CSCM10: Report - Gamification

Andrew Gray

445348

Submitted to Swansea University in fulfilment
of the requirements for the Degree of Master of Science

Department of Computer Science

Swansea University

17/02/2020

Abstract

As part of the module for CSCM10, we need to create a report that explains a subcategory of our masters' dissertation. In this report, we will look at how gamification creates the desire to keep the user engaged as well as reinforcing any potential learning taking place, through motivation techniques and incentives.

We will, in this report, be exploring the background of gamification, as well as how the science of gamification works, and practices currently used. In this report, we will also reflect on how to take a scientific topic, for example, Machine Learning (ML), and ways of applying gamification practices to them. While also taking into account the additional aspect of integrating gamification within education and teaching.

Contents

AI Artificial Intelligence

CHI Computer-Human Interaction

GRN Gamification Research Network

ML Machine Learning

Chapter 1

Introduction

This report aims to research the concept of gamification. Exploring what it is, by exploring its background and history, how education uses gamification, as well as how it aids fundamental teaching concepts. Also, focusing on how gamification, within a science context, has been applied. With the aim of the findings creating a foundation for the author's masters dissertation.

1.1 Project Description

The masters' thesis will be about creating a game about ML. Through using multiple libraries within Python, which helps to develop ML programs through such libraries as SciKit Learn, and by using Pygame, which helps develop game-like features while using Python, rather than the more traditional languages, such as C or C++. The aim will be to create a program that will allow players to interact with and, through playing, learn the mechanics of ML.

The main aim of the game will be to teach ML concepts, while at the heart of the program, applying ML to the program to create the core game. For example, the player will have to plot data points onto a game area of pre-populated data points. The player will then have to plot where they think the decision boundary is for that model. Once the player places where they think the boundary is, the model will score how accurate they were, rewarding a score depending on their accuracy. Therefore, in order for the player to do well within the game, they will have to know how the different ML models work. Areas within the game will explain the different models, allowing the player to understand the fundamentals of the model, with additional features outside of the game to help them learn more about ML.

1.2 Motivations

In the age of big data, ML and Artificial Intelligence (AI) have become a big part of peoples every day lives. "It is predicted that by 2025, the global AI market is expected to be almost $60 billion; in 2016, it was just $1.4 billion. Another research says that AI bots will drive up to $33 trillion of annual economic growth and also power 85% of customer service interactions by 2020 [1]." However, many people perceive ML to be a black box, a form of sophisticated computer magic. Nevertheless, ML is a complex technique to master; the underlining factors of ML are relatively simple, to a degree.

With the intentions to try and debunk this myth and misconceptions around AI and ML, creating a tool that can help educate people into the concepts of ML would be a valuable commodity. "Despite popular opinions, games promote learning and discourage negative behaviours. One study illustrates that regular gameplay improved mental health as well as cognitive and social skills [2]." With this in mind, creating a teaching and learning tool that incorporates gamification features would not only bring a source of enjoyment to people and players but also create interactive ways to keep the user engaged. In turn, aiming to help change the concept of ML from being an unknown black box into a well understood and embraced tool.

1.2.1 Objective

In this report, we explore what gamification is, what it consists of, and how it can aid and reinforce the teaching and learning. We will also explore techniques and features used within gamification that will aim to keep the product engaging as well as incentivise the user to return.

Chapter 2

Background into Gamification

2.1 History of Gamification

Gamification is known as a powerful tool for engagement, which has, since its initial conception, now become a standard feature within software development [3]. The term gamification first appeared in the context of software design in 2008 [4], but the term only started to get more widespread recognition within 2010. However, the term "gamification" was first coined by Nick Pelling in 2002 [3]. Its initial aim was to incorporate the social and reward features of games into the software. Gamification started to gain much attention, so much so that it got described by a venture capitalist as one of the most promising areas of gaming [5].

Researchers consider gamification to be the progression of earlier work that focuses on adopting game-design elements to non-game situations and contexts. Research in the human-computer interaction field that uses game-driven elements for motivation and interface design suggests that there is a connection between Soviet concepts of socialist competition and the American management trend of "fun at work" [5].

In 2010, Jane McGonigal delivered a groundbreaking TED Talk titled, "Gaming Can Make a Better World' [6]. This talk is considered the defining moment in the history of gamification. Within the talk, she prophesies a game based paradise. Where she states that "When I look forward to the next decade, I know two things for sure: that we can make any future we can imagine, and we can play any games we want, so I say: Let the world-changing games begin [6]." Hindsight informs she was right, as, from 2011, gamification starts to pick up steam. During this year, at a Computer-Human Interaction (CHI) conference, a workshop titled "Gamification: Using Game Design Elements in Non-Gaming Contexts [7]", which spawned

the Gamification Research Network (GRN) [11]. Through the years 2012 to 2016, gamification continues to grow. Even so, that gamification goes viral without people knowing through a game called Pokémon Go. Pokémon Go is one of the most successful applications of gamification with over 800 million downloads. People who would usually turn their nose up at badge collecting were out patrolling the streets searching for rare pokemon. Pokémon Go is one of the most successful apps of all time. It even broke records [3, 8]. It could be said thanks to Pokémon Go, that gamification is everywhere.

Many established technology and other companies, including SAP AG, Microsoft, IBM, SAP, LiveOps, Deloitte, and other companies have started using gamification in various applications and processes [9].

The increased popularity in gamification, within some contexts, has had led to many legal restrictions be placed upon it. However, this mainly refers to the use of virtual currencies and assets, as well as data privacy, data protection and labour laws. These laws are due to its nature of being a data mining systems that spread information online, known as data aggregator [10, 11].

2.2 The Science of Gamification

Games are fun, and there is no denying that whether it is playing more traditional video games, mobile games or a recent phenomenon McDonalds Monopoly. The games industry is work an estimated \$2.3 trillion, showing that the global entertainment and media business is massive everywhere [12]. There is a reason behind this, as games made are crafted with the human brain in mind. From each roll of the dice, getting the correct combination, to defeating an opponent and enemy, to building a new settlement, each action rewards the brain, and its reward centre lights up [13].

By incorporating aspects from games like points, levels and progression bars into non-game situations, we can recreate the experience of gaming. Having these elements within a product, to interact with the user, is why gamification is so powerful.

Games ranging from Super Mario Bros. to Monopoly have a real impact on brains and the way we learn. These impacts on are brain are due to dopamine. Dopamine is a neurotransmitter within a person's brain that is triggered within a person whenever we do something positive or when a person feels that they have achieved something [14]. In essence, dopamine is a natural drug that makes people feel good [13]. This drug, dopamine, is an integral part of our learning through reinforcement learning. As Nestler Lab explains, "activation of the pathway

tells the individual to repeat what it just did to get that reward [13, 15]." We do something well, and we get a sense of reward from our brains which leads us to do it again. Hence why we as humans tend to feel good when we are learning something; however, it is not very easy to stay motivated while learning as the learning requirements increases. At this stage is where gamification shines and can help keep the user/learner motivated with a little boost along the way. The motivation, the critical factor gamification tries to manipulate, is triggered by the sense of success. Which leads onto more willingness and desire to do something, this can be achieved by not only rewarding the final goal but by also releasing small amounts of dopamine as we are edging closer to a goal. Allowing a user to know if they are nearing a milestone can be achieved by using progress bars. Each sub-goal completed fills up the bar giving instant gratification, with small hits of satisfaction and dopamine, on the build-up to meeting the primary goal and that massive hit of dopamine, therefore creating that motivation to keep going. This situation becomes superseded only when an unexpected gratification situation occurs, releasing even more dopamine.

While motivation is at the centre of gamification, our enthusiasm comes from three main areas: Autonomy; Value; Competence [16]. If someone is in charge of their destiny, they are more motivated to succeed. Allowing the person more control will mean that they will work harder towards objectives, especially for a more extended period, when given the opportunity and authority to select their direction when solving a problem. This aspect is giving them autonomy. The second principal area value is about the person feeling value to an activity or action. If the person feels that there is self-worth to the activity, then they will increase interest in the activity and increase their motivation levels. Research states that a positive correlation occurs when a student values a subject at school and their willingness to investigate a question. If the person cares, they will keep going and work harder until the task gets completed [12, 16]. Finally, the third area is competence. If a person develops a certain degree of proficiency at something, they are more likely to keep doing it. Another study has shown that there is a link between a student's sense of mastery and their desire to continue certain activities. Those who give credit to natural talent rather than hard work will more likely give up more quickly.

Gamification aims to take advantage of our extrinsic motivations, factors like final grades or money, and intrinsic motivation, traits like personal gains or enjoyment, to try and enhance our daily activities or tasks. Therefore, in order for the gamification to be most effective, then both these motivation factors need to be accounted for within the task. In order for the person to feel good about oneself, a form of reward has to exist [12].
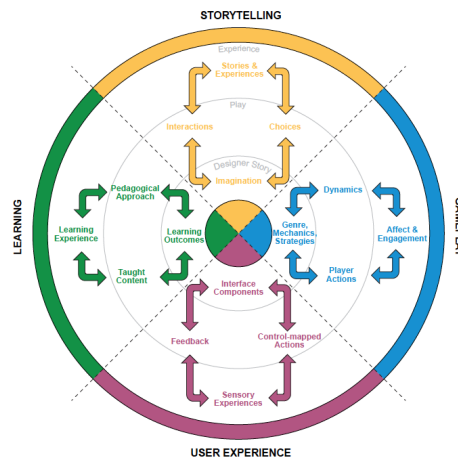
Figure 2.1: Serious game design methodology [21]

2.3 Gamification in Science

Although science concepts still use more conventional styles of gamification. Science concepts will often use a type of gamification game that has a primary purpose, which is other than just for pure fun, called a 'serious' or 'applied' game. These types of games get utilised by industries like scientific exploration, education, health care, defence, emergency management, city planning, engineering and politics [17]. Although not all do, serious games tend to share aspects closely tied with simulational games. However, all serious games still have other gamification features included (see fig: 2.1).

Nonetheless, in regards to the field of science, serious games' role is to include crucial activities for scientists. These include outreach, teaching and research. With serious games on the increase, an emerging sub-genre is called citizen science games (CSGs) [18]. CSGs enables the user to produce as well as, or instead, analyse data for scientific use. Some examples of CSGs are GalaxyZoo, Foldit and HiRE-RNA [19, 20]

Studies suggest that there are ten main rules for serious games to follow. These are [18]:

1. Define a serious goal - we must first define the purpose of the game at the beginning of its development. Is its purpose for science, outreach, teaching or a combination of all three?

2. Get the balance between entertainment and serious tasks - the game design should be implemented as a function of the objectives of the game. Therefore equilibrium and compromise need to be found between scientific accuracy and player accessibility.

3. Allow the player to interact with the scientific data - players interest increases if they can interact with the science data, enriching the learning experience. The ability for players to generate data also creates another perspective for the player, increasing interaction.

4. Promote onboarding and engagement - Expectations of players are varied. Therefore the reward system needs to be versatile. Ideally, the entry-level should be low and the difficulty altered to each player.

5. Manage Information Flow - How the information to the play gets received will impact their behaviour, either positively or negatively. So if the focusing is on the outcome, this could influence the results.

6. Provide an appropriate narrative - This is important for all games, but also crucial for serious games. The narrative should give the player context to the game, allowing them to know what to do.

7. Adapt the level design - Depending on the objective, variation on level designs needs implementing. These can include duration, tasks and difficulty.

8. Develop good graphics that are not just pleasing on the eye - High-quality graphics increase the player's immersion into the game.

9. Use all modalities, especially sound - Using just a visual channel can overload the player. Therefore it is vital to take the load of the player's vision and use several different channels — for example, sound.

10. Iteratively assess what works and what does not - However, it is vital to take into account three different perspectives for serious games. The developer, the player and the scientist as they all have different views on what they believe the game needs adapting based on their desires.

2.4 Gamification in Education

The gamification of learning is an educational approach to motivate students to learn by using game elements in a learning environment [22]. Which is very much the same thing as gamification in general, but more of a focus on learning. However, gamification in learning has two main views within academia. One that categories gamification of learning as learning,
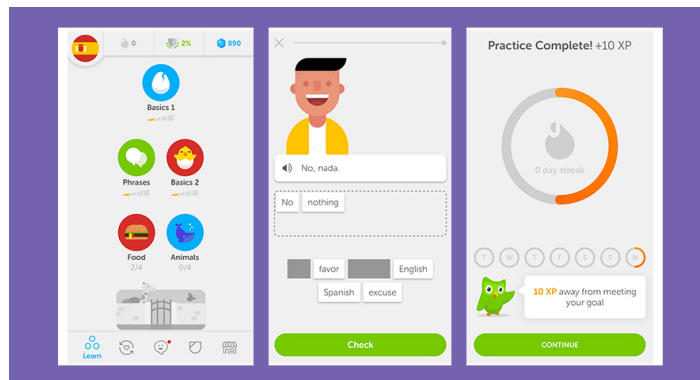
Figure 2.2: Example of gamification in action [23]

with game-like features, but only when learning is happening in a non-game context, like a classroom. This version would involve a range of elements that get presented in a system, or game layer, which aims to happen in parallel to the learning in a regular classroom. At the same time, the other half includes games that have been designed to induced learning within them [22] (see fig: 2.2).

Gamification within an educational or learning situation has multiple benefits. It is not just about trying to improve attendance with incentives by reaching a particular score, or extra rewards for completing specific tasks within a lesson. It can aid in cognitive development in adolescents, increase levels of engagement and can aid with accessibility within the classroom [24]. Games produced for enhancing cognitive development are known as "brain games" [24]. These popular games typically are centred around a series of questions and problems for the player to solve or answer. These games improve the rate the player can maintain information and increase the brain's ability to process information. The levels of engagement increase, when gamification has been used, within a classroom. A study was performed by scientists, which aimed to measure students levels of engagement in a classroom where gamification elements where are used [25]. They assigned a point system to multiple daily activities. Each student had a measurement of the perceived level of engagement. Its finding is that the game like setting was supporting the learning within the classroom and increased productivity. By increasing engagement levels, it also means it helps students be able to access the content of the lesson, that is or needs to be delivered.

Even though gamification can aid teaching students of all needs, a study conducted on students who had autism using video games showed that this training package was powerful in teaching content that was age-appropriate [26]. However, gamification of learning is not some-

thing just for the classroom; its an excellent tool for learning outside the classroom. Games like Spore create a deeper understanding of life and evolution as the game simulates a world where the player's character will evolve, adapting to their surroundings through reproduction. Another game by the same creator, Will Wright, Sim City aims to teach the player key skills like [27]: Supply and demand; Budgeting; Urban planning; Managing the environment; Understanding utilities and services like transport systems and public services; Reading and maths skills.

Gamification of learning has excellent potential benefits. The benefits involve [22]: Allowing students to have ownership of their learning, as well as giving opportunities for the learner to gain a sense of their 'own identity', through alternative role-playing selves. The freedom, without any negative repercussions, to fail and keep on trying again. The ability to increase fun and joy while learning. The opportunity for tasks to be differentiated. Making the learning visible and providing opportunities to inspire intrinsic motivators for learning. Also, the ability to aiding in motivating students with low levels of motivation.

Chapter 3

Conclusion

Gamification is a powerful tool for engagement. Since its initial conception in 2002 and then Jane McGonigal's groundbreaking TED Talk in 2010, gamification has become a vast field, with it going viral in 2016 with the release of Pokémon Go. CHI conference offered a workshop around gamification, which spawned the GRN in 2011. Who focuses on the development of gamification.

Gamification takes advantage of extrinsic and intrinsic motivations, aiming to enhance our daily activities or tasks. Therefore, in order for the gamification to be most effective, then both these motivation factors need to be accounted for within the task. In order for the person to feel good about oneself, a form of reward has to exist. This feel-good factor is due to the release of dopamine within the body. They are, therefore creating an incentive for the person to do that action again. The mechanics of gamification is tapping into the release of the dopamine. Through using game components like points, badges, leaderboards, performance graphs, avatars and teammates within non-traditional gaming settings, this allows the player to get a sense of competition with themselves, to do better, or with other people. These get achieved by giving the player autonomy, value in what they are doing and a sense of competence.

All types of gamification work well with science concepts, but the main one used is serious games. These types of games have a primary goal in mind when being designed and are suited for outreach, teaching and research goals.

Gamification in education is fundamentally the same thing as normal gamification, but with more of an emphasis on the learning. However, whether gamification in education has to be done within a non-digital world or not, splits the academic community. Still, academics do

agree that gamification, within education, has a positive effect on learning, allowing students to have a sense of ownership of their learning.

Including gamification elements within the final masters' thesis, should help create a positive experience for the user. Using mechanics to encourage them to continue playing as well as being able to teach the user key ML concepts, to help educate them and debunk the misunderstanding of what is ML, all within a fun and interactive encounter.

Bibliography

[1] S. Martin. (2019) Top industries getting revolutionised by artificial intelligence. [Online]. Available: https://medium.com/hackernoon/top-industries-getting-revolutionised-by-artificial-intelligence-686a440857c0

[2] S. Arnold. (2017) 10 important facts about games and learning. [Online]. Available: https://www.classcraft.com/blog/features/10-facts-games-learning/

[3] Growth Engineering. (2019) The history of gamification: From the very beginning to right now. [Online]. Available: https://www.growthengineering.co.uk/history-of-gamification/

[4] S. Walz, in *The Gameful World: Approaches, Issues, Applications*. MIT Press, 2015.

[5] Wikipedia. (2020) Gamification. [Online]. Available: https://en.wikipedia.org/wiki/Gamification

[6] J. McGonigal. (2010) Gaming can make a better world. [Online]. Available: https://www.ted.com/talks/jane_mcgonigal_gaming_can_make_a_better_world?language=en#t-1184578

[7] Gamification: Using Game-Design Elements in Non-Gaming Contexts. (2011) CHI. [Online]. Available: http://chi2011.org/communities/games/index.html

[8] R. Swatman. (2016) Pokémon go catches five new world records. [Online]. Available: https://www.guinnessworldrecords.com/news/2016/8/pokemon-go-catches-five-world-records-439327

[9] R. Silverman, "Latest game theory: Mixing work and play — companies adopt gaming techniques to motivate employees." Wallstreet Journal, 2011.

[10] M. Herger. (2012) Gamification and law or how to stay out of prison despite gamification. [Online]. Available: https://web.archive.org/web/20120425121358/http:/enterprise-gamification.com/index.php/en/blog/4-blog/65-gamification-and-law-or-how-to-stay-out-of-prison-despite-gamification

[11] Wikipedia. (2020) Data aggregation. [Online]. Available: https://en.wikipedia.org/wiki/Data_aggregation

[12] Wranx. (2014) The science behind gamification and why it works. [Online]. Available: https://blog.wranx.com/the-science-behind-gamification-and-why-it-works

[13] J. Coppola. (2017) The science behind gamification: Why it works. [Online]. Available: https://wistia.com/learn/marketing/the-science-behind-gamification

[14] Web MD. (2020) What is dopamine? [Online]. Available: https://www.webmd.com/mental-health/what-is-dopamine#1

[15] Neuroscience Department Laboratories. (2020) Brain reward pathways. [Online]. Available: https://neuroscience.mssm.edu/nestler/brainRewardpathways.html

[16] D. Yuhas. (2012) Three critical elements sustain motivation. [Online]. Available: https://www.scientificamerican.com/article/three-critical-elements-sustain-motivation/

[17] Wikipedia. (2020) Serious game. [Online]. Available: https://en.wikipedia.org/wiki/Serious_game

[18] M. Baaden, O. Delalande, N. Ferey, S. Pasquali, J. Waldispühl, and A. Taly, "Ten simple rules to create a serious game, illustrated with examples from structural biology." Public Library of Science, 2018.

[19] R. Follett and V. Strezov, "An analysis of citizen science based research: usage and publication patterns," *PloS one*, vol. 10, no. 11, p. e0143687, 2015.

[20] L. Mazzanti, S. Doutreligne, C. Gageat, P. Derreumaux, A. Taly, M. Baaden, and S. Pasquali, "What can human-guided simulations bring to rna folding?" *Biophysical journal*, vol. 113, no. 2, pp. 302–312, 2017.

[21] T. Bates, "Serious games and gamification," 2019, [online; accessed February 2020]. [Online]. Available: https://www.tonybates.ca/2019/09/07/serious-games-and-gamification/

[22] Wikipedia. (2020) Gamification of learning. [Online]. Available: https://en.wikipedia. org/wiki/Gamification_of_learning

[23] 2muchcoffee, "Using gamification in your startup: Examples of leading apps and our experience," 2019, [online; accessed February 2020]. [Online]. Available: https://2muchcoffee.com/blog/using-gamification-in-your-startup/

[24] A. Deese. (2020) 5 benefits of gamification. [Online]. Available: https://ssec.si.edu/ stemvisions-blog/5-benefits-gamification

[25] ——. (2012) Using gamification to aid in adolescent development in the classroom: Cognitive and physical processes can enhance growth. [Online]. Available: http://www.ashleydeese.com/2012/09/26/ using-gamification-to-aid-in-adolescent-development-in-the-classroom-cognitive-and-physical-processe

[26] A. Blum-Dimaya, S. A. Reeve, K. F. Reeve, and H. Hoch, "Teaching children with autism to play a video game using activity schedules and game-embedded simultaneous video modeling," in *Education and Treatment of Children*. West Virginia University Press, 2010, pp. 351–370.

[27] M. Doyle. (2014) Learning with simcity: Valuable lessons kids can learn playing mayor. [Online]. Available: https://www.brightpips.com/ learning-simcity-valuable-lessons-kids-learn-playing-mayor/