;

Temporary assets Another tip regarding Greenpoly's assets, had to do with their time span. We were fond of the idea that some items, once bought, would stay permanently in one's wooden box, while others, for their properties, would expire after a limited number of uses;

Free dice Lastly, a funny criticism present in one of the surveys concerned the dice. Quoting her own words, the participant said that "it would be nice to let the dice roll freely instead of forcing it to have a pre-defined number". It seems that we forgot to explain why we were setting the value each time she pressed the dice button on the cardboard, hence the suggestion.

In the end, it took a generous amount of time *and* effort to plan, design, sketch, print, plasticize and evaluate the paper's prototype, but, only then, we had the basis to proceed with a more robust, feasible, high-fidelity computer version.



Computer Prototype

5.1 Game Engine

In order to create a powerful, 3D game we had the difficult task of choosing a game engine that would fit our needs. Among the alternatives there were five which stood out from the crowd¹, namely:

Unity 3D ² Unity supports three scripting languages: Javascript, C# and a dialect of Python named Boo. All three can interoperate and make use of .NET libraries which support databases, regular expressions, XML, networking, among others. It can be difficult to learn at first, but rookies may try working examples, read the scripting reference available online or even search the forums for a quick answer. Games can be exported as either standalone or web player and are compatible with Windows, Mac, iOS, Android, Wii and PS3. Specifically when running in a web browser, the deployed Unity Web Player can communicate seamlessly with the container web page. That way it is possible to leverage javascript communication and AJAX capabilities. For access to web pages and web services, Unity provides an easy to use interface for the World Wide Web with both synchronous and asynchronous modes being supported.

¹<http://www.moddb.com/engines/rated>

²<http://unity3d.com/>

Source³ - Source engine is a 3D game engine developed by Valve Corporation. Its unique features include a large degree of modularity and flexibility, an artist-driven, shader-based renderer, accurate lip sync and facial expression technology, and a powerful, efficient and completely network-enabled physics system. It relies on Microsoft Visual Studio and targets the PC and Xbox 360 platforms. Source uses Valve's platform-independent custom GUI framework to mimic most of the windows controls but is rendered using the Source engine for consistent in game and out of game UI. Finally Source engine games utilize multi-core processors in both the PC and Xbox 360 to deliver high-performance gaming experiences. In terms of networking, Source's players may opt among a list of active game servers and choose which one to participate on. As a consequence players can filter and sort server lists in order to speed up the loading times.

CryEngine 3⁴ CryENGINE 3 was the first development platform for Xbox 360, PlayStation 3, MMO, DX9/DX10 and also truly next generation ready with scalable computation and graphics for all major upcoming platforms. It provides the complete game engine to create AAA quality next generation games, and includes the CryENGINE 3 Sandbox level editor, a production-proven, 3rd generation tool designed by and for professional developers. CryENGINE 3 comes with significant new features specifically designed for console, online, MMO and next generation game development. It can be used free of charge for non-commercial projects and has extensive documentation and tutorial for beginners to get on the fast track quickly. Finally CryENGINE's technology is world famous for its award winning rendering and is considered by many to be the world's fastest, high-end renderer.

Unreal Engine 3⁵ - Every aspect of the Unreal Engine has been designed with ease of content creation and programming in mind, with the goal of putting as much power as possible in the hands of artists and designers to develop assets in a visual environment with minimal programmer assistance. Furthermore it is capable to give programmers a highly modular, scalable and extensible framework for building, testing, and shipping games in a wide range of genres. It's editor (UnrealEd) is a pure "What You See Is What You Get" content creation tool filling the void between XSI, 3D Studio Max and Maya, and shippable game content. It is able to export games to PC, Mac,

³<http://source.valvesoftware.com/>

⁴<http://mycryengine.com/>

⁵<http://www.unrealengine.com/>

iOS, Android, Xbox 360, PS3, PS Vita and Nintendo's Wii but as no browser support at the time of this writing.

Torque 3D⁶ - Despite the fact of having such a low rating when compared to its opponents we decided to include Torque here because together with Unity3D these are the only game engines capable of deploying directly to web browsers. With a proven tech backbone that's already available on multiple consoles, the focus for Torque 3D is the toolset. In fact, this game engine comes with a robust collaborative design activity import pipeline so that all assets are updated live in-engine from external tools, allowing for zero-second asset iteration. Its license price range varies from \$1000 dollars for the indie version to \$4K+ for the studio edition with unlimited projects.

Have given careful thought to all aforementioned alternatives we decided to go with Unity3D. After all, we wanted a game engine where prototyping and development would be fast and for that Unity's WYSIWYG editor with instant changes and live editing is hard to beat. Furthermore, apart from shaders and effects which can simply be turned on in some game settings, Unity provides numerous scripts which can be simply dragged onto 3D models making animations seem trivial. Last but not least, our needs regarding Facebook integration were very strict which left only Unity and Torque3D to decide between and for its pricing and lack of maturity in the market the latter was discarded.

5.1.1 Flash *versus* Unity3D

Citing a well-known gaming blog⁷, "Leading-edge tech that supports immersive play, such as in 3D browser-based games, will surely have a major impact across the web" and "developers have two choices: adopt Unity 3, the third version of Unity Technologies' increasingly popular Unity 3D development platform, or utilize Molehill, the new 3D version of Flash, now in beta and scheduled for the next release." the decision between these technologies was far from easy. First of all we had to consider Flash worldwide adoption with over a billion PCs running Adobe Flash Player, twenty thousand apps in mobile markets and a community made up by more than three million developers. Besides its impressive statistics, Flash has some meaningful drawbacks⁸, such as:

⁶<http://www.garagegames.com/products/torque-3d>

⁷<http://www.gamasutra.com/>

⁸<http://forums.indiegamer.com/>

There is no right click Curiously we didn't use this feature in Greenpoly, but we prefer to disregard this option than not having it at all;

Flash games often lose focus This is quite a problem for all web players no matter the underlying technology so we did not consider this as an actual pitfall but included here as a potential tie-breaking factor;

3D content in Flash requires Stage3D Latest versions of Flash, such as Flash 11 require developers to install Stage3D (proprietary license) in order to create 3D content in one of the available platforms (e.g. Flare3D, Away3D, Minko). If we take into account that Greenpoly involves downloading and installing Unity3D in advance, Flash doesn't really have an advantage;

Actionscript is slower than C# This was probably the strongest downside of using Flash to develop Greenpoly. We wanted to create a 3D learning environment as fluid as possible and considering that C# almost always means best performance, there were no doubts here;

External libraries Truth be said, Flash does not benefit from the great variety of libraries that are available for C#/.NET. In Greenpoly, for example, we had great need for connectivity. For database interaction, parsing XML/JSON files and establishing TCP/IP channels to communicate with external servers, existing C# libraries seemed very appealing and hard to neglect;

Having seen the strengths and weaknesses of Flash technology it was time to let Unity shine. At the moment of this writing Unity Web Players' installs already crossed the one billion mark and due to its NaCl publishing mode they already run automatically in Chrome without requiring a plugin. Unity3D has very efficient streaming capabilities, giving developers complete control of what packages to stream and when to do it. Furthermore, it relies on powerful .NET libraries that make it easy to create powerful applications with little coding. Embracing the challenge of learning this fresh game engine and exploring some of its formidable features outweighed its still low adoption and plugin's installation requirement. After all, we could always swap to Flash if we happen to change our minds because nearly after the beginning of this project Unity announced⁹ a great add-in: the possibility to publish from Unity3D to Flash PLayer. This meant that next to the already existing build options of a Unity project, it was now possible to target Flash with Stage3D and get the best of both worlds.

⁹<http://blogs.unity3d.com/2011/09/01/unity-and-flash-a-sneak-peek/>

5.2 Technical Details

In this chapter we will drill some of the technical details of our approach, starting with the architecture model of Greenoly's computer prototype, followed by the database schema created to store game-related content, then a quick review on how localization is handled, standards used for data interchange between servers and finally target specifications and restrictions.

5.2.1 Architecture

After deciding to go with Unity we started to structure our application by defining its varying parts. The final model is depicted in figure 5.1 and is composed by three layers resembling the popular model-view-controller software architecture¹⁰ which separates the representation of information from the user's interaction with it. Storage of game-related information is divided into a MySQL database and multiple XML files for language-specific strings. While most of the tutorials and webinars undertaken to learn Unity were based on UnityScript, we opted to code only in C# for its performance and versatility. If on the one hand communication between server-side and Greenpoly is only possible through PHP functions, on the other hand client requests made through the user's web browser are handled by Javascript routines running on their local machine. Some lines of HTML and CSS were added to center Unity's web player in the iFrame and retouch the surrounding page where the game would run. Finally JSON was chosen to be the standard used for data-interchange, allowing for third-party applications to send player and application IDs, points and other relevant attributes.

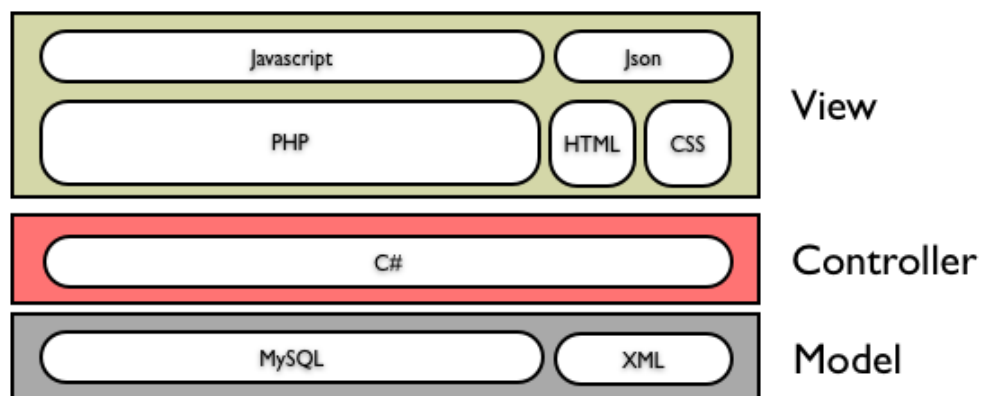


Figure 5.1: Greenpoly's architecture

¹⁰<http://en.wikipedia.org/wiki/Model-view-controller>

5.2.2 Database

The database model was one of the most challenging stages of Greenpoly's implementation. It had to be flexible enough to handle updates during Greenpoly's development and at the same time allow for new modules to be added without risking to lose previous stored data. The underlying database management system used in Greenpoly is MySQL for its reputation with online services¹¹. Furthermore, we took advantage of MySQL high performance, scalability and availability to build a robust transactional support for our game to settle on.

The database itself resembles a data warehouse star schema, with players' storage simulating a fact table at the center (see figure 5.2) and the remaining assets (dimensions) close in orbit.

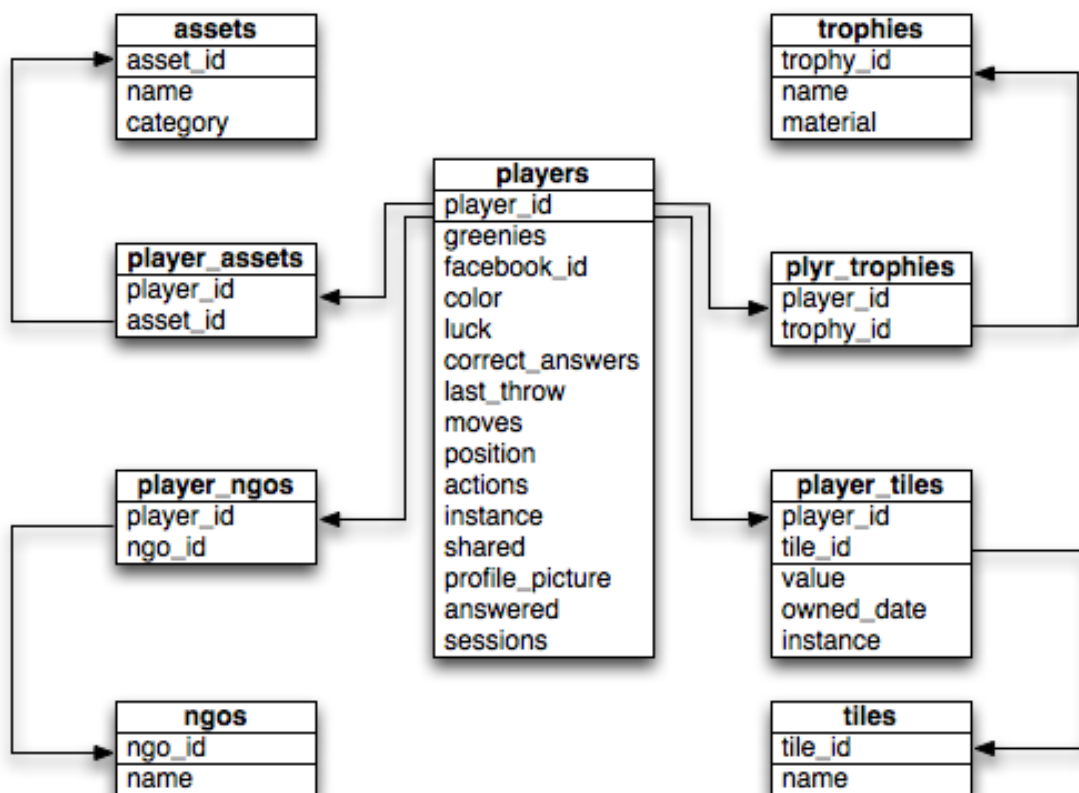


Figure 5.2: Conceptual model of Greenpoly's database

We have included here a brief description of some of the attributes used:

Greenies Stores the amount of greenies earned until the present moment;

¹¹<http://www.mysql.com/why-mysql/topreasons.html>

- Facebook ID** Ten digit number which uniquely identifies each Facebook user;
- Color** Stores a string with the player's color. Options are: light-blue, dark-blue, light-green, dark-green, orange, purple, yellow and red;
- Luck** Stores the number of consecutive lucky cards (resets to 0 if unlucky);
- Correct Answers** Number of quiz questions this player answered correctly;
- Last Throw** Stores the last time this players has thrown the dice;
- Moves** Stores how many times this player can throw the dice in each session;
- Position** Stores a number from 0 to 39 equivalent to this player's current tile;
- Actions** Stores the number of volunteering actions this player has done;
- Instance** Instance of Greenpoly in which this player is playing;
- Shared** Stores how many times this player has shared an eco tip in Facebook;
- Profile Picture** Stores the url to this player's Facebook's profile picture;
- Answered** Returns true if this player has answered the survey, false otherwise;
- Sessions** Stores the sum of sets of three moves this player has completed.

The connection to the database is done via an HTTP Secure Protocol through a PHP file called "internal.php" which is responsible for querying the database and building up a JSON string with the contents retrieved (see code excerpt below):

```

1 if(get_request("action")== "get_used_colors") {
2     $facebookID = get_request("facebookID");
3     $query = mysql_query("SELECT_color_FROM_players_WHERE_facebook_id!=
4     _____ '$facebookID' _AND_instance=(SELECT_instance_FROM_players
5     _____WHERE_facebook_id=_' $facebookID' _LIMIT_1)");
6
7     $answer = array();
8     while($row = mysql_fetch_array($query)) {
9         array_push($answer, $row['color']); }
10
11     echo json_encode(array("colors" => $answer));
12 }

```

The aforementioned JSON encoded string was then mapped to an object in the SqlConnection C# class which would associate the color's thumbnail with each item in the color array and present them to the user.

5.2.3 Localization

We believe that for a game to succeed in such a broad social network as Facebook it must be prepared to support multiple idioms. It was agreed that Greenpoly's localization should be easily scalable and nearly effortless to maintain. In such way we opted to follow a well-defined xml-schema from which a XMLReader class could read and interpret. This schema is as follows:

```
1 <xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema">
2   <xs:element name="localizableStrings">
3     <xs:complexType>
4       <xs:sequence>
5         <xs:element name="meta">
6           <xs:complexType>
7             <xs:sequence>
8               <xs:element type="xs:string" name="gameName"/>
9               <xs:element type="xs:string" name="version"/>
10              <xs:element type="xs:string" name="author"/>
11              <xs:element type="xs:string" name="university"/>
12            </xs:sequence>
13          </xs:complexType>
14        </xs:element>
15        <xs:element name="group">
16          <xs:complexType>
17            <xs:sequence>
18              <xs:element name="string" minOccurs="0">
19                <xs:complexType>
20                  <xs:sequence>
21                    <xs:element name="text" minOccurs="0">
22                      <xs:complexType>
23                        <xs:simpleContent>
24                          <xs:extension base="xs:string">
25                            <xs:attribute type="xs:string" name="lang"/>
26                          </xs:extension>
27                        </xs:simpleContent>
28                      </xs:complexType>
29                    </xs:element>
30                  </xs:sequence>
31                  <xs:attribute type="xs:string" name="id"/>
32                </xs:complexType>
33              </xs:element>
34            </xs:sequence>
35            <xs:attribute type="xs:string" name="id"/>
36            ...
```

A folder called “Localization” stores several xml files each one containing strings specific to a part of the game, such as: *puzzles, quiz, NGOs, tutorial, store, store, taxes, tips*, among others. An example of one of this files is presented below:

```

1  <?xml version="1.0" encoding="UTF-8" ?>
2  <localizableStrings>
3      <meta>
4          <gameName>Greenpoly</gameName>
5          <version>Beta</version>
6          <author>Jorge Andre Pereira</author>
7          <university>Faculdade de Ciencias e Tecnologia</university>
8      </meta>
9      <group id="home">
10         <string id="play">
11             <text lang="pt">Jogar</text>
12             <text lang="eng">Play</text>
13         </string>
14         <string id="learn">
15             <text lang="pt">Aprender</text>
16             <text lang="eng">Learn</text>
17         </string>
18     </group>
19 </localizableStrings>

```

To place a message correctly XMLReader firstly seeks for the xml file corresponding to the scene currenty open followed by the area being displayed to the user (identified by the group’s id) and only then returns the text under the language chosen at the beginning of the game. This way, to include other idioms, one must add a single line under one of the existing options. For example, if we wanted to translate the action “Play” to French we would alter the above file to:

```

1      <string id="play">
2          <text lang="pt">Jogar</text>
3          <text lang="eng">Play</text>
4          <text lang="fr">Jouer</text>
5      </string>
6      <string id="learn">
7          <text lang="pt">Aprender</text>
8          <text lang="eng">Learn</text>
9          <text lang="fr">Apprendre</text>
10     </string>

```

5.2.4 Data Interchange

As we have seen Greenpoly used the two most common standards for data interchange. If on one hand we wanted to have stricter localization, text-based, position-independent files naturally led us to XML, on the other hand JSON proved a better choice to communicate with the database server where a fast, compact and convenient serialization of data was required. We depict the use of both standards in the following diagram:

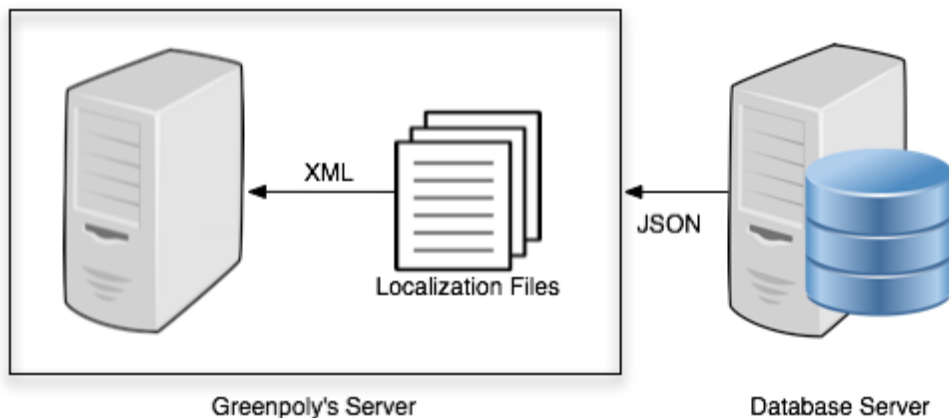


Figure 5.3: Data interchange standards used in Greenpoly

5.2.5 Target Specifications

To incorporate an application in Facebook there were both technical and non-technical requirements that needed to be fulfilled. In this subsection we start with a light explanation of the Facebook Platform's architecture, followed by some of the policies adopted by this social network and some standard settings common to all Facebook applications.

Background on the Facebook Platform

Figure 5.3 shows aspects of the Facebook Developer Platform's architecture that are relevant to our application. In this architecture, a user interacts indirectly with the application's server through Facebook's API servers. This enables Facebook to protect users from malicious content that may be embedded in the response data by the application servers, since Facebook can process and strip undesirable content from the server responses before forwarding them to users.

We must note, however, that Facebook has an alternate method for deploying applications on its platform that enables users to interact directly with the application servers. We adopted the latter to develop Greenpoly hence reducing the number of resources required to render content to users under the commitment of having higher risk.

Similar to all other Facebook applications, Greenpoly, requires user subscription (or installation). Once a user installs Greenpoly, it may provide updates on his profile as well as their friends' activities in the game.

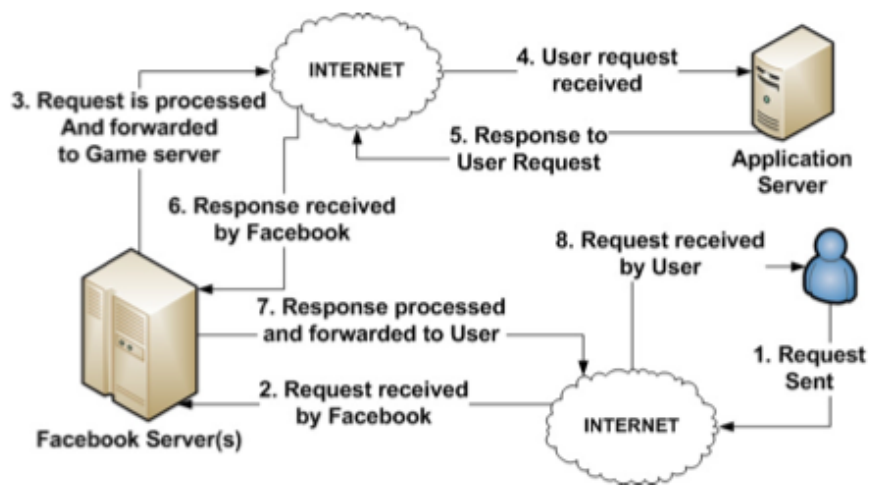


Figure 5.4: Facebook's architecture overview

Facebook Platform Policies

Facebook defines "basic account information" as a user's name, email, gender, birthday, current city, and profile picture URL. In order to play Greenpoly, one must accept to share this information as well as the right to publish in his/her name. This is due to our "share this tip" and "share your trophy" actions which will add content to the player's wall.

Among other principles¹², we, as developers, are legally restrained from sharing this content with any third-parties or use this information to gain profit or consciously prejudice its owners under penalty of having our application banned from this social network or, ultimately, having to answer before justice in court.

¹²<https://developers.facebook.com/policy/>

Facebook Application Settings

Apps on Facebook are basically web apps that are loaded in the context of Facebook in what they refer to as a Canvas Page, thus one can build his app using any language or tool chain that supports web programming, such as PHP, Javascript, C# or, in our case, a combination of the three. This Canvas Page comes with a Canvas URL that contains the HTML, Javascript and CSS that refer to the Unity plugin where Greenpoly runs. When a user requests the Canvas Page, Facebook loads the Canvas URL within an iframe on that page. This results in our app being displayed within the standard Facebook chrome. The canvas chrome is 760px wide by default but it can be set as a Fluid Canvas so that it is left aligned and takes up the full width and height of the user browser. Greenpoly takes up a fixed width and height, namely 1000px width by 600px height.

Once a user starts playing Greenpoly, Facebook creates a bookmark to enable users to easily navigate back to our game from within Facebook. During gaming experience Greenpoly triggers app-generated requests which are sent only to users who have authorized Greenpoly. Furthermore, Facebook shares stories with friends when a user starts using a new app or first installs a new game. These installation discovery stories show up in friends' News Feed and enables users to discover popular apps their friends are using. This way we expect Greenpoly to promote itself by showing up in other people's walls. Facebook also keeps a gaming activity log for each app by generating monthly reports on how many users are using the app, how frequently do they play and the average time spent on it.

When a Facebook application reaches 10 monthly active users it is automatically queued to be included in the search index the next time Facebook rebuilds their search index (usually every 2-4 weeks). After the index is rebuilt the app becomes discoverable via Search. Greenpoly was added to the Search bar nearly three weeks after deployment which already pointed out to a great start. Finally, every app in Facebook may be promoted by a Facebook Fan Page where users can comment and rate the application, check new releases or simply click "Play the Game" to try it out.

5.3 Interface/Class Description

As stated before it took more than three months of coding to finish the first prototype of Greenpoly. With far more than ten thousand lines of code, Greenpoly was far more complex than the average academic project and the result was an impressive 3D environment, populated with immersing game dynamics, working under a well-defined set of rules with a sole purpose on mind: to have a chance in the competitive social game market where players are evermore demanding and not easily satisfied. By recurring to a gaming jargon, Greenpoly is made up of four main scenes, three mind-challenging puzzles, several plugins and around thirty other classes which define specific behaviors such as animations, scripts, input/output connections and auxiliary functions. In this section we shall cover some of the aspects we consider to be relevant in a more technical manner.

5.3.1 Scenes

When working with Unity's game engine, scenes are what they call an empty environment which simulates physics laws which a developer can manage to fit his/her own purposes. A scene is characterized by a dynamic 3D referential which creates the illusion of depth when filled with solid objects. Unity comes with a set of ready-to-use gizmos or boundary boxes to manipulate 3D objects like particle systems, cameras, box colliders, audio sources, meshes or character joints. The first scene in Greenpoly is the splash screen. This screen (Figure 5.5) is the simplest of the four, composed by a background camera which points to a 1000x600 image of an island, a 2D sound (3D sounds in Unity become louder as the camera moves closer and progressively faint when the camera drifts away), a 2D text which displays the percentage of the scene already loaded, a XMLTextReader which allows for language selection and a SqlConnection class. The latter was included for speed optimization. By using the splash screen to create a background connection between the game server and the database, we were able to significantly reduce the delay of retrieving user's data in the following scenes.

While a little more complex than the previous one, the tutorial screen is still pretty straightforward. Two different cameras (one for the background and one pointed towards Poly), three point lights (two of which above the board and one beside Poly to focus the player's eyes on our cheerful host) and a 2D environment sound (ambient audio) create the set of this screen. The board and playing tiles were included out of the camera's range and animated towards its visible window in order to make the learning process more entertaining. The consecutive text messages that appear above Poly as "talking balloons" are taken from the localization files in the game's server and animated by iTween functions (detailed below). All but the text boxes, the two little arrows (which allow the user to proceed or return to a preceding explanation) and the wooden cross at the top-left corner, are 3D objects with an individual mesh, colliders, mass and dimension properties. With a different purpose than before, an SQLConnection-dedicated class was now necessary to search for available colors for the player to choose from or to check if the player had already made this choice thus returning his/her previously selected color.

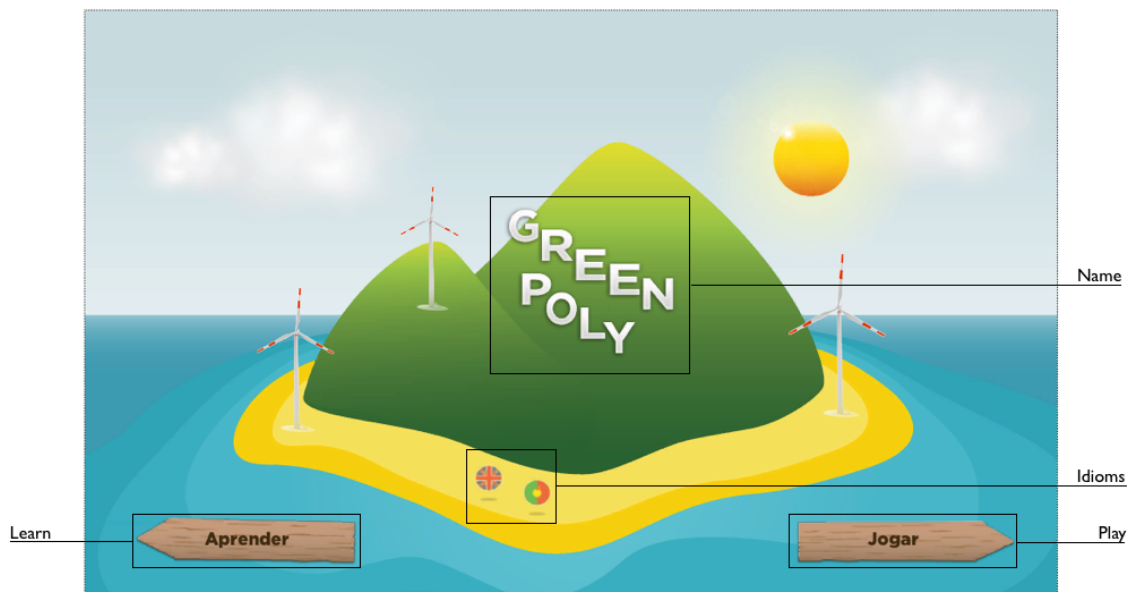


Figure 5.5: Sply Screen

Next, the main scene of Greenpoly: the board screen. Here, a player could roll the dice (another plugin described in the next subsection), see his/her token move across the board and see the outcome of any given tile where he/she eventually landed on. Similar to the tutorial screen, there are three point lights, three cameras (an additional one for Poly), a background image, an SQLConnection and, of course, the ambient audio. Additionally, there is a spotlight pointed to

Poly to increase the light around this figure and a Facebook hidden object which keeps the thumbnails of the player's opponents up to date. Before rendering the main scene, the underlying controller searches for already conquered tiles and fills them with their owner's color, retrieves the number of available moves and all player's related data such as his/her greenies, his instance, their opponents' colors, his/her last known position and his/her token. For speed optimization, proprietary assets like ecological items or lucky charms are only loaded when the player falls on the corresponding tile. Information regarding NGOs is generated randomly as are the Environmental threats at the corners so there is no way to know for sure what a player will get, before effectively seeing it.

Curious fact: Some players have found to be a delay between falling on a tile and seeing the window that it triggers. This is due to the fact that we chose to only lower the window when the content to be displayed is already loaded. A possible alternative would be to immediately start the animation with the risk of having empty windows until the information could be fetched and displayed. We thought that our approach would be less confusing to players and even add a light-reduction effect for them to know that there is something going on and that the game did not crash (a loading bar would also be a reasonable workaround).



Figure 5.6: Map screen

Last but not the least comes the map screen or the options' screen as we like to call it since it's here that a player can set his/her strategy by buying ecological assets and avoid to incur in large penalties. The backbone of this screen is very

similar to both the board screen and the tutorial one in terms of lights, cameras, audio and board. The two main differences here are the offset of the camera (positioned further from the board) and the presence of three large buttons which change when hovered: a wooden box, a treasure chest and a wind mill (inspired by The Ingenious Gentleman Don Quixote of La Mancha). When clicked, each of these buttons, clear the screen and show a composition of 2D images which overlap the background. This is only possible by using different cameras for the back and the foreground. Poly is not present in this scene but promptly flies in when the player returns to the playing screen. Also worth noting is the existence of a 2D version of every conquerable tile which appear over a scrabble-like wooden basis when they are currently owned by this player.

5.3.2 Puzzles

We felt that it would be a good idea to enrich Greenpoly with classic mind-challenging puzzles that could still be related with our Environmental cause. To achieve this we ordered the jigsaw puzzle pack from Wyrmtale¹³ and adapt it to our own needs. While the sliding and jigsaw puzzles proved easy to change (all we had to do was change the theme and the mixed images for others of Earth's beautiful fauna), the memory's game required some days to convert. We had to completely redesign its underlying matrix (we opted to use recyclable items as matching pairs), change each piece reverse side (replaced the Wyrmtale logo with a stylized G for Greenpoly) and altered the background for a brown, catchier one.



Figure 5.7: Recyclable items in memory puzzle

¹³<http://u3d.as/content/wyrm-tale-games/jigsaw-puzzle-pack/1Ap>

5.3.3 Plugins

Plugins are an essential part of Greenpoly. From the iTween library which allows for 2D movement, through input/output parsers like LitJSON or XMLReader to the DiceRoller, these libraries are what makes Greenpoly a whole. The iTween package allows developers to move, rotate, shake, punch, fade, scale any 3D object, control audio or even fade cameras. Moreover iTween functions have the ability to create animations with full control over things such as delay, looping and callback functions. It uses hash tables for passing the parameters needed in custom animations, such as the initial and final positions, speed, delay or duration. We have used iTween exhaustively in an attempt to give life to Greenpoly. From the catchy intro where the letters start to fall orderly to create the title of our game to the smooth transitions between balloons when Poly is “talking” or the cartoonish animations used to change between scenes, everything but Poly itself has, at least, one iTween routine running on the backstage.

LitJSON, on the one hand, is a small and fast library for handling data in the JSON format and it’s used to communicate back and forth with the database as well as with other gaming servers for third-party inclusion. LitJSON converts a traditional array into a well-formatted JSON string, with key-value pairs which are easy for a script to parse and yet is readable by humans. XMLReader, on the other hand, saves XML structured data to a dynamic tree and uses it to fetch information dynamically as its needed. It is quite valuable because it spared us from the extra effort of parsing XML files ourselves and even came with some built-in routines to seek for uniquely identifiable strings which made the difference in the overall time spent localizing our game messages.

Another plugin we felt important to include here is the DiceRoller. This prefab came in handy because of its embedded physical properties. In other words, when a force is applied to it (in our case, gravity), it simulates the action of a second Force vector from its side while preserving its angular momentum. For the user, this results in a nice, seamless illusion of roll very similar to the real one. Even if this was a great plus we still had to implement a function to return the dice’s value after stopping. As the organization of numbers in a dice is always equal we used a simple mapping function to retrieve the opposite value. For example, by using a mesh collider between the board and the dice and by naming each side of the dice the number that it displays, we would simply recur to our mapping cheat sheet to find out how many tiles should the player’s token move.

Assuming a traditional dice scheme (Figure 5.8) and detecting the mesh collision of side number 1 (the dice had to be idle at this point), we know that the number on the top has to be 6, if the value faced-down is 4 than the player currently sees 3 and so on.

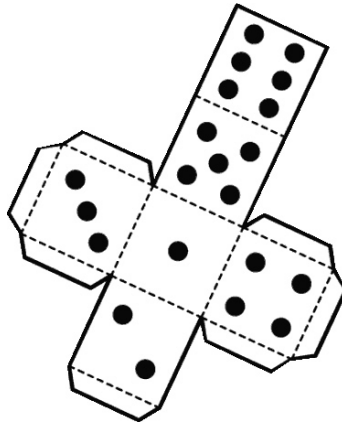


Figure 5.8: Dice scheme used in Greenpoly

5.3.4 Other Classes

The remaining classes provide the mechanisms underlying each tile, the board itself and other auxiliary scripts. Some of these classes are specially important and we feel should be briefed with little more detail, namely:

Facebook.cs - This class is responsible for all integration with Facebook C# API.

It uses an access token to retrieve a player's social data. By using Open Graph we were able to get a user's friend list, pictures, interests, posts, games and, of course, his/her Facebook's uniquely identifiable number;

Quiz.cs - The Eco-Quiz included in Greenpoly was made by scratch as a means to gain some experience with Unity's game engine. It was the first part of the game to be rendered and it holds a question randomizer, an internal timer and dedicated triggers to animate Poly;

Store.cs - The Eco Store was another great challenge to implement. It is a page-based 2D screen where players are able to scroll available items. It was necessary to load assets partially in order to reduce the large delay times we were having when we first tested it, check whether a particular item had already been bought, verify if the current amount of greenies allows the transaction and finally make it visually stimulating.

5.4 Partnerships

We have kept to the end of this chapter what we consider to be one of the greatest strengths of Greenpoly: the inclusion of Non-Governmental Organizations for which today's Environmental threats make up their daily work. We thought that it would be important to raise people's awareness not only towards climatic change but also of some of the initiatives promoted by national and international organizations which aim to reduce the consequences of this change. As so, we started by introducing ourselves to these NGOs, such as the portuguese Quercus¹⁴, LPN¹⁵ (Liga para a Proteção da Natureza) and the more well-known WWF¹⁶ and Greenpeace¹⁷. While we didn't receive any answer from the latter, the remaining three agreed to schedule an interview with us to know more about our project and to ask how could they be of help.

We have included the letter sent to WWF, as an appendix, which promptly replied through their portuguese representative: Dr^a Marta Barata.

While NGOs were our starting point in our attempt to create a bridge between the academic field and other institutions concerned with the Environment, we didn't stop there. We went forward and invited Sociedade Ponto Verde¹⁸ (a private, state-funded enterprise) to join forces with us and share some useful tips regarding recycling, since they are the ones responsible for promoting garbage recovering habits among portuguese citizens. Furthermore, we earned the support of a publishing house, Zero a Oito, which agreed to give us more than 250 questions related to the Environment in a compilation called the Eco Quiz under the condition that we would not monetize our game and keep it profit free.

5.4.1 Advertisement

In all interviews conducted with the aforementioned groups, we knew that we hadn't much to offer besides free advertisement. Still, as we became aware, one of the greatest challenges for private and public organizations is to successfully reach their target, which leads to an enormous amount of capital invested in advertising initiatives and other marketing campaigns. We started by explaining

¹⁴www.quercus.pt

¹⁵www.lpn.pt

¹⁶www.wwf.pt

¹⁷www.greenpeace.org/portugal/pt

¹⁸www.pontoverde.pt

our project, how were we planning to reach a broad number of people, specially from a young age, keep them entertained and reward their proactivity towards the Environment with virtual money and fancy trophies. This modest but confident approach has really paid off as all interviews eventually led to them posing the golden question: "How can we be of help?".

Quercus

Quercus is known for its campaigns and ecological initiatives which allow people to volunteer and help the Environment. Apart from how persuasive a game can be it will always not be as good of getting out there and really fight for a change to happen. By partnering with Quercus we saw the opportunity to promote not only virtual activities, like our puzzles and eco-quiz but real actions that, if, of course, properly motivated, a player could join. Quercus gave us several ongoing campaigns for us to choose which we wanted to share. Even though the selection wasn't easy we came up with the following three:

Green Cork - The Green Cork is a Recycling Program developed by Quercus, in partnership with Corticeira Amorim, the world's leader in the cork industry. It targets not only the transformation of used corks, but also its recycling effort, by funding the "Forest Policy", which states that only trees native to our country, like the cork oak, should be used in the manufacturing of corks;

EcoCasa - Launched by Quercus in January 2004, this project focuses on on the issues of energy efficiency and climate change. Promoting campaigns to raise people's awareness towards better management of energy consumption in the domestic sector was, and still is, its main objective. By encouraging a more moderate demand and demonstrating how to make them more efficient daily intakes, EcoCasa continues to be a relevant and useful initiative;

Criar Bosques - Plant a Tree allows citizens to show that they care about the Portuguese flora. Through collaboration with various organizations and volunteers, thousands of seeds are harvested in strategic fields where there is great need for reforestation. Action does not involve any prior knowledge and it's a great way to feel valuable and to increase one's locus of control.

Liga para a Proteção da Natureza

Although this organization is not as acknowledged as the other ones we made contact with, its volunteers have surprised us with their receptivity and their will

to be part of this project. They invited us to visit their headquarters in Lisbon, gave us a book published for their 10th anniversary and briefed us about their recent work. We are proud to divulge some of their initiatives, including:

Lynx Program - The Lynx Program is aimed mainly at ensuring the conservation and long-term management of areas considered to be suitable habitats for the Mediterranean Iberian lynx (*Lynx pardinus*) in Portugal. People can help by supporting the Lynx Program's actions on the ground, either by strengthening its relationship with the local population, or by helping to clean the habitats and save the biodiversity that they host;

Castro Verde - This program aims to promote the conservation of steppe birds in the region of Campo Branco and its habitat. The pseudo-steppes or cereal steppes in this region are recognized nationally and internationally for their importance to several species of birds like the Great Bustard (*Otis tarda*), the Lesser Kestrel (*Falco naumanni*), the Common Crane (*Grus grus*), the Little Bustard (*Tetrax tetrax*), the Black-bellied Sandgrouse (*Pterocles orientalis*), among others. The first two are recognized as threatened species and are among the set of birds considered to be a protection priority by the EU.

World Wildlife Fund

WWF was very modest in their contribution, not because they were not excited with our approach but, as we were elucidated, they are restructuring their portuguese agency in order to increase their action in national territory. Despite this fact, their representative was glad to give us some important material which we included in our game and a few ideas that we could use to enhance Greenpoly.

Greenpeace

Before we move to our last partnership we would like to add here, that, even though Greenpeace hasn't replied us back, they have a straightforward explanation on the Frequently Asked Questions' section of their website¹⁹:

We get many requests at Greenpeace for help with general school reports about pollution and other environmental issues. We wish we could help each of you individually, but we try to keep focused on the tasks that people donate to Greenpeace for: to win campaigns for the

¹⁹www.greenpeace.org/international/en/about/faq/

environment. Don't forget that you can search through all the information at the Greenpeace site.

We are fully aware that offering free advertisement to an organization which is popular all over the World is not probably what they seek at the moment and as they clearly state in the above quote, the amount of requests regarding academic projects must really keep them hands-full. This being stated we will not give up to earn their collaboration but we fully understand why we didn't at this point and are happy for, at least, having tried. . . twice.

Sociedade Ponto Verde

Sociedade Ponto Verde was a little different from the previous one, not only because they are a private company with regular employees but also because they really invest in television ads (as well as other media channels) to raise awareness among citizens about what they can do towards Today's Environmental threats. One of these ads²⁰ became particularly famous for it ended by posing the question: Gervásio (a laboratory's chimpanzee) took exactly 1 hour and 12 minutes to learn how to recycle. . . and you, how much *more* time do you need?



Figure 5.9: An advertisement promoted by Sociedade Ponto Verde

We agreed to include in Greenpoly a brief description about SPV and what they do, in return of some useful ecological tips that people could apply at home or in their day-to-day life, such as: checking the tire pressure each fifteen days to

²⁰<http://videos.sapo.pt/iv9Zq2VPUtK GAMztdzmK>

reduce car deterioration, keeping car windows closed while driving to decrease friction, using USB pens rather than compact disks which take about 450 hundreds to decompose, among others useful recommendations. We were also given permission to use SPV's logo on a special tile dedicated to this organization.

5.4.2 Volunteering

Volunteering is promoted by writing the word "JOIN" in an NGO's tile. After reading a brief description of a randomly generated campaign, a player who wants to know more or who decides to actively participate is redirected to the NGO's page of subscription. From there, it's up to him/her to introduce him/herself and ask for further instructions. The sole action of subscribing to read more about a certain initiative grants a player a small reward in greenies and can go up to special trophies as we will see in the last subsection.

5.4.3 Rewards

Motivating potential volunteers for the campaigns promoted by our partners was certainly a challenge. We asked each organization how they reward people who join their initiatives and brainstormed how could we prove that they *did* participate through a computer-based script. Wanting to be part of something greater or feeling they should do something more to protect the Environment are, as we have been told, the main reasons that motivate volunteers. Before such arguments we agreed that adding virtual rewards and some social gratification for one's altruistic actions could only bring benefits.

Regarding proof whether one did or did not actually played part of an ecological activity we opted for a simple but efficient solution. We would generate, for each new initiative added to Greenpoly, a password which players must fill in the corresponding tile in order to be rewarded. This password would be given by the organization's team upon successful completion of all volunteer's tasks and can not be used twice, as our game keeps track of each player's achievements.

6

Results

We used the top applications' data from Developer Analytics to study the overall evolution of Greenpoly. Particularly, Facebook tracks Daily Active Usage (DAU), Weekly Active Users (WAU) and Monthly Active Users (MAU). We were specially interested in the number of unique users that visit the application at least once during a given day (we discuss Greenpoly's global usage patterns in the next section). There was no negative comments to Greenpoly up to this moment and the average rate is 4.5 out of 5 points which is highly gratifying.

In the next sections we shall cover some strategies used to start the Greenpoly buzz around Facebook, how we managed to promote it via multiple media channels and some interesting usage patterns during Greenpoly's apogee. We finish this chapter by analyzing the results of the conducted surveys and some preliminary results we came with after the impact testing phase.

6.1 Promotion

Short after its release, we invested some time in promoting Greenpoly. We did this by asking our partners to publicize our game in their Facebook pages and include references in their current campaigns. All but WWF added, at least, one post about our project and encouraged users to try out our application. We were also invited by Rádio Voz de Alenquer to participate in a radio broadcast and had

about one hour to explain what we were doing and people could find Greenpoly in Facebook. Other marketing initiatives have followed, such as, our 10 minutes speech in Greenfest¹, being interviewed by a popular TV Show “The Next Big Idea” or spreading out posters in our university’s campus (Figure 6.1).



Figure 6.1: Poster used to promote Greenpoly

6.1.1 Fan Page

We took the opportunity given by Facebook to develop a fan page for each application deployed in this social network to create a Greenpoly’s official Fan Page. The main goal of this page was to spread out news about the upcoming game

¹www.facebook.com/greenfestportugal

(prior to the first release) and raise curiosity among users with daily feeds about successful partnerships and important milestones.



Figure 6.2: Greenpoly's Fan Page

Even after release we continued to contribute with news on a regular basis by posting screenshots of our game or changes in new versions and encouraging people to invite their friends to join the fun. This effort proved to pay off when just a month after being made publicly available Greenpoly had already more than 100 active users (Figure 6.2) from which we estimate that around 70% heard about the game through it's fan page.

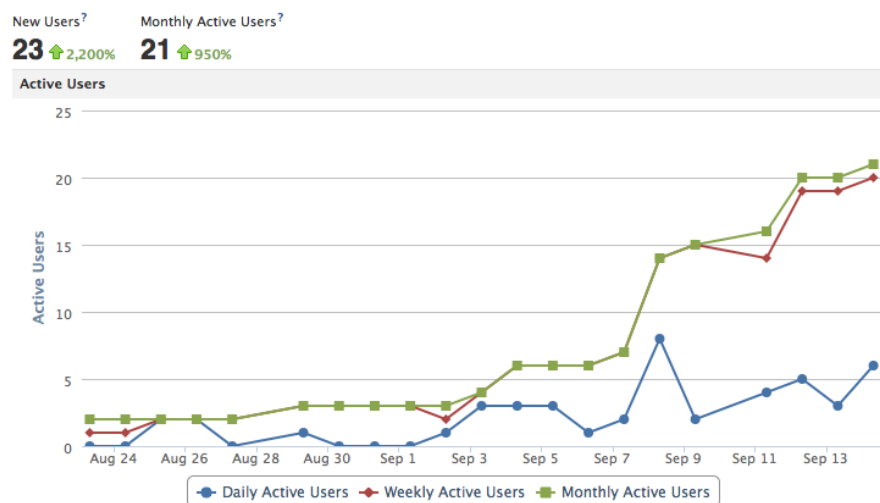


Figure 6.3: Greenpoly's Active Users

6.2 Usability Tests

Participants were encouraged to fill in a questionnaire after playing at least three sessions of the game. From this moment on, a pop up would keep showing in their screen until they accepted to participate (we can agree that it was a very light form of coercion). For this *subjective assessment*, users' responses were rated on a five-point scale, ranging from 1 (negative answer, indicating disagreement) up to 5 (positive answer, indicating agreement). We discuss below some of our findings:

6.2.1 Profile

Despite our efforts to encourage players to fill out our survey only 35 of them took the time to give us feedback about Greenpoly.

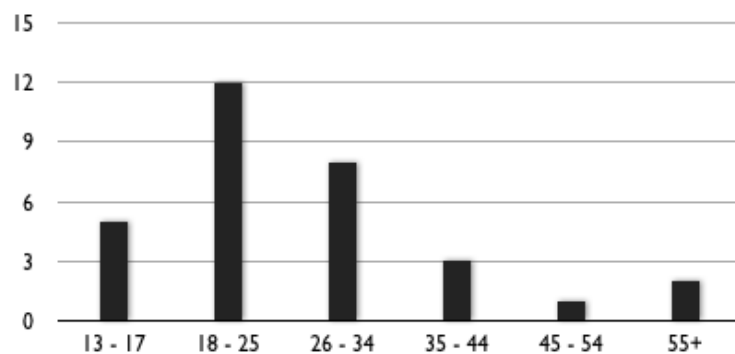


Figure 6.4: Age distribution of participants

From this 35, a great majority (66%) were male and only (33%) were female.

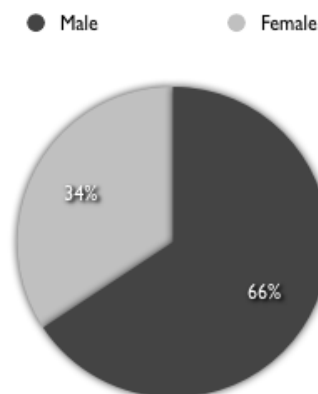


Figure 6.5: Gender distribution of participants

We were also interested in how further did participants go with their studies with results showing that less than half of them do not have a diploma.

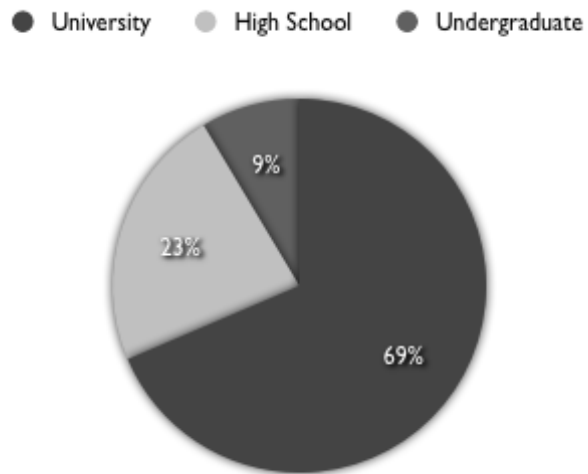


Figure 6.6: Question regarding player's level of studies

Regarding participants' familiarity with computer games, 22 of them answered that they did play computer games occasionally.

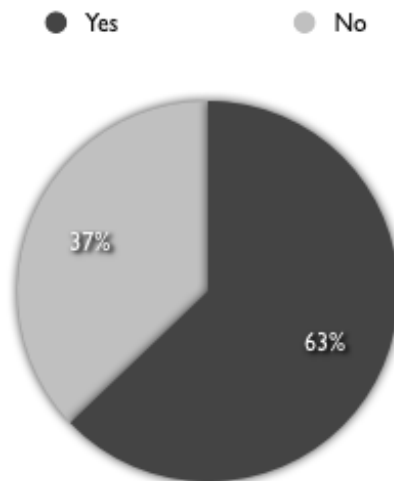


Figure 6.7: Question regarding player's gaming habits

Very contrasting results show that from all participants only 10 use Facebook to play games. This is an important fact, because it may have had an impact in all following questions as the majority of players did not have any references from other social games to compare Greenpoly with.

Lastly, it becomes evident in the following graph that social recommendation was by far the strongest channel through which users become aware of our game.

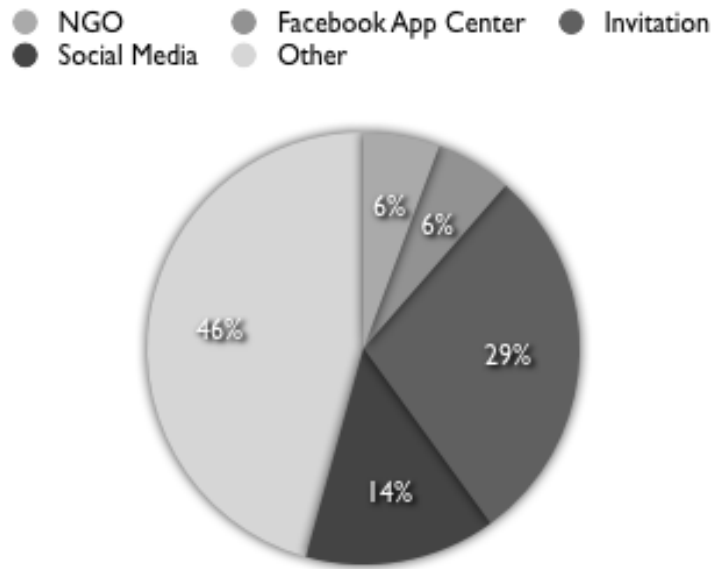


Figure 6.8: Channel through which participants heard about Greenpoly

6.2.2 Credibility

The following questions regard people's perceived credibility of Greenpoly:

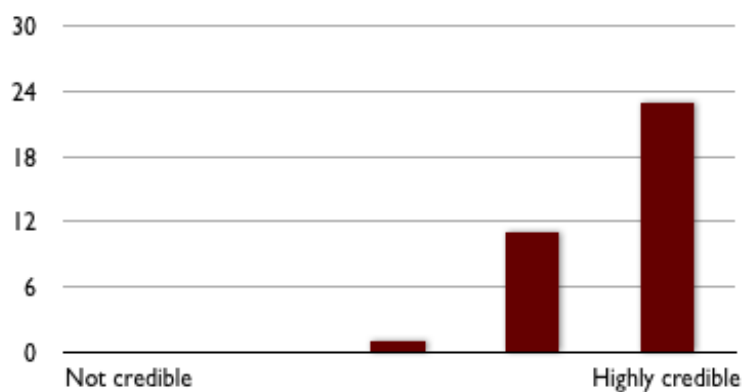


Figure 6.9: Perceived credibility of Greenpoly's computer prototype

Even though consent was not achieved, it becomes clear in this graph that Greenpoly is seen as a credible source of information. We think that's due to the combination of several factors as we shall see below.

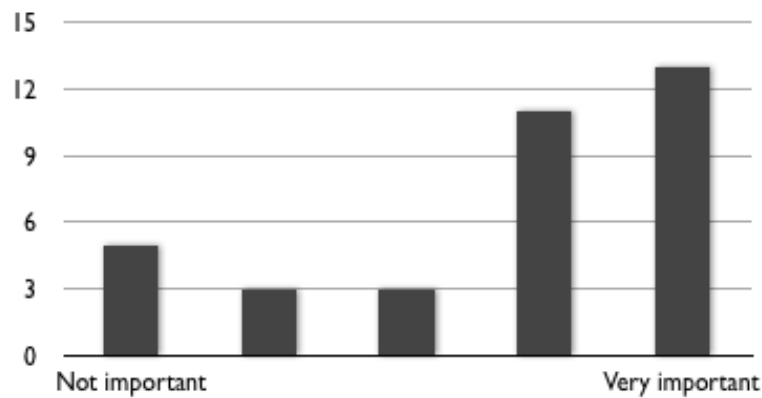


Figure 6.10: Credibility factor #1: Being an academic project

The fact that Greenpoly's prototype was the outcome of an academic project was only disclosed in its Facebook page. Results show that even if the largest percentage of people gives credit to our academic purposes, 9 of them do not think it's enough to be seen as a credible source.

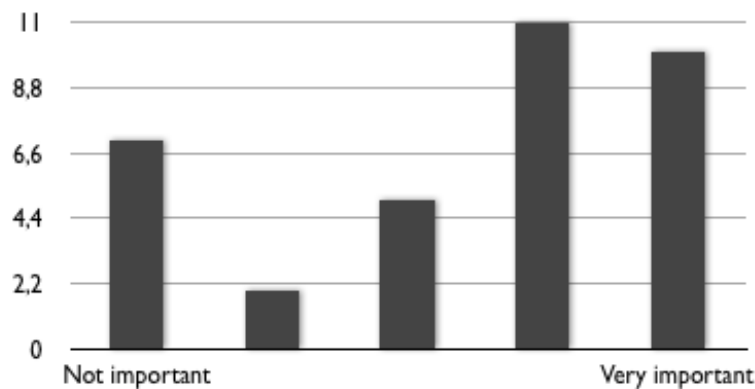


Figure 6.11: Credibility factor #2: Being profit-free

Being profit-free reveals that our prototype is unbiased and doesn't have subliminal intentions, but almost half of participants still do not think it is enough to be considered credible.

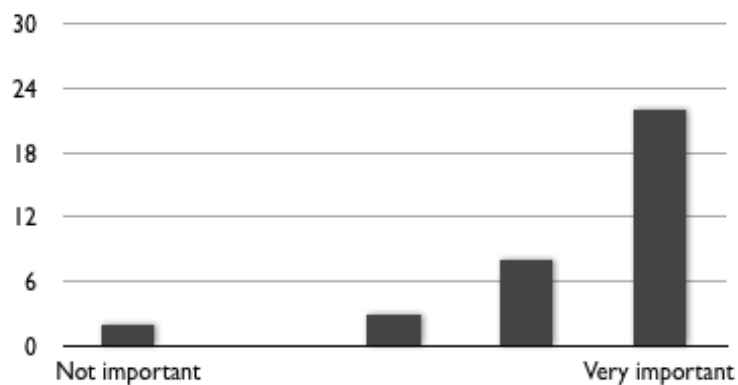


Figure 6.12: Credibility factor #3: Partnerships with popular NGOs

Unlike other factors, where results were not evident, the fact that Greenpoly had partnered with popular NGOs really influenced people's perceived credibility with only three individuals regarding it as not important.

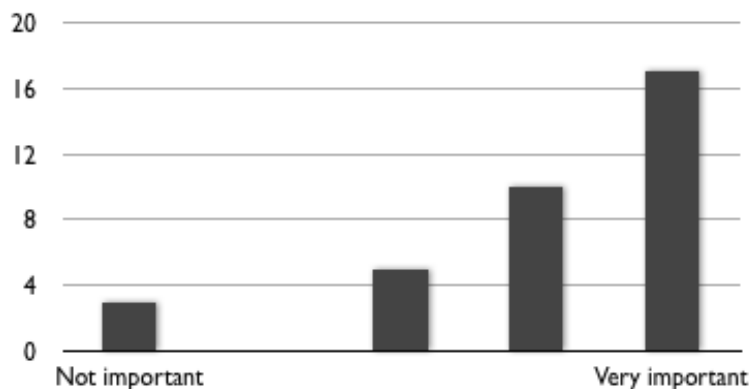


Figure 6.13: Credibility factor #4: Been funded by a trusted foundation

For our surprise, our sponsor had quite an impact on people's assessment on credibility. An incredible 78% percentage of the interviewees considered this an important credibility factor. Finally, social recommendation happened to have quite ambiguous results. While almost 20 of the participants found it a highly important proof of credibility, the rest were divided between somehow important and not important at all.

6.2.3 Interface

The following questions regard people's assessment of Greenpoly's interface:

The fact of being in 3D contributes to Greenpoly's realism and improves the overall gaming experience.

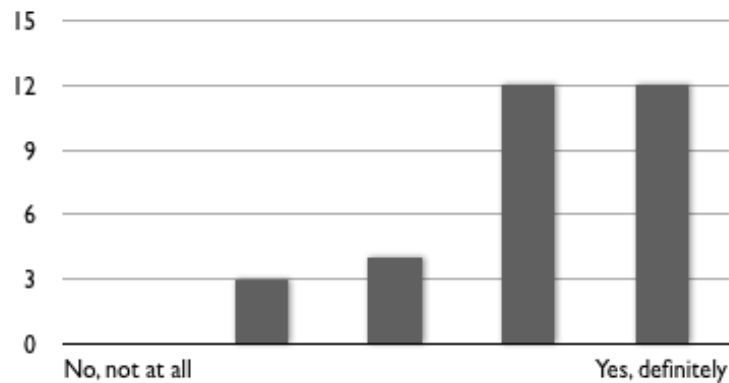


Figure 6.14: Greenpoly's 3D environment influence on the overall experience

We were very happy to find out that our decision on going with 3D paid off since almost all participants agreed that it did improve the overall gaming experience.

The animated host contributes to a more entertaining experience.

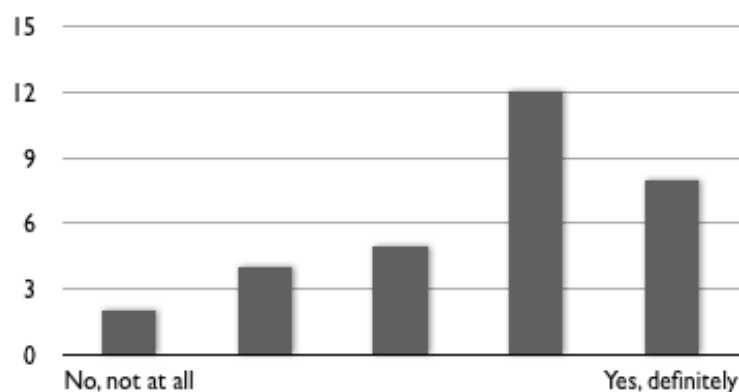


Figure 6.15: Poly's contribution to Greenpoly

While opinions tend to agree with the aforementioned statement there are still some doubts whether Poly does really make a difference in our scenario. We believe this reveals that there is still space for more animations during gameplay.

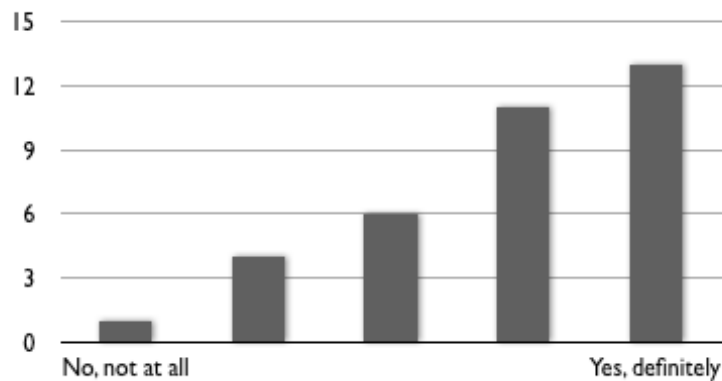
I felt empathy for the animal chosen to be the host.

Figure 6.16: Participants' empathy towards Poly

Five people did not feel empathy with Poly (four felt little empathy and one felt none). This is quite surprising and we would like to know more about this issue, but, unfortunately, justifications were not provided.

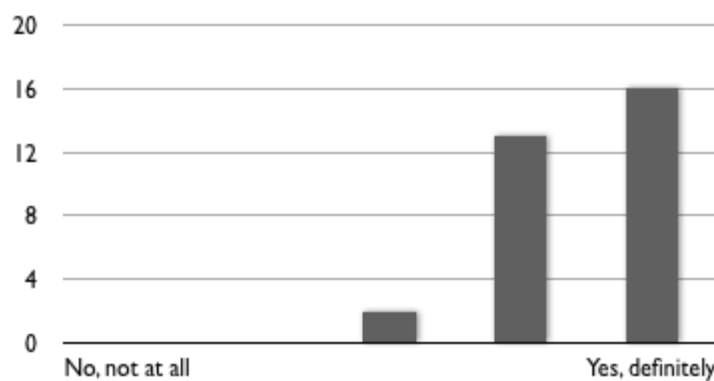
The animal chosen to be the host is related with the game's theme.

Figure 6.17: Poly's relation with Greenpoly's underlying theme

Whether they liked it or not, the truth is that participants agreed that Poly, the toucan, was definitely related to Greenpoly's underlying theme.

6.2.4 Partners

The following questions regard Grenpoly's partners.

Which of these organizations did you know before playing Greenpoly?

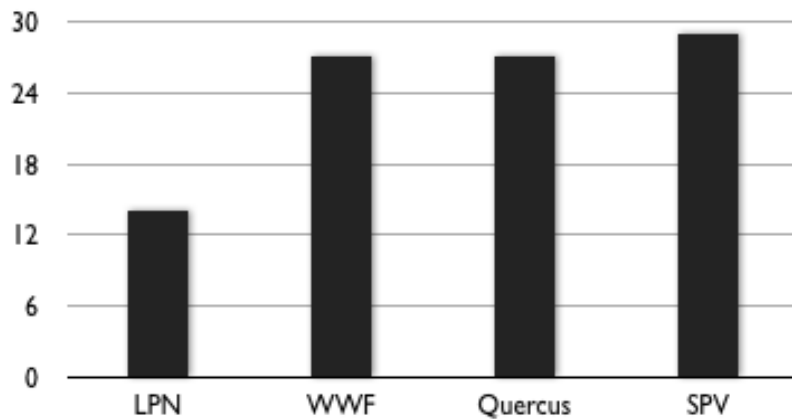


Figure 6.18: Participants awareness regarding Greenpoly's NGOs

Have you learned more about some of these organizations?

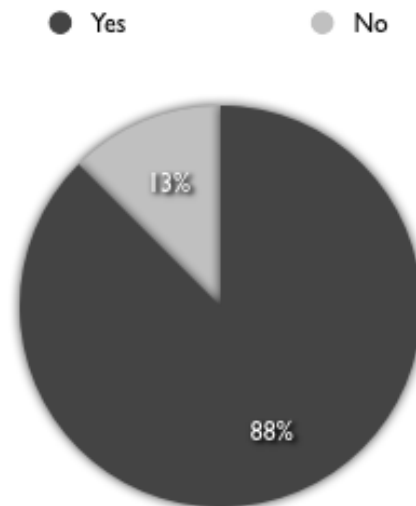


Figure 6.19: Question regarding whether participants learned more about Greenpoly's NGOs

6.2.5 Social Features

The following questions regard Greenpoly's social features.

I feel that it is important to share tips with friends so that they can also become aware.

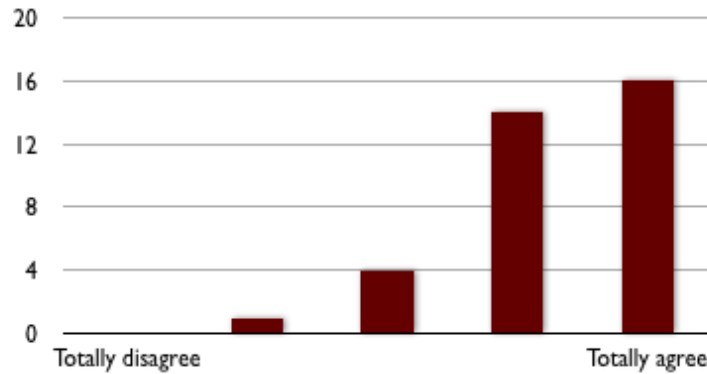


Figure 6.20: Results regarding the importance of sharing ecological tips

Competition in Greenpoly makes the game much more addictive.

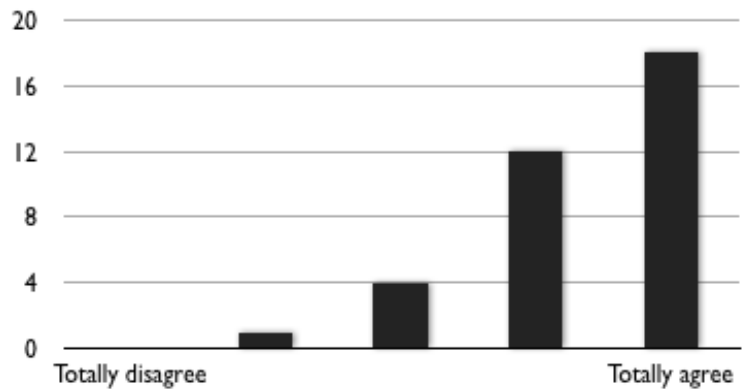


Figure 6.21: Relation between competition and addiction in Greenpoly

6.2.6 Impact Testing

The following questions regard Greenpoly's impact on players.

I haven't learned anything new while playing Greenpoly.

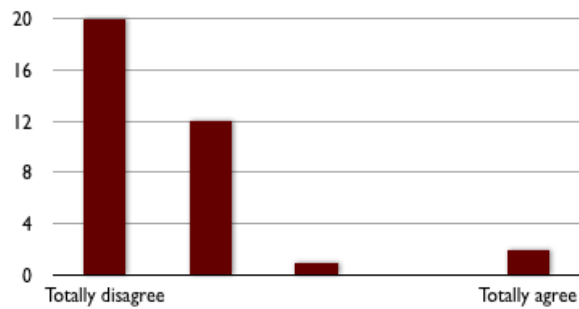


Figure 6.22: Results regarding whether participants learned something with Greenpoly

I found out interesting activities to which I can volunteer.

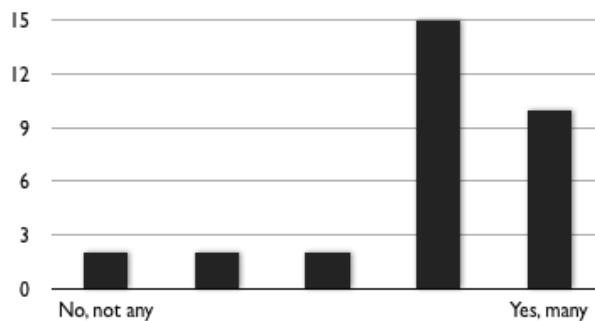


Figure 6.23: Results regarding environmental activities promoted in Greenpoly

I am now willing to do more to protect the Environment.

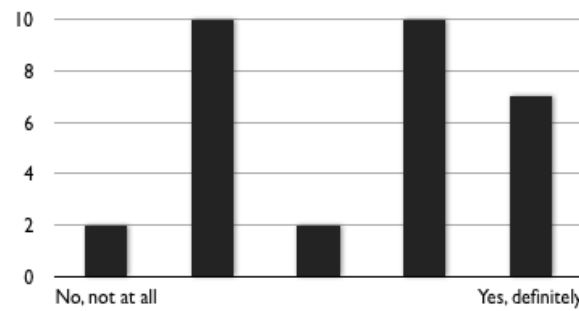


Figure 6.24: Results regarding participants' will to help the Environment

6.3 Preliminary Conclusions

Desire for social interaction

Despite their reluctance to post some of the eco-tips received, participants in our survey were very positive about social interactions prompted by Greenpoly. Some even suggested that it should be possible to share more game-related messages such as personal achievements and eco-items a player has just bought.

Opponents' progress can be demotivating

We had hypothesized that by viewing his/her opponents' progress one would be specially motivated to play and return to the game more often. We did not find statistically evidence of this. In fact, our interviews showed that viewing others' scores could sometimes lead to decreased activity. After beginning use of Greenpoly, some participants regularly returned during the day but as they found out some of their friends kept the same number of greenies over time (showing detachment from the game) subsequently decreased how often they played.

Scalability is mandatory for high performance under stress peaks

Some players faced considerable delays at peak hours (in the morning and after dinner). We searched for the cause of this problem and found out that our small server's capabilities were hardly enough to answer all incoming requests. We believe that for being highly database dependent our game would need some refactoring in order to improve connection speed thus reducing loading times.

Subsequent releases are the key to keep users engaged

is an important quality attribute of games. Games may evolve significantly during their development in the search for the elusive “fun” quality. Games are often extensively modified after their release as game expansions are developed. Massively multiplayer games evolve considerably over their online life, sometimes completely changing their character. Modifiability is a pre-cursor to reusability; the success of projects often relies on reuse of code from earlier projects.

The results are promising, but many questions remain and we need both more practical experience and more rigid research to know more about how this type of interventions can benefit from features from Social Networking Sites in order to prevent high attrition rates and facilitate social support.



Conclusions and Future Work

7.1 Conclusions

In order to conclude this project and assess how successful our approach was, let us recall the main contributions that we expected to achieve with our work and detail for each one of them how we perceive our results to be:

Create a platform within Facebook to integrate pro-environmental games provided an existing communication channel with this social network

This could just be the description of Greenpoly. We have successfully set and deployed a full-working computer prototype into Facebook with one built-in quiz, three external mini-games and the tools to integrate many more provided they are compatible with Unity. Moreover, Greenpoly's server is prepared to receive connections from any other web server to receive data from third-party applications no matter their hosting platform. DEAP's prior projects were linked to Greenpoly by this means so that, for example, players can conquer GAEA's tile while recycling virtual waste at their university campus.

Provide the tools to understand if the persuasive power of applications that foment behavioral change are more powerful as a group than isolated

This one is probably the hardest contribution to prove. We do not doubt that we have created an engaging experience which gave us the opportunity to test different kinds of games for a common purpose. From the user surveys, many of our players stated that they weren't fond of the sliding puzzle and that they usually got frustrated when they landed on that tile. However, almost all of them were already fans of the memory puzzle and wanted to beat their previous high-score at each new try. Whether this can prove very little about the persuasive power of the game it does induce that by creating a whole experience we can leverage mini-games aimed at different targets (recycling, water management, energy reduction) and still hope that people will play them, instead of just closing them if segregated. Furthermore, while results show that there is still a long way to go in order for people to volunteer after playing our game, we believe that, just by sharing these and other ways to reduce Today's Environmental threats (specially simple actions), we are raising awareness among our players' social network and, as we have seen before, being conscious is the first step to change.

Test if users are specially motivated to play when competition factors are at stake and whether or not they are willing to share with the network

These happen to be very different statements with contrasting outcomes. Competition in Greenpoly was achieved by showing a player his/her opponents' progress (number of greenies) and by allowing one player to "steal" tiles after he beat his predecessor's high-score. Interviews have proven that even though more ways to compete can only benefit the overall experience, getting to have one's color in what used to be a friend's tile was quite a motivation. Sharing is, yet, another matter. Surprisingly enough, Greenpoly's built-in variables show that less than half of players who fall on a sharing tile (eco-tips and eco-actions) do not spread the word to their friends. Given justifications include not wanting social peers to know about a player's social gaming habits or feeling that a particular tip is not relevant enough to share with all their social network.

Study the potential impact of social recommendation inherent to social networks as a mean to promote existent applications inside the DEAP project

Unfortunately, at the time of this writing it is impossible to determine whether we succeeded or not at this contribution. Even if we do have the tools to receive

and parse communications from third-party applications through C#, Objective-C or Java (through Greenpoly's APIs) none of DEAP's previous projects were available to the general public in order for us to test their general usage pattern.

Provide a way to associate *credibility* to the platform itself enhancing games developed by companies that present themselves as "Green"

Results show that the great majority of participants in our tests consider our prototype to be highly credible. Different strategies were applied to achieve this. For example, by adding NGOs' logos to some of our tiles we have shown that reputable organizations are working with us. We also believe that the fact of being profit-free helps diminish people's mistrust and lowers initial barriers. Despite this, results show that what really makes the difference is social recommendation. By getting to know about our game through a friend or social peer, players already arrive with good expectations which is our job to keep up with.

Create a bridge from the academic domain to real projects conducted by private institutions and non-governmental organizations

We have dedicated an entire section to this topic (see section 5.4). We can definitely check this out of our list, since we didn't only make one-time, isolated connections but established a professional relationship which will keep Greenpoly updated with new volunteering initiatives and ecological campaigns.

Allow future surveys about citizens' behaviors and pro-environmental attitudes to a broader target, through viral distribution throughout the Web

The last one of our expected contributions is probably the most straightforward. Greenpoly may host eco surveys as part of its activities. There is, still, one drawback: surveys are usually not fun to fill out and even if the reward is high we can risk the fun component of Greenpoly.

All in all, the true potential of Greenpoly which could and should be taken is the possibility that it offers to evaluate social studies about mass persuasion when applied to such real and high-priority issues such as global warming, melting of the polar ice caps, acid rains, oil spills, destruction of the ozone layer, extinction of endangered species, among many others. We are confident that by exposing this reality to our players through a ludic approach we have greater chances of changing wrong environmental behaviors.

7.2 Future Work

During the first two weeks of online testing we received very positive feedback from our users but also some suggestions for features they would like to see implemented in the next releases. We have assembled those requests and added some of our own in the list below:

Sound effects: Sound plays an important role when it comes to entertainment.

We believe that by adding collision sounds to both the token and the dice we would certainly improve the overall reality of Greenpoly. Mouse input should also be upgraded (e.g. like a sonorous effect over buttons or icons would allow users to quickly distinguish between what is clickable and what's not) as well as a victorious sound whenever a player conquers a new tile to keep him motivated;

Player's positions: Checking where our opponents are at each moment can be

engaging and may have interesting results in the game's overall experience. It is far from being an easy to add feature since it would need a method to distribute multiple tokens in a single tile without compromising visibility or creating rendering conflicts, but should be given careful thought;

Room board: There were some complaints about the lack of interactivity among

players inside each room. When starting a session, one does not know where are his opponents, their progress and status. To overcome this limitation a panel could be added above the board. It would display messages such as *player x excelled player y in memory skills and is now the owner of puzzle 1*, or *player y is in the mood for shopping, having bought a brand new double flush toilet and a pack of compact fluorescent lamps for his office*, or even *player z is in a losing streak with 3 unlucky cards in a row*;

Leader board: People do not play at the same rate or with the same skill. There

are players who are naturally good at puzzle games or happen to be really lucky thus earning a large amount of greenies very quickly. They often feel demotivated when there is a huge gap between them and the remaining participants. To enhance competition at a global scale we could add a leader board with the top 10 players of all rooms;

IRC chat: A real-time chat where players communicate, tease and brag about

their achievements is far from being a new idea. It is important and useful.

There were many more ideas that players recommended which probably came from other games that they have played and believe will also work here. We understand that having more puzzles, providing questions inside the quiz by levels, where rewards would be higher according to difficulty (e.g. easy, medium or hard mode), including the option to sell items to avoid bankruptcy or assigning ranks to players are valuable tips and Greenpoly would certainly benefit from them all. Unfortunately, though, the time was short, and we felt that at this point we had to prioritize features if we wanted to keep track of our deadlines.

Parallel to the aforementioned nice to have requirements, there are also many external potentialities that should be considered in future releases, namely:

Recommendation system: A major update Greenpoly would benefit from would be to fully integrate a recommendation system responsible for assigning user profiles and analyze their behavior inside the game. It could simulate a more real environment by copying the surrounding weather conditions inside the game, suggest objects by tracking player's previous shopping patterns and even adapt the game messages to the user's age group;

More games: Additional mini-games could be chosen dynamically to fit users' preferences and age group. By narrowing our target we could increase the effectiveness of the underlying persuasive methods of our platform;

Facebook Open Graph: Leveraging Facebook's social capabilities may have surprising results; By identifying relevant events that users are attending we may adapt our own (e.g. if someone usually attends a biking event at sundays, he or she is probably more aware of the benefits of choosing such a vehicle). Furthermore, if we gain access to people's best friends we may suggest actions that they could attend together thus improving our chances of promoting action. In the end, it would only depend on the author's creativity on the overwhelming amount of information that Facebook provides;

New partnerships: Promoting new partnerships is definitely something we want to spend our efforts on, not only to spread our game to a broader audience, but mainly to encourage private groups and multinationals towards a more green attitude by revealing them as active members of Greenpoly, sponsoring tiles and rewarding users with real and virtual prizes;

New platforms: We want to leverage Unity's wide range of exporting formats to reach new platforms by launching Greenpoly into the mobile market.

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Installation guide

There are a few steps to follow in order to play Greenpoly. Since it was created to run inside Facebook, an active account in this social network website is mandatory to access the game. There are several ways to reach Greenpoly, but in this guide we will opt to open it through its full url: **apps.facebook.com/greenpoly**. If a session cookie doesn't already exist in the underlying system a Facebook's authentication dialog, similar to the following, will be prompted.

Figure A.1: Facebook's authentication dialog

Greenpoly requires permission to access some private information, such as user's profile picture, pages and services which he has subscribed and his friends list. Such permissions must be given in order to continue the setup process.

In addition to a brief description of the application, there is a selection box where users may choose which groups can see the posts made by the application in their or their friends' timeline and a link to the application's privacy policy.

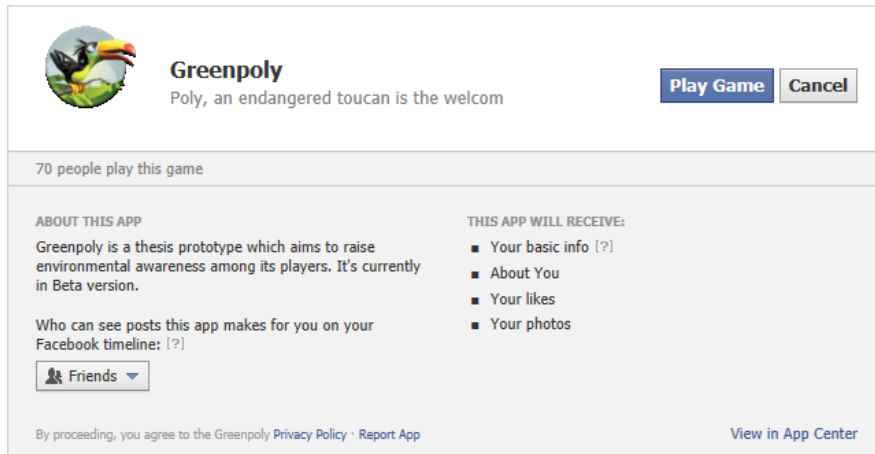


Figure A.2: Default permissions

Sometimes during game flow players are prompted to share information, ecological tips and game achievements with their peers. To ease such communication, users must allow the application to post on their behalf.

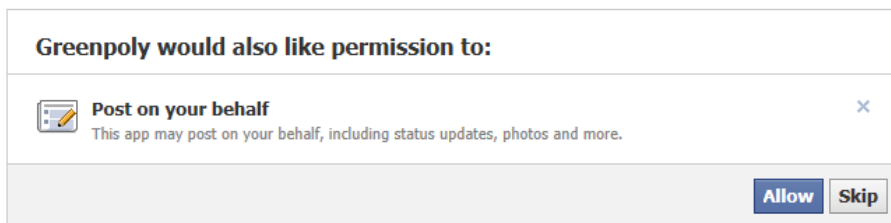


Figure A.3: Extended permissions

Being part of Unity Technologies, a Unity Player is necessary to run the application. Users without the plugin will be prompted with a single, flashy button which will redirect to Unity Player's download page.



Figure A.4: Unity player download

Unity official website will open inside Facebook's iFrame, with the detected user's operating system selected by default. At the moment, Unity runs on Windows XP, Vista and 7 and Mac OS X 10.5 or newer.

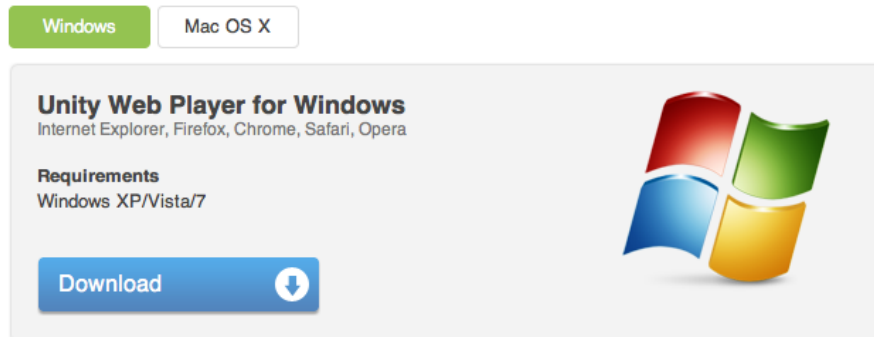


Figure A.5: Unity player's operating system

When plugin's installation reaches the end and the browser is refreshed, Unity will automatically start loading the game. Unity player benefits from a cache speed-up improvement which means that the loading time lowers significantly after the first execution. Average loading time with DSL connection is 30 seconds.



Figure A.6: Unity player's loading screen

Minimum resolution to play Greenpoly is 1280x900, since game's frame is 1000 pixels wide and Facebook's advertisement bar occupies nearly 280 pixels.

Key Issues

Greenpoly's basic or extended permissions denial

When it comes to users' information Facebook is very strict in the way it uses it, namely by generating a token required by all calls to the network's API. As a consequence, it is not possible to play Greenpoly if basic permissions are denied.

Web browser doesn't recognize Unity Player's plugin

Facebook has changed its default protection level to secured connections only, thus access to Greenpoly must be made through SSL by adding *https* to the url.



Collaboration

Letter to WWF

Dear Sir/Madam,

While visiting WWF official website users can read the following motto:

“WWF came into existence on 29 April 1961, when a small group of passionate and committed individuals signed a declaration (...) This apparently simple act laid the foundations for one what has grown into the world’s largest independent conservation organization.”

Unfortunately, people continue to have habits that contribute to environmental destruction. Here, in the Computer Science Department of Faculdade de Ciências e Tecnologia da Universidade Nova de Lisboa (FCT/UNL), we believe that even a slight behavior change in people’s actions can make the difference and be achieved by demonstrating them the consequences of their actions to the environment. The DEAP project introduces a new paradigm for environmental awareness, which will help motivate citizens to become more environmentally responsible in their everyday life and encourage them to make a difference.

What do we do exactly?

The purpose of this project is the study of how to stimulate citizens' responsible environmental behavior changes through interactive online and offline applications that sense and react according to users' activities. Since its early beginnings the DEAP project has been financed by the Portuguese Foundation for Science and Technology (FCT/MEC). Several prototypes have already been developed, addressing different key areas where citizen's behavior changes are important, such as recycling, electricity-consumption awareness or pollution control. Outcomes of the project will include the evaluation of persuasiveness in this field through the use of technological systems in order to determine the ideal configurations and the effectiveness of these systems.

Who's behind this?

The project involves seven researchers from FCT/UNL and Universidade de Évora, and one consultant from the University of California, Santa Barbara. The research team overall expertise spans through all scientific areas of the project: environmental education and systems, human-computer interaction, augmented reality, ubiquitous computing, persuasive technologies and ambient intelligence. A management committee with an extensive experience on project management in both academic and industrial settings coordinates the project. Graduate students have been hired for the project team through research fellowships.

What are we doing now?

Our most recent project for a fellowship is called Greenpoly and its main goal is to test if the persuasive principles behind widespread social networks, such as Facebook, can be used to enhance environmental consciousness in a large scale. To achieve this, social motivators including competition, entertainment, praise, and group recognition will be applied.

The prototype being developed, named Greenpoly, is an online Monopoly-like board game that can be played on Facebook. Greenpoly is all about the environment. Instead of buying properties, players must play individual and platform-independent games (we will have games running on iPhone, Android, and others can be used) related with environmental issues. The board itself works as a merging platform, containing quizzes with environmental questions and informational about green causes around the World.

These tiles describe non-governmental organizations and, hopefully, will encourage players to subscribe to their official Facebook page and join their cause.

How can you help?

To improve our chances of succeeding it would be great if anyhow we could establish a connection with such a powerful organization as WWF. To create this connection we would like to suggest two ways:

1. In one of the NGO tiles and because we truly believe in your efforts as a World leading organization in this field we will describe what you do and strongly advise players to visit your Facebook profile and subscribe to your page in exchange for a monetary benefit in greenies (Greenpoly's currency).
2. By providing us with some of your flash games' runnables (.swf of "Earth Hour Game", "Switch'em off" and "Bycatch Bonanza") or giving your permission to use them so we can create WWF tiles with those (see figure below). Of course, we will also share with you the development of this prototype, sending you a link to the application as soon as it is released, so that you can make a linking reference in your website, if you enjoy the game as much as we expect.

What are the next steps?

To sum up, we would like to join forces with you towards a better environment. As we have strict deadlines to fulfill in order to deliver this project, we would greatly appreciate if you could take our proposal into consideration and give us an answer as soon as possible.

Many thanks in advance.

Kind regards,
Jorge Pereira
MSc. Student and Researcher FCT/UNL

Prof. Teresa Romão (DEAP Project Coordinator)
Assistant Professor at FCT/UNL