Gamification Outside Physical Borders

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Thesis to obtain the Master of Science Degree in
Information Systems and Computer Engineering

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October 2016
Acknowledgements

I would like to thank my supervisors, Professor César Pimentel and Professor Carlos Martinho, for giving me the chance to make this thesis. Their patience, support and criticism lead to the making of this thesis, which wouldn’t exist if not for them.

To my family, I would like to thank them for their patience and support over these past years. To my father, Vítor Alves, thank you for being always present, helping me by discussing not only the topics contained on this thesis, but also various academic works I had. To my mother, Lucinda Alves, and my brother, Nuno Alves, thank you for all your love and care, to whom I am most grateful over my academic years. To my cousin, André Camões, for helping me in the first years of college when needed.

In my college years I found new friendships, and those were precious to me: in the worst times when I was down, they were there to help and cheer me up, and on the best times we enjoyed our academic years as both adults and teenagers. There are many to thank for, so I’ll keep it short: André Santos, Andreia Ferrão, Bárbara Pedro, Bernardo Santos, David Duarte, David Silva, Diva Castro, Élvio Abreu, Ivan Santos, João Godinho, João Murtinheira, João Pereira, Joana Condeço, Luís Figueiredo, Mauro Brito, Miguel Coelho, Nuno Barrocas, Ricardo Carvalho, Rúben Rebelo, Soraia Meneses Alarcão and Vânia Mendonça.

To relax myself of the academic duties, I was always amazed by my neighbourhood friends. Even as those duties draw me to a corner and left me no time to enjoy with them, they respected my choice and managed to have always some time to enjoy, even when there wasn’t any time at all. For that, I am truly grateful to them: André Damas, André Pedros, Bruno Correia, Cláudia Braga, Filipa Silva, Irene Sousa, João Pedro Silva, Pedro Soveral, Rita Gil and Rui Duarte. Every one of you is amazing for dealing with my long absence.

There are people who inspired me over and over again for their commitment to their goals and their willpower. For them, my warm salutations: David Quadrado, Íris Santos and Telma Brás.

And finally, to my girlfriend, Inês Santos, for helping me to stay on foot with my thesis. With her always alerting me, I was possible to do the best I could, even when work didn’t allowed me to do as much as I could. Thank you so much!

As for everyone who contributed directly with my thesis, for being in the testing phase or helping me guiding the way till the end, my double thanks.
Resumo

A motivação para este trabalho veio da crença que a nossa civilização está cada vez mais ligada ao mundo virtual, e que utilizadores usam cada vez mais ferramentas de comunicação virtuais de forma a poderem comunicar, sem necessidade dessa comunicação ser feita presencialmente. Isto leva a um ambiente mais isolado, onde pessoas só saem de casa quando estritamente necessário (ir às compras ou ao trabalho, entre outros).

Ao ver os efeitos positivos presentes em jogos, e usá-los em contextos que não envolvam jogos, foi criado o conceito de joguificação, que já é utilizado e investigado com várias abordagens. Contudo, não existe investigação feita com o âmbito de motivar os utilizadores a sair de casa.

Para este propósito, abordámos este tópico e desenvolvemos GeoChest como uma possível solução. GeoChest combina Joguificação e Geocaching, uma atividade ao ar livre, numa tentativa de perceber que técnicas de joguificação e mecânicas de jogo podem trazer uma resposta positiva dos utilizadores que usem a aplicação.

No final, concluímos que não só a aplicação foi bem desenhada, como também as mecânicas de jogo implementadas foram bem recebidas pelos utilizadores, terminando esta dissertação com a crença que fomos capazes de trazer contribuições interessantes para a investigação associada à joguificação.

**Palavras-chave:** Joguificação, Atividades ao ar livre, Geocaching, Satisfação do Utilizador, Motivação
Abstract

The motivation for this work came from the belief that our civilization is becoming more connected to the "virtual" world, and that users are using virtual communication tools to be able to communicate, mostly without the need to communicate face to face. This leads to a more closed environment, where people exit their houses only when needed (get groceries, go to work, etc).

By viewing positive effects of games on players, and using them in non-game contexts, gamification was created, and is already being used and researched with many approaches, but there is no research regarding its use on outdoor activities, as a motivator for people to exit their homes.

For this purpose, we approached this topic and developed GeoChest as a possible solution. GeoChest combines Gamification and GeoCaching, an outdoor activity, in an attempt to understand which gamification techniques and game mechanics can bring a positive feedback from the users that use the application.

In the end, we concluded that not only the application was well-designed, but also that most of the application's game mechanics implemented were well-received by the users, ending this dissertation with the belief that we were able to bring some interesting contributions to Gamification research.

Keywords: Gamification, Outdoor Activities, Geocaching, User Satisfaction, Motivation
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Chapter 1

Introduction

1.1 Motivation

Games are nowadays a powerful tool, either for companies, researchers, or actual players. According to the Entertainment Software Association (ESA) latest report of 2016, *Essential Facts about the Computer and Video Game Industry*[^1] 65% of U.S. households own a dedicated game console, and 63% of americans play video games regularly (3 hours or more per week). By registering 23.5 billion dollar sales in the year of 2015, the video game industry is currently one of the most profitable industries for the beginning of this decade, and also one of the most influential.

Companies, seeing the players’ commitment to games, created the concept of gamification, that is the use of game mechanics and techniques, along with game design, in applications that contain no game context, in order to engage customers around in their products. With success cases like FourSquare[^2], research teams around the world studied the concept, in order to understand its impact on society.

As technology created the means to contact with people far from our current location, such as friends and family in another country, this contact is creating a physical distance between people close to them. People nowadays are used to communicate using mostly their mobile devices, without leaving home, than to meet physically on a public location such as a garden or a library. That friction created by the technology is already visible on young adults. For instance we have social dysfunctions such as Hikikomor[^3] reported on Japan, mostly found on some of the most technologically developed cities.

The motivation for this work comes from the belief that we can develop applications that motivate people to be outside their homes. There are already some well-known examples that show this to be more than a belief, like Ingress and Pokémon GO, both made by Niantic Labs. This work is meant to validate which game mechanics used in gamification allow to influence more users to get outside.

[^2]: https://www.foursquare.com/
[^3]: http://www.warscapes.com/opinion/hikikomori-postmodern-hermits-japan
1.2 Contributions

The final goal of this work is to understand which game mechanics can create an impact on users, for outdoor activities.

This application allows users to practice Geocaching, while gamification gives motivation to those users to continue practicing the activity. This application was used for 2 full weeks and information regarding the user experience was sent to the database after that period.

For that purpose, we made 2 contributions:

1. We developed a GPS-based gamified application, focused on the purpose of this thesis. For this, tests were conducted with colleagues that have academic experience with user-centered design, in order to understand how the screens should be designed, and to have a product as close as possible to a final product;

2. By collecting information from people about the application’s influence on the testers, through a live test for 2 full weeks with over 24 users, and a from a smaller test that was conducted with some of those users, we reached some conclusions over the impact of the game mechanics that were present on the application.

We verified positive feedback from all game mechanics present in the application, with Achievements and Titles establishing better than the other mechanics.

1.3 Document Structure

In this chapter, we began to introduce our motivation and objectives for this work. In Chapter 2 we present the background and related work, where relevant subjects are introduced and analyzed to create a basis for this document.

In Chapter 3 we describe our solution, from its inception to the final product. We will describe the rationale for building the application, and tests that were made from inception to development phases, in order to have it ready for the testing phase.

In Chapter 4 we present the two tests made with our application: the quantitative test, which was made with 24 users in a 2 full-week period in a uncontrolled scenario, and the qualitative test, which consisted of interviews conducted to people with different experiences on GeoCaching.

Finally, we finish this document with the conclusions taken from the evaluation results, and from the developed application itself. We will also mention future work identified in the inception phase, but that could not be done for this dissertation.
Chapter 2

Background

In this chapter we present the concepts of Motivation and Performance, and the concept of gamification: its origins, methodology, and examples of applications that already use this concept.

2.1 Motivation and Performance

In a 2010 TED Talk, game designer Jane McGonigal stated that games can bring the best of the players\(^1\) making them super-empowered, hopeful individuals. According to her, gamers have four things that make them virtuosos at what they do:

1. **Urgent Optimism**: the desire to act immediately in order to tackle a obstacle, combined with the belief that the players have a reasonable hope of success;

2. **Social Fabric**: Players that play against other people would tend to like them better after the game, because to play a game with someone involves a lot of trust. So playing a game with someone builds up bonds, trust and cooperation, consequently resulting in stronger social relationships;

3. **Blissful Productivity**: Players are actually happier working hard than relaxing, or hanging out. Players are willing to work hard all the time, if they are given the right work;

4. **Epic Meaning**: Players love to get an epic meaning from what they do. For example, if a certain game pulls players in order to save the world from catastrophe, players become attached to the story, and work hard for that goal, since their purpose on the game has an epic meaning.

Her point of view is that gamers can change the world, by solving real-world problems and boost global happiness, as stated on her book. \([1]\)

Researchers have found that games motivate people to many activities. Much of the work was done in controlled environments where people, mostly kids, were subject to experiences in which the purpose was to create good habits \([2,3]\) or to learn skills in training environments \([4,5]\), and see their reaction to those experiments. The results showed that gaming can motivate people to learn new skills \([6]\) or to acquire good habits. Some of those examples will be referred later, in Section 2.2.3.

\(^1\)\url{http://www.ted.com/talks/jane_mcgonigal_gaming_can_make_a_better_world}
It is also said that passion is one of the factors that contribute for the motivation of a person in a videogame, and were analysed on a subject \[7\]. Results showed there are two kinds of passion: harmonious, normally bringing general positive affect towards the player, motivating him, and obsessive passion, bringing the negative affect.

Additionally, performance was also studied \[4,8\], and the reports showed that subjects that frequently play games have increased visual acuity and motor skills. Also, in the same study, task difficulty was evaluated, and as the players got used to the task at hand, the difficulty becomes less than an obstacle: experienced players had better performances, independently of the difficulty imposed on them, and inexperienced players demonstrated the worst performance levels.

Finally, in one of the studies mentioned above \[2\], there was a more significant dropout in the home group (single player), with 64%, than in the multiplayer group, with 15%, which could mean that a multiplayer environment better motivates the player than a single-player.

How can we help motivate people to use applications with no gaming context? For that we have gamification, which we will approach with more detail in the next section.

### 2.2 Gamification

#### 2.2.1 Definition and Story

Gamification is a term created very recently and, according to the Oxford dictionary[2], is the application of typical elements of game playing (e.g. point scoring, competition with others, and rules of play) to other areas of activity, typically as an online marketing technique to encourage engagement with a product or service.

This term was first coined by Nick Pelling in 2003. According to his blog[3], its purpose was, to make electronic transactions both enjoyable and fast. He started a company named Conundra Ltd, that used gamification as its motto, but eventually came to an halt on 2006, due to no significant customer interest. Only in 2010, gamification had its popularity increased, since Foursquare, a well known local search and discovery gamified application, had been run for about one year and has gained since then, according to its site[4] 55 million users across the world. Also on that year, DevHub, a website that lets users create their own blogs and web sites, added a point system to its website, and saw an increase of user engagement[5]. Later, on January 20, 2011, the first gamification summit was held in San Francisco, California, and all tickets were sold out, according to the official site[6]. In 2012, about 45 thousand people enrolled in professor Kevin Werbach’s online Gamification course, through Coursera.

In research terms, it was in November 2010 that gamification came to be known, when Gamification Research Network (GRN) was launched, alongside the call for participation for the 2011 CHI workshop.

on gamification[7]. Currently, [GRN] has more than 360 subscribed verified researchers, and it has become the main channel of reaching gamification researchers around the globe.

2.2.2 Gamification Techniques and Game Mechanics

Gamification Techniques strive to leverage people’s natural desires for socializing, learning, mastery, competition, achievement, status, self-expression, altruism, or closure. The opportunity for a user to appear on a leaderboard, or to attain a certain status can influence him to execute some actions that, in most cases, the user would not do.

Game Mechanics are the mechanisms used by game designers to reward activity among customers, employees or other users. There are many game mechanics available[8]:

- **Achievements**: virtual or physical representation of having accomplished something. They can be easy, difficult, surprising, funny, accomplished alone or as a group. Initially they are not accomplished until you fulfill some series of tasks required to unlock it. One example is the well-known World of Warcraft, a Massively Multiplayer Online Role Playing Game (MMORPG) developed and published by Blizzard for PC[9], which uses achievements to increase user engagement in the game;

- **Appointments Dynamics**: Game dynamics in which a user must log in or participate in game at a predetermined time/place, for positive feedback. Guild Wars 2, a MMORPG developed by ArenaNet and published by NCSoft for PC[10] uses this technique, by having a story that progresses with the game in certain time periods;

- **Behavioural Momentum**: Tendency of players to keep doing what they have been doing. This example is commonly used with social games, like FarmVille[11] and CityVille[12], two social games developed by Zynga in 2009 and 2010 for Facebook;

- **Bonuses**: Reward after having completed a series of challenges or core functions, or for a specific special (and optional, most of the times) task. One example is the game Transistor, in which there is a special room that contains tests for the player, and if the player accomplishes the specific test, it will unlock a music.

- **Cascading Information Theory**: Theory that information should be released in the minimum possible snippets, to gain the appropriate level of understanding at each point, during a game narrative. For this technique, we mention the game Antichamber, a single-player first-person puzzle-platform game made by Alexander Bruce on January 31, 2013, for PC[13], since it teaches new mechanics as the player advances in the game;

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• **Combos**: Reward skill through doing a combination of things. Usually rewarded with a bonus, the greater the number of actions executed, the better the combo and the reward. Examples for this are fighting games, like the Tekken, a fighting game series developed and published by Namco[^14] and Street Fighter, another fighting game series developed and published by Capcom[^15] games;

• **Community Collaboration**: Game dynamic wherein an entire community is rallied to work together to solve a riddle, problem or a challenge. Guild Wars 2, once again, is a good example, since it recreates this technique well when fighting a world boss, for example;

• **Countdown**: Dynamic in which players are only given a certain amount of time to do something, creating an activity graph that causes increased initial activity in a frenetic way, until time runs out, which is a forced extinction. Most social games have timed events, that corresponds to holidays or special events.

• **Discovery**: Also called Exploration, it represents the desire of players to discover/explore something, and/or be surprised by it. Most MMORPGs have different zones in the world map, only accessible when acquired a certain level, to which involves new discoveries to be made;

• **Free Lunch**: Dynamic in which a player feels that they are getting something for free due to someone else having done work. For this, is imperative that the work is perceived to have been done, to avoid breaking trust in the scenario. Social games involves this technique often when players need help from other players in order to advance in the game.

• **Infinite Gameplay**: Games that do not have an explicit end. Most applicable to casual games that can refresh their content or games where a static (but positive) state is a reward of it own. Once again, social games use this commonly, by having no level cap, nor end to the game;

• **Levels**: System by which players are rewarded an increasing value for a cumulation of points. In most games, there are features that are unlocked as players progress to higher levels. For gamers, leveling is one of the highest components of motivation. As aforementioned, social games use levels to compare the effort of players in a certain game, where a higher level represents a more dedicated player to the game, or that he spent more time in the game;

• **Loss Aversion**: Influencing the player behaviour not through reward, but by avoiding punishment. The punishments could vary, from players status to access, power, loss of resources or being downgraded;

• **Lottery**: Game dynamic in which the winner is determined solely by nature. This creates a high level of anticipation. The fairness is often suspect, however winners will generally continue to play indefinitely while losers will quickly abandon the game, despite the random nature of the distinction between the two. Most casino games (or emulations of those) use this approach;

[^14]: http://www.tekken.com/
• **Ownership**: When a character/object is owned by a player. All Role Playing Games similar to Dungeons & Dragons use this, since the game itself makes you represent a character ingame (a pre-made or made by the player);

• **Points**: Running numerical value given for any single action of combination of actions, usually connected with levels. One example of this game is Dragon Coins, a social game developed and distributed by Sega in 2014 for Android and iOS, in which points are given according to the player playing good or bad in a stage of the game;

• **Progression**: Success is granularly displayed and measured through the process of completing itemized tasks. World of Warcraft uses this technique, by having a progress bar representing the number of items collected or non-player characters killed;

• **Quests**: Also known as challenges, the difference being that challenges usually imply a time limit or competition, whereas Quests are meant to be a journey of obstacles a player must overcome. Most, if not all, MMORPGs uses quests to create interaction between the player and the world they play on;

• **Reward Schedules**: The timeframe and delivery mechanisms through which rewards (points, prizes, and level ups) are delivered. Quests from MMORPGs return a reward, normally in the form of Experience Points (XP), money income or, more rarely, in the form of items for the player;

• **Status**: Rank or level of a player. By achieving a higher status level, players become more motivated. Normally status can work together with achievements and points, by showcasing their achievements or expertise in a certain section of the game. Once again, MMORPGs use this in order to recognize players that performed or accomplished a certain task or challenge in the game;

• **Virality**: Game element that requires multiple people to play the game. Most used in social games, where help from other players is required in order to advance through the game.

Every game mechanic is associated with one of three different types: **Behavioural**, in which the game mechanics focus solely on human behaviour and the human psyche – Status is one example of behavioural game mechanic; **Feedback**, which completes the feedback loop in a game mechanic – Combos and bonuses are clear examples of those mechanics; and **Progression**, used to structure and stretch accumulation of meaningful skills – Achievements and Levels are some examples of Progression.

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2.2.3 Examples

As we already mentioned, gamification is mostly used as a tool of marketing, but it is quite used for many other purposes, such as to engage (physical exercise), teach (classrooms) and measure (for employee evaluation) a person. We will refer some examples, each containing a different purpose:

- **Education**: Duolingo\(^{18}\)

  **Figure 2.1**: Duolingo Webpage.

  Duolingo, as illustrated in Figure 2.1, is a learning website where people from around the world learn foreign languages. For the Portuguese community, there are over 10.3 million students learning English and 758,000 learning Spanish. For the English community, there are over nine completed language courses. In Duolingo, people can help produce courses for other foreign languages, in order to extend its range. For example, for the English community, there are 7 foreign languages, with Turkish and Hungarian almost finished in the incubating phase. This website uses many game mechanics, such as: **Discovery**, since not every level is unlocked at the beginning; **Levels**, since our progress is classified in levels; **Quests** and **Progression**, since to get a certain level, one should complete a certain number of quests or challenges; **Bonuses**, since a player can rapidly level up if he does the “shortcut exam”, for the desired level, with less than 3 errors; and **Community Collaboration** since, as mentioned above, the community itself extends the range of foreign languages.

- **Learning**: Multimedia Contents Production Course at Instituto Superior Técnico (IST)\(^{9}^{10}^{11}\)

  **Figure 2.2**: MCP public page.

  On IST there is a course focused on content production, which is highly based on gamification.

\(^{18}\)http://www.duolingo.com/
This course focuses on good learning experiences to the students, by rewarding them with XP with every content produced by them. The XP is then used as grade points, with every 1000 XP matching 1 grade point to the student. The scale can go from 0 to 20 grade points, even if the student surpasses 20000 XP.

Their contribution for gamification research is one step forward a better understanding of the concept itself, and how it can help students to have better grades, by giving them a rewarding experience. The course has the following game mechanics: **Achievements**, which are given as badges and XP to the final grade; **Progression**, in the form of a Skill Tree, which begins with simple challenges, and less XP but then it will unlock bigger challenges with greater rewards; **Quests**, which is a 20-part quest, each with his challenge. At the end, all students that participated at the quest will receive the same XP. **Rewards Schedules** as the normal process in giving XP during certain periods of the course, for example in practice labs.

- **Psychological Motivation**: SuperBetter

[Image of SuperBetter main page]

SuperBetter is a gamified website designed by Jane McGonigal, along with doctors, psychologists, scientists, and medical researchers, whose goal is to improve the lives of people with problems that go from anxiety or sleep disorder, to depression or chronic pain. It does so by building personal resilience, which is the ability to stay strong, motivated and optimistic, even when facing difficult challenges, boosting physical and emotional well-being as a result. The player initially defines what their problem is and who the bad guys are (which depends on the problem of the player itself), and performs quests, some of them daily, others not. This game, according to Jane McGonigal on a 2012 TED Talk [20] had helped patients with terminal diagnosis, like Amyotrophic lateral sclerosis.

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19 https://www.superbetter.com/
20 https://www.ted.com/talks/jane_mcgonigal_the_game_that_can_give_you_10_extra_years_of_life
ALS, to get an happier life. This application has the following game mechanics: **Quests**, where a player defines a purpose for himself, and all work bases on that purpose alone, with specific quests for that purpose; **Status**, where the player has a status corresponding to the work made; **Achievements; Levels, Progression** and **Reward Schedules**, since every quest or task given by SuperBetter increases a certain resilience of the player (in this case, their status).

In October 2015 there was a IndieGoGo campaign for SuperBetter 2.0[^17] that got over $22.195, from 645 backers.

- **Physical Motivation:** Zombies, Run: 5K Training[^22]

![Figure 2.4: Workout selection screen and workout description screen, respectively.](image)

Zombies, Run: 5K Training is a mobile game, made by Six to Start, that motivates people to do physical exercise, by having an 8-week training program, and audio adventure for beginners that will improve players’ fitness, so that they can run a five kilometer distance. It was kickstarted in 2011, and by October 10th it was successfully funded, with 581% funding. It has a focus on **Quests, Progression** and **Reward Schedule**, since every workout is to train the player little by little. At the end of the training (in the case of this application, eight weeks), the player will be prepared to do a five-kilometer run.

- **Information Retrieval:** FourSquare[^23]

Foursquare is a local search and discovery service mobile app created in late 2008, and launched in 2009, by Dennis Crowley and Naveen Selvadurai. It serves to provide a personalised local search experience to its users, by having users comment about the places they have been to. Until July 2014, it had the “check-in” feature, in which a user would tell the application when they were at a particular location. Foursquare used **Achievements, Behavioural Momentum, Community**

[^22]: [https://www.zombiesrungame.com/](https://www.zombiesrungame.com/)
[^23]: [https://www.foursquare.com/](https://www.foursquare.com/)
Collaboration, Discovery, Points, Status and Virality until 2013, when the game developers decided to remove all gamification mechanics, since the game became famous for its gamification design and now, as the user base for the application is quite big, the need for gamification became irrelevant.

- **Augmented Reality**: Niantic, Inc.

Formally known as Niantic Labs, Niantic, Inc. was created in 2010 by John Hanke, founder of Keyhole, Inc, initially as an internal startup within Google. It changed his name into Niantic, Inc. in October 2015. It is responsible for two of the most well-known applications that feature Augmented Reality, the gamified application **Ingress** (in 2012 for Android devices and 2014 for iOS devices) and the game **Pokemon GO** (in 2016 for both Android and iOS devices).

https://www.nianticlabs.com/
Ingress is an Augmented Reality (AR) GPS-dependent MMORPG mobile gamified application created by Niantic Labs, in 2012. It uses the mobile phone to capture Exotic Matter (or XM) and hack portals, located at specific places in the world. For that purpose, location services provided by the Android system are used.

This application has captivated many players, with reports stating that, as of May 2013, there were about 500,000 players globally, and in 2015 there were 7 million players. There are also 3 to 4 events happening annually across selected regions, with the most recent, Via Lux, happening from August 27 until September 24.

As for game mechanics, the game has **Behavioural Momentum, Discovery, Free Lunch** (since players can get portals hacked by other players, for their side), **Infinite Gameplay, Levels, Ownership, Status**, and **Virality**.

Pokémon GO is an AR GPS-dependent MMORPG mobile game created by Niantic, Inc., initially released in July 2016, for selected countries. This application began initially as an April Fools’ Day game made by Google and The Pokemon Company, called Pokémon Challenge, in 2014. The purpose of this application is to collect Pokémon spread out across the world, up to 150 Pokémon as of August 2016. This application has the same database as Ingress, with a small difference: this application features Pokéstops, where the player can collect items that will help the user heal or catch Pokémon, and gyms that allow your Pokémon to battle with other player’s Pokémon, conquer the gym and gain XP and coins. These 2 different locations replace Ingress’s portals, giving more variety for the player. Additionally, the player can get eggs from the Pokéstops, upon hatching them by walking 2, 5 or 10 kms. Pokémon will come across the game, and there is not a definite pattern regarding when and which Pokémon appear for this game.

![Figure 2.7: Ingress Gameplay.](image)
According to Metacritic\textsuperscript{27}, this game had mixed reviews by the the population, and much controversy regarding the players, with some entering cemeteries and memorials\textsuperscript{28}, and others even playing while driving\textsuperscript{29}.

While this application is a game and not a gamified application, there is a vast connection between the game and the consequences that gamification can bring, as it is already being observed by the people that played it\textsuperscript{30,31} and by researchers that are already investigating this phenomenon \textsuperscript{12}.

One important factor about the three latter cases (Instagram, Ingress and Pokémon GO) is the real world location feature. Having a common location for players to concentrate and socialize, e.g. with portals for Ingress, or PokéStops and Gyms for Pokémon Go, can incentive players to go to those locations.

2.3 Discussion

We first talked about our motivation, focused on explaining games as one of the most powerful tools nowadays for companies, researchers and actual players. The impact that gaming has now on people is vast, with gaming being currently one of the most profitable industries, but also one of the most influential ones. We analyzed how gaming influenced people, not only on the positive side, by inspiring them to practice and exercise, but also on the negative side, with people being closed inside their house, with

\begin{itemize}
\item \url{http://www.metacritic.com/game/ios/pokemon-go}
\item \url{https://theconversation.com/some-places-should-be-off-limits-for-games-such-as-pokemon-go-62341}
\item \url{http://www.theverge.com/2016/8/25/12637878/pokemon-go-driver-kills-woman-japan}
\item \url{https://elearningindustry.com/pokemon-go-gamification-in-the-workplace}
\item \url{http://www.educationdive.com/news/why-pokemon-go-shows-the-future-of-learning-gamification-1/423816/}
\end{itemize}
cases like Hikikomori. As such, our motivation derives from the belief that it is possible to influence people to get outside their homes, and we listed some applications that do so, such as Ingress and Pokémon GO.

In order to fully understand how can we influence or motivate people, we looked into Motivation from games, and how researchers and game designers found that games can be used to motivate people, or help them in learning purposes, such as learning new skills or acquiring good habits. We also looked into Performance, and how gamers have increased motor skills and visual acuity, against its non-gamer counterpart. And finally, we found that multi-player environments are preferred by users than single-player ones.

The problem was in how to adapt this for situations that involves non-game context. For that reason, we approached gamification, a term recently coined by Nick Pelling in 2003, which means to use mechanics or techniques used on games in non-game contexts. This concept was only used later for researching purposes in 2010, with the GRN, and since then there were some solid papers focused on gamification for education. We showed the game mechanics that are most used and, with some current examples, we focused on finding many examples of gamification being used on the community, with most of them having positive impact on the user.

We found that, to our best knowledge, there was no research at this time that cover outdoor activities. Therefore, in order to further improve research on gamification, we decided to focus on outdoor activities, and how we can influence or motivate people to leave their house, and explore the world around them.

We searched for outdoor activities that already have a large number of users, in order to be easier to find testers that frequently do those activities. One of those activities, and the one we chose for our solution was GeoCaching.

**Geocaching** is an outdoor recreational activity, in which participants use a Global Positioning System (GPS) receiver or a mobile device, and search for hidden waterproof containers across the world, geocaches or caches for short. In most of the cases, Geocaches contain a logbook where people that find the container can register their nickname and the date when they found it.

From this outdoor activity, and using some of the game mechanics mentioned in Section 2.2.2 we created our solution for this project.
Chapter 3
Solution

In this chapter, we will approach the developed solution, GeoChest.

GeoChest is a Gamified Geocaching application. We recorded in the application a total of 25 geocaches, with 15 of those being themed caches (5 trios of caches), and the rest non-themed. We made it this way so the application has more variety and the user could choose where to go and which caches to get. All caches were created by third-parties, and we requested their approval to use their caches for this application.

The application is similar to Ingress and Pokémon GO, having specific locations where people can receive rewards, but with the major distinction that GeoChest has physical items located in those locations, while Ingress and Pokémon GO are completely virtual, with no contact with the real world apart from the real location tracking. Additionally, in GeoChest we can create accessories we can equip on our character, while on Ingress and Pokémon GO we don’t have equipment, and there’s no crafting options.

We will divide this chapter into 3 sections:

1. Discuss the application, including its purpose, theme and user interface, and changes that were made during the Inception and Implementation phases.

2. Discuss the application architecture;

3. Discuss the gamification techniques and mechanics that were introduced in the application, and changes that followed during the inception and implementation phases;

3.1 Application Theme and User Interface

As for the application’s theme, we decided that the theme for the application would be a pirate-y one, since Geocaching is very similar to Treasure Hunt, one activity that is frequently related to piracy. In this application the user is a pirate searching for a treasure, which is represented by the geocaches present on the application. As a pirate, the user should look for thos treasures, in order to get special coins that will enable the user to trade those for metals and gems. Those gems and metals can then be used by the user, and transformed into jewelry, which can then be equipped into your pirate.
As for the user interface, we decided to design a simple layout, with an horizontal action bar present on the upper side, for user location on the application and quick action buttons (see Figure 3.1). This allows the user to have a simple and clean experience in order to not disrupt him from the purpose we want the application to have. This layout is already used in several Android applications, such as Google Play Store, Google Sheets or Google Keep, and allows the user to focus itself on the application’s content, without the need to learn and understand the interface, since it should already be known by the users.

We also use native icons already present on Android for the user, so he does not need to learn new icons. For some cases we needed to create our own icons, for the intent of the action buttons in the action bar to be as explicit as possible.

Figure 3.1: GeoChest Screen Layout. 1 - Screen; 2 - Action Bar. In the left side you can find the current location of the application to the user; 3 - Quick Action Buttons. These allow the user to access other screens on the application.

Figure 3.2: Example of the current screen layout, with the Main Screen.
As for the screens that were used for this application, we decided on the following:

- The **Main Screen**, also known as the **Map Screen**, is the screen that will appear when the application is opened. It features the *treasure map*, which contains all locations for treasure, represented by the geocaches. Clicking on one of the locations gives the user access to more information about that geocache;

- The **Cache Screen**, which contains all information for a certain cache, namely its name, location, description, possible hint, current state (defined by the cache icon on the map), and owner of the cache;

- The **Character Screen**, which contains the character. Also called as the **Gamification Screen**, this screen is the gateway for every gamification technique or mechanic implemented. In this screen we can see the character’s name, his current title, and his current equipment. The user can also check his created jewelry, by clicking on each button for each jewelry type: bracelet, ring and necklace. He can also change his title and his equipment and, finally, go to all other screens related to Gamification.

  We decided to use this approach in order to separate the Geocaching Core Module and Gamification Data Module. This would be later used in the quantitative tests, where the application would have Gamification Data Module or not, by adding or removing the action button that would let the user go to the Gamification Data Module, in the Main Screen;

- The **Crafting Screen** is where the user can create his jewelry. From this screen you can access the shop, to buy more resources for crafting. The crafting section will be explained with more detail in Section 3.4;

- The **Shop Screen** is where the user can invest his coins (silver or gold coins) to buy some resources. The coins are gained by finding a geocache, which will give gold or silver coins, depending on the geocache’s type (see Section 3.4);

- The **Achievement Screen** is where the user can find all existing achievements, how to obtain them and possible title rewards that can be applied to the user;

- The **Help Screen** will help the user to understand the screen that the user was on. This screen can be accessed by clicking the ‘?’ action button on the action bar, or “Help” option in case the user cannot see the icon. The Cache Screen and the Achievement Screens do not contain any help screen associated, but there are tutorial videos that explain the purpose of the page (see next Section).
Figure 3.3: Help Screen. The information shown will depend on the screen where the Help Screen was called. This one is for the Main Screen, with overall information of the application.

Below we show the screens’ accesses and flow among screens. The screens themselves can be found in Appendix A.

![Diagram of GeoChest Screens and flow]

Figure 3.4: GeoChest Screens and flow.

During the concept and development of the screens, we decided to make some tests with up to 10 MSc students that had attended a course related to user-centered design, in order to understand how certain screens should have their layout.

One of the tests that truly showed the screen evolution along the development phase was the crafting screen, which initially was meant to have a guide included, in order for the user to understand its basics, its layout was inverted, and textual buttons. Three different screen layouts were shown to the testers (see Figure 3.5): Layout A has no limits as for the resources that should be put into crafting accessories, leaving the user to discover how to craft an accessory, and what accessories could be created; Layout B breaks down the recipe in the crafting screen, by showing the different components of the recipe; Layout
C is a middle-ground between layouts A and B, where the screen is similar to Layout A, but limits the different resources that can be put on the crafting table to 3, similar to Layout B.

While there was an agreement for Screen C, there were also suggestions to not only remove some of the textual buttons, so there could be more space on the screen for the crafting itself, but also to include a guide on the Help Screen related to the Crafting Screen. The end result followed both suggestions, and we removed one of the text buttons (that would lead to shop), changing it to an action button on the action bar, and put a guide on the associated Help Screen (see Figure 3.6). This led to a more consistent screen, related to other screens already on the application.

![Figure 3.5: From left to right respectively, the Crafting Screen original layouts (A, B and C) and the current layout.](image)

![Figure 3.6: Crafting Guide, located on the Help Screen associated with the Crafting Screen.](image)

3.2 Behaviour

When the application is first opened, the user will have to make 2 configuration steps: first, he will choose the character’s gender, which will be shown on the Character Screen, and; second, he/she will write a nickname for the character. These steps will only happen once, and the character cannot edit those, once the choice is made.
The application’s behaviour focuses on two different fronts: the geocaching activity by itself, and the gamification part. This represents the 2 action plans which the player can interact with.

For the geocaching activity, it consists of finding a certain cache located on a specific location. The player travels to the exact location of the geocache and searches for it. Once the geocache is found, he can register his name in the logbook (optional) and register a code present on the geocache container. The code is an alphabetic and numerical 8-character long string, automatically generated by Random Code Generator. There was another approach, in which we also take into consideration the player’s location, compare it with the location of the cache, and wait for the log code to be put, serving as an additional validation. We chose the first approach from these two, because the second approach would consume more development time, and it is not part of the application’s main goal. Once a code is registered, the player receives 1 gold coin or 2 silver coins, depending on the geocache’s type.

There are 2 different types on this application: Themed or Non-themed. The themed caches are a trio of caches, close to each other, with the same theme. The available themes are Fantasy, Sci-fi, Fable, Horror and Adventure. The non-themed caches are spread out across the various locations. Themed Caches give 1 gold coins, and non-theme caches give 2 silver coins.

All geocaches were made by third-parties, and the permission to use those caches for this application was requested to all respective owners.

As for locations, we decided with 3 different locations: Sintra village and mountains, and also Oeiras and Lisbon, where two campi of IST are located. This choice was motivated by the fact that most of the potential testers for the quantitative test were IST students. As such, we put some caches near both campi, and others spread across Lisbon and Sintra, for people who would want to take on a challenge. This allowed us to engage both people that want a simple and easy test, and people who would want a bigger challenge, by searching in non-frequent places.

The second action plan, which is the gamification part, is more comprehensive, since the player has several possible actions that could be done:

1. Customize your character: the user has access to his character, which is male or female, depending on the choice that was made by the user in the beginning. The character can be customized in two different ways: titles and equipment. Titles allow the user to have a title in his character’s name (for example, Fast Discoverer Steven). As for equipment, the character can have 2 rings, 2 bracelets and 1 necklace;
2. Create your equipment: the user can create accessories for his character, by using resources bought in the shop;
3. Buy Resources: the user can spend his coins on the shop, to buy resources. There are 3 different resources: gems, metals and paint buckets;
4. Check Achievements: the user can visualize all possible achievements in the Achievement Screen, if he achieved those or not, and possible unlocked titles associated with those achievements;
The process of creating the accessories and the resources available will be explained with more detail in Section 3.4.

### 3.3 Solution Architecture

As for the solution architecture, we decided on an application that was mostly offline, only needing to be online for two different situations: 1) Tutorial videos that were put on Youtube, and 2) When sending the log information to the database. There was an intention to have a server-client application, but lack of resources and lack of time made this solution infeasible on a short period.

We decided to put the videos on Youtube to avoid occupying unnecessary memory space on the user’s phone, thus being able to work even on older smartphones. Additionally, we do not know if the user’s smartphone has local video applications ready to reproduce them. As such, we decided to put those videos online, and make a direct connection to those. We also made a local cache on the application, so that image processing could be as fast as possible. For that we used parallel threads so the processing is made outside the main thread, which controls the UI. After that, we made the main thread access that cache, in order not to consume processing from the main thread, which is vital for the correct execution of the application.

![Figure 3.7: GeoChest Architecture.](image)

Figure 3.7 presents the architecture for the application which is composed of 3 different modules. We call a module a set of classes/screens that have the same purpose within the module. There are communications between those modules, in which we enter or exit the module, with information being passed from screen to screen (inside the module and from module to module):
• Geocaching Core: this is the main module, which focuses on the geocaching activity itself. The Geocaching Core Module is able to register every geocache and update the application for geocaches that were already collected or geocaches that were still not obtained, in order to show them to the user, as already mentioned on Section 3.1. It comprises of the MainScreen and CacheScreen, along with the help screens related to those.

![GeoCaching Core Screens](image)

**Figure 3.8:** GeoCaching Core Screens. From left to right: Main (or Map) Screen and Cache Screen.

• Gamification Data: this module contains all the Gamification information, which includes achievements, titles, character customization, etc. We mention every gamification data that was included on the application, and how to access that information from the user's perspective in Section 3.4. It comprises of the CharacterScreen, AchievementScreen, CraftingScreen and ShopScreen, along with the help screens related to those;
Logging and Database Connection Module: this module has 2 different functions: the first one is to save information regarding users’ actions towards the application, e.g. screen times and titles that the user obtained, and the second one is to send that information at the end of the testing period to the online database located at IST. The information sent was:

- User’s GPS coordinates. This will only send the GPS coordinates when the application is open, and on the Main and Cache screens;
- Achievements. All achievements are sent, with a true or false flag, depending on the user completing or not that achievement;
- Caches. All caches’ information about being completed or not are sent, also with a true or
false flag;

– Character information, more specifically its’ name, gender and current title.

This module comprises of a class (with no screen associated) that deals both functions defined in the beginning.

The application is able to be installed in versions 4.0 and above. The decision to do this was related to the fact that Android suffered some great changes regarding location tracking and layout performance in versions prior to 4.0, so we needed to either push the application back to some older versions, or have it more updated to cover other recent smartphones. We decided for the second one, as our smartphones had Android’s 4.0 version installed, and the location tracking was locked to smartphones that had the Google Services application, which is only present on actual smartphones. This means that emulating smartphones was not possible for testing, which removed the first option as a possible solution.

Finally, the permissions that we requested from the user for the application included location-tracking, either fine or coarse locations, respectively to use Android Network Location Provider (ANLP) and GPS; This allows for better understanding the user’s exact location. We also requested permission for external storage access, in order to have the local cache. Finally, in order to access YouTube, we requested access to the internet, for the user to be able to send his log information, and watch the YouTube tutorial videos.

3.4 Game Mechanics

There were a total of 8 game mechanics implemented on this gamified application: achievements, character customization, crafting, currency management, ownership, progression, status and titles. The Discovery mechanic will not be approached, since GeoCaching main focus is in the Discovery mechanic, with the user being able to discover the cache on real life. The Countdown mechanic will not be approached as well, as the 2 full weeks for the testing phase are not meant for the mechanic to be used and the application can be kept by the user after the testing phase.

• **Achievements**: There are a total of 19 achievements for the user to obtain, defined into 4 different types: cache achievements, related to finding a certain number of caches; themed achievements, related to the themed caches; location achievements, related to the location of the caches found, and timed achievements, related to how much time the user dedicated to find those caches. The existing achievements (and titles) are listed in Table 3.1.

Initially, we considered on having secret achievements, as a Discovery measure, but since Geoaching has already this mechanic, we removed this feature, since the impact would not be as much as those of this list, specially for testers that already do Geocaching.

• **Character Customization**: There are two ways to customize your character. The player can:

  – Associate a title to the character: any title that the user unlocked can be associated with the character. Only one title can be equipped with the character;
- Equip accessories: a character can have 1 necklace, 2 rings and 2 bracelets equipped at the same time. Those accessories can only be crafted, by using the **Crafting** mechanic.

- **Crafting**: Crafting is the act of creating items, using resources bought in the shop. There are a total of 180 accessories that can be created from all existing resources: 3 accessory types, 6 different gems, and 5 different metals, with one of the metals needing to be painted with 1 of 6 different colors. We decided to give as much freedom to the user as possible with those combinations.

All created accessories have the same formula for its name:

\[(\text{Metal} / \text{Color}) \text{Jewel} \text{Accessory Type}\]

If the metal used for the accessory is Aluminium, we instead it call by the color used, since this metal needs a bucket of paint for its color. For other cases, we use the metal used on the accessory name. In Table 3.3 we present all existing resources in this game.

This mechanic was one of the game mechanics that evolved the most during its design:

- In the first iteration, the purpose of the crafting mechanic was to build a major trinket at the end of the game, contributing to the **Status** and **Progression** mechanics. The first iteration had the same 5 themes associated with the caches and, upon finding each trio of themed caches, a specific gem was given to the player, depending on the theme. The non-themed caches gave base resources to create the trinket. Upon finding all 25 geocaches, the player would be able to create the *Cacher Medallion*, which would be the pinnacle of both mechanics mentioned above. Unfortunately, we verified this to be a very linear progression, and no freedom of choice was given to the player;

- In the second iteration, we decided to give as much freedom to the player as we can. This iteration is quite similar to the current approach used on the application, with some additional features: first, there was an additional accessory type called the medallion, which would be a bigger version of the necklace. The user could use 1 necklace and 1 medallion at the same time; second, we had a 6th metal, **Steel**, with a steel gray color; third, we had 1 additional gem, instead of the current 6, with **Topaz** having the yellow color; the crafting recipe for creating a certain accessory would depend on the rarity of the accessory and the accessory itself (see Table 3.2).

We decided to remove those additional features because of memory and mobile design potential issues. Since this application would run on every Android smartphone, independent of the phone dimensions, this mean we should verify if the images would be clearly perceived from every dimensions. As such we verified that: 1) the steel metal could cause some confusion for silver and tungsten, which have a light and dark gray color already. For this reason, we removed steel; 2) the topaz gem could be confused with not only the gold metal, but with the amber gem, depending on the phone dimensions. This led to the gem also being removed; 3) the crafting itself could be
confusing with the different values needed, and it would imply further analysis of how the resource management could have a balance between number of resources of each type and the difficulty for buying those resources. Thus, we decided to have a simple recipe manual, with 1 metal making a ring, 2 equal metals for a necklace, and 3 equal metals for a bracelet (this does not remove the Aluminium case which requires an additional material, a bucket of paint). Finally, we also removed the medallion, since it would only be a bigger version of the necklace, as already mentioned. With all these additional features, we would escalate the already 180 accessories to a total of 308 different accessories, which would mean more memory space used in the smartphone for image processing, and a bigger cache for the processed images.

This resulted in the current design for the crafting mechanic, which is based on the following recipe: 3 equal gems and 1 to 3 equal metals. For the Aluminium case, we need an additional bucket of paint. So, for a Gold Ruby Necklace we need 2 Gold (metal) and 3 Ruby, as for Purple Emerald Ring we need 3 Emeralds, 1 Aluminium and 1 Purple Paint.

- **Currency and Resource Management**: When a user finds a cache, and successfully logs the cache in the application, the user will receive either 1 gold coin or 2 silver coins, depending on the cache type (see Section 3.2). This means the user can have a maximum of 15 gold coins, and 20 silver coins, and, consequently, 15 gems and 20 base materials for accessories. With only 15 gems, the person is limited to have only a maximum of 5 accessories. We want the user to manage his currency and resources, by forcing them to make a choice upon the resources that the user can gain.

  This currency was initially to be two different keys, which would enable the user to open chests, and receive random items, focusing on the Lottery mechanic, but it was quickly discarded, as it can have a negative impact for the user due to the randomness provided in such a short period, so we switched to coins. We want the user to have control over the game, and to not be dependent on luck;

- **Ownership**: The user owns a character, and decides on which title he associates to the character, and which equipment it has equipped. The only change that occurred was the inclusion of both a male and female character, to have both genders on the application. This does not bring any advantages, and the gender choice will only affect the image that will be shown on the Character Screen. This gender can only be chosen at the application setup, and it cannot be switched.

- **Progression**: In the bottom of the Character Screen we can see a chest, that initially will be empty. This chest is related to the number of caches that were found. The chest can go through 4 states, going from empty to full, depending on the percentage of geocaches that were caught.

- **Status**: The equipment and titles that the character has are used as a Status mechanic, which can be then shown to other users (outside the activity). This means that the Character Screen was created with an intent to be visible to other users, if the application allowed some sort of social interaction.
<table>
<thead>
<tr>
<th>Achievement Name</th>
<th>Description</th>
<th>Title Unlocked</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initiate Cacher</td>
<td>Find your first cache.</td>
<td></td>
</tr>
<tr>
<td>Junior Cacher</td>
<td>Find 5 total caches.</td>
<td>Count of Caches</td>
</tr>
<tr>
<td>Experienced Cacher</td>
<td>Find 10 total caches.</td>
<td></td>
</tr>
<tr>
<td>Senior Cacher</td>
<td>Find 15 total caches.</td>
<td>Duke of Caches</td>
</tr>
<tr>
<td>Master Cacher</td>
<td>Find 20 total caches.</td>
<td></td>
</tr>
<tr>
<td>Grand Master Cacher</td>
<td>Find all 25 caches.</td>
<td>Emperor of Caches</td>
</tr>
<tr>
<td>The Final Frontier</td>
<td>Find 3 Sci-fi-themed caches.</td>
<td>Space Explorer</td>
</tr>
<tr>
<td>Atlantis</td>
<td>Find 3 Fable-themed caches.</td>
<td>Historian</td>
</tr>
<tr>
<td>Wonderland</td>
<td>Find 3 Fantasy-themed caches.</td>
<td>Cheshire Cat</td>
</tr>
<tr>
<td>Elm Street</td>
<td>Find 3 Horror-themed caches.</td>
<td></td>
</tr>
<tr>
<td>Hyrule Castle</td>
<td>Find 3 Adventure-themed caches.</td>
<td>Adventurer</td>
</tr>
<tr>
<td>Moorish Castle</td>
<td>Find 5 caches in Sintra.</td>
<td></td>
</tr>
<tr>
<td>National Palace of Pena</td>
<td>Find 10 caches in Sintra.</td>
<td>Sintra Explorer</td>
</tr>
<tr>
<td>Jeronimos Monastery</td>
<td>Find 5 caches in Lisbon.</td>
<td></td>
</tr>
<tr>
<td>Monument to the Discoveries</td>
<td>Find 10 caches in Lisbon.</td>
<td>Lisbon Explorer</td>
</tr>
<tr>
<td>Gotta Go Fast</td>
<td>Find 3 caches in 1 day.</td>
<td>Fast Discoverer</td>
</tr>
<tr>
<td>Weekend Cacher</td>
<td>Find caches over consecutive 2 days.</td>
<td>Casual Tester</td>
</tr>
<tr>
<td>Weekday Cacher</td>
<td>Find caches over consecutive 5 days.</td>
<td></td>
</tr>
<tr>
<td>Full-time Cacher</td>
<td>Find caches over all test days.</td>
<td>Hardcore Tester</td>
</tr>
</tbody>
</table>

Table 3.1: GeoChest list of achievements and titles.

- **Titles**: There are a total of 13 titles that can be obtained from the user. Those titles serve as part of the Status mechanic, which will enable users to have a Status associated with the user. For example, having the Survivor title used serves to show that the user got all Horror-themed caches. It can also be seen as part of the Progression mechanic as well, as there are titles related to the number of caches obtained. There was a older version, in which the title would be on a different place, showing right above the character’s head, on the Character Screen, instead of being right before the character’s name, on the action bar. For consistency reasons, we remove that field from that place, and we created an icon on the action bar which, when clicked on, will leave the player to a new field, where the player can choose his title from the ones that are available.

Finally, we are using game mechanics that the user can more easily perceive, in order to be as easy as possible for the user to separate and order them by preference in the questionnaire after the test period ends.
Table 3.2: Old Crafting table for metals and accessory types.

<table>
<thead>
<tr>
<th>Resource</th>
<th>Type</th>
<th>Coin Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminium</td>
<td>Metal</td>
<td>Silver</td>
</tr>
<tr>
<td>Tungsten</td>
<td>Metal</td>
<td>Silver</td>
</tr>
<tr>
<td>Copper</td>
<td>Metal</td>
<td>Silver</td>
</tr>
<tr>
<td>Silver</td>
<td>Metal</td>
<td>Silver</td>
</tr>
<tr>
<td>Gold</td>
<td>Metal</td>
<td>Silver</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Resource</th>
<th>Type</th>
<th>Coin Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ring</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Bracelet</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Necklace</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Medallion</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>

Table 3.3: List of resources, and their cost in the application.

<table>
<thead>
<tr>
<th>Resource</th>
<th>Type</th>
<th>Coin Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amber</td>
<td>Gem</td>
<td>Gold</td>
</tr>
<tr>
<td>Amethyst</td>
<td>Gem</td>
<td>Gold</td>
</tr>
<tr>
<td>Diamond</td>
<td>Gem</td>
<td>Gold</td>
</tr>
<tr>
<td>Emerald</td>
<td>Gem</td>
<td>Gold</td>
</tr>
<tr>
<td>Ruby</td>
<td>Gem</td>
<td>Gold</td>
</tr>
<tr>
<td>Sapphire</td>
<td>Gem</td>
<td>Gold</td>
</tr>
<tr>
<td>Yellow Paint</td>
<td>Paint</td>
<td>Silver</td>
</tr>
<tr>
<td>Blue Paint</td>
<td>Paint</td>
<td>Silver</td>
</tr>
<tr>
<td>Black Paint</td>
<td>Paint</td>
<td>Silver</td>
</tr>
<tr>
<td>Purple Paint</td>
<td>Paint</td>
<td>Silver</td>
</tr>
<tr>
<td>Green Paint</td>
<td>Paint</td>
<td>Silver</td>
</tr>
<tr>
<td>Red Paint</td>
<td>Paint</td>
<td>Silver</td>
</tr>
<tr>
<td>Aluminium</td>
<td>Metal</td>
<td>Silver</td>
</tr>
<tr>
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Chapter 4

Evaluation

In this chapter we will begin to discuss the evaluation phase. This phase was divided into 2 different tests: quantitative and qualitative. We will discuss these approaches with more detail in the following sections.

4.1 Quantitative Test

During the project development, there was a need to test the application in the most realistic environment possible. This led to the quantitative test.

4.1.1 Procedure

This test consists of getting as many people as possible testing 2 versions of the application: one contained all game mechanics mentioned in Section 3.4, while the other was a simple Geocaching application, without gamification features. Since we divided both gamification module and geocaching module, we could easily remove the connection between those modules, by removing the icon which would give access to the Character Screen.

As we already stated on Section 3.2, in order to confirm the user is finding the geocaches, we had used random codes which were later put on every cache, to confirm that the caches are still on the desired place, not impacting the experience for the testers. There were some changes that happened due to this preparation, as some planned caches were missing from their locations. This led to change some caches’ locations, before the tests started. The main changes for the application to accomodate the new caches were on a database perspective, where the schema needed to be updated to cover all new caches, while removing the missing ones.

The testing phase took place on June 3rd, and ended on June 19th. Using the social media, we talked with the IST community and with the portuguese Geocaching community and released a form, in which those interested in participating would indicate the email to which we should sent the application, on the beginning of the testing phase. The real-time test with the application, by the participants, was on a uncontrolled environment, with the intention of not influencing the results and there was no direct
contact with the testers. The whole process was online, without the need for both us and the testers to encounter on a face-to-face situation or schedule any interview.

We got a total of 24 people that displayed interest in testing the application and we randomly selected 12 people that would use the gamified application, with the other half using the non-gamified version. We sent an email to every person with instructions on how to install the application on their smartphone, and briefly explaining the application itself. During the testing phase, everyone could contact us, in case of any question or issue regarding the application (as Android applications are more difficult to have a stable version, due to the number of different smartphones that have Android as their operating system).

After the testing phase, participants answered a questionnaire available on the internet (see Appendix B). The questionnaire itself has 2 versions, one for the gamified version, and other for the non-gamified version. The questionnaire links would be sent on the day after the last day of the testing phase, June 20th, to the designated testers, for each version. The questionnaire consists of 4 parts:

- Usage of the application: for how many days the user used the application, during the testing phase. This would allow us to understand how much the application was used, and cross it with the information of the next parts;

- Mechanics: this would ask the tester to state, on a scale of 1 to 7, with 1 being "Dislike" and 7 "Like", how much the tester liked each mechanic of the game. The main difference between the gamified version and non-gamified version of the questionnaires, is the inclusion or not, respectively, of this part on the questionnaire;

- Overall Satisfaction: for this part, we used the System Usability Scale\(^1\) and verified the user experience with the application. We also added a question related to the help screens, and what they thought of those screens;

- Personal Information: in this screen we gathered an interval of ages in which the user belongs, how often the user did geocaching before the testing phase, and his/her character’s name, which would be located on the Main Screen, on the Action Bar, accessible by both versions.

4.1.2 Results

During the test, there were some issues that happened:

- The first issue was due to some restructuring works being made on one location, which lead to the respective cache disappearing. We received feedback from two testers, referring that situation. This could have impacted the user’s experience, but there was nothing that we could do to avoid this situation;

- The second issue is also associated with some caches disappearing from their locations, as some testers did not find those caches.

\(^1\)https://www.usability.gov/how-to-and-tools/methods/system-usability-scale.html
Both these issues were resolved by individually giving them the codes that were used on the caches, after confirmation that the caches were missing. Apart from that, no contact was made due to erroneous behaviour from the application, or any difficulty on installing the application.

After the testing period, the application would request the user to send the information to the database. Out of the 24 people that received the application, a total of 7 results were sent to the database. Out of those results, 2 people showed more progress than the rest of the users, with a minimum of 10 caches discovered.

As for the questionnaire, we got 10 total responses, 4 from the non-gamified version and 6 from the gamified version. Results show that most people that tested the application were 18-30 year old, with only one person in the 36-42 year old interval, and most of them did not had experience with the Geocaching activity. Figure 4.2 shows that, independently of the version, the application was well-designed, and the help screens and tutorials were seen as very useful for the user. In comparison, Figure 4.4 the users with the gamified version used it for more days than the users with the non-gamified version. But, as the “additional comments” section mentioned, of those 10 users, 3 users did not install the application, and with data from a sample of only 7 people, out of the 24 that executed the tests, we cannot reach a solid conclusion.

Figure 4.1: Comparison between both Versions of the Questionnaire, for the number of days the user used the application. On the left we show the non-gamified version, and on the right its counterpart.
Figure 4.2: Comparison between both Versions of the Questionnaire, for the satisfaction of the user over the support information (help screens and tutorial videos), on a scale of 1 to 7, being 1 “Dislike” and 7 “Like”. On the left we show the non-gamified version, and on the right its counterpart.

Figure 4.3: Comparison between both Versions of the Questionnaire, for the age intervals. On the left we show the non-gamified version, and on the right its counterpart.

Figure 4.4: Comparison between both Versions of the Questionnaire, for the frequency of geocaching done by the users. On the left we show the non-gamified version, and on the right its counterpart.

As a consequence, we found these results to be inconclusive and we decided to include qualitative tests, which we will discuss next.
4.2 Qualitative Test

We decided to create this new test, mostly due to the few results achieved with the quantitative tests. As the name implies, this test will be focusing on quality, in order to obtain results out of which we can take conclusions.

4.2.1 Procedure

The qualitative test consisted of an interview with two different groups of 3 people each: one group which tested the application, and had no background with Geocaching prior to the quantitative test; and a group of people that does geocaching as a hobby. We will call the first group A and second group B. Some of the interviewed have experienced this application beforehand, in the quantitative test.

In the interview, we showed the application to them, and explained the game mechanics one by one. Afterwards we asked some open questions to the user, regarding the overall user satisfaction with the application, its mechanics, and suggestions to improve the application, taking into account the user's experience with the Geocaching activity (see Appendix C). The interview was made through communication tools over social media, e.g., Facebook, Skype. We gave freedom of choice to the user as for the communication tool to use, and the interview was as informal as possible, in order for the user to feel comfortable during the session. We decided to do this approach to be easier for both the testers and the main developer to be available for the interview. The interview was scheduled to last not more than 20 minutes.

4.2.2 Results

At the end of the interviews, we received a very positive feedback for the application, with the following results:

- For the people from Group A, their evaluation of every mechanic in the application was positive, with an overall average of 5.7 for all mechanics. As for the ones that were most liked, we observed that Achievements was the most liked, followed by Crafting, Ownership and Progression. As for the people from Group B, their evaluation of every mechanic was also positive, with an overall average of 5.8 for all mechanics (See Figure 4.5). As for the ones that were most liked, we observed that Achievements was also the most liked, followed by Titles and Status;

- Additionally, both groups agreed that all mechanics implemented were essential for the whole experience, and gave several suggestions to improve the experience, such as:

  1. **Achievements**: they should be more dynamic, giving more than titles, for example having also different completion icons (instead of the compass, used for everyone), and different clothing, which we will mention with more detail on the Title section;

  2. **Character Customization**: one particular detail that the users found as a negative point was the fact that both name and gender could not be changed by the user. Additionally, the title
that was selected at the moment could hide the character’s name. In both cases, a simple reiteration over the application could have led to a better user satisfaction;

3. Crafting: users referred that the crafted jewelry had simply an aesthetic purpose. Some said the crafted jewelry could have more impact on the application;

4. Currency and Resource Management: A less positive point that was mentioned was the fact that, after a user buys a resource from the shop, the user cannot sell it afterwards. That had a negative impact, as some users did not want to commit to the risk of buying wrong resources; thus, they did not buy any resources, instead keeping the coins. Additionally, every cache successfully logged by the user should be more rewarding and less linear, e.g. giving random resources or more coins, or both. Users did not find the shop to be intuitive enough, since there is no information from the screen that says which coins are needed for buying the resources;

5. Ownership: One of the users said that it would be interesting to give the character a personality and stats, giving the application a Role-Playing approach. For example, giving the character a shy personality, and having this reflect in the way the character reflects on other characters. Additionally, we would have stats such as “Explore”, “Luck”, etc., which would have some impact on the application.

6. Progression: The chest was seen as not intuitive. Many suggested that the chest should feature an animation of it being filled with treasure, as every cache is logged successfully;

7. Status: Two different suggestions were made. The first consisted in having a social feature, in order to compare their status with other users that use the application. The second suggestion was that achievements could be seen as part of the status of the player, and should be seen on the Character Screen;

8. Titles: There was a suggestion for the title to have more impact than merely its name. The most suggested addition was for the title to change the character art, and show different
clothing. So, if the user completed the sci-fi themed caches and obtained the title, having the title displayed would change the character from a pirate-y costume to a sci-fi one;

- Group A also said that Geocaching, in its core, is quite monotonous and adding the gamification mechanics brought more enjoyment and experiences with the application, as well as a sense of fulfillment from the users; Group B said that this application would help motivating younger people, around the 19-30 age interval, but they were unsure regarding people outside that interval, who could see this application unnecessary and unwanted;

- From a social perspective, both groups commented that adding a social component to the application would provide interesting experiences: not only the Status mechanic would bring more impact, but also there would be more interactions between different players, both in collaborative or competitive spirit;

- There were some suggestions from Group A to include more mechanics to the application, giving their experience with videogames:

  1. The first addition would be **timed events**, which could give new crafting recipes, more coins and exclusive titles. This approach was to be applied to the application, if the application had a client-server networking protocol. This idea was later dropped, due to time constraints;

  2. The second addition, in reference to Pokémon Go (See Figure 2.8), would be adding **com-bats** to the application, stimulating users that focus more on action-based games. While this suggestion is valid from the user standpoint, it would bring the application closer to a game, than to a gamified application, and more iterations would be required for this to be included;

- Finally, there were some suggestions from Group A to edit the user interface. The most common one was to have a "main menu" screen, instead of opening the application directly on the map screen, and access every screen from the main menu. Another suggestion was to give the user a notion of the difficulty of the geocache’s location.
Chapter 5

Conclusions and Future Work

In this section we will refer to every step taken during this project and draw meaningful conclusions. Additionally, we will review some possibilities for future work, either suggested by users or already intended but which could not be implemented due to time constraints.

5.1 Conclusions

The quantitative test was performed by few participants (many of the volunteers did not install the application in order to complete it), even with a document describing the steps. However, for the users that used the application, results showed that the experience was positive.

For this test, we would need to reformulate the procedure, and instead of getting the testers to install the application themselves, we would need to arrange a way to be easier for the users to install it, e.g. making the application available on Google Play Store. This would allow for an easier installation, and would also give the testers a sense of trust, by downloading the application from the official store, instead of having to enable the installation of applications from untrusted sources. Still, by having the application on the Google Play Store, that would lead to either have advertising, or paying an amount for the application to be available on the store.

While the quantitative test gave us mixed results, communicating with the testers on the qualitative tests resulted in the application being well designed, with many suggestions from both groups to improve the application. This could coincide with the point that we stated before: the installation process could be the main reason the quantitative test was not successful. This is still the expected behavior, as we developed the application to be as close as possible to a final product, with some improvements still needed from users’ feedback.

Taking into account our goals from Section ??, we can conclude that the first point was successfully done, with only some improvements to be made. The application was well designed, and from the interviews with both groups, all enjoyed the application as a complement to GeoCaching. For the second point, only with the second test we achieved some conclusions regarding the application’s design, and which game mechanics were better designed according to the application’s purpose, with Achievements
having the best results. While there were some differences between both groups, all game mechanics were well received by all interviewees.

In the end, we believe there are some improvements that should be done for the testing phase, which could have improved our overall results. As for the application, it fulfilled its purpose as a motivator for people to exit their homes and explore their zone/region.

5.2 Future Work

We identified some possible future work for this thesis, while we developed the application and tested it:

- The first feature to implement is a social feature. We only approached outdoor activities on this document, but we verified that social skills is still an underdeveloped field for gamification research. We believe social skills should be investigated, in order to approach society’s current issues;

- The second feature intended is to include more game mechanics, in order to have a broader and solid analysis towards all gamification techniques and mechanics previously discussed on Section 2.2.2. For this case we would need a larger analysis and a quantitative test with more participants, in order to obtain statistically relevant results. Additionally, we would need to validate if we should focus on some game mechanics, instead of trying to have a large quantity of mechanics incorporated.

- The third and last feature is to adapt our solution to the users themselves. While we made an application close to a final product, we intended to adapt the solution to the user type: if the user does not have time to log every cache or is unable to reach certain locations, or for users that will use the application with more frequency, we would adjust the application to their needs, in order to verify differences between the static version and the adjustable one.

5.3 Final Remarks

Being able to understand gamification’s roots and benefits towards our society, develop an application close to a real-life product that uses gamification to improve an outdoor activity, and being able to write this paper was a rewarding adventure. We can only hope our contribution can be of some use towards advancing gamification into a scientific approach for society, on future cases. Society nowadays has a more friendly approach to games and using their mechanics to improve humanity’s health, by motivating people to take a walk outside when there are people that are inactive at their home for the whole weekend, can be a possible future and not so far away from today.
Acronyms

ALS   Amyotrophic lateral sclerosis
ANLP  Android Network Location Provider
AR    Augmented Reality
ESA   Entertainment Software Association
GPS   Global Positioning System
GRN   Gamification Research Network
IST   Instituto Superior Técnico
MCP   Multimedia Content Production
MMORPG Massively Multiplayer Online Role Playing Game
XP    Experience Points
Bibliography


Appendix A – Questionnaire Questions

- How many times did you use GeoChest during the testing phase? (0-1 days, 2-4 days, 5-7 days, More than 7 days)

- Please select the frequency to which you navigate in each mechanic, from 1 to 7 where 1 is "Less Frequent" and 7 is "More frequent" (Achievements; Application Progression (Chest); Character Customization; Crafting; Resources; Shop; Titles) – **Exclusive to Gamification version of the Questionnaire**

- Please rate your satisfaction with the application, from 1 to 7 where 1 is “Strongly Disagree” and 7 is “Strongly Agree”
  - I think that I would like to use this application frequently.
  - I found the application unnecessarily complex.
  - I thought the application was easy to use.
  - I think that I would need support to be able to use this application.
  - I found the various functions in this application were well integrated.
  - I thought there was too much inconsistency in this application.
  - I would imagine that most people would learn to use this application very quickly.
  - I found the application very cumbersome to use.
  - I felt very confident using the cumbersome to use.
  - I needed to learn a lot of things before I could get going with this application.
  - I feel satisfied with the support information (help screens and tutorials).

- Please add your personal comments about the application (optional)

- What is your age? (Below 18; 18–23; 24–29, 30–35, 36–42, Above 42)

- How frequently have you done geocaching before using this application? (Never; Almost Never: 1 – 5 times per year; Seldom: 6 – 12 times per year; Sometimes: 13 – 24 times per year; Frequently: More than 25 times per year)

- What is your character's name in the application?
Appendix B – Interview Questions

- How frequently have you done GeoCaching previously to GeoChest?
- When you do GeoCaching, do you do it by yourself or in a group?
- There are a number of additional functionalities that were added to GeoChest. Please tell me, on a scale from 1 to 7, being 1 “Dislike” and 7 “Like”, what do you think of the added functionalities, and why you give that score: Achievements; Character Customization; Crafting; Currency and Resource Management; Ownership; Progression; Status; Titles
- Of the functionalities discussed earlier, which would you remove from the application? Why?
- Of the functionalities already discussed, which of them would you maintain on GeoChest? Why?
- Additionally, which functionalities do you think can be improved? How?
- Did you find GeoChest to be fun/entertaining?
- Do you think GeoChest can be used for GeoCaching? Why?
- Any final suggestions or questions? (optional)