

D2.3 Best practices in serious games

Smart Toolbox for Engaging Citizens into a People-Centric Observation Web

Abstract

Whilst citizen participation in environmental policy making is still in its infancy, there are signs of a growing level of interest. The majority of citizens, though, both as individuals and as groups often feel disengaged from influencing environmental policies. They also remain unaware of publicly available information, such as the GEOSS or Copernicus initiatives. The SCENT project will alleviate this barrier. It will enable citizens to become the ‘eyes’ of the policy makers by monitoring land-cover/use changes in their everyday activities. This is done through a constellation of smart collaborative technologies delivered by the SCENT toolbox in TRLs 6-8.

In this deliverable, we examine 28 serious games, mostly related to environmental protection and monitoring. By analyzing these games in relation to 4 components (game mechanics, story, aesthetics and technology), we aim at pinpointing best practices in the application of gamification techniques. Key learning points that will inform the work in Scent are also identified.

Keywords: gamification, serious games, game mechanics

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Acronyms and abbreviations

Abbreviation	Description
2D	Two-dimensional
3D	Three-dimensional
AI	Artificial Intelligence
Android	Google's operating system for pc and mobile devices
AR	Augmented Reality
CMS	Content Management System
CO2	Carbon dioxide
D	Deliverable, as in D6.1
EA	Electronics Art
EASME	Executive Agency for Small and Medium Enterprises
EC	European Commission
EDU	Educational
EU	European Union, as in EU-founded
FEMA	Federal Emergency Management Agency
Flash Player	A lightweight browser plug-in by Adobe Reader
GIS	Geographic Information System
GLEON	Global Lake Ecological Observatory Network
GPS	Global Positioning System
HTML5	Hyper Text Markup Language for World Wide Web
IIASA	International Institute for Applied Systems Analysis
iOS	Apple's operating system for mobile devices
M	Month, as in M18
MIT	Massachusetts Institute of Technology
MSC	Mkoji sub-catchment
NOAA	National Oceanic Atmospheric Administration
NSSL	National Severe Storms Laboratory
OSX	Apple's operating system for Mac
PC	Personal Computer



RBG	River Basin Game
STEM	Science, Technology, Engineering and Mathematics
T	Task, as in T2.5
UN/ISDR	United Nations Office for Disaster Risk Reduction
UNESCO	United Nation Educational, Scientific and Cultural Organization
VR	Virtual Reality
WP	Work Package

Table 1: List of Abbreviations



Executive Summary

This deliverable provides evidence of advances towards the achievement of project objectives by identifying some key learning points in relation to the application of gamification techniques in non-leisure contexts. Gamification is a critical element of the overall user engagement strategy of Scent and a core component of the software applications that will be developed (from the Captcha plugin to the alternate reality game application). These apps will allow the end-user to take pictures, annotate pictures and collect information in relation to land-cover/use changes and, as such, they will work as the technological backbone of a citizen observatory movement. Various gamification techniques will be employed to motivate end-users in participating to Scent.

The scope of this deliverable is to review existing games, mostly related to environmental protection and monitoring, and to distil some key learning points that will inform the design and the development of the Scent applications. The deliverable analyses 28 games (mostly videogames, but not only) according to 4 main characteristics: game mechanics, story, aesthetics and technology.

This analysis provides evidence that some gamification techniques work particularly well as educational and motivational factors. Generally, straightforward game mechanics and a short, fast-paced game play are particularly adequate also for a target audience of non-regular and casual gamers. Browser-based and cross-platform games (e.g., HTML5-based) ensure a broad participation, especially when the visual design is oriented toward a simple and well-guided interaction model (e.g., through the use of bidimensional, minimalistic graphics). Interactions among players is a key element to support challenges, rewards and the players' overall level of engagement. This is a crucial aspect to keep in mind to avoid that the educational aspect overshadows the gamification dynamics. To secure players' engagement, it is important to carefully balance the education aspect with solid game mechanics.

It is also important to avoid barriers such as forcing the users to register to play and implementing user interfaces that are complex and require a long learning process. The presence of a thorough tutorial helps players understanding the game in a quick and easier way.

In relation to the narrative dimension, stories that are simple, predetermined and easy to grasp seem to be particularly suitable for serious games. Anchoring the main story to a real location and/or real life conditions bring to further levels of user engagement.

Games that were offering real rewards (like smartphone or other goodies) were particularly successful in securing the players engagement, but this, of course, is a strategy that requires some economic resources to be invested to buy and offer the rewards.

These and some other key learning points emerged from this deliverable will serve to define the gamification mechanisms to be used for the Scent software applications. Further detail, also in relation to the process applied to select and analyse the games, is provided in the deliverable.



1 Introduction

1.1 Purpose of the Document

The aim of this document is to review some best practices in the area of gamification in order to find key learning points that can help in addressing the challenges of Scent, particularly as regards the end-user engagement.

After an initial section presenting the approach we used (Section 2: Approach), the document will provide some background notes and definitions of gamification and serious games (Section 3: Definitions of gamification and serious games) and will present key gamification mechanisms (Section 4: Key gamification mechanisms), as distilled by a literature review surveying the work of various authors, both researchers and practitioners (e.g., game designers).

The concepts emerged in these first chapters will be used as a basis to elaborate and analyse some of the best practices in gamification. In particular, Section 5 (Best practices) will illustrate select games already developed by third party, mostly in the area of environmental sustainability and water management and/or based upon crowd-sourcing processes. These games will be examined and commented in order to identify why they can be interesting for Scent.

Section 6 (Key learning points) will summarize the key learning points emerging from these best practices. A section containing some final remarks will follow.

1.2 Intended readership

This deliverable will be distributed to the partners of the Scent consortium.

In this sense, due to the interdisciplinary nature of the project, while writing the deliverable we tried not use a language that is too technical. In the first part of the deliverable, some introductory sections illustrate the key terms used for the analysis of the games. These sections intend to build a common vocabulary related to gamification and, as such, build a shared understanding of what gamification is and how it can be applied to effectively engage end-users.

1.3 Relationship with other SCENT deliverables

The outcomes emerging from this deliverable will offer some indications on how existing gamification mechanisms can be used in an effective way in Scent. Almost all the analysed games refer to themes that directly relate to Scent (generically: environmental monitoring and environmental sustainability). A limited number of games are not strictly tied to these areas, but are included in the deliverable because they provide good examples of interesting gamification mechanisms.

The outcomes of this deliverable will mostly feed the “D2.4 Game design document and engagement strategy”, due in M13, but, in general, they can also help fine tuning the “D4.1 SCENT Crowd-sourcing Platform Design” due in M13 and, more generally, inform the activities for the “T2.5 Games design and production”.



2 Approach

This document stemmed from the activities carried out in the Task 2.3 Analysis of the best practices in gamification and incentivisation. This task was mostly carried out internally by XTeam.

The selection of best practices resulted from this procedure:

- We reviewed various books and articles on gamification and serious games, both written by scholars and by practitioners and we identified some key gamification mechanisms (such as: incentives, goals, change of levels, points, badges; all these terms will be defined in the next sections).
- We subsequently reviewed existing games in relation to their use of these gamification mechanisms. Our goal was to identify a set of best practices, which would provide inspiration for what we have to develop in Scent. For example, we looked for existing games that implement effective incentives or use points and badges in an original way.
- In order to identify and select the 28 games that we analyse in this deliverable, we reviewed about 115 games. We looked at both academic sources (e.g., we reviewed potentially interesting articles in the areas of environmental sciences, geography and game studies) and non-academic sources (e.g., we looked at websites that collect best examples in gamification, like Climate Interactive¹, Make Us of², Game4Sustainability³). This review helped us in selecting games that were well-documented (also in terms of accompanying visual material) and that had the potential to further the understanding of some gamification mechanisms considering our goals in Scent. The complete list of games analysed during Task 2.3 appears in the Appendix 1.
- Analysing these best practices allowed us to distil some key learning points, which will be used to define the overall gamification-based engagement strategy behind Scent.

This analysis has been conducted by a transdisciplinary team: an expert in human-computer interaction, an educator with experience in environmental sustainability, a game designer and a game developer, all within XTeam. The interplay of their different perspectives, spanning from academia to a specific working experience in game design and development, allowed us to look at the best practices from different angles.

As for the use of the term ‘game’, since Scent has a strong digital component we mostly focus on video games, even though the key gamification mechanisms that we review in the next sections are not necessarily only related to video games and can work also for other types of games (e.g., board games).

¹ <https://www.climateinteractive.org/policy-exercises-and-serious-games/19-climate-games-that-could-change-the-future/>

² <http://www.makeuseof.com/tag/10-environmental-games-teach-kids-earth-ecology-conservation/>

³ <http://www.games4sustainability.org/>



3 Definitions of gamification and serious games

According to the philosopher Roger Caillois (Caillois, 1961), playing constitutes an essential element of human social and spiritual development. The game designer Jane McGonigal explains how, in particular, addressing the challenges that the games provide is what makes players happy:

Games make us happy because they are hard work that we choose for ourselves, and it turns out that almost nothing makes us happier than good, hard work. We don't normally think of games as hard work. [...] A game is an opportunity to focus our energy, with relentless optimism, at something we're good at (or getting better at) and enjoy. In other words, gameplay is the direct emotional opposite of depression. When we're playing a good game — when we're tackling unnecessary obstacles — we are actively moving ourselves toward the positive end of the emotional spectrum. We are intensely engaged, and this puts us in precisely the right frame of mind and physical condition to generate all kinds of positive emotions and experiences. All of the neurological and physiological systems that underlie happiness — our attention systems, our reward center, our motivation systems, our emotion and memory centers — are fully activated by gameplay. This extreme emotional activation is the primary reason why today's most successful computer and video games are so addictive and mood-boosting (McGonigal, 2011: p. 28).

With a perspective crossing social and positive psychology (Keltner, 2009), McGonigal argues that games are so important (and engaging) precisely because a good gameplay can elicit rewarding emotional and cognitive states and act as a powerful motivational factor. This is one of the reasons why in recent times various game mechanisms have been increasingly used in non-leisure contexts (Hamari, 2013). As the gamification expert Yu-kai Chou points out: “in a few short years, gamification has reached a social tipping point and is starting to creep into every aspect of our lives - from education, work, marketing, parenting, sustainability, all the way to healthcare and scientific research” (Chou, 2015: pp. 10-11).

Let us start by analyzing what a **game** is. Jesse Schell – building upon his experience as game designer and academic - provides a list of game qualities (Q) picked up from the definitions of various other authors (Costikyan, 2002; Fullerton et al., 2004):

- Q1. Games are entered willfully.
- Q2. Games have goals.
- Q3. Games have conflict.
- Q4. Games have rules.
- Q5. Games can be won and lost.
- Q6. Games are interactive.
- Q7. Games have challenge.
- Q8. Games can create their own internal value.



Q9. Games engage players.

Q10. Games are closed, formal systems.

(Schell, 2008: p. 34)

The Q1 refers to the free intention of players to enter the game and start playing. Games must have clear goals, such as the need to save a princess or to collect keys to open a secret door (Q2). To reach these goals, players have to resolve some conflicts (Q3, e.g., overcoming a monster that protects the secret door). Rules (Q4) are important since they determine the framework for the player's action (e.g., there could be a rule that determines that if the monster touches the player, the player loses some energy score). Games can be won or lost (Q5) and this is what makes them fun. Games are interactive (Q6), in the sense that specific actions are requested to the player (e.g., collecting coins or killing a monster). These actions must be structured in a way (Q7) that the players feel challenged enough (and not too much) and that they get rewarded when they overcome these challenges (Q8 and Q9). The last characteristic defined by Schell describes a game as a closed, formal system, in the sense that it is thanks to well-designed, robust and effective game mechanics that the game becomes an immersive experience that can engage the player at a level that is fulfilling and rewarding. This is a key point, stressed by many authors who focused on how fun is a critical component of games and their capacity to motivate people (Burke, 2011; Koster, 2005; Groh, 2012; Lee and Hammer, 2011).

Recently, game techniques and mechanisms have been increasingly used in non-leisure contexts (e.g., to support educational or healthcare processes, productivity, user engagement) (Hamari, 2013; Breuer et al., 2017). The term used to refer to this phenomenon and strategy is **gamification**. Many definitions of gamification exist, also in relation to various contexts of application: "current uses of the word seem to fluctuate between two major ideas. The first is the increasing societal adoption and institutionalization of video games and the influence games and game elements have in shaping our everyday life and interactions. The second, more specific idea is that - since video games are explicitly designed for entertainment rather than utility - they can demonstrably produce states of desirable experience, and motivate users to remain engaged in an activity with unparalleled intensity and duration" (Deterding et al., 2011: pp. 1-2). Gamification can be applied in as varied contexts as marketing (Olenski, 2014), business (Werbach and Hunter, 2012), innovation and open innovation (Christensen and Raynor, 2003; Paiano et al., 2015), and project management: "the use of gamification tools and methods has the potential to benefit project managers from all industries because of their fundamental potential to shape and influence behaviour" (Association for Project Management, 2014: p. 6). In this sense, gamification is not only an area of academic studies, but a tool that is increasingly used by a variety of organizations and, as such, also popularized by big consulting companies such as Deloitte:

Gamification can instil challenge, pay-off, and new perspective into day-to-day tasks, tapping into the same human instincts that have led to centuries of passionate competition and engagement – our innate desire to learn, to improve ourselves, to overcome obstacles, and to win. As business becomes increasingly social, our professional and consumer lives are being built using digital interactions. This momentum can be tapped to augment



performance by embedding gaming mechanics into traditional processes. Technology in the workplace can be rewarding, and (gasp) even fun. (Deloitte, 2013, p. 52)

Various authors offer a characterization of the various components of gamification (Wood & Reiners, 2014; Deterding et al., 2011; Zichermann & Cunningham, 2011). For example, according to Sebastian Deterding and colleagues, gamification refers to:

- *the use* (rather than the extension) of
- *design* (rather than game-based technology or other game-related practices)
- *elements* (rather than full-fledged games)
- *characteristic for games* (rather than play or playfulness)
- *in non-game contexts* (regardless of specific usage intentions, contexts, or media of implementation) (Deterding et al., 2011: p. 5).

A report recently published by Oxford Analytica (2016) is particularly interesting as it focuses on the potential of gamification to support education and transformative change and, as such, it is close to the aims of Scnt. Through the application of gamification techniques in non-leisure contexts, gamers can “collectively use their problem-solving skills not only to solve puzzles within a digital game but also to approach social and political issues in the real world” (Oxford Analytica, 2016: p. 9). This position echoes what the already mentioned Jane McGonigal points out: “Increasingly, some education innovators are calling for a more dramatic kind of game-based reform. Their ideal school doesn’t use games to teach students. Their ideal school is a game, from start to finish: every course, every activity, every assignment, every moment of instruction and assessment would be designed by borrowing key mechanics and participation strategies from the most engaging multi- player games” (McGonigal, 2011: p. 128; see also: Rockwell, et. al., 2013; Glover, 2013).

Another quite often used and related definition is the one of **serious games**. According to Scott and Ghinea, “the ‘serious’ adjective is generally prepended to refer to video games used by industries like defense, education, scientific exploration, health care, emergency management, city planning, engineering, and politics” (Scott and Ghinea, 2013). This idea shares aspects with simulation environments, including flight simulation and medical simulation, but explicitly emphasizes the added value of fun and competition. While discussing gamification as a technique for motivating learner, Glover describes the differences and the relation between the concepts of serious games and gamification: “these [the serious games] focus on creating games (and game-like experiences) which impart an educational benefit, and includes software such as simulators. This is the direct opposite of educational gamification, which seeks to add game-like concepts to a learning process”



(Glover, 2013). While serious games refer to specific, self-contained game experiences (e.g., a single videogame, a single flight simulator with game mechanics), gamification mechanisms can be applied to a variety of contexts, including experiences articulated across multiple software applications and platforms, communication channels, devices and points of interactions with the user/player. As such, gamification refers to broader contexts of application.

Beside the many voices praising the potential of gamification and serious games, various authors and scholars have expressed quite **critical positions in relation to gamification**.

The media studies scholars and game designer Ian Bogost states that “gamification is marketing bullshit” (Bogost, 2011) as the concept and the application of it have been extremely oversimplified, at a point that the complex dynamics behind the creation of a successful game have been reduced to the mere use of game properties such as points or levels. Similarly, Werbach and Hunter (2012) state that many gamified systems fail due to poor design and the uncritical application of easy gamification-based fixes. In a quite vocal way, Chang (2012) states that gamification as applied to many current projects is a techno-utopian fantasy. Antin (2012) posits that it is not really elements such as the uncritical use of points that drive engagement, but rather social factors such as self-efficacy, community and peer approval that reward users. Seaborn and Fels provide a thorough review of various critical positions in relation to the application of gamification (Seaborn and Fels, 2015).

Within the scope of Scent, we will take the criticism offered by these authors quite seriously. The process that we intend to follow is one based upon a comprehensive understanding and careful application of interrelated game mechanics. In the following section, we identify the key elements that will guide our work.



4 Key gamification mechanisms

Scholarly literature and specialized press offer various ways of categorizing gamification mechanisms (Priebatsch, 2010; Wójcik, 2013; Oxford Analytica, 2016; Simeone, 2016).

The categorization offered by Schell (2008) has the advantage to look at the overall elements of a game and to see how the game mechanics interact with other three elements (story, aesthetics and technology):

- **Mechanics:** These are the procedures and rules of a game. Mechanics describe the goal of the game, which actions players can and cannot do, and what happens when they play (incentives, goals, change of levels, points, badges, etc.)
- **Story:** It describes the sequence of events that unfolds in the game.
- **Aesthetics:** This is how the game looks, sounds, smells, tastes, and feels. Aesthetics are an incredibly important aspect of game design since they have the most direct relationship to a player's experience.
- **Technology:** It refers to any materials and interactions that make a game possible such as paper and pencil, plastic chits, or high-powered lasers.

Whilst the last two points (aesthetics and technology) are quite self-explanatory, the scope of this section is to provide a short introduction for those elements, which might be less well-known to a target audience of non-experts in gamification.

Incentives are critical components to support the player's involvement. As the game designer and theorist Chou argues, "incentives are what the experience designer can give users when they commit the desired actions and arrive at the Win-State" (Chou Y.K., 2015: p. 470). Incentives, of course, are not only strictly related to games, but can be applied to all aspects of life where people want to feel engaged and, as such, they look for "growth and advancement, recognition and rewards, a higher goal to pursue, and a sense of teamwork. These are among the things that well-designed games and gamification efforts excel at" (Kapp, 2012, page XVIII). Figure 1 provides an example of incentives. In this game ("World of Warcraft"), the player is invited to proceed in the game so that she can unlock achievements by doing some actions or by collecting various sets of items. All the achievements can be viewed in a dedicated menu.





Figure 1 Example of incentives from “World of Warcraft” (courtesy of MMO-Champion.com⁴).

Each action provides **points** that give an idea on how the player progresses in the game. Figure 2 offers an example of points. In this game, the main character - Dartanan - has to collect some coins. Each coin gives 10 points. All the points are indicated in the top right part of the screen.

⁴ <http://static.mmo-champion.com/mmoc/images/news/2008/july/ssAchievements5.jpg>



Figure 2 Example of points, from the game Dartanan (courtesy of 3D Tune-in project⁵).

Levels are another key component of gamification strategies. To increase a player’s competitive instinct, a series of levels with incremental difficulty can be implemented. As players earn points, they move up to next levels. Candy Crush (Figure 3) offers a good example of levels. In this ‘match 3’ game, the player must complete the combinations of candies to finish one level and move on to the next one. The next level will be more difficult because, for example, the movement of the blocks will be faster or because there will be more obstacles like chocolate blocks, which are complicated to remove.

⁵ <http://3d-tune-in.eu/>



Figure 3 Example of levels from Candy Crush (courtesy of Fandom by Wikia⁶).

To pass from one level to the next is necessary to achieve some specific **goals** (e.g., collecting a key or killing a monster); the introduction of a goal adds reason, focus and measurable outcomes. The goals must be clearly defined, unambiguous and must adhere to a sequence, so as to motivate the players to work hard and long to get them. Games can have several mini-goals which yield points towards the ultimate overarching goal (Oxford Analytica, 2016).

⁶ http://candycrush.wikia.com/wiki/File:Level_135

http://vignette1.wikia.nocookie.net/candy-crush-saga/images/7/7f/Level_135.png/revision/latest?cb=20130905095803

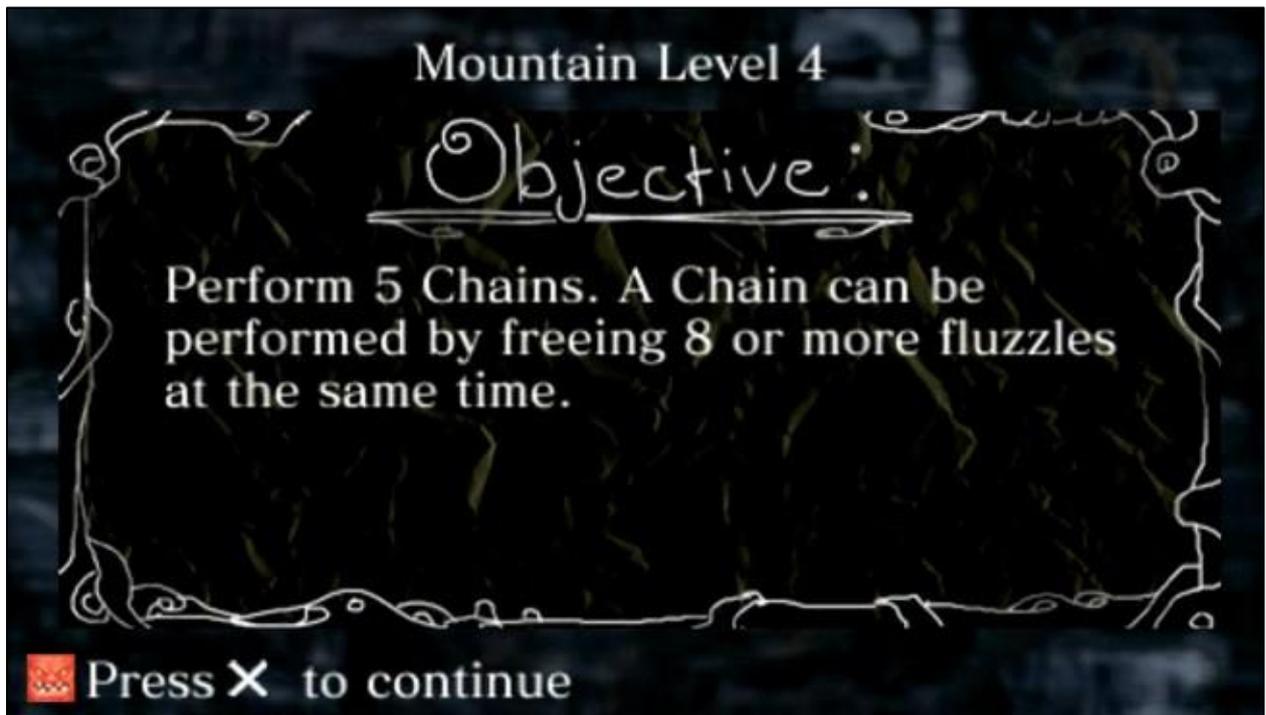


Figure 4 Example of goal from the game “Mad Blocker” (courtesy of Sitsam.com⁷).

In some games, when a player reach a goal, she gets a **badge**. A badge is generally a graphic icon (identified by a specific label like “Expert” or “Professional”) that shortly summarizes the status and the achievements of a player.

⁷ <http://www.sitsam.com/> <http://www.sitsam.com/wordpress/wp-content/uploads/2011/07/Mad-Blocker-Alpha-objective.jpg>



Figure 5 Example of badges that reward users who download a high number of games (Steam platform⁸).

Stories can help tying together all these gamification mechanics. The story is a critical element to secure the users’ attention and involvement. According to Zichermann (2011), “the ideal mode for gamification of brands is to allow consumers to play with the narrative that already exists, experiencing it in new ways. Imbuing it with feedback, friends and fun, and giving the user wider latitude for expression, collaboration and achievement.” Figure 6 provides an example of a story from the game “Warcraft 3: reign of chaos”. In this game, the story is narrated not only through the gameplay but also with some videos and dialogues, which help the player to better understand the overarching story and make it more immersive and structured.

⁸ <http://store.steampowered.com>



Figure 6 Example of a story from the game "Warcraft 3: reign of chaos" (courtesy of Dailymotion.com⁹).

According to Glover (2013), **leaderboards** are also an important mechanism. Leaderboards are lists of players ranked according to their success within the game. Through a leaderboard, the player understands how well the other players are performing in the game and she is stimulated in playing harder and performing better.

⁹ <http://www.dailymotion.com>





Figure 7 Example of leaderboard, from the ScootPad Blog¹⁰.

¹⁰ https://scootpad.files.wordpress.com/2014/04/leaderboard_correct.jpg



5 Best practices

In this section, we analyse a selection of games that can offer ideas and inspiration for the gamification procedures to be implemented in Scnt.

Picture Pile

URL: <http://geo-wiki.org/games/picturepile>

Publication date: from International Institute for Applied Systems Analysis, Laxenburg, Austria, 2015

Short description from the authors:

This is how the authors of the game describe it:

The new Picture Pile game—for Android, iPhone, and desktop computer—brings citizen science to the study of global forests. While multiple maps of global forest cover exist, deforestation is difficult to track for several reasons: first, satellite imagery can be of too low-resolution for forests to be accurately mapped. Secondly, deforestation often occurs in small chunks that may not be visible in medium-resolution imagery. High resolution data can provide a clearer view of forested and deforested land, but the datasets are massive and not free of charge “It’s easy to look at an aerial photo or high resolution image and say, are there trees there or not,” explains IIASA researcher Steffen Fritz, who leads the institute’s Citizen Science Center. “But to build a map you need millions of data points—and to see change over time you need to repeat the exercise for multiple years of data.” That’s where IIASA’s network of citizen scientists come in. The new Picture Pile game builds on the successful Cropland Capture game, which relied on players’ input to help build a new map of global cropland. This time the focus is on forests initially starting in Tanzania. Picture Pile makes use of very high resolution imagery from Digital Globe, spanning the last decade. The game is arranged as a pile of picture pairs, with side-by-side images of the same location several years apart. It asks, “Do you see tree loss over time?” After examining the image the player drags the image right to say “yes,” or left for “no,”—much like the popular dating app, Tinder, except that players can also swipe down to say “maybe” if they can’t tell from the photo pair whether forest has been lost. Since the game’s initial launch two weeks ago, players have already sorted 40,000 photos, a stack the size of an elephant. The goal is to sort all 5 million photos in the dataset. Once that’s done, the researchers say they plan to continue the game, turning the focus to other questions related to deforestation and land use change. “It’s not just about monitoring deforestation, but also looking at what happens after an area is deforested—is it turned into farmland or a plantation, or is it allowed to regrow?” says Fritz. He says that future iterations of the game could also turn towards mapping human impact, disaster damage mapping, or water. (<http://www.iiasa.ac.at/web/home/about/news/151029-picture-pile.html>)

Key characteristics:

- **Mechanics:** The player receives a “pile” of photos and for each photo she has to answer a question (the same for all the photos) by clicking “yes” or “no”. The player chooses the pile of photos she wants to tag by choosing from various available piles. The game makes use of



gamification techniques like achievements, leaderboard, score and real prizes. It is also possible to play as a guest.

- Story: There is no added narrative layers. There is a tutorial which explains the game mechanics.
- Aesthetics: Streamlined and simple.
- Technology: Browser-based or mobile app game; Internet connection required; CMS to manage the various piles of photos and the players' information.

Why we like it:

This game can be played through a registration (which means that the score will be recorded even after closing the game), or as a guest, a feature aimed towards those who want to simply try it out. The registration results nonetheless attractive as an excellent gamification system is in place: multiple gamification techniques are implemented to get the player involved and prompt him/her to continue playing, creating this way the prerequisites for trustworthiness. There are present: a score system, a leaderboard based on these scores (ranking), statistics of the game, achievements and rewards items for the players who achieved the highest score. (smartphone, tablet, pc, etc.). The first stage of the game explains to the user the game's rules, through a short tutorial. The mechanic is simple but well structured in order to result intuitive and easy to use, in line with the aim of the game: answering a question, based on the picture attached to said question, by choosing one of the proposed answers. This system allows to simplify the assignment of tags, as the user answers a single question, without loading the player with too much information and requests. The graphics is pleasant and basic, facilitating the gaming experience. The contents of the game also evolves: as a matter of fact the pictures are not always the same, but new ones are added, catalogued, and grouped together into "piles". This adds dynamicity and diversity to the game, creating a challenge to those players who want to win the rewards. A chat is present in the game to create a community and dialogue between players.

Key takeaway in relation to SCENT activities:

Cross-platform, HTML-based games can be particularly suitable to support the broad citizen engagement envisioned in SCENT (Scent objective #8) and this game also creates a community where players can dialogue and challenge each other (Scent objective #4).

This game requires the user to tag pictures in order to describe them better: this methodology is intuitive and useful especially for SCENT Explore app and Collaborate.





Figure 8 Screenshot of Picture Pile (from Google Play¹¹).

EyeWire

URL: <http://eyewire.org/explore>

Publication date: from Wired Differently, Inc. (formerly M.I.T.), Boston, U.S.A., December 2012

¹¹

<https://lh3.googleusercontent.com/1gsrDFnIV8Cqfg22f7E5HudoOObl6I94A22fyWYAEUfrYkbDpJXxw2UE5UqxIs11hjt7=h900>



Short description:

This is the short description given on the official blog of EyeWire:

By joining Eyewire, you can help map the connectome, starting with connections between retinal neurons. Eyewire gameplay advances neuroscience by helping researchers discover how neurons connect and network to process information. You also help develop advanced artificial intelligence and computational technologies for mapping the connectome. In Eyewire, players are challenged to map branches of a neuron from one side of a cube to the other. Think of it as a 3D puzzle. Players scroll through the cube (measuring about 4.5 microns per side or ~10x smaller than the average width of a human hair) and reconstruct neurons in volumetric segments with the help of an artificial intelligence algorithm developed at Seung Lab.

As you trace through each neuron you'll rack up points based on speed, skill, and accuracy. Trace your way to the top of the leaderboard, engage in themed competitions against your Eyewire friends, and earn badges to show off your Eyewire achievements. If you're good enough you can climb the ranks to Advanced Player, Scout, and the prestigious Order of the Scythe.

[\(http://blog.eyewire.org/about/\)](http://blog.eyewire.org/about/)

Key characteristics:

- **Mechanics:** The player has to try to reconstruct the brain connectome by solving some “puzzles”. In these puzzles, she must colour some areas in a series of 2d scans (just like radiology exams) by simply clicking on these areas. In this way, she will establish the neural connection needed to solve the puzzle. The game continuously guides the player and clearly indicates whenever she is doing something wrong.
- **Story:** There is no added narrative layer. There is only a detailed tutorial to explain the game mechanics.
- **Aesthetics:** Very well curated and impactful and composed of various 2D and 3D graphics and animations.
- **Technology:** HTML5 browser-based game, registration/login via Facebook, in-game chat, awesome use of 3D graphics to see the other players progress in real time.

Why we like it:

This game can boast impressive graphics, and this makes it extremely attractive to the eyes of gamers. Furthermore, the gameplay offers a level of challenge suitable for everyone, both casual and hardcore gamers. The game mechanics are well explained, through a bulky tutorial, which follows the player at the beginning of the game, helping him/her understand all the aspects of the game. All of this is surrounded by a valid gamification technique:

- the registration is done through either Facebook or an email address, and this allows the user to get in and be part of the players’ community, in which it is possible to communicate with each other using the in-game chat;
- it is possible to see the leaderboard and check the contribution of every player present on the game map



- this map is shared among every player and every player contributes to expand it and enlarge it.

Moreover, a point based system is also present, which allows the players to monitor their own contribution to the game. Each level has its completion rate: for the level to be cleared it is not necessary to reach 100%, but it is up to the player to decide if he/she wants to take it easy or to continue in order to reach the highest score. This game has received several awards: for this reason it is often mentioned in publications related to crowd-sourcing applications, and this allowed the game to have a large propagation compared to other titles of the same genre.

Key takeaway in relation to SCENT activities:

Strategies that support wide and open access (e.g. guest login, tutorials) can support crowdsourcing processes (Scent objective #8). This game has also a system of rewarding along with a way to monitor the progress through levels (Scent objective #4). The concept of rewarding with badges is also suitable in Scent Explore app; moreover, also Scent Collaborate and Explore contain a tutorial and the possibility to access by guest.

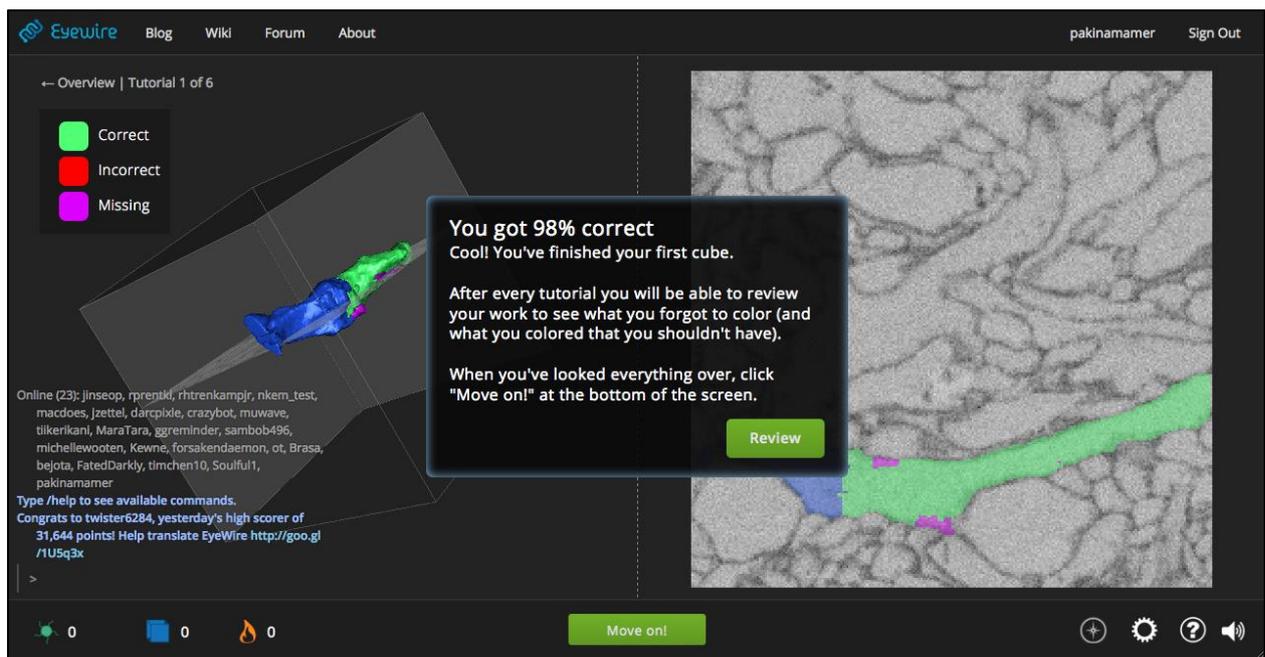


Figure 9 Screenshot of EyeWire (courtesy of Nature.com¹²).

¹² <http://blogs.nature.com/houseofwisdom/files/2014/04/Eyewire-Game-Screen-shot-2014-04-08-at-10.28.38-AM.png>

Foldit

URL: <https://fold.it/portal/>

Publication date: from Washington University, USA, 2008

Short description:

Foldit is an online puzzle game created by the University of Washington, in which the players explore protein folding, a complex biology phenomenon. While having some knowledge on the subject may certainly help, it is not required to enjoy the game, as most of the player base of this game are not scientists. The purpose of this game is to improve the algorithms used by the researchers in existing protein folding software. The structures of the proteins can be complex and predicting them can be demanding. For this reason, by researching how the human brain solves these puzzles, a more efficient solution for protein folding may be found. As the number of players increase, so is the number of puzzles solved, which will result in researchers obtaining a better understanding of the structure of proteins. In this game, a key component of success is the continuous communication between the developers and the users.

Key characteristics:

- **Mechanics:** The player has to solve some puzzles related to various 3D models of proteins, moving the components of this protein using the mouse to solve problems such as a wrong connection or a wrong position for some elements. The puzzles are divided in levels with increasing challenges for the players. There are also leaderboards and various game-related statistics.
- **Story:** There is no specific and dedicated storyline.
- **Aesthetics:** Simple, but effective 3D graphic. Good visual animations.
- **Technology:** Multiplatform game (PC/OSX/Linux); multi-language support; offline or online playing.

Why we like it:

This game is one of the most mentioned videogames that feature crowdsourcing applications. One of the most interesting things is that this game does not need any specific knowledge related to protein folding: the well detailed tutorial explains everything that is needed for the player to understand what she has to do. The player simply needs to move the various parts of the 3D model by dragging them with the mouse. Also thanks to a complete user interface, the player always has everything under his/her control (special instruments, score, etc.). This game also makes very good use of gamification techniques: every puzzle has a score that is determined by how well the model is solved and if it is actually solved without errors. Also there is a wide community, organized in a leaderboard in which all the players are ranked with an overall score. There are also a lot of achievements unlockable during the game to improve the playability of the game. The 3D models



are not too complex and this helps the player in understanding how she should operate with them. Finally, the game also offers multi-language support.

Key takeaway in relation to SCENT activities:

A well-designed system of rewards can be important to support citizen engagement over time and in relation to scientific purposes, even if any prerequisite on the subject is requested (Scent objective #4).

The reward system to increase the gamification aspect is a key point also for Scent Explore app.

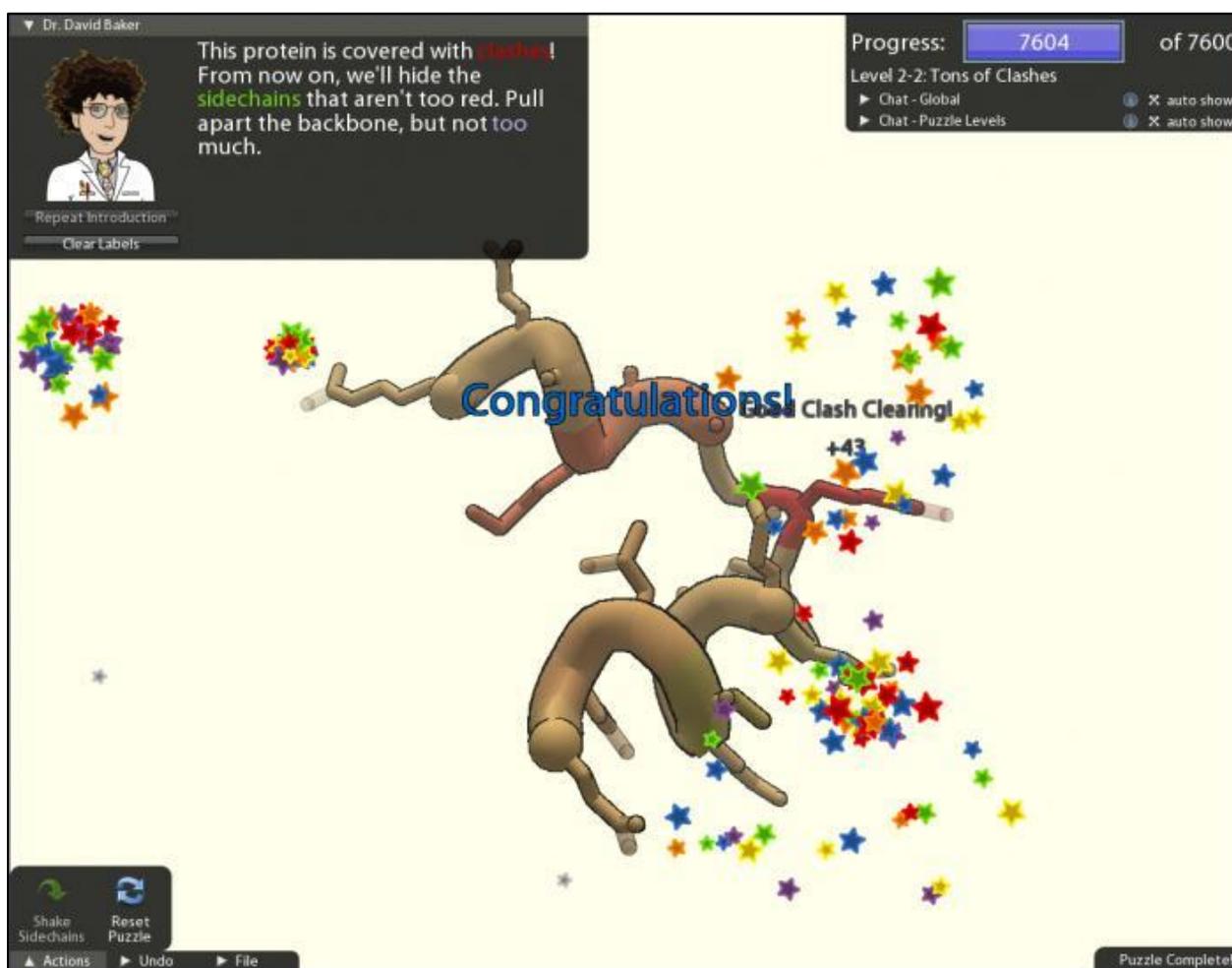


Figure 10 Screenshot of Foldit (courtesy of Softonic¹³).

¹³ <https://features.en.softonic.com/how-gaming-can-help-cure-diseases>



Cerberus Game

URL: <http://www.cerberusgame.com/index.php>

Publication date: from BlackShore, Noordwijk, NL, 2011

Short description from the authors:

This is how the authors of the game describe it:

Cerberus can be defined as an automated processing engine to translate any type of photographic satellite data into usable GIS data by harnessing the power of the crowd. In the form of an interactive computer game players get to process photographs where they have to mark interesting features like river deltas on Mars, the evolution of glaciers on Earth and so on. Cerberus as a game is equipped with an extensive learning experience in order to ready the players to do the job. Because of this Cerberus serves three important factors within the space business which are E-learning, Outreach and Crowdsourcing (<http://www.cerberusgame.com/about.php>).

Key characteristics:

- Mechanics: The player receives a series of photos and she has to carefully examine and annotate each of them, for example indicating whether there are rivers, dunes, anomalies, etc.; gamification techniques like avatar and levels are employed.
- Story: No story, only an initial tutorial to explain the game.
- Aesthetics: Overall, the graphic design is in line with the kind of game, but the user interface is a bit too complex.
- Technology: Browser-based game. Registration required.

Why we like it:

In this game, the player will have to take a good look at some photos, trying to get the most information she can from them, by clicking on certain points and adding tags when required. Also, this game makes use of a nice series of gamification techniques: the player at the beginning of the game can choose an avatar which will represent her in the game and this avatar has ranks like the military ones. This can help the player in better understanding how she is proceeding in the game and let the other players know at what level is the player and vice versa. Using achievements can also incentivize the player in trying the various instruments the game offers. Because this game is quite complex, there is an initial tutorial for the new players. The idea of dividing the photos in tiles makes the annotation process easier for the player.

Key takeaway in relation to SCENT activities:

This game provides a good example of a tagging crowdsourced system with some similarities with SCENT (Scent objectives #1 and #2). The technique of reporting pictures and tag them, is also suitable for SCENT Explore e Collaborate. Widely, this suits well into WP2 activities of engaging people (Scent objective #8).





Figure 11 Screenshot of Cerberus Game (courtesy of Partyflock¹⁴).

Google Image Labeler

URL: <https://get.google.com/crowdsourcing/imagelabeler/category>

Publication date: from Google, 2006 (discontinued in 2013, and subsequently amended)

Short description:

Google Image Search is a popular search engine used to find pictures, and this game helps improve its performance by asking users to tag images. Google managed to transform this activity into a game. When the game starts, two players are paired up and they are shown an image for 90 seconds. Within this time the players have to find a label for the image, which would give points, and after the time limit expires, the origin of the image and the answers of both players are shown. By repeating this process again and again and by showing the same image to other groups of players, Google can use the process to accurately label images, thus improving the search performances of their engine.

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http://img01.deviantart.net/52f1/i/2010/197/1/9/cerberus_an_experimental_game_by_blackshore_creative.png



Key characteristics:

- Mechanics: Through streamlined dynamics, the player is offered images to annotate. Game play is very fast.
- Story: No overarching and added storyline.
- Aesthetics: Clean visual design, fully in line with the overall Google user experience.
- Technology: HTML5 browser-based game.

Why we like it:

The game is fast and straightforward, there is only little text for the player to read and that makes it extremely easy to play. The player simply looks at the picture and chooses among sets of predefined categories. The graphics support this streamlined game play, thanks to the usual simplicity that characterizes the various products offered by Google. However, this game lacks a bit on the gamification side: the player has no full recognition for what she does (e.g., through some badges or a leaderboard).

Key takeaway in relation to SCENT activities:

Very easy-to-use Cross-platform, HTML-based user interface that could be taken as a model to develop some features of the SCENT applications. Although streamlined user interfaces can be taken as a model for all the Scent application. This game provides closer inspiration for SCENT Collaborate, especially for the annotation and classification of pictures (Scent objective #2).





Figure 12 Screenshot of Google Image Labeler (courtesy of Newgrounds.com¹⁵).

Lake Observer App

URL: www.lakeobserver.org

Publication date: from Cary Institute of Ecosystem Studies, U.S.A., 2016

Short description from the authors:

This is how the authors of the game describe it:

The Lake Observer application is a tool that empowers citizen scientists to more easily record measurements and observations while working in the field. Lake Observer was designed by members of the Global Lake Ecological Observatory Network (GLEON) as part of a crowdsourcing platform to facilitate the collection and sharing of lake- and water-related information across the globe (www.lakeobserver.org).

Key characteristics:

- Mechanics: The app is a tool for registering information regarding water observations (lakes, rivers, wetlands, etc.).
- Story: No added storyline.
- Aesthetics: Simple app, whose visual style is not particularly distinctive.
- Technology: Geolocation features; registration required to store the data.

¹⁵ <http://bbsimg.ngfiles.com/1/17211000/ngbbs48a8970aa7645.jpg>



Why we like it:

The visual style of the app is quite basic and there is no added narrative layer or engaging gamification mechanisms. However, the app is interesting because it provides an example of a process where citizens can help gathering data about various water/related parameters; the user can collect and input data without the need for any expensive sensors. The use of geolocation features allows annotating data with geographic markers.

This app is distributed for iOS and Android mobile devices.

Key takeaway in relation to SCENT activities:

Quite essential, straightforward and easy-to-use software application for data collection processes that are supported by the engagement of citizens. The idea of a crowdsourced platform relates more to Scent objective #2. Through the measurement provided by citizens, useful info can be spread across the world: this feature improves accuracy of scientific model. The engagement strategy also relates to Scent objective #8. The measurement toolkit created by SCENT is more complex than those available by this app, but they try to achieve the goal of a more specific knowledge provided by citizens. The simple and easy to use interface, with big icons, is particularly suitable for small screens, like in the case of Scent Explore.



Figure 13 Screenshot of Lake Observer app (courtesy of Cary Institute of Ecosystem Studies¹⁶).

Stop disasters!

URL: <http://www.stopdisastersgame.org/>

Publication date: from the UN/ISDR, 2007

¹⁶ <http://www.caryinstitute.org/science-program/research-projects/understanding-freshwater-ecosystem-response-global-change/lake>



Short description:

This online video game engages children aged 9 to 16 and teach them how to protect urban areas and villages against natural hazards through disaster risk planning and management. Its main objective is to raise awareness about the issue and does not pretend to educate children on all the aspects of disaster risk reduction issues.

The game includes five different scenarios, with different natural hazards in each one: flood, tsunami, wildfire, hurricane and earthquake. They are all set in different environments, thus creating different situations that require a different approach from the player. The score is calculated based on how much the player managed to protect and save, so the lesser the damage, the higher the score.

Key characteristics:

- **Mechanics:** This is a strategy game, with clear goals and a few robust mechanics (based upon points, no badges, few incentives). The game has a short and easy game play.
- **Story:** Simple, predetermined, easy to grasp.
- **Aesthetics:** Intuitive and easy to understand, even though not distinctive and particularly impressive.
- **Technology:** Essential Flash/based game. The challenging part is the AI behind the game. The user experience could be extended having in mind the potential of recent technologies such as augmented or virtual reality.

Why we like it:

The peculiarity of this game is the simulation of various kinds of natural disasters, in which the player, by using the available budget, must try to limit the damages by performing various actions (such as building new defence structures), which will then influence the impending disaster. This game uses a simple gamification tool: the score. The score is based on how the player manages to reduce damages by building appropriate structures. These kinds of actions will reward the player’s foresight in understanding how to manipulate the environment in order to minimize the impact of these disasters. The gaming part and the educational part are joint together in a fundamental aspect on risk prevention: the knowledge on the environment in which one lives in. The game offers levels with a variety of different simulations that mimic the characteristics of real-life phenomena. Like in real life, the user does not have a precise idea on when a disaster will occur. This lack of certainty allows the game play to unfold in quite different ways every time. The graphics are minimalist and fit the purpose of the game.

Key takeaway in relation to SCENT activities:

Simulated environments use storytelling techniques to create engaging settings appealing for users (Scent objective #8). This takeaway affects the whole gamification approach of Scent, rather than only being tied to either of the Scent applications.





Figure 14 Screenshot of Stop Disasters (courtesy of Andrews Geography Blog¹⁷).

Game of Floods

URL: <http://www.marincounty.org/depts/cd/divisions/planning/sea-level-rise/game-of-floods>

Publication date: from Adaptation Clearinghouse, U.S.A, May 2015

Short description from the authors:

Here, for example, the short description given on the official site of County of Marin:

The “game of floods” was developed by the County of Marin as a public education activity on sea level rise adaptation, including traditional flood protection measures such as levees, wetland restorations, and beach nourishment; and policy/zoning changes. The Game of Floods is a small group activity, with 4-6 participants tasked with developing a vision for “Marin Island 2050”, a hypothetical landscape that highlights the conditions that will be experienced in Marin in coming years with sea level rise and increased storm impacts causing the loss or deterioration of homes, community facilities, roads,

¹⁷ <http://2.bp.blogspot.com/-ddQnR-lkA8o/UFO2Nm7KIL/AAAAAAAAADc/SWT7RoS9MrY/s1600/Tsunami1.jpg>



agricultural land, beaches, wetlands, lagoons and other resources.

<http://www.marincounty.org/depts/cd/divisions/planning/sea-level-rise/game-of-floods>)

Key characteristics:

- **Mechanics:** Board game, in which each player chooses an asset she needs to protect and manage, then she chooses a strategy to ensure that that asset is protected against floods. After that, each player shares their strategy and they all work together to create the best joint strategy keeping in mind other factors like costs, environment, etc.
- **Story:** There is a minimal narrative layer that introduces the players to the game.
- **Aesthetics:** Graphics are good and detailed, perfect for a board game.
- **Technology:** Criterion not relevant, since this is a board game.

Why we like it:

This is an example on how even a board game can be useful to sensitize citizens about environmental themes. This game, free to download online, puts players in the shoes of some managers, who have to manage, organize and control public and private infrastructures of a territory. Another strong point of this game is that it ignites dialogue among the players: each player must envision the best strategy to manage their own infrastructure and at the same time discuss their strategy with the other players. In this way, each player can then see other possible lines of thoughts and then make her own contribution to the discussion. Through this dialogic process, the players can reach a solution that works for everyone. Like in real life, the game does not provide a single and a one size fits all optimal solution. To allow the user to feel even more involved in the game, a well-illustrated storyline is presented at the beginning of the game, allowing the players to have a clear idea of the situation. The game features a straightforward but distinct graphics, with bright colours and visible details, a style that best suits a board game as it will not make the gaming session heavy. Given the way the game is played, mainly as participatory dialogue and discussion, the technology is almost non-existent, it all simply comes down to the game board, the instructions and the usage of the dice to determine the order in which each player will present his/her own thoughts to the other players.

Key takeaway in relation to SCENT activities:

This game represents an example of how gamification strategies can be extended also beyond digital interfaces (Scent objective #8). It is really instructive and make people “learn by doing”: as in SCENT, the main goal to achieve is a more common sense about environmental protection and preservation among citizens.

For the previous reasons, this takeaway is actually connected to all Scent Toolkit and not only to one of the developed apps.



- Technology: Quite simple; the game use probability and random simulation of floods.

Why we like it:

This game uses as a real and well defined geographic area as key component of a storyline, in which the player will have to decide the environmental policies which will prevent the risk of flooding. This game helps the citizens understand and choose various strategies, while taking also the responsibilities for them. In this way, the player will increase her own awareness regarding the environmental theme and its risks. The game mechanics focuses on teaching to the player some key dynamics of the flooding phenomenon. During the gameplay, the player is guided by a virtual assistant when taking decisions; the virtual assistant provides contextual information and tips on how to proceed. The basic, but pleasant graphic design is an added value, as it makes the game attractive and easy to understand. Scores and leaderboards track the players’ performances. Statistics are also present (at the end of three turns), which highlight which of the decisions made by the player (during their own play) were taken more into account by the other players.

Key takeaway in relation to SCENT activities:

This is an example of a game that adopts simulations to engage a variety of publics, including policy makers, in better understanding how to respond to flooding. The game deals with floods and how to prevent/avoid them: this relates to the entire Scent approach. As planned for Collaborate and Explore, the game contains tutorials and explanation, along with a simple but effective aesthetics.

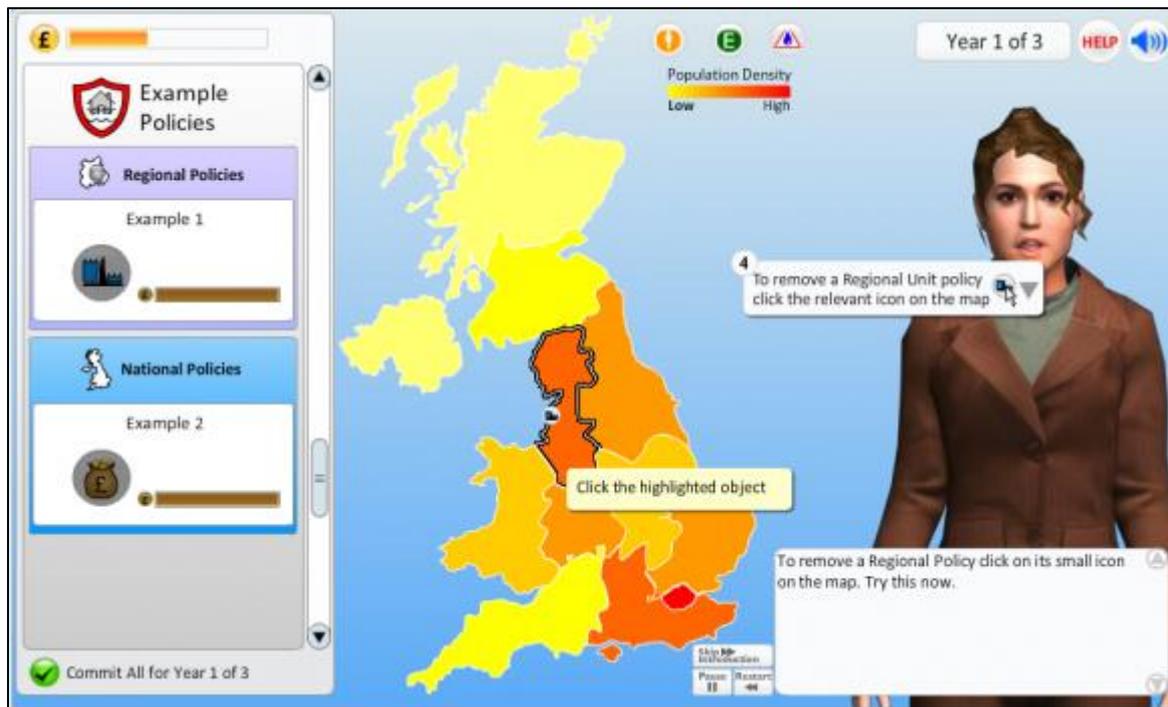


Figure 16 Screenshot of FloodSim (courtesy of Playgen¹⁹).

¹⁹ <http://playgen.com/play/floodsim/>

Sai Fah: The Flood Fighter

URL: <http://www.floodfighterthegame.com/>

Publication date: from Government of Japan, 2014

Short description from the authors:

This is the description on the official website:

UNESCO Bangkok and the Regional Bureau of Education in Asia Pacific created a mobile game at the beginning of the year to teach children real-life lessons on disaster safety and survival. This was in response to the 2011 floods in Thailand, which resulted in scores of preventable deaths. The app follows the adventures of a young boy trying to reunite with his mother during a flood disaster, UNESCO says, and players learn flood safety lessons as they encounter flood hazards, from live electrical currents to dangerous wildlife (<http://www.floodfighterthegame.com/en/about>).

Key characteristics:

- **Mechanics:** Simple puzzle solving mechanisms, where the players have to clear objectives and advance in the game. Controls and animations are very simple and intuitive and the tasks are varied between the game levels.
- **Story:** The player plays in the role of Sai Fah, a child who has many task to do to help others and his mother before, during and after a flood that is going to hit his hometown. Every task will teach the player how to behave in the circumstances of a flood.
- **Aesthetics:** Graphics are simple and suitable for children.
- **Technology:** Mobile-based (iOS/Android) 2D adventure game.

Why we like it:

We found “Sai Fah: the flood fighter” interesting because it is aimed at younger users and especially because it is based on the concept of education and learning regarding the best practices to adopt in case of a natural disaster, more precisely a flood. In this sense, the game is well suited to be presented and used in schools or during courses dedicated to children and/or teenagers, or it can be played in total autonomy. A streamlined user interface allows simple gestures from the players (e.g., touching the screen to move, interact with other characters or take actions), which makes the gameplay extremely intuitive also for younger audiences. The game is also structured into levels, in order to make the game more varied, faster and more fluid to play.

The story told in the game progresses through the various levels and this motivates the player to continue the game to learn how the story unfolds, but it also creates a progressive emotional attachment toward Sai Fah, who represents the player. In this case, a child for example, will feel a bond between himself/herself and the character he/she is playing.

The visual design is carefully studied and contains colourful and polished 2D graphics elements. Each level has a final score represented by “stars” (3 is maximum, while 1 is minimum): this choice is



motivated by the fact that the game is aimed at a young audience. To make the concept of score simple and easy to understand, it was decided to use pictures and images, instead of tables and/or numbers.

Key takeaway in relation to SCENT activities:

Mobile-based, 2D games with nice graphics, aimed at young target audiences: this really achieves a high level of engagement which is one of the objectives of the project (#8).

The game is tied to Scent Explore especially for the 2D graphics and a user-friendly interface, which reaches also young players. It is in this spirit that Scent Explore will make use of a playful storytelling based on a variety of characters (e.g., little and cutely designed animals popping out when the user reaches specific geographic locations).



Figure 17 Screenshot of Sai Fah: the flood fighter (courtesy of China Daily Asia²⁰).

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https://www.google.se/search?q=sai+fah+the+flood+fighter&source=lnms&tbm=isch&sa=X&ved=0ahUKEwjI9S424SAhWJGCwKHSYjBrQQ_AUICSgC&biw=1366&bih=662#imgrc=KxzOw7XWKLJ5uM:

Pokemon Go!

URL: <http://www.pokemongo.com/>

Publication date: from Niantic (Nintendo owns the property of the Pokemon trademark), U.S.A., 2016

Short description:

Pokemon Go is a mobile game based on the augmented reality and geolocation technology. It was developed by Niantic and it was released in July 2016 in most regions of the world. The game allows the player to catch and battle Pokemons, which appear based on the real location of the player. In this way the player has to travel in the real world in order to reach a specific location in game to catch a certain Pokemon. While there are additional in game items that can be purchased with real money, the game itself is free-to-play.

Key characteristics:

- **Mechanics:** The player has to move in the real world to search and collect every Pokemon (Pocket Monster) in the game by simply throwing Poke balls (spheres that are required to capture Pokemons) at them. The player can also fight against other players using her Pokemons.
- **Story:** The player gets introduced to the game and learns about the objective of the game, which is to capture every Pokemon in the world and become the number one Pokemon trainer in the world. She also learns what the Pokemons are and how the game revolves around them.
- **Aesthetics:** Graphics and animations are outstanding and perfectly in line with the Nintendo's video games and TV shows of Pokemon
- **Technology:** The game makes use of AR and geolocalization features to let the player search around her to capture the Pokemon.

Why we like it:

This game is probably one of the most innovative and peculiar commercially released game in recent memory, because it merges a unique system of services of geographic maps, the geolocation offered from smartphones, augmented reality (activated using the camera of the device), and the strong intellectual property of the Pokemon. Pokemon is one of the most known brand in the world in the field of catchable monsters and for this very reason it has been chosen to be part of the game.

The integration of these technologies is well implemented and the whole is enriched by gamification techniques, like the presence of achievements in the game, a user profile for the player (required to play), the creation of a customizable avatar, and a division in levels to track how much the player is using the app. In order to advance from one level to the next, the player has to earn experience



points, which are obtained by executing various actions in the game (catching Pokemon, hatching eggs, etc.). This game design gives the player a constant feeling of growth.

The graphics and the animations are particularly polished and engaging.

Despite the many technical features, the game remains nonetheless simple in its many functions and mechanics: a new game from a new player will start with a quick tutorial which explains in few words the various game mechanics, and even then, after spending some time playing, from the player only few intuitive commands to execute various actions (catch a Pokemon, move around the map, etc.) are required.

Key takeaway in relation to SCENT activities:

One of the rare examples of successful location- and AR-based games. This can serve as inspiration for the ARG to be developed in SCENT. Anyway, the most impressive feature in relation to SCENT activities is the capability of engaging people (Scent objective #8). The AR technology, with some funny characters to be found by the player, the reward given after the “hunt” are quite interesting and suitable game elements to be considered for the SCENT Explore app.

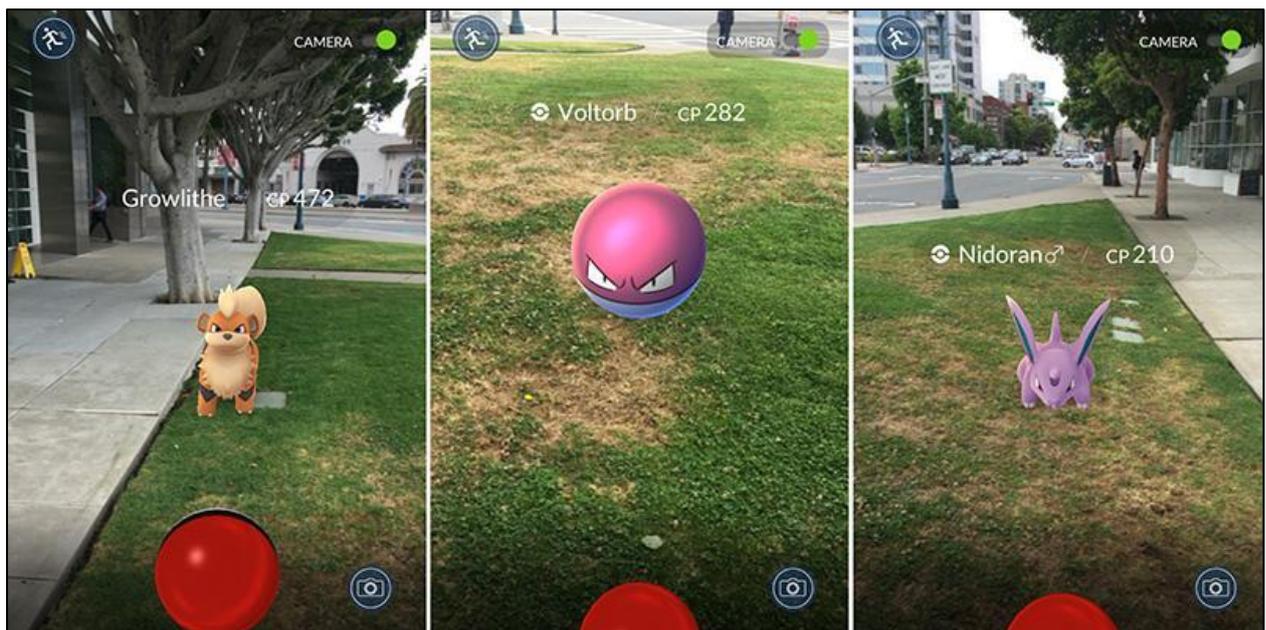


Figure 18 Screenshot of Pokemon Go! (courtesy of Il Post²¹).

²¹ <http://www.ilpost.it/2016/07/06/pokemon-go-download-apk/>

SchaVis

URL: www.secom20.eu/game-based-learning/flood-games-examples

Publication date: from RheinMain University of Applied Sciences, Wiesbaden (DE), 2010

Short description:

In this game, the player finds herself in a house of a friend that is going to endure an upcoming flood. The player will need to secure the various part of the house to save the highest quantity of her friend's belongings. The game simulates a real flood and the damages related to this flood will be visualized in the house so that the player will understand and comprehend the impact of a flood on buildings.

Key characteristics:

- **Mechanics:** The player needs to help a house that is about to be hit by a flood. The player will need to explore the house and gather or buy materials to save everything she can
- **Story:** Realistic, quite well defined and focused.
- **Aesthetics:** The game is quite old and the graphics are a little out-dated.
- **Technology:** Point and Click adventure game for Windows PC

Why we like it:

This game, made almost 10 years ago, picks up the “Point and click” adventure games; today, these type of games are still loved by many gamers, especially adults: this is the reason why we picked this game instead of others for our review of interesting games.

SchaVis puts the player in a imminent catastrophic situation, in which the player has to limit the damages, and do it in first person view: in this way, the player can act and react more decisively and with more sharpness when dealing with the difficulties presented during the game. The player finds herself living inside the game, moving freely in the environment and feeling as an active part in the decisions which triggers the action. The presence of a plausible plot gives even more realism to the game, and makes it even more “real” in the eyes of the player, involving the player in the dynamics of the game and in her role in it.

The game mechanic of the “Point and click” (which uses only the mouse) is so simple and easy to understand, that it will help the player during the game, thus, filling this way, the objectively speaking hardship, of the language barrier (only German instead of English, for example). The use of a graphical interface simplifies the game for the user, because she will always have available objectives, inventory, etc., in front of her.

To simplify even more the game, the player can move in the 3D map only at certain instances by clicking on the appropriate icon: despite the reduced freedom of movement, the instances where the player can move are nonetheless more than enough to allow her to scan in detail the environment in which they are in, with no risk to be disoriented. The game has good graphics, simple but detailed and equipped with all the necessary elements for a smooth gameplay: thanks to this balance, the player does not have any risk of losing herself in the excessive details which could



compromise the lightness of the game mechanics. There are also simple yet “cinematic” cutscenes designed to tell the story without having the need for the player to intervene.

The technology and gamification are especially focused on the plot and gameplay, splitting the game into four scenarios: this will ensure the game has more gameplay, and will then be an incentive to continue playing. At the end of each scenario the player will have, in the form of a final score, the results of her actions during the game: the higher the score, the better were the choices/decisions made by the player. Unlockable achievements are also available during the game and that will allow the game itself to be even more accessible and user-friendly.

Key takeaway in relation to SCENT activities:

Games based on realistic situations can reach good levels of engagement as they are anchored to possibly real-life experiences of the players (Scent objective #8). A particularly interesting feature is the fact that this game is browser-based. Our plan is precisely to deploy browser-based components for Scent Collaborate. The topic of this game - flood hazard - is also in line with what we intend to tackle within Scent.



Figure 19 Screenshot of SchaVis (courtesy of Secom²²).

²² <https://www.secom20.eu/game-based-learning/flood-games-examples>

mPING App

URL: <http://www.nssl.noaa.gov/projects/ping/>

Publication date: from NOAA National Severe Storms Laboratory, U.S.A, January 2016

Short description from the authors:

The NOAA describes the game as follows:

The NOAA National Severe Storms Laboratory is collecting public weather reports through a free app available for smart phones or mobile devices. The app is called “mPING,” for Meteorological Phenomena Identification Near the Ground.

mPING reports are immediately archived into a database at NSSL, and are displayed on a map accessible to anyone. To use the app, reporters select the type of weather that is occurring, and tap “submit.” The anonymous reports can be submitted as often as every minute.

Weather radars cannot “see” at the ground, so mPING reports are used by the NOAA National Weather Service to fine-tune their forecasts. NSSL uses the data in a variety of ways, including to develop new radar and forecasting technologies and techniques (www.nssl.noaa.gov/projects/ping).

Key characteristics:

- **Mechanics:** The user selects the type of weather report she wants to submit (visibility, wind, flood, etc.) and reports that status to the system. This is an app and does not contain gamification mechanics.
- **Story:** No added narrative layer.
- **Aesthetics:** Simple app with basic functions, no particular graphics.
- **Technology:** Mobile app for iOS and Android; the app make use of GPS to easily locate the user.

Why we like it:

This app allows you to collect, catalogue and send data regarding the weather conditions (rain, tornados, floods, reduced visibility, etc.).

This app is structured so that this data collection is performed in a short amount of time: few “taps” are enough to send a report or a weather scan, and with the help of the smartphone’s geolocation the accuracy regarding the position is guaranteed, reducing the number of operations the user has to perform and assuring that the position matches with the position of the citizen, thus reducing the margin of error.

Key takeaway in relation to SCENT activities:

This is another example of a software application that backs crowdsourced processes tied to earth observations. The game invites citizens to gather data and info and send them to the research



center where they are adopted to improve weather forecast. This is a quite similar crowdsourcing mechanism as the one we intend to implement in Scent (Scent objective #4). Also Scent Explore and all the SCENT toolkit for measurements will collect information about weather conditions, water level, etc. in order to build more reliable models and observations. mPING is also an example of a mobile app building on the GPS-related location-based functionalities.



Figure 20 Screenshot of mPing App (courtesy of 40north 70west²³).

The Playful Danube

URL: <http://playdanube.at>

Publication date: from the Austrian Ministry of the Environment, Water Management Section, Austria, 2011

Short description from the authors:

This is how the authors of the game describe it:

The game takes players on an interdisciplinary journey on the Danube as they navigate a kayak along the course of the river in Austria. Along the way, players must answer 36 questions at three different levels; the questions are chosen randomly from a large database ensuring a new experience with each

²³ <http://40north70west.com/wp-content/uploads/2014/11/mping.jpg>

game. Each question is supplemented with a short text that often hints at the correct answer, which must be chosen from multiple choice options (<http://playdanube.at>).

Key characteristics:

- **Mechanics:** The player takes a tour of the Danube Delta, using the keyboard to move in the river, and has to answer some questions in 15 seconds. Every correct answer and additional bonuses in the game let the player earn points.
- **Story:** Simple narrative layer, anchored to a real geographic area.
- **Aesthetics:** Simple graphics and good animations.
- **Technology:** Flash-based 2D browser game.

Why we like it:

This game uses a basic gamification technique to collect points, particularly, compared to other products, it uses a dual interactivity of the product: you must collect bonuses (and dodge maluses) in an arcade style, at the same time keeping in mind the flora-fauna of the surrounding environment through a quiz (therefore you must know the terrain and the environmental characteristics). There is no actual story to follow, but it is interesting the presence of a map with the path that the Danube follows. This trick allows the digital game to connect with the real course of the Danube, creating a simple but engaging narrative layer.

The graphics are very simple, but functional to the product. Particularly interesting is the usage of real-life flora and fauna, which allows for a larger educational impact of the project.

Key takeaway in relation to SCENT activities:

Cross-platform games can be appropriate to enhance the broad citizen participation envisioned in SCENT (Scent objective #8). Streamlined but nevertheless effective gamification mechanisms (e.g. collecting bonus and rewards while gathering information) can be leveraged to support player engagement in the Scent applications (thus with some ties with Scent objective #4). Lastly, this game focuses on water management, which is a theme particularly central in Scent.





Figure 21 Screenshot of The Playful Danube (courtesy of ICPDR²⁴).

Awqa Water

URL: <http://alms.ca/wp-content/uploads/2013/09/AWQA-Game.swf>

Publication date: from Alberta Lake Management Society, Canada, 2008

Short description:

This game teaches the players about the health of a lake and, in particular, about the water compositions and pollution. By performing various kinds of experiments, the players can learn the effect that human and animal interventions can have on the lake, such as the use of fertilizers.

Key characteristics:

- Mechanics: Following the step-by-step instructions, the player performs some guided experiments to check the pollution of the water of a lake.
- Story: No added narrative dimension.
- Aesthetics: Graphics and animations are simple but nicely designed.
- Technology: This is a simulation browser-based game, with very simple technology.

Why we like it:

Despite the simplicity of the graphics, we find the game interesting for its educational side. Compared to others, this game lets the user advance the game through the implementation of a series of scientific operations, guiding the player during all its stages, in a purely linear manner, suitable to achieve a predetermined goal (i.e., to calculate the pollution of a water reservoir).

²⁴ https://www.icpdr.org/main/sites/default/files/images/dw/dw1101/p04_2.jpg



Even if the type of gamification proposed may result boring, as it is too linear and technical, it allows the user to repeat the proposed experiments in a scientifically correct way, providing a solid foundation in case they want to repeat the same measurements in the real world, allowing everyone to test the quality of the water in a simple and intuitive way.

This project is interesting as the implications are not only virtual, but also possible in real life, but it also provides an example where the educational aspect overshadows the gamification mechanics.

Key takeaway in relation to SCENT activities:

A game where the unbalanced combination of gamification mechanisms and educational aspects does not lead to optimal user engagement. As such this can inform our efforts toward some objectives of the project (e.g., Scent objective #8). Surely, the educational aspect is a concern for SCENT activities, as it is for Awqa Water. However, the engagement level which SCENT Explore and Collaborate aims to achieve will build on a more playful approach rather than a too dense educational layer, where people might feel overwhelmed by notions, concepts and information.

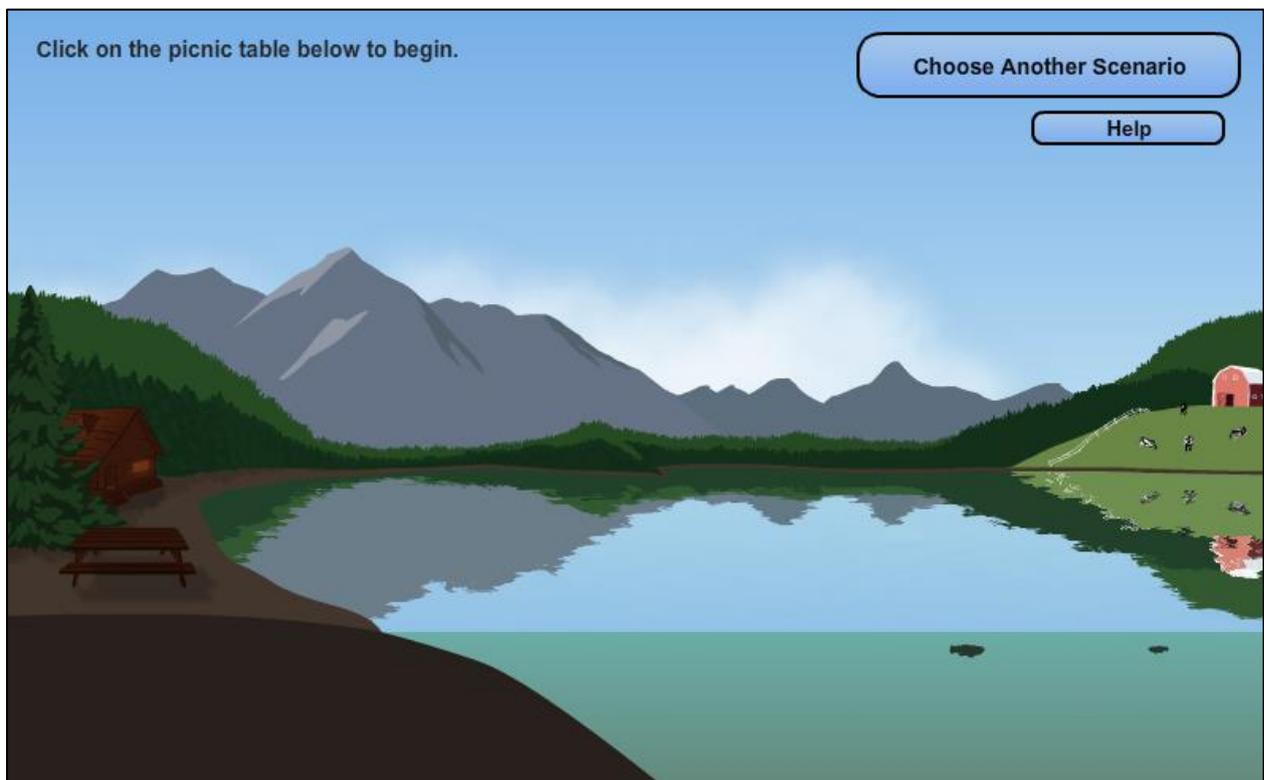


Figure 22 Screenshot of Awqa Water (courtesy of Alms, California²⁵).

²⁵ <http://alms.ca/wp-content/uploads/2013/09/AWQA-Game.swf>

Run the river

URL: <https://itunes.apple.com/au/app/run-the-river/id826169995?mt=8>

Publication date: from Murray-Darling Basin Authority, Australia, December 2014

Short description:

This game allows the player to control dams in order to keep the water level of the river in check. The player has to connect a river to the ocean, while also allowing it to flow towards areas that need water, while keeping in mind variables such as floods, drought, seasons, water level.

Key characteristics:

- **Mechanics:** The player has to distribute water to some areas of a small map by tapping and pressing the screen, always remembering that water is limited.
- **Story:** The game is divided into scenarios and each scenario has a little introductory story.
- **Aesthetics:** Graphics and animations are rich and appealing.
- **Technology:** Strategic mobile game for iOS and Android.

Why we like it:

The player has the power to choose which environmental/urban/natural etc. resource will have water access in order for it to continue being operational, while keeping in mind that the amount of water available from the river is limited and must be handled with care so that everyone can benefit from it.

The controls available to the user are intuitive, just touching or pressing one of the resource is enough for it to get access to the water supply. A series of instructions are also present in the game, so that the player can learn how to operate these simple commands.

There is no plot, but there are a series of scenarios, which can be defined as levels, in which the victory conditions, the number of resources that need water, the difficulty, etc. can vary. This ensures a good replay value to the title, while keeping the gameplay constant.

Aesthetically, the graphics contributes to making the title very appealing: rich, detailed, captivating and polished, very colorful, with fluid animations and visually pleasing. This is a very important asset, as the game is developed for mobile devices, where the market tends to favour and highlight titles with above average graphics.

Key takeaway in relation to SCENT activities:

This game demonstrates the need of paying particular attention to the visual design in order to ensure engagement and playability. The preeminent quality of this game is the user experience design, which supports the playability and the user engagement. This is one fundamental characteristic in SCENT activities (Scent objective #8). A close attention toward an effective user experience design is a feature of all the Scent applications.





Figure 23 Screenshot of Run the River (courtesy of Google Play²⁶).

Flood Runner: Armageddon

URL: <http://armorgames.com/play/11131/flood-runner-armageddon>

Publication date: from Armor Game, U.S.A., April 2011

Short description:

The objective of this game is to run away from the disaster. Danger approaches and the player has to avoid it and the destructive power of nature. The player has to face various challenges including an erupting volcano and the fury of the tsunami, while relying only on their own abilities.

Key characteristics:

- Mechanics: The player has to escape from some disasters, as fast as she can. She just needs to jump, avoid enemies or avoid falling underground. There are also achievements and points for the player to improve the game playability.
- Story: No specific storyline.
- Aesthetics: Graphics and animations are very good and responsive.
- Technology: 2D action browser-based game; use of keyboard to play.

²⁶ https://lh5.ggpht.com/rP-j7fZDPqFagQD3NEy8JLbG_HVLCafMy0pi8sMHCQhiEO-Ftrh6NfF2AJxAHi8phw=h900



Why we like it:

The interesting idea here is to try and explain the danger of natural disasters in a dynamic and fast paced way (floods and eruptions), especially towards a young audience who can generally see such dangers only from the media. Particularly interesting and polished is the way the achievements are being used: they can be unlocked as the game progresses, by collecting and/or performing specific actions. These achievements have appropriate names (for example LIFE SAVES) and also have different ranks (bronze, silver, gold).

Runner games (which generally represents this kind of games, like Temple Run) are very repetitive, and they are hardly played over and over again, so the introduction of the achievements gives the game a longer longevity. The graphics are simple and minimalistic, which contributes in making the game dynamic, while also being appropriate for a browser game. In fact, the player does not need and (especially) should not concentrate on the details, as it would distract the player from the action and the “run”. The animations, on the other hand, are fast paced and fluid. This is another strong point for a game based on speed and reaction time.

Key takeaway in relation to SCENT activities:

Another clear example of cross-platform, HTML-based games which reaches a good level with regard to citizen engagement (Scent objective #8). The minimalistic, less-is-more approach as regards the user experience and the visual design is a particularly important feature to be replicated in Scent. Scent Explore is also based on a “tour” which the player should complete and the user interface is streamlined as not to distract the user from taking pictures of interesting situations.



Figure 24 Screenshot of Flood Runner 3: Armageddon (courtesy of Giocagratis.it²⁷).

²⁷ http://giocagratis.it/wp-content/thumbs/mochi/F/flood-runner-3_img1.jpg

The President for a day: floodings

URL: <https://school.seriousgames.net/flooding/>

Publication date: from Serious Game Interactive, Denmark, 2015.

Short description:

President for A Day is a turn-based strategy game where the player is put as the president of Pakistan. Not much time is left before the election and while you feel confident in your victory, problems start to arise one after another. The only way to pull it through is to demonstrate true ability and handle everything with determination.

Heavy rain starts to fall and it creates a flood in the north. It destroys everything in its path and it's up to you to save your citizens, from their rescue to the management of the aftermath, such as clean food and water and shelter for the refugees, to the outbreak of diseases and rebels insurging everywhere. Are up for the challenge?

Key characteristics:

- **Mechanics:** The player acts as the president of Pakistan, who needs to manage floods in his country by providing food and help refugees in every region of his country. Also there will be random rebels that the player will need to take care of to ensure control of the country. The player has 15 days (in game time) to do the best he can and win the upcoming elections.
- **Story:** Little story, the game starts with an overview of the country and the player is told everything he need to take care of
- **Aesthetics:** Graphics and animations are simple but nice enough for the game
- **Technology:** managerial strategy (PC, OSX) videogame, complex algorithm for the various parameters, random encounters

Why we like it:

This game is quite complex in its dynamics, but it's interesting as the player ("The President"), in addition to dealing with the management and the containment of a phenomenon such as a flood, also has to keep in mind other elements and pressing events of not insignificant importance, and tied to the latter, things such as refugees, evacuees, food management, water supply, health and humanitarian emergencies, level of the political "thermometer", are essential in order to obtain victory. As a matter of fact, one of the main feature of the game is the vast amount of statistics given to the players, allowing them to make the best decision in that specific tun. These decisions are also limited by the scarce available resources, and this, added with the other factors, makes the game more complicated, but at the same, more exciting, forcing the player to ponder and think in order to reach a better choice in managing the resources in that turn, while also trying to foresee possible events in the next turns.



To increase the difficulty there is also a time limit for each turn: if the time runs out the next turn will automatically begin, regardless of whatever the player did reach a decision or not. So this is particularly interesting as, in addition in making the game more competitive, it makes the game more realistic, since in the real world, sadly, there is never enough time when taking a decision of this magnitude.

The story, while being original, is not told, but it's limited in the presentation of the situation the player find himself/herself in: this throws the player in the actual game, putting aside the details which are irrelevant for the game.

Aesthetically e graphically speaking, given the platform used, it's an average game, nothing exceptional: nevertheless, the gameplay is not diminished, the goal of the game remains clear, thus we can say that the graphics are fit for the purpose.

The game makes use of achievements, so that it can be replayed solely for personal enjoyment, and the difficulty level can be increased in order to reach a specific achievement. At the end of the game, in addition to the result (victory or defeat), an evaluation is presented, with the game played being evaluated in statistics: popularity levels, average health in the country, security levels and number of deceased caused by the flood, which can be useful to the player in case he/she wants to learn and improve his/her play style.

Key takeaway in relation to SCENT activities:

The analysis of this game showed that although in principle it would be possible to add managerial game dynamics to Scent, these game dynamics would not be probably suitable to large audiences and would not be suitable for a game to be played on-the-go and while paying attention to the external environment (like in Scent Explore). In this sense, this game helped us realize that we should imagine simpler mechanics as to reach a more solid user experience in terms of playability and enjoyment (Scent objective #8).



Figure 25 Screenshot of President for a day: floodings (courtesy of Failmid²⁸).

Catchment Detox

URL: <http://www.abc.net.au/science/catchmentdetox/files/play-game.htm>

Publication date: from Moon Communication Group, UK, 2008

Short description:

The game gives the player a catchment to manage and she has 100 years to manage it and create some establishments to advance in the game and earn money and resources. The player will see directly how her buildings and policies will impact on the environment and the health of the catchment. The player will have a wide number of parameters to focus and every action she makes in the game will have result in variations in the score and in the water quality and health of catchment. Once the 100 years are over, the player will see how her decisions have influenced the catchment and the earnings of her activities.

Key characteristics:

- **Mechanics:** The player owns a land with a river and she has to manage agriculture, industries and tourism to earn money and increase population and, at the same time, she has to pay attention carefully to the environment and the water health. Every turn the player gain points and at the end of the game (100 turns) the overall points are shown.
- **Story:** No added storyline.
- **Aesthetics:** Graphics and animations are very nice, colorful and easy to grasp.
- **Technology:** managerial strategic turn- and browser-based game; complex algorithm to manage the various parameters; no achievements or badges; no user registration.

Why we like it:

The challenge proposed by this game is the balancing of two sides: gaining profit while respecting the environment you live in.

The game is turn based, and the player has a great variety of infrastructures she can use to expand her business, some of these unlockable as the game progresses and the player accumulates wealth. This allows the player to always have an ever-changing game, thus avoiding repetitivity.

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http://cdn.akamai.steamstatic.com/steam/apps/368770/ss_810b6e84a69416d0ee783b0fd7e1d756109827f8.1920x1080.jpg



The absence of a plot does not negatively influence on the structure of the game, precisely because the game renews itself thanks to the strategy adopted by the player.

The graphics are well made, of an above average level, with good details and good animations, definitely suitable to this type of game, making it interesting and engaging.

Since the variety of the game depends on the strategy adopted by the player, the rightfully used gamification technique is that of having a score: based on the revenue and the environment health and other final parameters, the player receives a score and relative statistics, allowing her to clearly and accurately understand the course of the game, like the strong and weak points of the used strategy.

Key takeaway in relation to SCENT activities:

Another example of gamification mechanism that do not necessarily require user registration and, as such, can be suitable also for non-tech, casual gamers (Scent objective #8). The absence of real plot is not a drawback, as we plan to do for Scent Explore: a real story is not required to engage people for the project’s purpose.



Figure 26 Screenshot of Catchment Detox (courtesy of Fresh Water Watch²⁹).

²⁹ <https://freshwaterwatch.thewaterhub.org/sites/default/files/catchment-health.jpg>



Plan It Green Game: the big switch

URL: <http://www.planitgreenlive.com/en>

Publication date: from National Geographic, U.S.A., 2013

Short description:

This game offers the player the possibility to create and manage a city: she will have to create many buildings for residential, commercial, industrial and recreation purposes, progress with scientific research and always monitor the environment and the citizens health and happiness. The game is also good to learn about policies and tips related to energy saving and eco living. The player is not alone: players from all over the world can play this game and create their cities, visit and talk to other players, and see how the others are progressing in the game thanks to achievements and ranking.

Key characteristics:

- **Mechanics:** The player has to create and manage a city in a specific area; she also has other players as neighbours who can be visited and added as friends to earn resources and bonuses. Also, the game offers some missions to help the player in creating her city and also give her some bonuses. There are various gamification techniques: customizable player profile, log in with social networks, connection with other players, achievements, points for the city and level/experience for the player.
- **Story:** No story, the player only knows that she has to create a city.
- **Aesthetics:** Graphics and animations are astonishing, extremely detailed and nice and at the same time. The animations are smooth and appropriate.
- **Technology:** Strategic managerial HTML5 browser-based game. Registration required with email or social networks (Facebook, Twitter, Google+)

Why we like it:

This is one of the most interesting game chosen by us, for many reasons. All the main features of gamification are fully achieved, reaching a high degree of appreciation and satisfaction from the users.

In order to play, a login is necessary, which can be done through a classic registration or through an already registered social network (such as Facebook, Twitter or Google+), making the operation smoother.

Regardless of which method was used, the player has the possibility to create and customize their own profile, in which she may choose the profile image (if the registration was done through social, their own picture will be used, otherwise, a preset avatar will be used) and the name of the city they are going to be built.



To further personalize the profile while allowing the player to enjoy the game as it progresses, the experience and skill of each player are ranked into levels: higher the level, higher is the experience and greater are the items at disposal to build the city. This gives the player a status inside the game, and builds in her expectations and longing for the higher level items. In order to allow the player to increase their own level, she will have to simply play the game, and every action taken will give “experience” points, which will put the player a step closer to the next level. The player is very enticed to do all of this, as with every level increase, the player will be rewarded with resources that can be used in the game. Another great gamification technique used to lure the player into playing the game and raise their levels, is that of giving the player objectives or “quests”.

Another very interesting element is that every city in the game is visible from a single global map, and the player has the possibility of visiting the cities of other players: in doing so she will have the chance of obtaining more resources as bonus and make friends with other users. This allows the player to see the playing style or the stylistic choices made by other players, thus allowing her to take inspiration for her own city, without any type of competition needed. Moreover, as the player profile has a level, the city too has its own score, which indicates how well it is built, while always keeping in mind the well being of the environment. This allows the player to identify immediately the many types of city, from the one created by a inexperienced user to the more structured ones.

Another very interesting component is the presence of some simple mini-games, which allow the player to obtain even more resources: this is incredibly tempting, as for a player, other than having a way to earn more resources, it is also a way to vary the gameplay, by relaxing with an even more simple and easy activity, while always remaining pleasing.

The complexity of this gamification and its proposed game mechanics is to make the presence of a story almost meaningless, which is limited to only the in-game explanations.

Aesthetically the game has a high quality level: the graphics are very polished and detailed, with a very good choice of colour and style, the animations are smooth, dynamic and convey lightness, curiosity and desire to play.

Key takeaway in relation to SCENT activities:

A robustly developed game relying on proven gamification mechanisms, including the fact that the user interface of the game is designed in a way that lets the player see the other players’ contributions in real time (Scent objective #8). The reward system is contained also in Scent objective #4. This game shares with Scent Explore the absence of a well-structured story and a very colourful and pleasant graphic, along with a solid rewarding system.



Figure 27 Screenshot of Plan It Green Game (courtesy of The Green Village³⁰).

Energy City

URL:http://content3.jason.org/resource_content/content/digitallab/8250/misc_content/public/popup.html

Publication date: from Filament Games, U.S.A., 2010

Short description:

The player has to manage and improve a city by working on energy management of the city itself, always remembering that her choices have an impact on the surrounding environment. At the same time, the city will need a minimum amount of energy or it will not work anymore and the game will end. If the player will manage everything in the right way, she will be able to create a self-sufficient city without damaging the environment.

Key characteristics:

³⁰ http://thegreenvillage.co.uk/wp-content/uploads/2009/04/planitgreen_screenshot03.jpg



- **Mechanics:** The player owns a city and she has to make the city grow, taking into account the environment, air quality and available money in 10 or 20 turns. Every turn the player must generate some electricity from the power plants to go to the next turn. At the beginning of each turn, some money will be regained. Also some in-game stakeholders give some quests to help gain some more resources. The moment the player has no money or the environment quality is too low, the game ends.
- **Story:** Essential storyline, where the player only knows that she owns a city and has to make it prosper.
- **Aesthetics:** Graphics are simple and colorful, easy to grasp.
- **Technology:** Managerial strategic turn-based browser game, complex algorithms, random events related to how the player is progressing.

Why we like it:

The peculiarity of this game is its ability to let the player choose which and how much of an energy source to use, for a city lifestyle, which requires, regardless of the type of resource chosen, a constant supply of energy. Nevertheless, the player's objective is that of always keeping in consideration the environmental impact that the energy production can have on the terrain.

The controls the player has to use are very simple and are introduced at the beginning of the game: also, to differentiate and diversify the game, the player can choose between two difficulty levels, which will indicate the number of available turns, and various starting scenarios, where the initial conditions will be different (type of energy used, environmental situation, etc.).

In order to diversify the game even more and make it more interesting, the game randomly offers secondary objectives, which allow the player to have advantages for their own city or effects on the environment, or else disadvantages in case these secondary objectives were not fulfilled. Given the type of the game (strategy game), rather than a story, "thoughts" are presented in the tutorial, which allows the player to better understand the situation (both in game and real world) and how to face the difficulties of the game.

The aesthetics are of an appropriate style to this type of game, simple yet effective, thereby making the game easier to understand to those playing.

The game provides to the player a wide range of strategies for the choice and use of the energy resources, from the renewable ones to the inexhaustible ones, to the non-renewable ones, etc.

At every turn, statistics related to the used resources are given, together with the environmental and atmospheric situation, allowing the user to have a history of action taken by the player.

Key takeaway in relation to SCENT activities:

An example of a complex user interaction based upon a variety of well-designed game mechanisms: this concerns Scent objective #8. Once again, the browser-based dimension of the game with a simple but captivating graphics is particularly relevant for Scent.





Figure 28 Screenshot of Energy City (courtesy of Ecogamer³¹).

SimCityEDU

URL: http://www.simcity.com/en_US/simcityedu

Publication date: from Electronic Arts and GlassLab, U.S.A., 2013

Short description from the Electronic Arts official website:

SimCityEDU will serve as a resource for classroom teachers who have a strong interest in utilizing digital platforms as a learning tool to drive student interest in STEM (Science, Technology, Engineering and Mathematics) subjects.

Educators will be able to create and share digital SimCity-based lesson plans that will encourage students to think critically about the challenges facing modern cities. In the classroom, SimCity will be more than a game – it will be a way for the next generation of leaders to hone their skills through urban planning, environmental management and socio-economic development (http://www.simcity.com/en_US/simcityedu).

Key characteristics:

³¹ <https://www.ecogamer.org/energy-consumption/135/>



- **Mechanics:** The player has to build and manage a city using the money at her disposal. She has to manage every single aspect of this city, like energy production, air pollution, satisfaction of the citizens, healthcare, security, traffic and more.
- **Story:** No complex storyline, the objective of the game is to create a city and make it prosper.
- **Aesthetics:** Graphics and animations are astonishing.
- **Technology:** managerial strategic game for Windows PC; server for multiplayer; complex AI for traffic, environment and events simulations.

Why we like it:

The player has to manage every single aspect of the lifestyle of their own city, trying to balance and handle them the best they can, making this game as real as possible. The management of areas such as education, security, transportation, urban planning, health, energy and environmental resources, pollution, etc., gives the player the feeling of complete control of the terrain.

Although this incredible quantity of details may turn away less experienced players, the game can still, through tutorials and instructions, make the player understand how to manage all these aspects of the game without discouraging her.

To further prove this point, the user interface available to the player is rich, but well structured and organized: this prevents the player from getting lost in all the options available waiting to be implemented in their city.

The game gives the player the freedom to choose their starting area, giving variation to the geography, environment, energy and structural features of the terrain. This allows the player to create each time a different city, possibly completely different from those already built, giving more replay value to the title.

The graphics are of the highest levels, as expected from games of this magnitude: the graphical details are impressive, and every aspect of the city, from the citizen to the many transportation vehicles, are well animated, and can be constantly monitored by the player, giving the player a living sense of realism in the city.

A game of this calibre focuses on the complete freedom of the player to build their “dream city”, and in order to make it so, there is no storyline, with the exception of the tutorial.

The game also offers the possibility to play in multiplayer, which means that multiple players can share a large area of the game and build there their city. This allows the players to check out each other’s city, and gives them the possibility to have economic trades with the neighbouring cities (feature also present in singleplayer mode, but handled by the computer).

To be able to handle all the features mentioned above, the game makes use of very complex algorithms in order to simulate events such as the urban traffic.

To increase the difficulty and make it more replayable, a good amount of achievements are present in the game, independent for each game mode.



Finally, to help the player have a greater control and a clearer idea on the state of their city, the player can continuously access statistics to monitor every aspect and event of the city.

Key takeaway in relation to SCENT activities:

This is a quite good example of a high-level simulation games, which is here examined in relation to some possible gamification and user interface ideas that can be replicated in the SCENT Explore, as to meet objective #8 of the project requirements.



Figure 29 Screenshot of SimCityEDU (courtesy of Slideshare.net³²).

Disaster Hero

URL: <http://www.disasterhero.com/>

Publication date: US Department of Homeland Security and the Federal Emergency Management Agency (FEMA), U.S.A, 2013

Short description:

This is an educational game for children and teenagers, in which the player wants to become a hero by enrolling in a hero academy. Here, to prove her worth, she will face the other 4 heroes and each of them will be related to a natural disaster like earthquake, tornado, hurricane and flood. When challenging these heroes, the player will learn many things about these disasters and how to

³² https://edshelf.com/wp-content/uploads/simcityedu_4_UI.jpg



be prepared to face them in times of need. The game also offers additional resources for parents or teacher to be helpful in education and learning at home and at school.

Key characteristics:

- **Mechanics:** The player is a hero and has to answer some questions related to a disaster chosen by the player against another hero (played by the computer). Also there are lots of other educational mini-games, like puzzles and logic games, which also teach about the disaster. There are also achievements and the player character is customizable (hair, dresses, etc.) with unlockable content.
- **Story:** There is a little storyline, which describes the organization that train the disaster heroes.
- **Aesthetics:** Graphics and animations are good and articulated in a comics-book style.
- **Technology:** Browser-based game

Why we like it:

The game itself appears to the player like a cartoon, with a initial cutscene and dialogue between characters: this introduces the story and at the same time entertains the player.

Given the target audience, the game mechanics are very interesting: the player has to play a multitude of minigames, and, as she solves them, the player can access to the next ones. This game play is appropriate, as children do have the necessity of something quick and intuitive, instead of a complex game, possibly too articulated for them.

The player has the freedom to choose to create an account, or if she does not wish to do so, the player can play as a guest. On the other hand, the game itself will inform that, as a guest, the player will not be able to save their progress, forcing her to start over each time. In order to make the game even more appealing, the player can create their own “hero”, who will then appear in the game and storyline. The mini-games will show a score, at the end of each of them, based on speed and skill of the player, and the achievements unlocked in the form of medals obtained throughout the mini-game.

Finally, to increase the desire to play Disaster Hero again, three difficulty levels are available, so that less experienced players can orient themselves, play and have fun, while more experienced player can engage in harder challenges.

Key takeaway in relation to SCENT activities:

This game demonstrates the need to follow some design principles that aim at creating fast-paced and quick-to-play games which are particularly suitable for a broad target audience of casual players (Scent objective #8). The animations present in this game are, in a certain way, an inspiration for Scent Explore (which adopts also AR); moreover, the reward system after achieving goals is also present in both Disaster hero and Explore.





Figure 30 Screenshot of Disaster Hero (courtesy of Npr³³).

BBC Climate Challenge

URL: http://www.bbc.co.uk/sn/hottopics/climatechange/climate_challenge/

Publication date: from Red Redemption Ltd, UK, 2007

Short description:

The player acts as the president of the European Union and as such, she will have to deal with climate change by issuing policies, grants and bans to limit the emissions of CO₂, without compromising the resources of the country such water, food, etc.

She will also need to be favoured by its citizens: if citizens disapprove the choices of the player, even if they are good for the environment health, they will go against the president and she will not be elected again, making the player lose the game.

Key characteristics:

- Mechanics: The goal of the player is to issue policies to reduce CO₂ to a certain level. To do so, the player has to create and collect resources (including economic) and invest these resources, while keeping an eye of the approval level from the citizens. Random events can affect how the game play unfolds.
- Story: There is no story, only the objective to win the game.
- Aesthetics: The graphics and animations are good, simple but effective.
- Technology: Strategy managerial turn-based browser game. Complex AI and algorithms.

³³ http://media.npr.org/assets/img/2013/01/29/disasterheroes_wide-87f7ba19e1b07e60c92f2d091376d205584ac2ed-s900-c85.jpg

Why we like it:

The peculiarity of this game is that the player represents a world authority like Europe and in order to manage an environmental problem such as air pollution, the player must identify himself/herself into a much larger reality, and manage and evaluate all aspects of the problem in place, bearing in mind the needs of the population (food, energy, etc.).

Many options are then presented to the player, but these are all well explained thanks to a graphical representation of the objective and the available resources. To further support this user experience, every action available to the player is shown as a card game: this is interesting because it contributes in making the gameplay easier to understand and gives the player the idea of having all the information needed in one card. The choices available to the player change every turn, as to not make the game repetitive.

Rather than a story, the game explains to the player the situation in the game, which is more than enough considering how simple and accessible the concept of the game is.

The graphical choice is very interesting: functional and at the same time refined (the combination of the colours, the contrast between the color and the black and white tones, an essential but firm trait).

To better identify oneself into the game, the player is required to create an avatar and a nickname, which will represent him/her during the course of the game, customizable with a range of preset models.

In addition, the player always has an idea on the state of the game thanks to a report at the end of every turn, which indicates the popularity rating of the player (in other words, how the game is going). This allows the player to better understand if he/she is going in the right direction, or if a change of approach is needed.

Key takeaway in relation to SCENT activities:

A good example of a clear and functional user interface, even though the typology of the game is quite different from what we imagine for SCENT. The User Interface is linked to Scent objective #8 considering the effort to engage citizens, which is a fundamental point for Scent Collaborate and Explore.





Figure 31 Screenshot of BBC Climate Change (courtesy of MakeUsOf³⁴).

Disaster Master

URL: <https://www.ready.gov/kids/games/data/dm-english/>

Publication date: from Ready, UK, unspecified date

Short description:

In this game, the player becomes part of a series of interactive graphic novels: while she is reading the story, she will have to make some decisions that affect the storyline. Whenever the player makes the right decision, she will earn points and energy that will be needed to continue the game. On the other hand, picking a wrong decision makes the player lose energy. The graphic novels offered to the player are related to a particular disaster (for example, wildfire, tornado, flood, etc.). As these novels are in a predetermined order, to unlock a specific novel the player has to play the other novels until she finds the one she is looking for.

³⁴ <http://cdn.makeuseof.com/wp-content/uploads/2010/08/Environmental-Games02.jpg?004f0d>



Key characteristics:

- **Mechanics:** The game is divided in chapters and every chapter refers to a particular disaster (for example, earthquake, tornado, wildfire, etc.). In every chapter the player, as the story goes on, has to answer a question and choose the correct option to gain points. In some cases, choosing the wrong question ends the game.
- **Story:** Every chapter is centred on a specific story; stories are easy to grasp and revolve around the prevention of various disasters.
- **Aesthetics:** The graphics are inspired to comics; the storyline is represented as a simple and colourful comic strip.
- **Technology:** Browser game.

Why we like it:

The way this game tells and teaches the player how to behave during problematic situations or natural disasters (floods, wildfires, etc.) is very interesting as, in these years, games are less and less often narrated in a comic book fashion way.

Very interesting is also the importance of some questions, which in some cases can lead to an early game over. This can be frustrating, but it is also there to teach that in some cases, during these disasters, a bad decision can be deadly, and the best way to make it understandable is to do it in a “shocking” way, by interrupting the story.

For each story, points are collected, which will indicate the skill of the player in correctly answering the questions.

Key takeaway in relation to SCENT activities:

In relation to the narrative dimension, this game represents the principle for which simple and easy to grab stories seem to be really adequate to casual gamers: SCENT Explore also addresses casual gamers and tries to achieve a good level of engagement through the simplicity of the story (Scent objective #8). Scent Explore does not contain a real story which goes through the entire game but the single characters do.



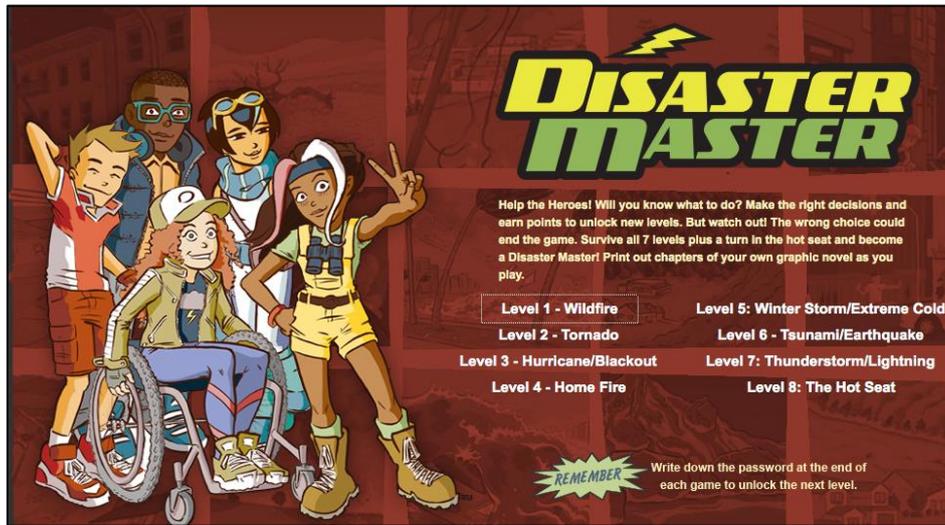


Figure 32 Screenshot of Disaster Master (courtesy of <http://cckids.weebly.com>³⁵).

River Basin Game

URL: <http://www.sciencedirect.com/science/article/pii/S0378377407002107>

URL video's example: https://www.youtube.com/watch?v=fjFa_NEXVlc&feature=youtu.be

Publication date: described in (Rajabu, 2007).

Short description from the authors:

This is the abstract of the article in which the game is presented:

The Rufiji river basin in Tanzania is faced with many conflicts over water use due to water scarcity problems at local levels. In order to get water users to understand and frame their own practices, problems and solutions, and to contextualise that within the wider basin, a practical dialogue and decision support tool, called river basin game (RBG) was designed. RBG was used as a participatory dialogue tool to engage stakeholders in Mkoji sub-catchment (MSC), Rufiji river basin in analysing key water resources issues, and the resulting impacts. RBG was played in MSC during three different workshops, each lasting 2 days. Whereas day 1 of the game was devoted in demonstrating and discussing various scenarios on water availability and water use that had occurred in MSC, day 2 involved various group discussions, plenary sessions and agreements on ways and strategies to improve water management and increase productivity of water. Results showed that at the end of the RBG workshops, participants' understanding of system dynamics, common-property pitfalls,

³⁵ http://cckids.weebly.com/uploads/2/0/0/2/20028855/3884569_orig.png



which issues are most critical and what solutions might be considered, was greatly enhanced. Participants learned and realised that being at the top of the river has advantages, whilst tail-end systems experience water shortages; community actions are better than individual strategies in ensuring equitable water allocation; local level water users' actions have basin-wide impacts such as environmental degradation and water scarcity to downstream areas; many solutions and strategies exist whereby crops can be grown using less water; and a sub-catchment committee is required to oversee water allocation and management. Tracer and impact studies have shown that the RBG triggered not only discussions on technical, institutional and socio-economic arrangements for equitable water allocation, but also behavioural change in the way people regard and use water (Rajabu, 2007, p. 63).

Key characteristics:

- **Mechanics:** Every player randomly chooses a land connected to the bridge. The players have to cooperate and find the best way to position their weirs to make all the lands be watered, according to the dimension of the land.
- **Story:** No added narrative layer.
- **Aesthetics:** Simple but effective.
- **Technology:** Board game, only cooperation between the players.

Why we like it:

We have been particularly impressed by the functionality and simplicity of this game in dealing with a current issue such as the management of water resources in some areas, especially in developing countries. This game teaches cooperation and discussion as a way to reach a common goal.

The random assignment of the terrain to the players allows them to expand their point of view and puts them in a new situation every time, making the game replayable.

Other than the description of the scenario and the purpose of the game, there is no story, as this probably would not be relevant and would slow down the game.

The simplicity of this game allows it to be played even with items and materials found at home, making it accessible to everyone who wants to try it.

Key takeaway in relation to SCENT activities:

In this game, a strong narrative layer is anchored to real locations and/or real life conditions thus providing further elements of interest for the gamers (Scent objective #8). The main linker between this game and SCENT activities is the setting: all Scent apps relates to real condition/environments, which is then superimposed also to fictional characters with the goal of further engaging the player.



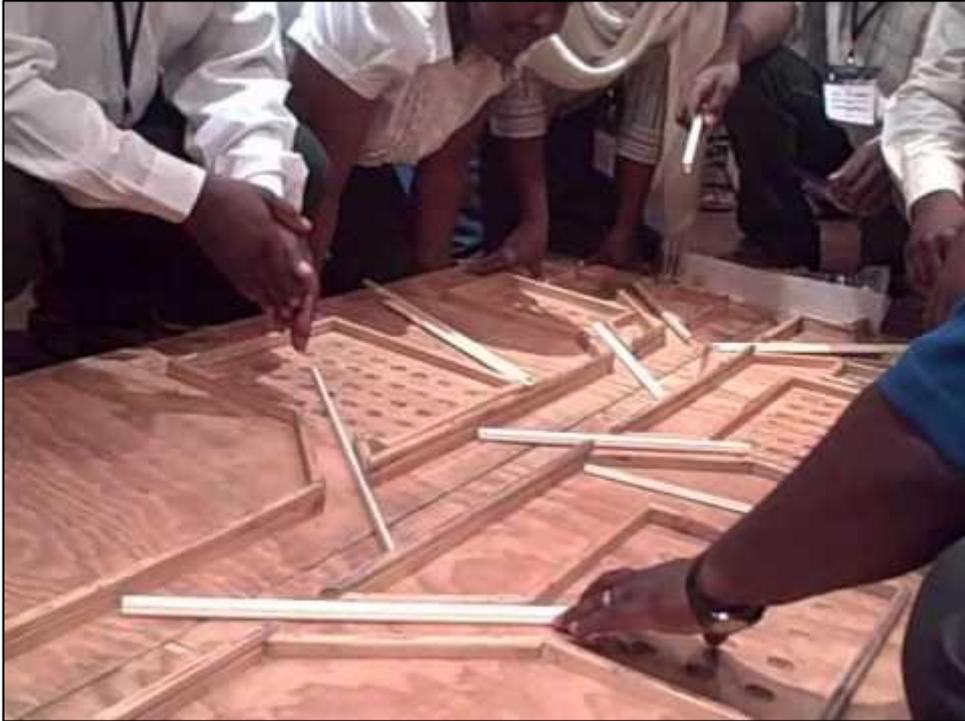


Figure 33 Screenshot of River Basin Game (courtesy of YouTube³⁶).

Abzû

URL: <http://www.abzugame.com>

Publication date: from Giant Squid Studios, USA, 2015

Short description from the official website:

Discover a lush hidden world as you descend into the heart of the ocean, where ancient secrets lie forgotten and encounters with majestic creatures await. ABZÛ is an epic descent into the depths of the sea, where players will explore beautifully rendered ocean environments with fluid swimming controls. The experience draws inspiration from the deep innate narrative that we all carry within our subconscious: the story of ABZÛ is a universal myth that resonates across cultures. The name references a concept from the oldest mythologies; it is the combination of the two ancient words AB, meaning ocean, and ZÛ, meaning to know. ABZÛ is the ocean of wisdom. (www.abzugame.com)

Key characteristics:

- **Mechanics:** The player has to swim and explore the vast sea which compose the game. To do that, he controls his character directly using the controller or the keyboard/mouse, telling him where to swim and how to interact directly with the environment (take a close look at

³⁶ https://i.ytimg.com/vi/fjFa_NEXVlc/hqdefault.jpg

fishes, activate some scene objects, etc.). Every interaction that the player can make is well indicated by the game and contributes to the journey of the player.

- Story: There is no narrative layer. The controls are very simple and essentials, so a tutorial is not required
- Aesthetics: The game offers an astonishing 3d sea world, with lots of well detailed fishes, a vast interactable environment and nice cinematics.
- Technology: PC/PS4/XBoxONE game, achievements system (both pc and console version), full support for controllers.

Why we like it:

The game has an incredible graphic quality and lots of fishes that gives the player the feeling of being under the sea, surrounded by water and fishes. This also gives the idea of a realistic environment, even if the graphic style is not extremely realistic, which will attract the younger players thanks to the detail of every single graphic element of the game. Lights and animations are also fantastic, adding quality and realism to a very big game that needs to be explored to see every detail of the sea.

The game revolves around exploring the sea and there is not an objective outside this: the player has no instructions beside swimming wherever he wants. This could be a flaw due to the fact that some players would prefer something new overtime but the real scope of the game is to make the player relax: in fact the player is not obligated to do something to progress the game because it is already at his disposal and he just need to journey without risking anything bad against his character.

Relax and easiness are the keys and the mechanics perfectly reflect that: the player has very few commands to control his character so there is no problem for the player to learn the game or learn again everything after a long period without playing this game. Also every possible interaction is well explained during the game so the player doesn't need to think at anything beside swimming.

This game is released on PC and consoles, widening a lot the possible buyers for this title. In the last 20 years consoles have spread a lot, mostly to there younger players, and lots of players today only use a console to play video games. Thanks to the achievement system present in the game (both PC and console), the player is more inclined to explore every corner of the sea to collect and unlock everything of the game.

Key takeaway in relation to SCENT activities:

This game represents an example of fast and direct mechanics that allow users to play also for few minutes; this is suitable for a wide variety of casual gamers (Scent objective #8). This game is a good example to follow on developing SCENT toolbox. Moreover, the very refined graphic is one of the key characteristics for Explore.



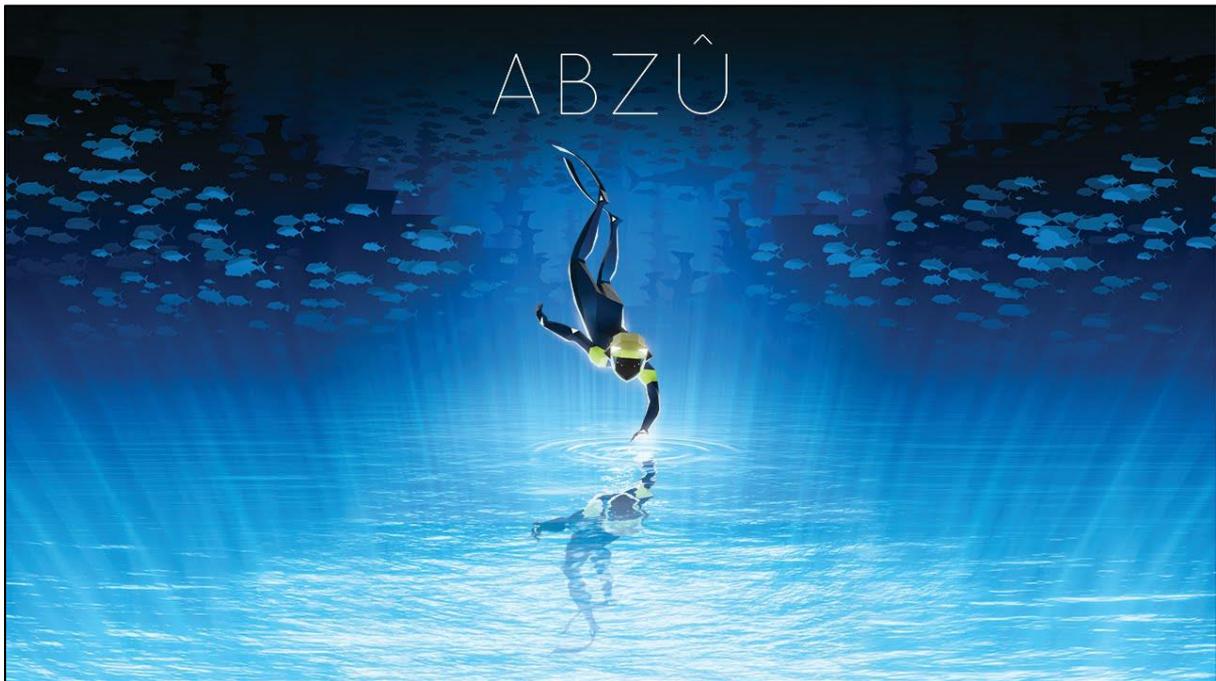


Figure 34 Screenshot of Abzû (courtesy of Abzugame.com³⁷)

Subnautica

URL: <https://unknownworlds.com/subnautica/>

Publication date: from Unknown Worlds Entertainment, USA, 2014

Short description:

Subnautica is an open world survival game set in a near future where humanity travels space to explore new worlds. The player plays as a scuba diving exploring an alien aquatic planet after that his spaceship “Aurora” crashed on it. In this game the player has to survive in the surrounding environment, which is extremely dangerous, by collecting resources, building a refuge to live in and manage the reserve of oxygen until been rescued by a rescue spaceship.

Key characteristics:

- **Mechanics:** The player has to manage the resources in an appropriate way to survive, build a base to protect from other creatures and the surrounding environment and collect the materials he need to explore his surroundings.
- **Story:** The story is essentially built to dive the player in the game atmosphere and introduce him the exploration of the aquatic planet (called 4546b), the game revolves around surviving and all the game evolution is related to the choices of the player.

³⁷ <http://www.abzugame.com>

- Aesthetics: The graphic is 3D and the design of the various aquatic elements, (like plants, creatures, seabed, et.) is very well represented. The technological structures on the other hand are more plain and basic in comparison to the graphic quality of the environment.
- Technology: Open World Survival Game for PC/Mac/Xbox One, single player game, with algorithms to manage the aquatic world, creatures and resources.

Why we like it:

Subnautica is a survival game and very easy to grasp: the player has to survive until the rescue arrival, but the game is structured to be fun and dynamic.

Basically, it is an open world game, so it is possible to play it in different ways every time and the game evolves with the player choices: which food to eat, where to build refuges, the danger of the creatures the player can find, etc.

This implicate a constant exploration of the environment to understand the best strategy, convert resources found in food, oxygen or tools that can help the player to survive. All the game structure is very complex and at the same time very interesting: it is possible to understand the ecosystem and locate the equilibrium of the underwater life by observing the changes caused by external agents (in this case, the player).

The interesting side is this educative aspect, because even if the game is set in an alien planet, the game makes the player reflect on various aspects that have rather significant even here on earth: to monitor the changes that could occur in an environment influenced by man, the high consumption of natural resources and how to survive making use of these natural resources given by the environment in an eco-friendly way, without depleting them to survive in the environment we are in.

Key takeaway in relation to SCENT activities:

Yet another example of storylines that are simple and easy to grasp and do not require considerable previous experience with gaming in order to be appreciated thus leading to a wider engagement potential (Scent objective #8).

Although the setting of the game is another planet, this is in a certain way linked to Scent Explore characters, where the player is surrounded both by real environment and a fictional animal world.





Figure 35 Screenshot of Subnautica (courtesy of Unknown Worlds Entertainment³⁸)

³⁸ <https://unknownworlds.com/subnautica/>



6 Key learning points

In this section, we extract some key learning points from the 28 games analysed in the previous pages³⁹.

These elements seem to work particularly well:

- A. Cross-platform games, such as HTML5-based games that can be played on various devices: laptops, desktop computers, tablets and smartphones. This browser-based distribution strategy gives the players the greatest flexibility in terms of accessing and playing the game. Among others, games that employ this strategy are EyeWire and Picture Pile.
- B. Games that do not necessarily force the users to register. In some cases, to play a videogame a preliminary user registration is required. In some other cases, the videogames also offer the possibility to play without any registration (e.g., following what can be termed as ‘guest mode’). As it also emerged from the surveys and the focus groups in WP1, some users do not want to register and provide their personal data to play the game. It is important to give to these users the possibility to play with the Scent applications in guest mode. A similar strategy is used, for example, by the game Catchment Detox. As an alternative, registration can be based upon existing accounts on other social media platform (e.g., Facebook, Twitter, Google+, etc.). This strategy - adopted, for example, by EyeWire and Plan it Green Game - streamlines the registration process.
- C. Bidimensional graphics, simple but still curated and polished, seem to be more suitable for cross-platform design and development strategies. A basic but effective graphics can contribute to the playability and enjoyment of the game (e.g., The President for a day: floodings, The Playful Danube). 3D elements can be used, but with flat rendering so as not to require high processing power from devices such as smartphones and tablets. Examples of games that follow this strategy are Pokemon Go! and Disaster Hero.
- D. In some games, the educational aspect overshadows the gamification dynamics (e.g., Awqa Water). To secure players engagement, it is important to carefully balance the education aspect with solid game mechanics.
- E. In some cases, games were offering real rewards (like smartphone or other goodies) to help the players engagement (e.g., Picture Pile). This is, of course, a strategy that requires some economic resources to be invested to buy and offer the rewards.
- F. Interactions among players is a key element to support challenges, rewards and the players’ overall level of engagement. Seeing how the other players are scoring (e.g. through the use of leaderboards, like in Foldit, Cerberus Game) can be a powerful motivational factor. In some exceptional circumstances, the user interface of the game is designed in a way that lets the player see the other players’ contributions in real time (e.g., SimCity, EyeWire, Plan it Green Game). In some other cases, the interaction among players also allows them to

³⁹ A comprehensive table summarizing these key learning points can be found in Appendix 2.



- create their own teams and groups and exchange goodies (e.g., graphics, sounds, assets, tips, etc.), like in the case of Plan it Green Game.
- G. In terms of gameplay, fast and straightforward game mechanics that allow to play also for just few minutes seem to be particularly suitable for a public of casual gamers (one of the target audiences of Scnt, for exemple, Abzû). Examples of games with a potentially short game play are Flood runner: Armageddon and Sai Fah: the flood fighters. A quite similar strategy to design fast-paced and quick-to-play games structures the overall game mechanics around a series of mini-games included in the main game. These mini-games make the overall gameplay more dynamic, fun and diverse (e.g., Disaster Hero; Plan it Green Game)
 - H. The presence of a thorough tutorial helps players understanding the game in a quick and easier way (e.g., Picture Pile, Eye Wire)
 - I. In relation to the narrative dimension, stories that are simple, predetermined and easy to grasp seem to be particularly suitable for casual games (e.g., Disaster Master; Run the river, Subnautica). In some cases, the main story is anchored to a real location and/or real life conditions (e.g., River Basin Game).
 - J. In some apps, the operation of data collection is very fast, and, thanks to geolocation, the error margin is reduced (e.g., mPing App, Lake Observer App). Some apps allow the creation of a database that stores data and creates statistics based on the collected data (e.g., Lake Observer App)

These are all key learning points that we will take into consideration when designing the apps for Scnt. Following the examples of games such as Game of Floods, FloodSim and Sai Fah: the flood fighter, we are very interested in developing a gameplay that can stimulate participatory dialogue and discussions in our users and, potentially, also used in schools for educational purposes.



7 Conclusions

This document described the process carried out by XTeam to select and analyse some best practices in serious games.

The document started by introducing some key conceptual terms related to gamification and serious games provided by various academic scholars and professionals working in the game industry. The various elements behind a game were also illustrated: mechanics (incentives, goals, change of levels, points, badges, etc.), story, aesthetics and technology.

These elements were then used to analyse a selection of 28 games, mostly digital serious games (but we also have some leisure games and a board game). The analysis of these games provided some key learning points that will be considered while designing and developing the Scent applications.



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Appendix 1 - Complete list of games and apps analyzed during T2.3

Name	URL
1. Picture Pile	http://geo-wiki.org/games/picturepile
2. Eye Wire	http://eyewire.org/explore
3. Foldit	https://fold.it/portal/
4. Cerberus Game	http://www.cerberusgame.com/index.php
5. Google Image Labeler	https://get.google.com/crowdsource/imagelabeler/category
6. Lake Observer App	www.lakeobserver.org
7. Stop Disasters!	http://www.stopdisastersgame.org/
8. Game of Floods	http://www.marincounty.org/depts/cd/divisions/planning/sea-level-rise/game-of-floods
9. Flood Sim	http://playgen.com/
10. Sai Fah: the flood fighter	http://www.floodfighterthegame.com/
11. Pokemon Go!	http://www.pokemongo.com/
12. SchaVis	www.secom20.eu/game-based-learning/flood-games-examples
13. mPING App	http://www.nssl.noaa.gov/projects/ping/
14. The Playful Danube	http://playdanube.at
15. Awqa Water	http://alms.ca/wp-content/uploads/2013/09/AWQA-Game.swf



16. Run the river	https://itunes.apple.com/au/app/run-the-river/id826169995?mt=8
17. Flood Runner: the Armageddon	http://armorgames.com/play/11131/flood-runner-armageddon
18. A President for a day: floodings	https://school.seriousgames.net/flooding/
19. Catchment Detox	http://www.abc.net.au/science/catchmentdetox/files/play-game.htm
20. Plan it Green Game: the big switch	http://www.planitgreenlive.com/en
21. Energy City	http://content3.jason.org/resource_content/content/digitalab/8250/misc_content/public/popup.html
22. SimCityEDU	http://www.simcity.com/en_US/simcityedu
23. Disaster Hero	http://www.disasterhero.com/
24. BBC Climate Challenge	http://www.bbc.co.uk/sn/hottopics/climatechange/climate_challenge/
25. Disaster Master	https://www.ready.gov/kids/games/data/dm-english/
26. River Basin Game	http://www.sciencedirect.com/science/article/pii/S0378377407002107
27. Aqua Republica	http://aquarepublica.com/
28. The Lost Ring	http://work.akqa.com/thelostring/
29. Lords of the valley	https://lordsofthevalley.games4sustainability.com/
30. Flood-Wise	http://floodwise.nl/results/the-game/



31. Recycle City	https://www3.epa.gov/recyclecity
32. World of Warcraft	http://worldofwarcraft.com
33. Web Earth Online	http://www.webearthonline.com/
34. Beat the Quake!	http://www.dropcoverholdon.org/beatthequake/game/?beatthequake/game
35. Fate of the world	http://store.steampowered.com/app/80200/
36. Flood Control-Flood Ranger	http://www.discoverysoftware.co.uk/FloodRanger.htm
37. Clim'way	http://climway.cap-sciences.net/us/index.php
38. Flood resilience Game	http://floodresilience.games4sustainability.org/
39. Earth Day Games	http://www.primarygames.com/holidays/earth_day/games.php
40. Crossroad Village	http://gel.msu.edu/crossroadsvillage/
41. Water-Energy Nexus Game	https://crs.org.pl/en/games/
42. The Arcade Wire: Oil God	http://persuasivegames.com/games/game.aspx?game=arcadewireoil
43. Minecraft	https://minecraft.net/it-it/
44. WideNoise	http://cs.everyaware.eu/event/widenoise/
45. OCFL Alert	http://www.macobserver.com/tmo/article/in-case-of-emergency-free-ios-apps-youll-want-to-have
46. Fix my Street	https://play.google.com/store/apps/details?id=or



	g.mysociety.FixMyStreet&h
47. SafeCity	http://www.fairobserver.com/region/central_south_asia/is-there-a-role-for-citizens-in-indias-smart-cities-challenge-01191
48. Clean India	http://www.fairobserver.com/region/central_south_asia/is-there-a-role-for-citizens-in-indias-smart-cities-challenge-01191/
49. The Satcam App	http://nasawavelength.org/blog/exploring-earth-citizen-science-observing-our-home-planet
50. Beach Observer	http://www.coastalandoceans.com/Core-Services/Education/
51. Noise Tube	http://www.scientificamerican.com/article/8-apps-that-turn-citizens-into-scientists/
52. Disaster Detector	http://www.gamesforchange.org/play/disaster-detector/
53. Marin Debris Tracker	http://www.scientificamerican.com/article/8-apps-that-turn-citizens-into-scientists/
54. What's Invasive	http://www.scientificamerican.com/article/8-apps-that-turn-citizens-into-scientists/
55. SECCHI	http://www.scientificamerican.com/article/8-apps-that-turn-citizens-into-scientists/
56. The GCSOTips	http://gcso-tips.appstor.io/
57. Mission H2O	http://www.stormwaterwa.asn.au/news/49-mission-h2o-game
58. Flood Manager	http://playgen.com/play/floodmanager/
59. Simulation: inside the Haiti Eartquake	http://insidedisaster.com/haiti/experience



60. Bioharmonious	http://www.gamesforchange.org/play/bioharmonious/
61. Climate Defense	http://www.gamesforchange.org/play/climate-defense/
62. The ESP Game	https://web.archive.org/web/20090106145854/http://espgame.org/
63. Old Weather	https://www.oldweather.org/
64. The Flame in the Flood	http://store.steampowered.com/app/318600/?
65. Citizen Science	http://www.gamesforchange.org/play/citizen-science/
66. My 2050	http://my2050.decc.gov.uk/
67. Loss of the night	http://www.scientificamerican.com/article/8-apps-that-turn-citizens-into-scientists/
68. Project NOAH	http://www.scientificamerican.com/article/8-apps-that-turn-citizens-into-scientists/
69. Electro City	http://www.electrocity.co.nz/
70. Global Calculator	http://uncached-site.globalcalculator.org/
71. Florima	http://www.floodsite.net/juniorfloodsite/html/en/teacher/thingstodo/games/florima.html
72. Extreme Event Game: coastal city	https://www.koshland-science-museum.org/explore-the-science/extreme-event/game-setup
73. Energy Hog	http://www.energyhog.org/childrens.htm
74. Earth Girl Game	http://earthgirlgame.com/earth-girl.php
75. Young Meteorologist Program: Severe	http://www.gamesforchange.org/play/young-



Weather Preparedness Adventure	meteorologist-program/
76. Energy Transition Game	http://energytransition.games4sustainability.org/en/home-2/
77. McDonald’s Video Game	http://www.mcvideogame.com/index.html
78. Sustainable Delta	https://www.deltares.nl/en/software/sustainable-delta-game/
79. Evacuation Challenge Game	http://www.games4sustainability.org/gamepedia/evacuation-challenge-game/
80. Never Alone	http://neveralongame.com/
81. Climate Health Impact	http://playgen.com/play/climate-health-impact/
82. Climate Game	http://www.games4sustainability.org/gamepedia/climate-game/
83. Simpachamama	http://www.inesad.edu.bo/simpachamama/what-is-simpachamama/
84. Marine Spatial Planning Challenge 2050	http://www.mspchallenge.info/msp-challenge-2050-2013.html
85. Hurricane Strike!	https://www.meted.ucar.edu/training_module.php?id=31#.WLWHNzvDIU
86. Disaster Dynamics: Hurricane Landfall	http://www.dd.ucar.edu/
87. Be a Hero...Build a kit!	https://www.ready.gov/kids/games/data/bak-english/index.html
88. The Supervolcano Game	http://www.bbc.co.uk/sn/tvradio/programmes/supervolcano/game.shtml
89. Phone Story	http://www.phonestory.org/index.html
90. Flood Control Game	http://www.floodcom.nl/en/#/services



91. My Sust House Game	http://www.mysusthouse.org/game.html
92. Dissolving Disasters	http://climatecentre.org/resources-games/dissolving-disasters
93. Can you keep the earth in balance?	http://channel.nationalgeographic.com/channel/content/earth-the-biography/interactive/main.html
94. Green & Great	https://greenandgreat.games4sustainability.com/
95. 3RD World Farmer	http://3rdworldfarmer.com/
96. World without oil	http://writerguy.com/wwo/metahome.htm
97. Planet Science	http://www.planet-science.com/
98. Treme-Treme	http://www.earth-prints.org/handle/2122/9655
99. Rangeland Rummy	http://www.sciencedirect.com/science/article/pii/S0301479714004320
100. Si viaggiare App	https://www.onepetro.org/conference-paper/SPE-168440-MS
101. Second Life	http://www.emeraldinsight.com/doi/pdfplus/10.1108/IJDRBE-08-2013-0032
102. The Beer Game	http://enviroinfo.eu/sites/default/files/pdfs/vol104/0743.pdf
103. The Shortfall Online	https://www.researchgate.net/publication/253579012_Shortfall_online_The_development_of_an_educational_computer_game_for_teaching_sustainable_engineering_to_Millennial_Generation_students
104. Risk-Rewards	http://www.annualreviews.org/doi/full/10.1146/annurev-environ-030713-154609 https://volunteerscience.com/experiments/



105. Africa as Technology Creator	https://www.witpress.com/elibrary/wit-transactions-on-ecology-and-the-environment/56/1109 www.witpress.com/Secure/elibrary/papers/WMO2/WMO2077FU.pdf
106. Legend of Zelda-Ocarina of time	https://www.researchgate.net/profile/Tom_Satwicz/publication/268359607_In-Game_In-Room_In-World_Reconnecting_Video_Game_Play_to_the_Rest_of_Kids'_Lives/links/54b9947f0cf24e50e93dc84a.pdf
107. Fish Game	http://cloudinstitute.org/fish-game/
108. My Town 2	http://www.my-town.com/
109. Abzû	http://www.abzugame.com
110. Subnautica	https://unknownworlds.com/subnautica/
111. Beyond Good and Evil	https://www.ubisoft.com/en-US/game/beyond-good-and-evil-hd/
112. Firewatch	http://www.firewatchgame.com/
113. Dear Esther	http://dear-esther.com/
114. The Vanishing of Ethan Carter	http://ethancartergame.com/
115. Alan Wake	http://www.alanwake.com/alan-wake.html



Appendix 2 - Table of key learning points emerging from the analysis of the games

Key Learning Points	Games
Cross-platform games like for example HTML5-based games; offering real rewards (like smartphone or other goodies) help the engagement of the game by the players; The presence of a thorough tutorial helps players understanding the game in a quick and easier way.	Picture Pile
Cross-platform games like for example HTML5-based games; Registration can be based upon existing accounts; The presence of a thorough tutorial helps players understanding the game in a quick and easier way; A motivational factor can be a user interface where the player can see the other players' contributions in real time.	Eye Wire
Interactions among players is a key element to support challenges, rewards and overall engagement.	Foldit
Interactions among players is a key element to support challenges, rewards and overall engagement.	Cerberus Game
In some apps, data collecting is very fast, and thanks to geolocation, the error margin is reduced; Some apps allow the creation of a database that stores data and creates statistics based on the collected data.	Lake Observer App
Story: simple, predetermined, easy to grasp; Game play that can be used in schools for educational purposes.	Stop Disasters!
Game play can stimulate participatory dialogue and discussion; Game play that can be used in schools for educational purposes.	Game of Floods
Game play can stimulate participatory dialogue and discussion; Game play that can be used in schools for educational purposes.	FloodSim



Fast and straightforward game mechanics. Short game play. I can play also for just few minutes; Game play that can be used in schools for educational purposes.	Sai Fah: The Flood Fighter; Abzû
2D graphics, simple but polished, because more suitable for cross-platform strategies. In some cases, 3D elements can be used, but with flat rendering.	Pokemon Go!
A serious game without a good game mechanic can be less entertaining or bore the players.	SchaVis
In some apps, data collecting is very fast, and thanks to geolocation, the error margin is reduced.	mPING App
A basic but effective graphics can contribute to the playability and enjoyment of the game; Game play that can be used in schools for educational purposes.	The Playful Danube
In some games, the educational aspect overshadows the gamification dynamics. Game mechanics are poorly or superficially applied and the result is that the games are not fun to play.	Awqa Water
In some games there are some scenarios within small stories and objectives to be achieved.	Run the river
Fast and straightforward game mechanics. Short game play. I can play also for just few minutes.	Flood Runner: Armageddon
A basic but effective graphics can contribute to the playability and enjoyment of the game; Using complex algorithms and AI, to give a higher yield of the game: variety of strategies and inclusion of randomness and unpredictability.	The President for a day: floodings
Games that do not necessarily ask the users to register.	Catchment Detox
Registration can be based upon existing accounts; A motivational factor can be a user interface where the player can see the other players' contributions in real time; Creation of a community for players, where players create networks and exchange data (e.g., graphics, sounds, assets, tips, etc.) between them; Adding mini-games in the game, to make it more dynamic, fun and diverse.	Plan It Green Game: the big switch
Using complex algorithms and AI, to give a higher yield of the game: variety of strategies and inclusion of randomness and	Energy City



unpredictability.	
Interactions among players is a key element to support challenges, rewards and overall engagement; A motivational factor can be a user interface where the player can see the other players' contributions in real time.	SimCityEDU
2D graphics, simple but polished, because more suitable for cross-platform strategies. In some cases, 3D elements can be used, but with flat rendering; Adding mini-games in the game, to make it more dynamic, fun and diverse.	Disaster Hero
Using complex algorithms and AI, to give a higher yield of the game: variety of strategies and inclusion of randomness and unpredictability.	BBC Climate Challenge
Story: simple, predetermined, easy to grasp.	Disaster Master; Subnautica
Realism vs. simulations. Realism in the narrative layer: gameplay anchored to a real location and/or real life conditions.	River Basin Game

