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**DATA LITERACY AND SERIOUS GAMES: CAN THE GAMIFICATION OF OPEN
DATA PROVIDE A SOLUTION TO ITS DISUSE?**

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ABSTRACT

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Problems arise in communities that are sometimes either not easily addressable, while other times the issue is not always as evident and transparent as we would tend to believe. Open data can help in this matter by providing data about a number of dimensions that, when analyzed, can produce insight into what the problem is and how to cater to it. But open data is not always as readily usable by the general public, who could potentially use it for the betterment of societies.

Thus, the main objective here is to explore whether providing open data in a more palatable and enjoyable manner in the form of a serious game would help the average citizen to interact with it and potentially become data literate. Additional questions involve whether the implementation of different strategies in serious games prompt different responses from individuals, and whether the various players having different psychological preferences would react differently to the serious games.

The theoretical section sheds light upon the various topics under consideration, and then upon the gamified interface to open data, collected from an initiative called Sensei, created for the research. It also explains the survey used to gather responses from the users about their playing preferences and about their experience with the application.

The results show that serious games can indeed help support the fight for data literacy, but with a number of considerations. It shows that certain types of information may be inherently uninteresting to some people despite however much it is well incorporated. The study also delivers a set of considerations that can thereby act as solid foundation for further research.

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Gratitude to everyone who helped me with my research.

Meher Yar Khan

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1. Introduction

Games are not new in terms of terminology in the vocabulary of many individuals. Indeed, games dating from as far ago as 2600 BCE (Soubeyrand, 2000) have been found, showing that this is not a recent invention. As far as the definition of a game goes, it is an activity in a structured format usually for the purposes of enjoyment and sometimes also used as an educational tool (Merriam-Webster, n.d.). The concept has been around for a long time, and whereas initially it referred to more physical acts, it has now transcended the realm of the physical and progressed into that of the virtual and digital. Games, the definition used in olden times and the definition that it has morphed into at present, are seen to provide valuable traits to a person such as team-play, amenability, patience, the motivation to succeed, and various others (Mead, n.d.). It was therefore not a great leap to actually consider games, albeit in different forms, to be used in contexts to teach lessons and skills more quantifiable such as in recent years.

Referring to games that can actually be considered as learning machines, one only needs to visit a brick and mortar business or online store and find video games such as *System Shock 2*, *Deus Ex* and others for prime examples of learning machines. Such sorts of games provide the user the environment to learn principles that can be applied to settings such as in teaching subjects such as science in schools (Gee, 2003).

Other games, such as Minecraft, have actually enabled teachers to simulate actual physics concepts and build geographically significant landmarks in order to better engage the students and improve their retention of such important lessons (Mojang Synergies AB, n.d.)

With further technological advancements and greater research into the science of using games to teach and instruct and help in the learning process, the term ‘Serious Game’ has been coined. Serious Games involve the usage of instructional and videogame elements in contexts of non-entertainment (Charsky, 2010). Whereas games were not specifically aimed at teaching but more for the purposes of entertainment, these are used primarily in order to provide an environment such that it promotes learning and is more intriguing for the users, taking advantage of one’s inherent inclination towards games.

Serious games are being implemented in various spheres of life in the current era. From spheres such as electricity usage of one's homes (Opower, 2007) to physical workout regimens (Six to Start, 2012), the implementation of games and strategies from games in order to reduce the barrier of entry and increase the rate of adoption and sustained implementation of certain systems has increased. Such games have taken on a new meaning, and from using them as simulations of real life scenarios and for training the mind all the way to playing them in order to make a living, they have entrenched themselves into the very fabric of the current generation.

The success of games has been envied by individuals in other fields as well, and as such, in order to replicate some of those accomplishments, companies providing business environments and settings actually began introducing certain elements taken from games that may have been contributing to the success of those games, and the gaming industry in general. The result was a new concept termed 'Gamification':

'A process of enhancing a service with affordances for gameful experiences in order to support user's overall value creation.' (Huotari & Hamari, 2012)

Thus gamification has brought about a revolution of its own that has seen many companies implementing it, from Facebook to LinkedIn to many others. And depending on the way it has been used, it has shown great potential.

Gathering data from games such as these, and through other avenues as well, has become a priority for many individuals and companies. With the advent of Machine Learning and sophisticated algorithms in the software domain, taking more informed decisions on the basis of gathered and analyzed data and the habits of one's customers has become a very effective way of standing out of a crowd. In many cases, this data and other datasets such as census data, satellite and mapping data and data from surveys are available on the internet. Many are free, some are paid, but large corporations and governments have been gathering data that they have been serving the public on the web for many a year now. This data that is available for free and accessible by anyone is referred to as Open Data, as the definition states:

'Open data is data that can be freely used, re-used and redistributed by anyone - subject only, at most, to the requirement to attribute and sharealike.' (Open Knowledge International, n.d.)

Having other terms for it as well, Open Data is available for anyone to use. But with so much efforts having been put on gathering it, the process of actually using it has been an avenue relatively untapped. Reasons for this include people not being aware, people being data illiterate, people being overwhelmed by the amount of data and its representation thus inhibiting them from actually pursuing the path to become data literate, and a host of other reasons (Janssen, et al., 2012).

In lieu of all of the progress made by the companies that have taken on business models related to serious games, of how much the games themselves have brought about revolutions in the present dynamics of society, and of the grossly underused open data available on the web that can actually be analyzed and used in order to analyze bottlenecks and problems in various societies and figure out effective countermeasures for them, the current thesis was conceived and begun. Having used serious games and otherwise, and being addicted to not only one, the author of this thesis reflected upon the impact such games has held on him and therefore decided to research a few notions that have captured his interests.

Following are the research questions that the author decided to research during his thesis:

- Do serious games involving open data motivate people to advance from data illiteracy towards data literacy?
- Do certain gamification strategies have different effects on people accessing serious games?
- Are people of certain gamification player types (Hexad Player Types) more motivated by serious games in relation to open data than others?

Considering these research questions, the format of going about the research was such that the literature review was done concerning the questions and the various topics under consideration. The literature review was performed with the keywords already having been outlined and those words were then used in searches on the various platforms containing the various literatures, such as Science Direct and Research Gate. After this step, receiving a number of search results, the limiting factor decided upon was how recent the searched papers were. A cutoff point was kept at 2013, so that the literature was more recent than very old. And the documents with titles that were more relevant to the current research were considered.

The papers and articles studied also had a number of references within them, which were further studied as per their relevance to the literature being reviewed, despite some of them being a little older than 2013, due to the perceived significance of the information that was potentially held within.

This process was adopted in order to glean as much information from existing literature to see if there was any indication or a starting point for the research.

Following the literature review, the development of the serious game which would be used during the research was set underway and the application was then to be implemented in order to gather the data from the users. A survey was also developed during the course of the serious game development, which would ask questions related to the game and related to the users' gaming profiles in order to be able to make a connection and retrieve information that would help solve the research questions.

Finally, following the survey, the findings were analyzed and the results ultimately written up. The following section begins with the literature review performed for the thesis.

2. Open Data and its Disuse

Open data is the information that has been usually provided by a government organization in the form of datasets and the use of open data is when an individual or a group use this available information in order to glean further insight into problems and their potential solutions from it (Zuiderwijk, et al., 2015).

There are various steps to the usage process of open data. Attempting to view the datasets, to understand the information, to analyze the details provided, scrutinizing and evaluating the data provided, and visualizing the information are all activities that could be performed upon the open data provided in order to make use of them.

According to policy-makers, open data is on its way to becoming accepted by the masses and is being used more than before, and it will ultimately yield great benefits in several of the fields of the government and other. Transparency, increased participation and greater collaboration (Gascó, 2014) and innovation are all examples of how this could be able to transform current departments and organizations into more productive ones.

There are barriers to open data though, that contrast with the perceived benefits that are usually touted in favor of open data as providing all the solutions (Janssen, et al., 2012). According to them, open data is not to be considered as a homogenous area.

Considering the providers and users of open data to be linked to each other in terms of being able to actually make use and provide value, open data can be used as the first step in setting up dialogs between them. Such discussions, with the intent to figure out the learnings from the use of open data, can prompt governments to improve a multitude of their processes and ultimately make their decision-making more productive (Davies, 2010).

There are many datasets widely available on the internet for use by the citizens, but only a select few of them are being utilized and used (Bertot, et al., 2012). Encouraging its use is essential (Solar, et al., 2013) and acceptance of the technologies is very important in order to promote them to be used in value creation, but the main goal has been data provision as of yet (Foulonneau, et al., 2014). Data use has been a relatively neglected aspect. And with the

promotion of open data not being widely prevalent to the general public and them being difficult to use, the average individual is not incentivized to a significant degree (Janssen, et al., 2012). A statistic shown to exemplify the situation was that out of 22,759 datasets within the data.gov.uk website, only 378 applications were using the open data provided while the proportion was even lower for the US maintained data.gov website (Wolff, et al., 2017).

But as yet, there is yet a dearth of research into the predictors that affect open data's acceptance and its usage. Many events and initiatives have been taken in order to promote this field such as hackathons and workshops, but if the governments wants various stakeholders such as the citizens and researchers and entrepreneurs to take part in its usage and begin value creation, it is vital to understand under which circumstances these parties would be willing to adopt the technologies. Considering that it is still a relatively new field and the predictors and its acceptance has barely been investigated, there is still therefore much to learn about the various aspects of open data technologies.

The Unified Theory of Acceptance and Use of Technology (UTAUT) model explains that there are a number of factors that lead to the change in one's intention towards the acceptance and use of any system or technology. It explains that there are four constructs that foretell the behavioral intention of willing to use Information Technology. These four consist of Performance Expectancy (PE), Effort Expectancy (EE), Social Influence (SI), and Facilitating Conditions (FC). There are, in addition to these four, there are an additional four moderators that include Gender (G), Age (A), Experience (E), and Voluntariness of Use (VU) (Venkatesh, et al., 2003).

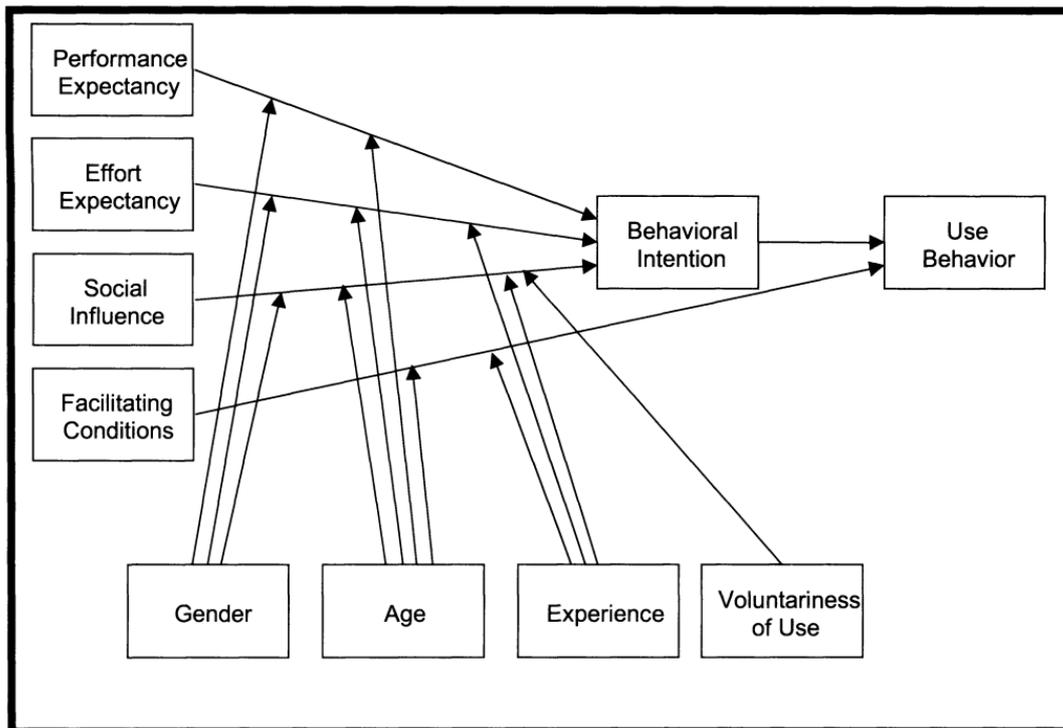


Figure 1. The Unified Theory of Acceptance and Use of Technology model, adopted from (Venkatesh, et al., 2003)

While that may be the case, the actual use of the said system is usually a combination of this behavioral intention along with a few conditions which provide assistance for the practical implementation (Sykes, et al., 2009).

The willingness to do something, in this context, is termed as 'Behavioral Intention', which is defined as 'an individual's intention, prediction or plan to use a technology' (Zuiderwijk, et al., 2015). There is great research into behavioral intention and several models have been developed in which they stress the fact that, in order to predict a human being's behavior, behavioral intention is the best means of doing so (Lee & Rao, 2009).

3. Gamification

During the current era, gamification and gamified systems are areas of research that are very popular (Kasurinen & Knutas, 2018). The meanings of the terms have already been explained in the sections previous. But according to Kasurinen et al., they note that these terms are widely used though there is a discrepancy in the way they are referred to since they do not always mean the same thing in all the varying contexts that they are used. These terms are usually associated with software products. Applying elements of a game in order to create an interface of a certain system is the main essence of gamification, but they claim that it is not always so. And based on their study, it has been found that there is a pressing need in the research regarding the field of gamification that practical applications and their impacts are studied more than the proof-of-concept prototypes and other such theoretical researches in circulation.

The application of gamification and the perceived success of the technique is a highly context dependent enterprise (Hamari, et al., 2014). Gamification is not a one-size-fits-all approach (Codish & Ravid, 2014). The various activities for which the approach is applied have dissimilar intrinsic and extrinsic motivators associated to them, and therefore the manner in which the technique is to be implemented requires great consideration. That approach has been shown to have many limitations and risks as have been alluded to in other researches (Berkovsky, et al., 2010) (Khaled, et al., 2008). It is hypothesized that gamification user types play a vital role in determining which approach would be better suited for one type of person or another (Orji, et al., 2018).

The study of Knaving and Bjork can be considered an extension of this as it implies that many of the systems that use gamification fail to achieve the desired result due to not being integrated successfully and only exist as a filler the user has to go through for the content (Knaving & Björk, 2013). According to them, gamification should not be used as an entity on its own rights, but rather be incorporated to promote playfulness.

Even cultures and the way it shapes the individuals coming from those ecosystems have effects on the responses and preferences of those beings, and the gamification tactics deployed for the people related to the different cultures have varying effects (AlMarshedi, et al., 2017). Culture, which is defined in a number of manners from being a structure of patterns that separates the

individuals of one group from the individuals of another (Hofstede, 1997) to it being a collection of habits and meanings that are seen contextually by the individuals of that particular culture (Usunier & Lee, 2013), thus also has an effect on the types of gamification tactics that may prove favorable for a certain type of people.

User interface design, persuasive technologies and various other techniques have all been seen to improve the efficacy of Gameful systems when the user's personal traits are taken into account and the systems are adapted in order to cater to those traits. There is a need to personalize gamified systems to the various personalities of the users of the systems, but that is a difficult task. Despite it having been noticed in a number of studies that this methodology does actually yield positive behavior change, but the factors that bring about these positive changes are as yet not properly understood (Tondello, et al., 2017).

But on the other hand, Khaleel et al., in their work, summarized that in modern systems, even if consideration given to the design elements is minimal and the elements used are not very functional for the activities being performed in the application, lacking any gamification entirely would actually yield a more harmful outcome than the contrary (Khaleel, et al., 2015). Cheung et al. in their work, were able to analyze the first hour interaction between the users of over 200 systems. In doing so, they were able to glean the information that current game design is more about making the participants feel satisfied with the product and instilling in them the desire to continue interacting with the system rather than help users seek information about or within the product. And as such, the first hour of interaction is given more priority than other parts of the system, such as the 'last hour' of play (Cheung, et al., 2014).

3.1. Gamified Learning

Various methods have been tried in order to motivate individuals, particularly students, to improve the way they receive information and how they learn. Various strategies have been tried by professors and researchers to see what best works. And Gamification has been seen to hold great potential in this field.

From Lee Sheldon's proposed method of turning a course into a technology-less game simply by allowing students to begin the course with a F grade and make their way through all the intermediary grades until they reach the A+ score that the high achievers target; they level up their grades as they gain 'experience points' and complete challenges (Lee, 2011), to Dominguez et al.'s strategy of providing badges and medals upon completion of certain exercises (Domínguez, et al., 2013). And further on to the various online learning resources such as Khan Academy (Khan, 2007) and Codecademy (Sims & Bubinski, 2011), the concept of gamification seems very practical and highly influential in the field of learning. There was also a study performed to see what kinds of students could be identified from those taking part in the game-cum-course, and how their behaviors could be studied with regards to their gaming characteristics (Barata, et al., 2014).

For the study, qualitative and quantitative data was gathered regarding the students gaming habits and the player profiling was done via the BrainHex model (Nacke, et al., 2014) which is a product of neurological research into gameplay. Other models such as Bartle's MUD classification and the Demographic Game Design 1, which in turn was based on the Myers-Biggs personality model (Myers, 1962), were not considered for the research.

The seven archetypes in the BrainHex model are as follows:

Profile	Archetypal Tendencies
Seeker	This is someone who is curious about his surroundings and the world they are in, finds pleasure just by being part of it, and adventuring in order to find hidden gems and treasures.

Survivor	This is a player that finds joy in the thrills of horror and terror and they prefer escaping from scary situations and taking pulse-pounding risks.
Daredevil	This is the type of player that loves playing on the edge, taking part in death-defying activities and high-paying risks.
Mastermind	This archetype defines those people that seek pleasure from being able to solve tough puzzles, mapping out strategies to get through situations, and focusing on efficiency rather than brute force.
Conqueror	These players love achieving victory after having to go through great difficulty as they are challenge-oriented individuals, believing in adages such as 'No Pain, No Gain'.
Socializer	As the name suggests, this archetype refers to people that take part due to the joy and pleasure they get from being around and talking to other people, by helping them and whiling away time with them.
Achiever	This last type refers to a person that is goal oriented and who seeks long-term achievements such as collecting special items and gathering currency.

Table 1. BrainHex Classes

Four types of students were found from the study showing varying levels of interest based on the different gaming elements implemented (Barata, et al., 2014). And each type of students was found to have the characteristics fitting the profiles of certain archetypes as per the BrainHex model.

3.2. The Gamification User Types Hexad Scale

There are many other types of user player typologies that can be considered. Bartle's player typology was created specifically to categorize players playing Multi-User Dungeons (MUDs) identifying four types of players, namely Achievers, Explorers, Socializers and Killers (Bartle, 1996), but has been used for gamification as well. According to Tondello et al., such generalizations should be avoided though (Tondello, et al., 2016). The BrainHex model took into consideration previous typologies developed and also neurobiological research in order to come up with seven archetypes of players (Nacke, et al., 2014). But this was also developed specifically keeping game design in mind and not gameful systems.

Coming to the types created for Gameful Systems so as to be better integrable with similar systems, one such instance of such models is the output of Barata et al.'s study which they identified while studying student performances and their gaming preferences; the four types identified were Achievers, Regular Students, Half-hearted Students and Underachievers (Barata, et al., 2014). But this is geared more towards the gamified learning environment and may not be applicable in a more generalized setting.

The Hexad framework, on the other hand, was developed by Marczewski after research on player types, human motivation and practical design experience, and with gameful systems of a more varied and generalized setting. And the types that are identified in this are based on the personification of the intrinsic and extrinsic motivations of people, derived from the Self-Determination Theory (Tondello, et al., 2016).

SDT is a method to understand an individual's innate tendencies and psychological needs that cause a person to be motivated and have certain personality traits. And through empirical processes, three basic needs have been identified, namely: The need for competence, relatedness and autonomy (Ryan & Deci, 2000).

Competence is the need to have skills in performing a certain task. Relatedness is the feeling of being related to others other than the self. And autonomy shows that the more a person feels as though they are in control of what they are attempting, the more likely they are to succeed. These three together provide the support which bolster internal motivation. The Hexad Model

also considers the fact that meaning (purpose) supplements internalization which in turn increases motivation as well (Tondello, et al., 2016).

Player preferences for game genres and game elements as well as how a person experiences satisfaction in various systems is affected by personalities. For the purpose of facilitating this, the Big Five personality model was taken into use which provides a measure of a person's personality factors divided in 5 main categories: Openness, conscientiousness, extraversion, agreeableness and neuroticism (John, et al., 2008).

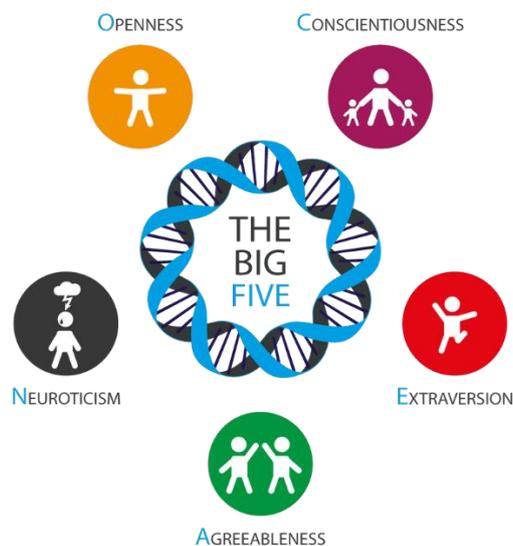


Figure 2. The Big Five personality model, image adopted from ' (Elaine, 2017)'

Openness is the trait that points to a person open to the willingness to try novel experiences. It is an indication to their adventure seeking nature. Conscientiousness is a trait that shows one's ability to be organized and oriented on their goals. Extraversion is a trait that gauges whether the person has an outgoing and sociable personality. Agreeableness refers to an individual's inclination towards tolerance and trust with their relations to other people. And Neuroticism focuses on how the person responds to negative emotions such as anger and frustration and is a measure of their self-confidence.

According to a study, various correlations were found between the various traits of the 'Big Five' and several of the gaming elements used in gamification (Jia, et al., 2016). Examples are extraversion being positively correlated with points, levels and boards whereas negative

correlations between emotional stability, which is the opposite of neuroticism, with points, badges, progress and rewards.

Another study was also conducted in which it was found that gamified elements were seen to impact an individual's self-determination according to the SDT (Sailer, et al., 2017).

Psychological need	Mechanism	Game design element
Need for competence	Granular feedback	Points
	Sustained feedback	Performance graphs
	Cumulative feedback	Badges
	Cumulative feedback	Leaderboards
Need for autonomy (decision freedom)	Choices	Avatars
Need for autonomy (task meaningfulness)	Volitional engagement	Meaningful stories
Need for social relatedness	Sense of relevance	Teammates
	Shared goal	Meaningful stories

Table 2. Psychological needs with matching game design elements, table adopted from (Sailer, et al., 2017)

Hexad Gamification User Types is therefore a model that was created with the purpose of capturing a user's predisposition, their motivations and their particular style of interacting with the various game elements on offer (Tondello, et al., 2016). There are six types described in this model, the six being Achiever, Socializer, Philanthropist, Free Spirit, Player and Disruptor. Each type, as the name suggests, explains how the user interacts within the game environment.

Achiever	This is someone willing to progress by displaying competence and overcoming challenges.
Socializer	This is someone who is more inclined towards creating a social connection with others.
Philanthropist	This is someone who is altruistic and is moved to doing by having a purpose and helping without expecting anything in return.

Free Spirit	This is someone that does not like to be controlled, but instead, would like to act upon their own freedom and explore as per their leisure.
Player	This is someone who is driven by rewards, doing any activity in order to receive the reward they are after.
Disruptor	This is someone who prefers to test systems and the rules, push the limits and trigger change, whether negative or positive.

Table 3. Hexad Player Profiles

Some of the motivations of one user type are relatable to the motivations of another while there are user types for which the motivations overlap. Examples are that Achievers and Players, though having different focuses, are both motivated by achievement in the system. Players want to receive rewards while Achievers want to focus on their competence in the gameful system, but the achievement factor is present for both. Philanthropists and Socializers are interested in interacting with other players, but whereas the former is more focused on wanting to help others, the latter is purely interested in the interaction itself. And when it comes to Free Spirits and Disruptors, the common motivation for both of them is autonomy and creativity but where the Disruptor seeks these in order to bring change to the system, a Free Spirit would want to stay within the system and explore.

This is not to say that a person using the system would always fall distinctly in one of the categories; indeed, many people exhibit tendencies for more than one user type, but there usually is a principal tendency that they display .

Philanthropists and Socializers were found to be positively correlated with extraversion as well as agreeableness, Achievers and Players with conscientiousness, and Free Spirits with openness. Free Spirits and Disruptors both were found to be correlated with emotional stability as well (Tondello, et al., 2016).

Table 4 below provides further elaboration on each of the user type and the various elements that provide each of them with motivation.

User Type	Suggested by Marczewski		Improved Associations			
	Design Elements	τ	Principal Elements	Additional Elements	τ	Imp.
Philanthropist	Collection and Trading Gifting Knowledge Sharing Administrative Roles	0.039	-	-	-	-
Socialiser	Guilds or Teams Social Networks Social Comparison Social Competition Social Discovery	0.257 **	Guilds or Teams Social Networks Social Comparison Social Competition Social Discovery		0.257 **	0%
Free Spirit	Exploratory Tasks Nonlinear Gameplay Easter Eggs Unlockable Content Creativity Tools Customization	0.341 **	Exploratory Tasks Nonlinear Gameplay Easter Eggs Unlockable Content Learning Anonymity Anarchic Gameplay	Customization Challenges Creativity Tools	0.386 **	13%
Achiever	Challenges Certificates Learning Quests Levels or Progression Epic Challenges	0.347 **	Challenges Certificates Quests	Anonymity Learning Badges or Achiev. Levels or Progression	0.362 **	4%
Disruptor	Innovation Platforms Voting Mechanisms Development Tools Anonymity Anarchic Gameplay	0.326 **	Innovation Platforms Voting Mechanisms Development Tools Creativity Tools	Social Competition Anarchic Gameplay Challenges	0.379 **	16%
Player	Points Rewards or Prizes Leaderboards Badges or Achievements Virtual Economy Lotteries or Chance	0.383 **	Points Rewards or Prizes Leaderboards Badges or Achievements Virtual Economy Levels or Progression Collection and Trading	Social Comparison Social Competition Social Discovery Anonymity Challenges Certificates Quests	0.420 **	10%
Overall						9%

** $p < 0.01$.

Table 4. Bivariate correlation coefficients and significance between the Hexad user types and suggested game design elements, Table adopted from (Tondello, et al., 2016).

As the table shows, the correlations found were mostly positive between the Hexad user types and the various elements of game design that were considered for the testing (Tondello, et al., 2016). The table shows the Kendall's tau (correlation coefficient) of the various Player types with the design elements. The first column of coefficients were as suggested by Marczewski (Marczewski, 2015) while the second column shows the improved associations that Tondello et al. were able to discern. The last column that shows the percentages are the suggested improvements over the coefficients that Marczewski had initially provided.

4. Gameful Systems and Gamification with Open Data

Many systems are using persuasive strategies (Fogg, 2002) in order to make their users adopt certain types of behaviors (Alahäivälä & Oinas-Kukkonen, 2016) (Hamari, et al., 2014). There is not much research as to the efficacy of the tailoring and what the most effective way is, but there have been suggestions as to how these should be approached. One such is the suggestion that the system is based on tailoring and adapting the activities based on how the user carries out actions and activities in the game (Tondello, et al., 2017).

A research where the Hexad Gamification User Types with ten persuasive strategies was conducted in order to research the sorts of approaches that could be used to potentially nudge a person into the behavior pattern that the creator of the system hopes for (Orji, et al., 2018). Those ten include Competition, Simulation, Self-monitoring and Feedback, Goal setting and Suggestion, Customization, Reward, Social Comparison, Cooperation, Personalization and Punishment. The explanation of each of the strategy is provided in the table below:

Competition	Where users compete to perform a certain behavior
Simulation	Where a user is able to view the cause-and-effect connection of their activity
Self-monitoring and Feedback	Whereby the user is able to keep a check upon their own behaviors and progress
Goal setting and Suggestion	Where the user is required to set a particular goal for the system that they would like to reach and be accordingly suggested preferable steps in order to achieve the goal
Customization	Where a user is allowed control over manipulating the system's contents and functions as per their desires
Reward	Whereby a user is provided rewards for performing the behavior targeted
Social Comparison	Whereby the user is able to compare themselves with other who are also participating in the game

Cooperation	Whereby the user is made to take part in team activities and rewarded for the team's performance collectively
Personalization	Whereby the system is tailored according to the user's characteristics and desires
Punishment	Where the user is penalized for not being able to perform as per the required outcome

Table 5. Ten Persuasive Strategies identified and used in (Orji, et al., 2018).

In a previous study, Orji et al. were able to show a connection between a person's personality traits and how the ten selected persuasive strategies were perceived in gameful settings, showing that a person's disposition can be a good indicator as to what they would find more influential for them (Orji, et al., 2017).

Factors	PLA	PHI	DIS	FRE	SOC	ACH
Goal-setting and Suggestion	-	-	-.15	-	.20	-
Competition	.26	-	.11	-	.25	-
Comparison	.14	-	-	-	.28	-
Cooperation	.13	-	-	-	.29	-
Customization	-	-	.14	-	.31	-
Reward	.15	-	-	-	.33	-
Punishment	.11	-	-.12	-	.32	-
Personalization	-	-	-.15	.13	.17	-
Simulation	-	.18	-.15		.17	-
Self-monitoring and Feedback	-	-	-.14	-	.19	-
PLA = Player, PHI = Philanthropist, DIS = Disruptor, SOC = Socialiser, FRE = Free Spirit, ACH = Achiever						

Table 6. Coefficients for each of the strategy against Hexad Types, table adopted from (Orji, et al., 2018).

As Table 6 indicates, all of the strategies seem to have a positive influence on the user that is a Socializer while none seem to have a significant effect on an Achiever. Disruptors, on the other hand, have been shown to be influenced negatively by five out of the ten strategies, showing that the methods would actually influence them negatively.

When a system is designed, the intended Flow of the system also needs to be kept in check. Flow may be defined as an individual's skill versus the challenge that they are up against, and the dynamic and relative increment of the two (Moneta, 2012) or as being a state of peak experience where the individual is completely engrossed in the activity being carried out, among other definitions. This model explains experience in three distinct stages between which all experiences oscillate. The stages are flow, anxiety and boredom.

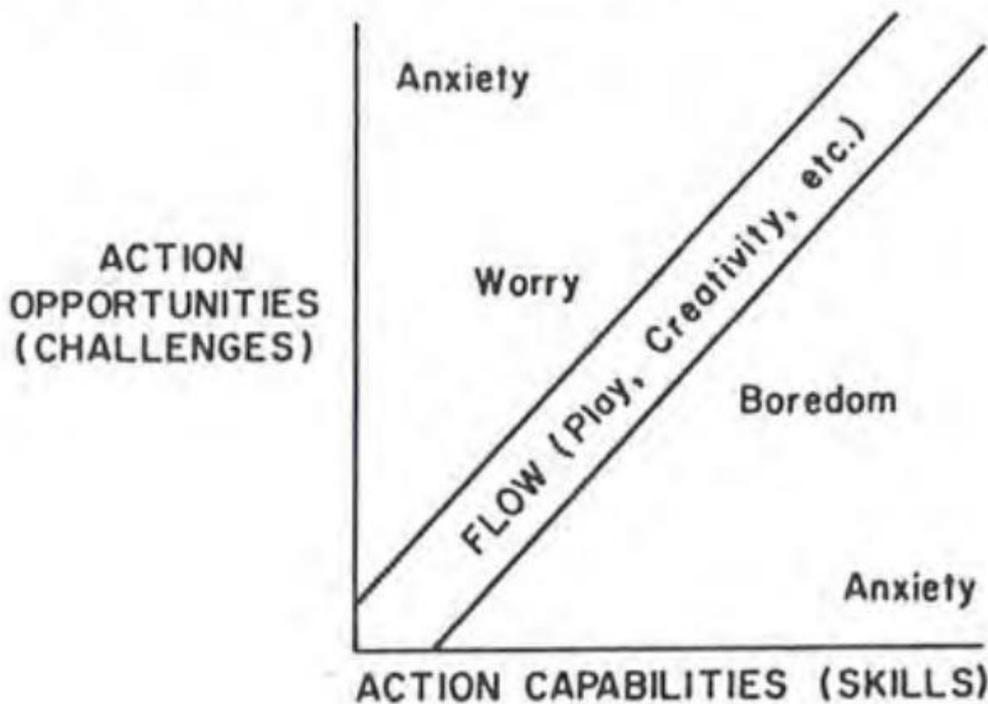


Figure 3. Graph showing the Flow channel, adopted from (Csikszentmihalyi, 1975).

The figure shows that the more uneven the skills or the challenges get, the more the user delves deeper into the ranges categorized by Anxiety or Boredom. The levels need to be kept in a balance in the flow range. And all flow states are not the same, since a lower capability level would mean a lower challenge but as the user's abilities increase, the challenges increase in complexity accordingly and thus, despite being in the flow region, the flow state is in essence different (Moneta, 2012).

This is because a study conducted showed that the more immersed a person is in a gameful system, the more there is a positive effect on the learning outcome (Hamari, et al., 2016). Both

the challenge and the increased immersion and engagement with the system had positive learning outcomes.

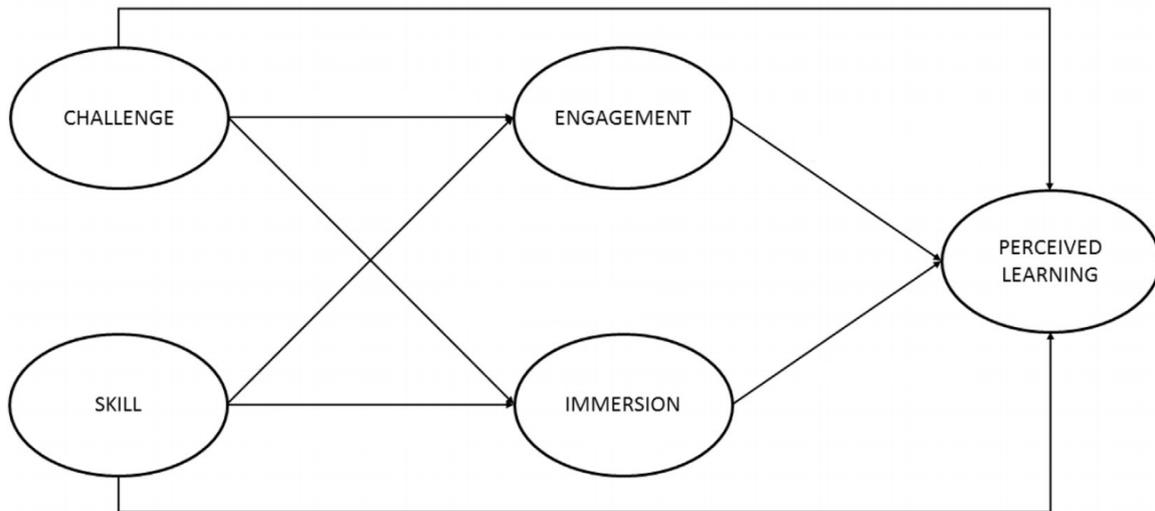


Figure 4. Immersion path model, adopted from (Hamari, et al., 2016).

The figure above displays how the challenge presented by the system and skill of the individual both play their respective parts in the engagement and immersion that would take place in the system, which would ultimately result in perceived learning.

Considering this research into gameful systems and gamified environments and the paths that would ultimately help in improving interaction and learning, along with the literature on gamification, the benefits of using these systems with open data alludes towards the possibility that the two in unison would be able to elevate the currently dismal situation of open data usage. If the datasets are used with greater thought into the process of delivering it to the end users so that they view a game rather than just numbers, it is possible to tackle data illiteracy and improve the usage of the data.

The next section will detail how the researched literature has contributed to the understanding of the issue of widening participation concerning open data. It will also describe the experimental design and considerations to test the ideas.

5. The Mode of Research and Implementation of the Serious Game

Open data is widely available on the web. As the name suggests, it is open to anyone and everyone who would want to use it or distribute it. But there is a dearth of the actual usage of these datasets when it is viewed from a practical angle. Applications tracking their users' daily caloric expenditures and the data providing holistic views of the activities performed by the people of certain geographical localities. Datasets provided by governmental departments and other large companies in order for the meteorological data from them to be used by apps to their business advantages, and a host of others. There are certainly many applications in which open data is being and can be used, but it is not as widespread as one would think, or as one would have hoped.

Open data is provided, free of cost, by the government or other in order to provide access to sets which an individual or a company would otherwise not have access to. This data has many reasons for its existence, including points such as bringing about transparency to focusing on discrepancies which viewed from a holistic angle would yield solutions hidden in the numbers. These are certainly viable reasons, but which are not being fulfilled at the moment when the sheer number of datasets available and the number of datasets being used are taken into consideration.

It is considering this scenario of underutilized usage of the precious resource that the conception of the topic of this thesis took root. A large amount of resources are spent every year with the hopes that they would be utilized, only for those large datasets, accumulated by many machines and humans working in tandem, to be wasted. They are seen as a wastage due to the fact that they are not being used for what they were intended. There are many reasons which lead to this outcome of which people not being data literate, the data not being organized in a very user-friendly manner, and people not considering it something they would be able to do are but a few of the myriad of prevailing reasons.

Were the datasets mined in order to glean useful information from them, many problems being faced by communities and cultures along with corporations and organizations would have been improved and possibly even avoided in future iterations. The trend is in a gradual manner going towards such a state, but that is a nascent culture being brought about in companies and organizations. When taking into view the average individual or members of a society, they are yet to embrace the idea of delving into open data and wondering out the intricacies and planning their own line of action with the data.

This is where the concept of serious games was brought into play. After having considered the situation with the underutilization of the open data, the author considered what means of involvement would be beneficial in order to get people to participate in the usage of the data available.

The first consideration was to reflect upon whether people were cognizant of the fact that data was available to them online such as the ones being discussed here. There are people who have not considered this to be the case, and there are people who know of such stores of information to be available on the internet but do not have the motivation or the intention to actually access the information to see what is available. Then there are also people who have been on websites that offer them the stores of information, but when considering how the layout of those platforms worked, they were lost and lost the motivation to continue. There are people with these variations and a lot more stories as to why they have not been seeking the avenue of becoming data literate and considering what they could do with the data.

After considering the above, the next step was to decide upon a tactic that would fulfill the purpose of them having a good time while also being able to teach them in a non-intrusive manner. The consideration went over a number of options, but the one that was at the forefront of the list was something that has kept the author entertained all the while instilling valuable lessons in him and teaching him a little of the language as well: Games.

Games, as already mentioned, have been around for centuries. Whether board games, card games or physically active ones where one is supposed to run and do all sorts of acrobatics, games have been compelling people to work and think and grow for more than several lifespans of humans. The recent addition have been digital games that one plays on devices while viewing the interface through a monitor, but the same essential concepts are involved. It attracts their attention (or awareness), causes them to get interested in whatever aspect of the game is most appealing for them, creates a desire in them to play and then calls them to act upon that desire, when considering the AIDA model of marketing albeit this not being a marketing campaign (DeMers, 2013).

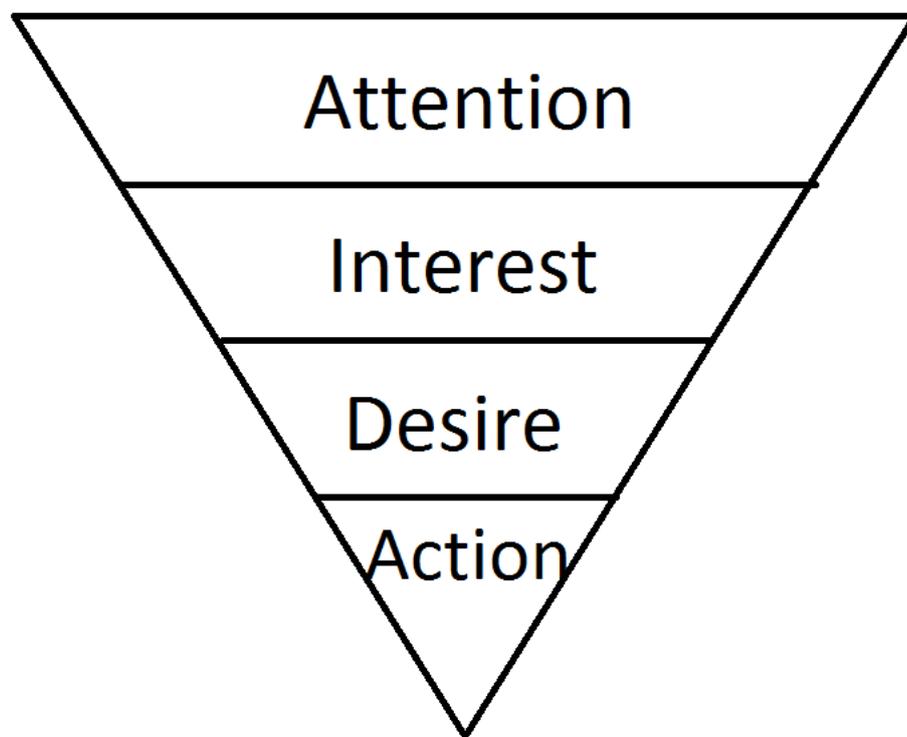


Figure 5 - The AIDA Model

In such a manner, the user is engaged and is more attentively made to play the game while taking in the information that is being divulged to the person.

Associated with games is an impulse that causes people to play it, whether they be casual game such as those played on the phones or more serious games such as those played on consoles or expensively built gaming machines that catch a person's fancy. Children, young adults, and adults play games. So it was a more natural decision to decide upon a game for the format of the application which was to distill the data that was going to be decided upon.

Once the decision of a game had been adopted, it was then time to decide what sort of game was to be introduced to the user. This is a point which had many considerations, as there are games that are targeted towards a wide range of people. There are games which are very action intensive that might move the focus of the play in a direction not wanted. There are other, simpler games that involve a lot of repetition in the gameplay, such as has been the trend in casual games. But the search for a game format that would provide a good balance of familiarity and thought provocation caused for a progression through a wide array of games on offer. Board and other games were deliberated upon until a tried and tested game was decided upon as the basis of the game that was to be used. During the search, a certain type of card game was also put under consideration, one that was instantly familiar, and one that has caused people to deliberate and ponder over their moves very carefully.

The game that was to be the basis of the game finally implemented in the thesis; the game settled upon after a great deal of pondering, was a game that graced the scene all the way back in the year 1978 (Art & Hue, 2018), one that is called 'Top Trumps'. It is played in a manner that the various players are provided with a set number of cards, each card showing a certain character or player, depending on the theme of the game. For example, if the card set is related to Football, then each card will be dedicated to one player. On the card will be shown a number of attributes, such as speed, agility, etc. with a numeric value in front of it. And in each round, an attribute is chosen and then each player has to choose a card that will likely have that attribute value higher than the other cards in that round. The one with the highest value wins the round.

This game has already been documented to have benefits such as promoting social inclusion and the ability to harness self-confidence in the children playing the game without having any

discriminating features. It has thus also been demonstrated to promote positive learning outcomes among the children that were made to use it (Winning Moves UK Ltd., 2018).

This game has been loved and is still loved by adults and children alike to the present day and is still played by many. It is instantly recognizable and has brought about playful joy and laughter to many of its players. And considering the layout of the cards and the manner in which it is played, it provided an ample platform to use and thereby research the various questions set out to answer in this thesis.

After having decided upon the Top Trumps game, it was planned upon to do a digital version of it. This was because of the need to receive a more general and genuine response from neutrally inclined people who were not inconvenienced due to the time and effort it would have required for them to relocate themselves physically in order to play a card game. To the author's understanding, that would have produced a negative emotional bias towards the game they would be asked to play.

One of the other goals of the thesis was also to find out whether gamification could be used to more effectively motivate people into playing the serious game as compared to the more traditional versions of the game. For this, it was decided upon that the game would be made into three versions. One version, the most basic of the three, would remove as much of the game elements that could be done so without causing people to simply not play the game at all. The second game, more common version, was to incorporate the regular attributes of the game, acting as the control of the experiment, in order to get a more generic response. And the third version of the game would include an added dimension from the gamification realm in order to see what effect, if any, which would have on the gameplay and the motivation.

The layout pondered upon was selected as similar to the Top Trumps of old, as shown below. It was a game often played, and the layout of the cards such that people who have played it would be instantly able to recognize, thus providing a learning curve with a low gradient. It

would be instantly recognized by many individuals, and they would be able to get into the game with more ease.



Figure 6. Top Trumps Horror Cards, Devil Priest Set 1978, image adopted from (Bagnall, 2015).

With the layout selected, the next question was to decide upon which sort of information was to be used in the game. There are thousands of datasets available online, open data almost

literally providing every sort of statistic one might require, albeit some being dated and some not so clear, but for the purpose of this thesis, any could be considered. Data from the open data could be considered, while another option was to make up data since one of the goals of the thesis is to find out about whether the users get motivated to find out about open data, the data itself could be fabricated in a way as to represent data from the real world. That may also have sufficed. But on the other hand however, there is a project being developed within the Lappeenranta University of Technology premises known as 'Sense It', referred to locally as Sensei. It is being run by Victoria Palacin.

The project is related to Citizen Science, a field that refers to the fact that data is provided by the citizens in order to gather data. This is also one of the means through which data is gathered and then made public as open data, but the focus of this thesis not on the methodologies used in Citizen Science, and therefore that shall not be talked about in greater detail.

But the Sensei project, in a nut shell, basically involves the citizens reporting on certain aspects within the city of Lappeenranta within Finland. Three categories are reported by the citizens through the apps available, them being Nice Places, Invasive Species and Lost Items. The terms themselves are self-explanatory. How it works is that when a citizen, out on his or her own or with others, encounters anyone of the three categories they take a picture of it, upload it to the application where it is marked and added to the database, and then can be checked on the map provided on the Sensei platform on the website sense.it. If someone finds a certain spot within the city or an artefact which may belong to someone but the person may have accidentally dropped it or they see a certain plant or tree which they deem not indigenous to the locality of Lappeenranta, they can then upload the location and the picture and its description so that anyone wanting to find a nice place, finding their lost property or just a nature enthusiast can see it and check it out for themselves if they feel the need to do so.

The way in which the game would work would be that the user would be given cards that would contain attributes (the number of Nice Places, Lost Items and Invasive Species found by the citizens) of certain localities within the city of Lappeenranta. On the basis of a photograph and the name on the computer's card showing the locality visible to the user, they would then decide

on which attribute of their own card they would pit against the same attribute of the computer's. The one who would win the round would score along with receive the other's card to be played later, until the opponent was out of cards. The number of cards, that is, the number of localities considered to be used for the game was eight, decided upon after consultation with the author's supervisor. Eight was a number that was a realistic figure which would not burden the player into having to play an extendedly long game which would otherwise have become tedious and caused the player to lose the will to continue.

Deciding on making use of this application's data with the permission of those heading the project as it would be something that may further intrigue the locals of Lappeenranta. The people finding more out about their city, which is one aspect of open data, along with being introduced to the open data would be an added advantage of this thesis for those participating in the experiment despite it not being a required directive of the thesis.

5.1. Top Trumps Sensei App Development

After securing the support of the Sense It team, the development of the front-end of the application began underway with various requirements to fulfill. Noting down the time, the player's and the opposition's score and a number of other parameters in order to be saved in the future for analysis of the data.

It is pertinent to note here that the digital version of the game pits the individual player against a computer counterpart, and the computer is not provided with the ability to go first in any round. The player is always made to choose the attribute that would be played in that round. This was not necessary for the game dynamics, but it was decided upon in order to bypass any chance of suspicion in the mind of the player as to whether the computer was 'cheating' due to possibly being privy to the knowledge as to which attribute would definitively win the round for the computer.

By the end of August, there was an event in the City Center of Lappeenranta known as 'Green Reality Carnival' where the various stalls were set up where information related to Green and Sustainability projects were being introduced. One of the stalls was that of the Sensei project as well, where the citizens of Lappeenranta that did not know about the project underway could be informed and their help further enlisted to promote the acquisition of further data. During this event, the author and his supervisor took part where the information that had thus far in the Sensei Data Gathering phase of the project been acquired was used in the form of various games. The data gathering had been underway for a little over a month at the time, and therefore the information present was from data gathered over a four week period. The games were Shark Bytes, Speed Data-ing and Top Trumps. They were all modifications on pre-existing immensely popular card games making use of the Sensei data, the Top Trumps being the physical representation of the digital version of the game under development. On the same table, the digital representation of the game that had been completed thus far was on offer to be played on an Apple MacBook as well.

The games were mostly physical, where three were physical card games that one could play at each table set out within the stall. There was also an arts and crafts section where children, and adults that wanted to play along, could make use of various crafts materials and make sculptures and drawings inspired by the information they had gathered from the Sensei project data being presented. There were some really nice displays of creativity at that corner of the event.

There was also another piece of equipment at the Sensei front: A large TV attached to a laptop showing the actual Sensei platform with the map displayed, showing all the data that had been gathered visually which was quite the attraction for the elderly as the arts and crafts portion of the event was with the children.

Till that point, the game had progressed well and the first version of the application was coming to a close regarding the front-end of the application that was to be interacted with by the users.

After this point, the back-end of the application and the two other versions of the game were to be realized and implemented. The information to be stored after each iteration of the game had already been decided upon, with the additional piece of information that may seem important later on being added during the time the development was taking place.

The final number of columns to be held within each table holding the information were 11. The first being an ID that is the provided incrementally for every player, and the others being a username, the individual's Year of Birth (both of these requests being assumed, in case there are people who do not want to disclose the actual information), a randomly generated ID which is used for the purpose of the application and does not have any bearing on the actual thesis data, the time taken by the player in seconds in attempting to complete the game (or to note down the exact time from hitting the play button till the user finally left the game, whether that was after or before completion), the player's score, the computer's score, the cards that each party played in order to achieve the score, and then columns that show whether the person played the game to completion or not and whether the person intended on replaying the game. The following is the image of a table that would constitute the data tables from each of the game:

ID	username	assignedRandomID	yearOfBirth	completed	playerScore	compScore	totalTime	playerCardsPlayed	compCardsPlayed	repeated
int	varchar	int	varchar	boolean	int	int	int	text	text	boolean

Table 7. Format of Table for Acquisition of Data from Users

There is one such table for each of the various versions of the game in order to be able to easily and concretely distinguish the data from one another and not have any confusions in the data.

With the information gathered in these tables, the plan of the author is to gather as much data as could be required during the final analysis and accumulation of results.

Along with the backend of the game, the need to diverge from the current version of the game into three distinct playable versions was high on the list of actionable items. It was at this point that the author began authoring the applications in such a way that the three versions conceptually designed could bear fruition.

The control experiment had been decided upon as the one that would include the regular features of the Top Trumps game. That means all the cards along with the points being counted as to which player is winning; the user or the computer. That is considered standard, and therefore the best option for a control.

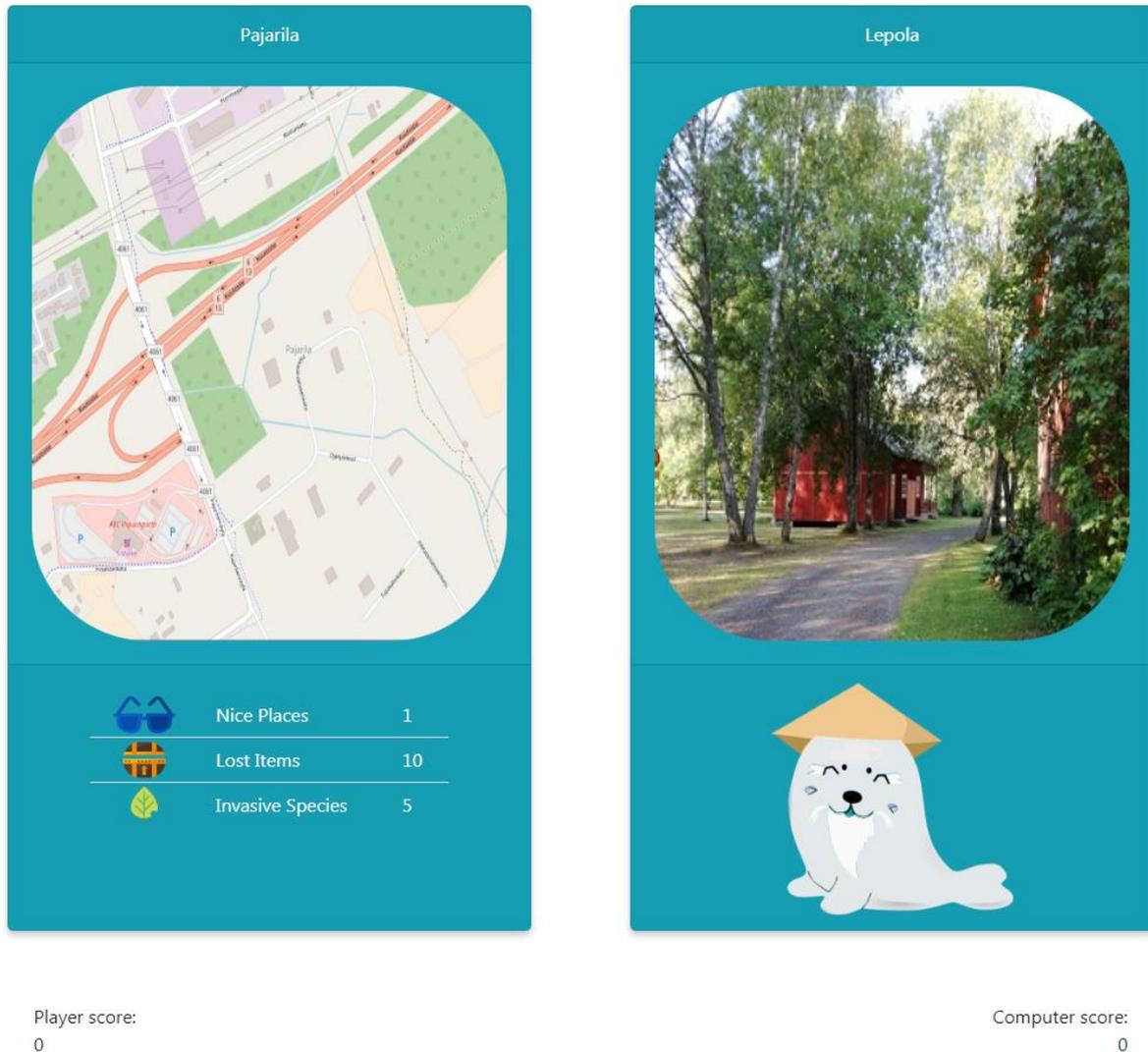
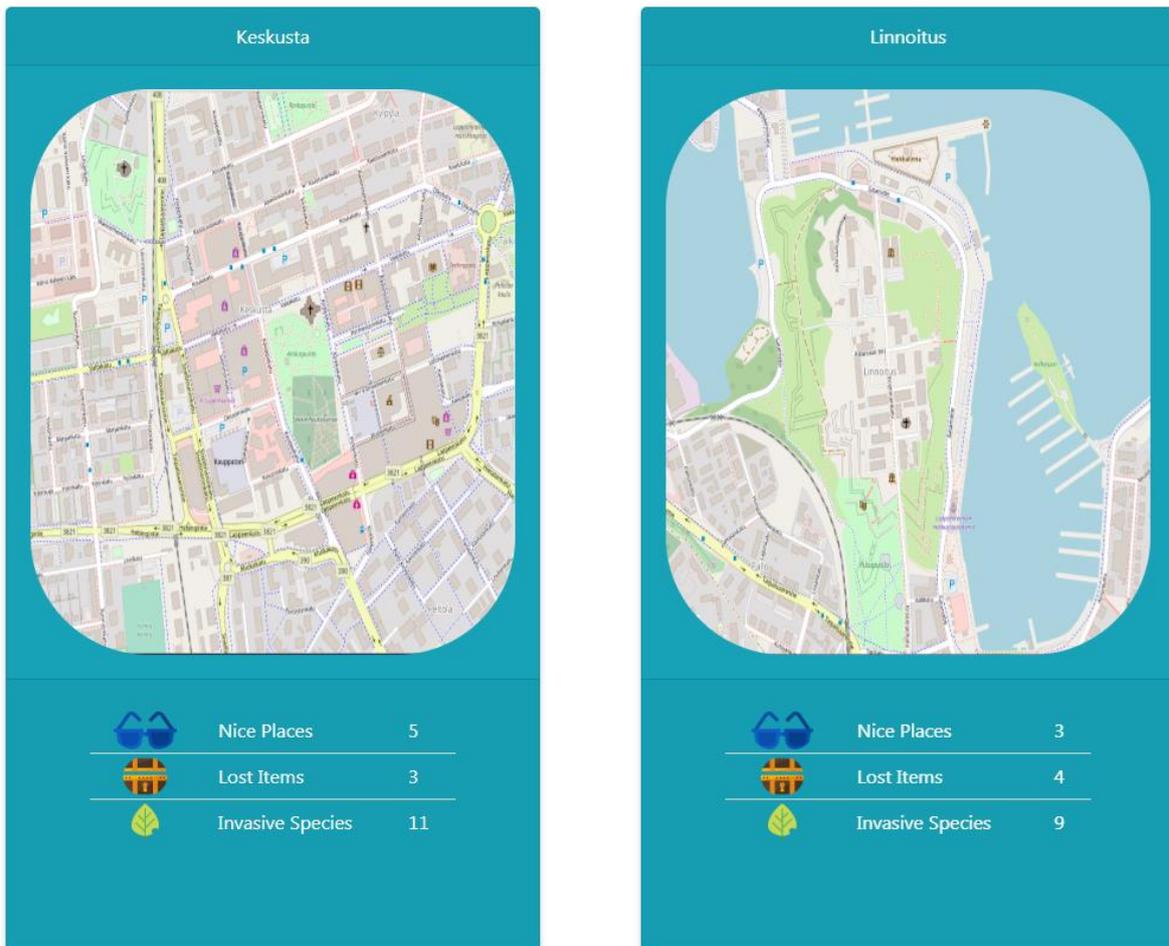


Figure 7. Top Trumps Sensei App layout

The second version of the game was to be stripped of one of the gamification features. And as such, the best consideration for this was the points system, which in itself is one of the most major recognizable features of Gamification. The triple threat of the gamification technique is what is called the 'PBL'. This acronym stands for Points, Badges and Leaderboards (Master, 2017).



Bad luck this time

Next card

Figure 8. Top Trumps Sensei App Without Points Version

These are the most basic of the Gamification tactics, and was therefore considered the most pertinent to remove for a non- or less-gamified version. In this version, the player plays the same game but without being privy to the points that they have gained or that the computer has gained. Unless, that is, if they continue counting each card played and who wins. This is a consideration taken due to the manner in which players of card games on the computer in general play, where they themselves are not counting the cards but rely on the computer to provide them with that information.

The third and final version of the game, the more gamified version of this Top Trumps application, is with the inclusion of a narrative into the plot. Along with having points showing the progress of the game and the information available on the cards, the author of this thesis decided to add another piece of information in the form of a narrative in order to further indulge the individual playing. With a narrative that was playful as well as including the numbers being displayed on the card in a more holistic, and sometimes comedic, manner, the user would feel more engaged and therefore feel more motivated to continue learning.

The following are the pieces of narrative deemed fit for the gamified version of the application, which are then implemented in the system as shown in Figure 9:

Card / Locality	Narrative
Kuusimaki	Ever wanted a lake near your home where you could take a dip in clean waters and sit back and enjoy the scenery? This place might be for you... But watch out in case your home gets infested by plants... You might have to call in the zombies to wipe them out! Remember? Plants vs Zombies? The game? Umm... Ok...
Lepola	Remember that place from back when you were a child? Maybe where your extended family lived, or maybe where a friend's family was situated, which seemed like a good place to live? Not much happening, but an acceptable locality? Lepola is that sort of place. Not great, but definitely not bad.
Keskusta	Having so many shops and stores and vegetation in parts, and since it is the center of town, no wonder Keskusta has a good mix of all the categories researched. It is a good place to visit if you do not want to remain in solitude, which is quite common outside of this part of town. But the number of reported invasive species in the semi-concrete jungle is surprising.

Kivisalmi	As they say in the cartoons, ‘Absolutely nothing to see here, move along folks.’ Just two Lost Items here, which may themselves have been flukes. I am sure. Or am I? What do you think?
Linnoitus	Wide open fields, dotted by plant life creeping wherever the sun shines, hiding treasures that people have misplaced and the rare notable area or two. Might be nice for a stroll or two.
Pajarila	Remember that time when you would always be losing your pen or something or other? You never did find out where all those items ran off to, right? Well it seems that we have found our culprit: Pajarila. A veritable black hole of lost items. But it isn't black; it is a green hole thanks to all the vegetation.
Skinnarila	Fancy going out for a walk with a loved one but you do not know where exactly to visit? By popular consensus, Skinnarila seems to have quite a few sites to see that would make you feel better than when you arrived. And on your way there, you can even run into some invasive species – just make sure you avoid any man-eating flowers if you ever find one!
Uus-Lavola	Judging by the amount of invasive species invading this part of the world, the World War of the Plants seems to have already begun with Uus-Lavola taking center-stage. Where are these plants migrating from? You didn't bring them along with you from your travels to different parts, did you? (Just Kidding!)

Table 8. Quotations for each of the localities used

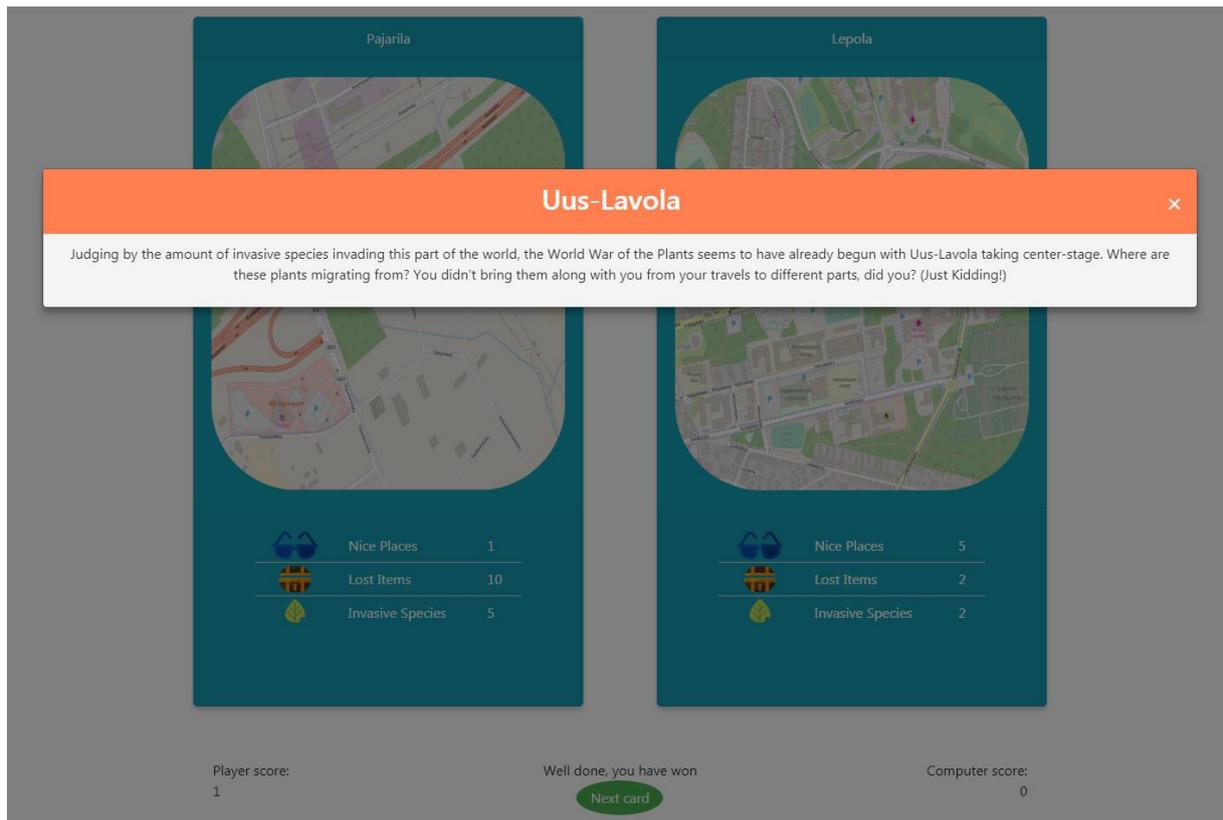
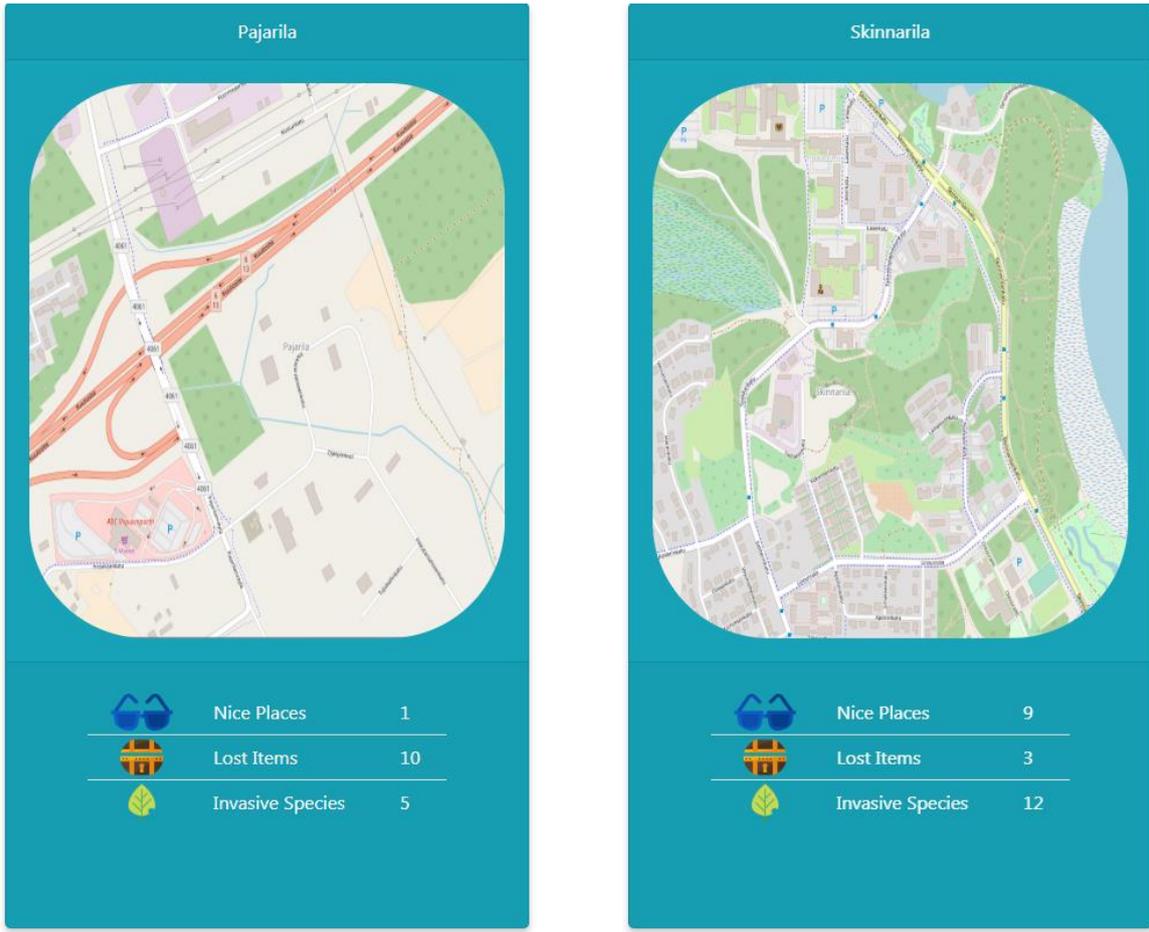


Figure 9. Modal showing quotation after selection of the attribute in the game

With the development of the short pieces of narratives for each card and finalizing the development process of the second and third versions of the game done, it was time to develop the survey. This survey was to be implemented after the player had played the game, in order to take the user's reaction to the serious game and also to find out the player's own proclivities according to the gamification character player types, with the hopes of making a correlation between the types of players and the gamification tactics used.



Player score:
5

No more cards. Play Again?

Computer score:
1

Play Again

Survey

Figure 10. Completion of the game & on to the survey

5.2. Survey Construction

During the development and continuous improvement of the application which was to be implemented to research the questions stated, the survey was to be accordingly designed.

There were a number of considerations to be made, but in order to go about it in a systematic and organized manner, the survey was broken down into three parts.

Before the development of the survey was underway, a very important consideration was to be made: When administering the survey, it is crucial to try to receive as much of a sincere response as possible. But due to the Social Desirability bias, which is a bias among the survey takers that, in order to be viewed in a more favorable light by their peers and other individuals, they might fabricate their answers (or at least respond in a manner that is not true to their nature), there may be certain questions that cause the people being questioned to not respond in a truthful manner (Grimm, 2010). Even if no one is present, one's mind may be reluctant to tick an answer that they would otherwise anonymously have marked as the true case.

Therefore the questions needed to be crafted in a way to elicit a genuine response, but more than that the identity of the individual was to be kept secret. It is due to these reasons that before the game and the survey, a single assumed username and an assumed Year of Birth were asked. This is in order to not impose upon the user by asking for information that they would otherwise not want to give, since there are people would like to keep such information private.

We live in an increasingly digital world where many applications require the person to select a username, and therefore maintaining many such usernames becomes difficult. It is possible that many people have a single username for a number of those applications, and that when prompted for a username, that is the information they automatically go to. But that information may be considered private to give by those people, as well as their year of birth. Therefore, by providing the option that they could be disingenuous with regards to both of these aspects, they

are provided a greater level of security as to their data, and thus the responses elicited would be of a more genuine nature and not be hampered by the social desirability issue.

The first part, the initial and relatively simpler portion of the survey, was to check the proclivities of the user. Every person is an individual with their own tastes and fancies. Every human has a predisposed inclination towards one thing or another. After all, every individual is a unique creature. And therefore, in order to check what sort of inclination the person has, the test for the player type was to be performed.

As initially stated, there are a number of methods to check which player group any person falls into. There are ones with a basic of four player types (Bartle), and others that can range a higher, more specified types. For the purpose of this thesis, the Hexad Player Types was used. This is a widely approved and accepted players types convention used by the gamification community, and was seen as a viable methodology to research the question of whether certain types of gamification strategies help people to be motivated or learn better.

It is for this reason that the Hexad Player Types survey was taken into account and considered, the player types being Achiever, Socializer, Philanthropist, Free Spirit, Player and Disruptor.

There was, however, a very important consideration to be made. The survey for the player type alone was a whole thirty questions long. Even though the questions were not difficult and did not need to be thought over for a long time, thirty questions following a game that may come to an end between a few seconds to a few minutes may not be the optimal solution in keeping user fatigue away. Especially considering that these thirty questions were to be supplemented with a few more that were directly relevant to the game and the research questions trying to be solved.

It is due to such considerations that a more intuitive and user friendly version of the survey was required. As such, the number of survey questions within the initial Hexad player types survey

was rather extensive and could be cut down without affecting the score rather significantly (Tondello, et al., 2016).

User Types	Items	5-items subscale correlation (r)	4-items subscale correlation (r)
Philanthropist	P1 It makes me happy if I am able to help others.	0.786	0.780
	P2 I like helping others to orient themselves in new situations.	0.779	0.775
	P3 I like sharing my knowledge.	0.733	0.783
	P4 The wellbeing of others is important to me.	0.771	0.763
	P5 I feel good taking on the role of a mentor.	0.667	removed
Socialiser	S1 Interacting with others is important to me.	0.730	0.734
	S2 I like being part of a team.	0.624	0.617
	S3 It is important to me to feel like I am part of a community.	0.670	0.676
	S4 I enjoy group activities.	0.688	0.662
	S5 It is more fun to be with others than by myself.	0.569	removed
Free Spirit	F1 It is important to me to follow my own path.	0.529	0.480
	F2 I often let my curiosity guide me.	0.491	0.546
	F3 I like to try new things.	0.507	0.525
	F4 Being independent is important to me.	0.538	0.496
	F5 I prefer setting my own goals.	0.373	removed
Achiever	A1 I like defeating obstacles.	0.603	0.574
	A2 It is important to me to always carry out my tasks completely.	0.483	0.485
	A3 It is difficult for me to let go of a problem before I have found a solution.	0.553	0.569
	A4 I like mastering difficult tasks.	0.612	0.604
	A5 I am very ambitious.	0.454	removed
Disruptor	D1 I like to provoke.	0.579	0.588
	D2 I like to question the status quo.	0.451	0.398
	D3 I see myself as a rebel.	0.569	0.569
	D4 I dislike following rules.	0.523	0.577
	D5 I like to take changing things into my own hands.	0.323	removed
Player	R1 I like competitions where a prize can be won.	0.445	0.459
	R2 Rewards are a great way to motivate me.	0.561	0.622
	R3 Return of investment is important to me.	0.359	0.313
	R4 If the reward is sufficient I will put in the effort.	0.580	0.568
	R5 I look out for my own interests.	0.305	removed

Table 9. Concise version of the original Hexad questionnaire, table adopted from (Tondello, et al., 2016).

As per Table 9, the subscale correlation scores provided have been used to explain that out of the five question in each of the six groupings, there was a weak link that, if not incorporated into the main body of the conducted survey, the result would still not be heavily affected. This is an understandable claim if one views the questions themselves, with the scores providing

more concrete findings. It is due to this reason that in each of the six groups, the weakest of the questions with not much bearing on the output of the surveys was dropped. The resulting survey then contained 24 questions.

This would have been acceptable, if the survey were the only issue being tested. But in the case of this Master's Thesis, the author was not finding out only whether a person could be categorized under one or the other player type. Keeping the user fatigue after playing the game and then having to answer the survey in mind, the questions for the survey proposed, despite them being very valid questions, were too many for the purpose of this test. It is due to this reason that rather than four, only one of the questions per category were selected. Two would have been better if the question was only about being more accurate in figuring out whether a person was a philanthropist or any one of the other types, but it would have resulted in fewer responses and therefore the decision was made in favor of one question per category. The questions, or rather, statements with which the individual could agree or disagree, used are as follows:

1. It makes me happy if I am able to help others.
2. Interacting with others is important to me.
3. I often let my curiosity guide me.
4. I like mastering difficult tasks.
5. I like to provoke.
6. Rewards are a great way to motivate me.

Having considered the Hexad portion of the survey and with that out of the way, there were two more sections to be tested in order to get a good reading of how the game performed in terms of answer the research questions.

The second section to be made was regarding the learning of the individual from all three versions of the game. For this, and not wanting to have too many questions in order to not wear the player out, three questions were decided upon and documented to be used in the survey.

The reason for the three used was because there were three attributes being tested in the Top Trumps game, and therefore one question for each of the attribute being tested was deemed enough. The questions, unlike the Hexad player types questions, were not according to the Likert-type scale. Instead, they were Multiple Choice questions with each question having three options: One option being the correct answer, another being a false answer, and the third signifying that the person did not remember the details upon the cards. Although that is not likely due to having to play at least four rounds where two of the cards out of eight are played by both the players in each round, the human mind is fickle and therefore sometimes tends to forget. Therefore, rather than guessing and getting the right answer at a probability of 0.5, it was therefore decided to add this third option to reduce the guesswork resulting in correct or incorrect answers. The questions are as follows:

1. Would you take your friends to Lepola or Uus-Lavola for a scenic outing?
2. Is Keskusta more invaded by the floral species or Kivisalmi?
3. Would you rather go to Kuusimaki or Pajarila if you were afraid of losing your wallet?

With two portions of the survey done and the last segment left, it was in this segment that the actual results of how the game performed were to be tested. The author needed to document qualitatively how much of an effect this game had had on the users with respect to their level of motivation, piquing their curiosity, and raising their interest in general with regards to the open data and data literacy.

The first three questions were made while keeping the three attributes in mind and making sure not to lead the survey taker in any particular direction. The questions were to be neutral; they are not supposed to lead the user towards answers the author of the survey wishes to receive. It is therefore that, though the Likert scale of five points was used similar to the questions in the Player Type section, the meaning of the points were altered for all the questions to reflect what was being asked. Though this removes from the usual 'Agree/Disagree' template of survey questions, an added benefit, besides it providing a more neutral form of questioning, was that these would prompt the user into pondering over the questions for a brief moment before

deciding on the answer they were going to select. This was with the hope of receiving more candid and genuine responses. The questions have been recorded below:

1. How surprised were you to find so many lost items in the area of Pajarila?
2. How interested are you to find out where the invasive species are coming from and how?
3. How willing would you be to go out and check the nice places in Skinnarila yourself if other people are advocating them?
4. Did you know about open data being available on the internet for you to use?
 1. If yes, do you interact with the data?
 - If no, do you not interact with the data because you find the data's presentation difficult to understand?
5. Has the presentation of findings in such a game-like fashion raised your interest in open data?
6. If open data were available in such a format (i.e. serious game style), how interested would you be in researching and possibly developing solutions for problems such as those highlighted in this game?

The first question is to represent whether the player was interested to find people having lost items in the localities of Lappeenranta. The second was to gauge their interest in wanting to see the plant culture of the localities after noticing the invasive species. And the third was in order to check whether one was willing to explore the areas and see the nice places after being informed that others found nice sites to visit.

Following the questions, a Multiple Choice question followed with nested questions within it in order to find out whether the user was already privy of the knowledge that there was such a thing as Open Data available to them on the internet, and if so, whether they had tried to use it, and the reason for why they had not bothered to access it if they knew about it.

Another dichotomous question included in the survey required the asking of whether such a manner of presentation for open data (i.e. in the form of a serious game) increased their will to learn about such data sets or whether it did not afford them any such interest. This was considered important to ask in the aftermath of the previous nested questions dealing with whether the individual had been in contact with open data or not.

And the final question in the survey was regarding a personal preference of the individual being questioned to whether such incorporations of open data into serious games would be beneficial in probing the person into doing their own research into the data available on the internet and subsequently trying to develop solutions from those datasets. The response to this was decided to be recorded in the initial 5-point Likert scale method.

With the completion of this survey and its polishing, the survey was ready with all of the questions in three sections. The assumed Username and assumed Year of Birth being asked for in the beginning of the survey was in order to link the survey to the data gathered from the game played prior, and to be able to make meaningful information out of the data.

It was now time to put in the actual values of the attributes that were to be deployed for the testing. The data from the Sensei project was collected in a manual manner, zooming in on each of the locations being used using the map tool provided on the Sensei online platform. Then each of the instances for each of the categories was counted and noted down. The results were as follows.

Place	Attribute	Original Value
Skinnarila	Nice Places	13
	Lost Items	2
	Invasive Species	24
Kuusimaki	Nice Places	4
	Lost Items	4

	Invasive Species	8
Uus-Lavola	Nice Places	0
	Lost Items	0
	Invasive Species	23
Pajarila	Nice Places	0
	Lost Items	20
	Invasive Species	5
Linnoitus	Nice Places	2
	Lost Items	4
	Invasive Species	9
Lepola	Nice Places	5
	Lost Items	1
	Invasive Species	1
Kivisalmi	Nice Places	0
	Lost Items	1
	Invasive Species	0
Keskusta	Nice Places	5
	Lost Items	2
	Invasive Species	21

Table 10. Original Values of the attributes obtained from the Sensei platform

But considering the discrepancies as to some of the values being in the twenties and some values being null, the values were expected not to give a sense of flow to the player playing the game. For the concept of Flow to work, the level of the player and the difficulty of the game need to be at a scale similar to each other in order to indulge the player and cause the right amount of adrenal rush that the player engages with the game (Hamari, et al., 2016). And with the current values, the game was not going to be at the individual's difficulty level.

Therefore, after deciding on how to manipulate the data in order to provide a more competitive feel, an algorithm was decided upon where any zero-value of an attribute would be made into a one, a one would be converted into a two, and a two into a three. After that, having taken care of the lower values, the upper end of the spectrum was manipulated in a way that every number

above ten, ten itself being inclusive, but below twenty (excluding that number), the value was then divided by 1.5 and raised to the nearest whole number. And for any attribute with the value twenty or above, the number was to be divided by two and again raised to the nearest whole number. In this manner, the game was made more competitive by having the attribute values lie close to each other, thus causing the individual to activate their memory.

And thus, the final table of values decided upon are as follows:

Place	Attribute	Updated Value
Skinnarila	Nice Places	9
	Lost Items	3
	Invasive Species	12
Kuusimaki	Nice Places	4
	Lost Items	4
	Invasive Species	8
Uus-Lavola	Nice Places	1
	Lost Items	1
	Invasive Species	12
Pajarila	Nice Places	1
	Lost Items	10
	Invasive Species	5
Linnoitus	Nice Places	3
	Lost Items	4
	Invasive Species	9
Lepola	Nice Places	5
	Lost Items	2
	Invasive Species	2
Kivisalmi	Nice Places	1
	Lost Items	2

	Invasive Species	1
Keskusta	Nice Places	5
	Lost Items	3
	Invasive Species	11

Table 11. Updated Values of the attributes obtained from the Sensei platform

6. Results & Discussion

After having deployed the game on a server provided by 000webhost and maintaining the database along with setting up the survey upon the Google Forms platform, the digital addresses of the three versions of the game were uploaded onto various social media platforms and users were asked to take part in the research. A few days were provided in order to provide ample time for people to play the game, and after the allotted timeframe had elapsed, the databases and the google form responses were collected and formatted into a more readable format using Microsoft Excel in order to analyze the data and glean the insights from it.

After reviewing the responses and the data gathered, it was distilled down to 26 responses for both the surveys and the data in the tables of the database of the various versions of the game. But for each, there were two anomalies. There were two users in the game that were not to be found in the survey responses, and there were two responses to the survey filled by individuals that had not gone through the game in order to do so. This is because of the different usernames and the different sequence in which the responses were attained. The data captured in these four instances are deemed to have been from different people, two of which did not play the game and two of which did not fill in the survey, and though there is a low probability that the individuals may have been the same, due to the lack of evidence, it shall be assumed that they are different people.

In the case of the individuals having played the game, their data can be used since the various metrics captured can still provide valuable insight into the effectiveness and the value of the different versions of the game. But with regards to the surveys, other than the information provided by the two individuals that did not play the game that was not directly related to the cards such as their Hexad Player Type profiling and their knowledge about open data, the rest of their responses were deemed inapplicable. The assumption made here was that they had been guessing on the questions asked about the cards within the game as they did not have other avenues of answering those particular survey questions. This is considered a reasonable assumption, in light of the fact that they had not played the game and therefore did not know

what was contained by the cards. Thus, the information from them in those questions may have been misleading and therefore neglected.

6.1. Reaction to the Data presented on the Cards

The first few questions asked were about there having been lost items and a number of invasive species as well as nice areas to see and visit in the regions that the cards represented. Regarding these questions, the responses received were not surprising. Without having been provided the facts, the individuals would otherwise have not come to know such information. Especially about lost items and invasive species. Individuals in general have an eye of noticing nice places, especially when considering an individual who likes the outdoors who is innately want of noticing them, but when it comes down to lost items and invasive species, it is harrowing to note so many of them in these areas.

Thus, the following charts depict the results. The results, except for a limited few in the case of invasive species citing that the individuals are not intrigued to find out about where they are coming from and in what manner they are being transported, the vast majority were surprised to see the findings from the Sensei platform regardless of whether they played one version of the game or the other and regardless of their Hexad Player Type inclinations.

How surprised were you to find so many lost items in the area of Pajarila?

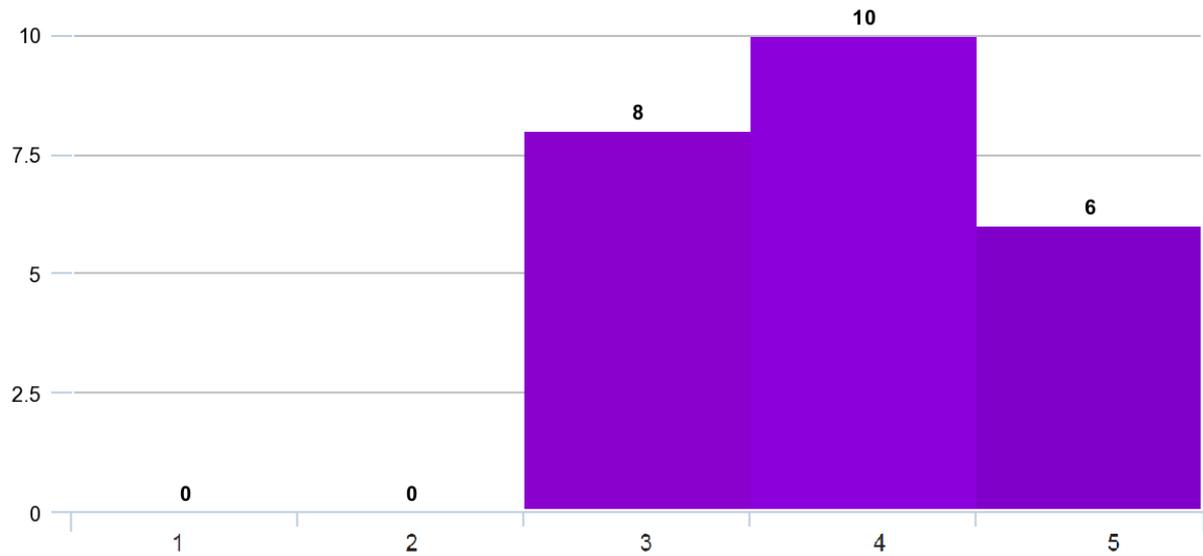


Figure 11. Stats indicating responses to 'How surprised were you to find so many lost items in the area of Pajarila?'

How interested are you to find out where the invasive species are coming from and how?

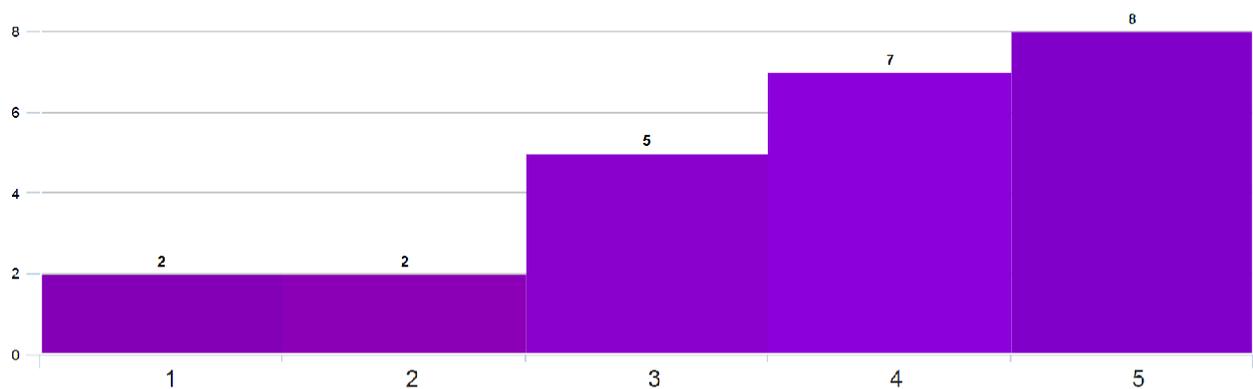


Figure 12. Stats indicating responses to 'How interested are you to find out where the invasive species are coming from and how?'

How willing would you be to go out and check the nice places in Skinnarila yourself if other people are advocating them?

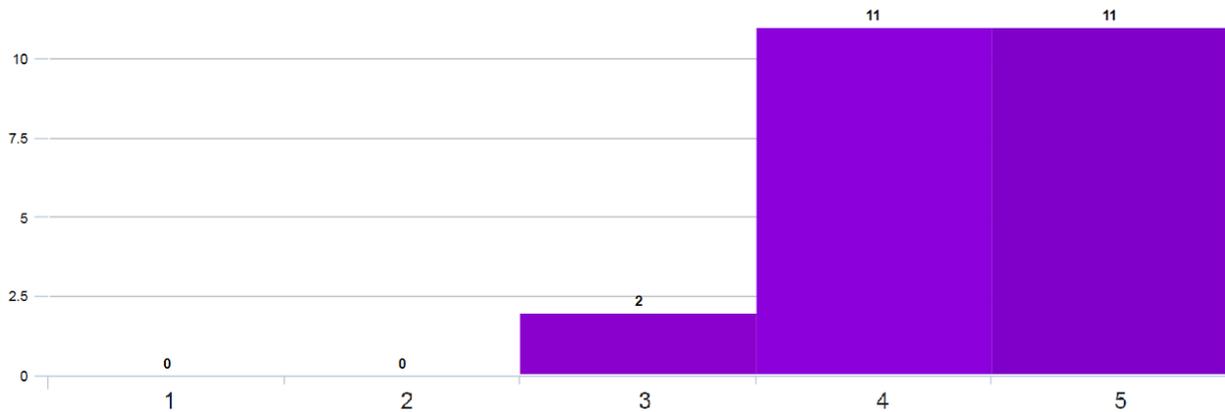


Figure 13. Stats indicating responses to ‘How willing would you be to go out and check the nice places in Skinnarila yourself if other people are advocating them?’

6.2. Regarding Open Data

Regardless of whether users were asked to play the version that involved the regular method of maintaining only points, involved the points alongside quotations in the form of narratives, or the version that lacked both the above mentioned properties, the questions were the same for them in order to find out about their past interactions with open data till this point in time. This was so that information related to their knowledge about and interaction level with open data could be gauged.

Out of the total responses to the survey, in this case considering the entirety of the 26 responses because the questions only asked about their interaction with the data available online and not anything related to the application, the following were the results obtained.

Did you know about open data being available on the internet for you to use?

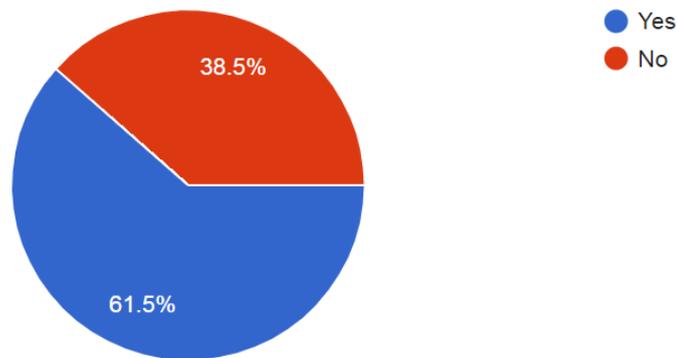


Figure 14. Stats indicating responses to 'Did you know about open data being available on the internet for you to use?'

The pie chart of Figure 14 shows that most of the individuals surveyed had awareness as to what open data was and about it being available to them online. Sixteen out of the total Twenty-Six candidates knew about the availability of these data sets and that they could interact with them. And those 16 survey takers were eligible for the next question.

If yes, do you interact with the data?

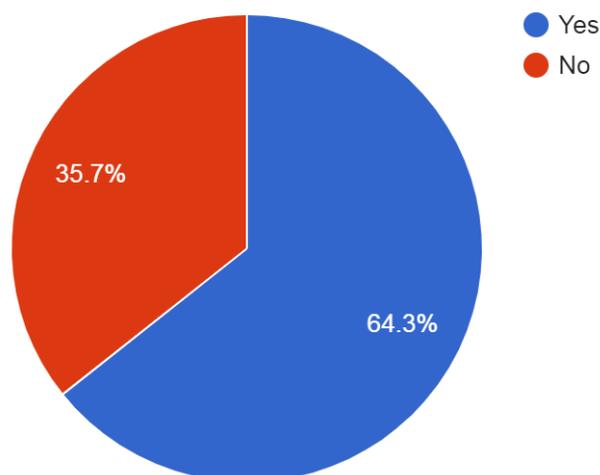


Figure 15. Stats indicating responses to 'If yes, do you interact with the data?'

As the pie chart of Figure 15 further illustrates, out of the individuals that had selected ‘Yes’ as their answer to the previous question, they were further asked if they interacted with the data.

And out of those answering this question, 11 answered with a ‘Yes’ while Five answered with a ‘No’. This question provided the insight that out of the initial 26 candidates, only 11 of them actually interacted to a certain degree with the open data. Some of the candidates may be doing so due to their studies, or due to their work requiring them to do so, or other.

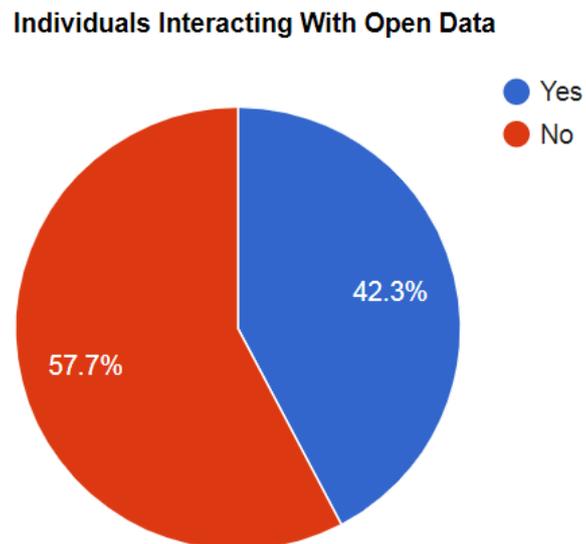


Figure 16. Stats indicating total individuals interacting with open data out of user pool

The pie chart shows that less than half of the population tested actually interacted with open data, even at a cursory level.

Those who had selected ‘No’ as their answer for the question ‘Do you interact with the data?’, they were presented with the next question.

If no, do you not interact with the data because you find the data's presentation difficult to understand?

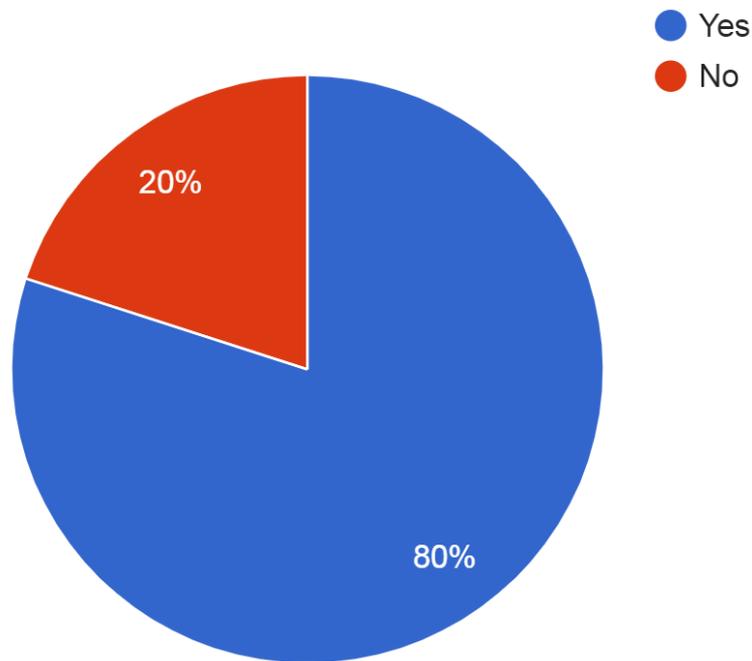


Figure 17. Stats indicating responses to 'If no, do you not interact with the data because you find the data's presentation difficult to understand?'

Figure 17 shows the percentage of individuals that claim to have not interacted with the open data because the presentation was not user friendly. This refers to open data not being presented in a way that encourages user interaction, according 80 percent of the question answerers (4 out of the 5 people that were eligible for the question).

For the following questions in this section, due to the requirement of the game having been played, the data of the two users without having accessed the game is rejected and no longer considered.

Has the presentation of findings in such a game-like fashion raised your interest in open data?

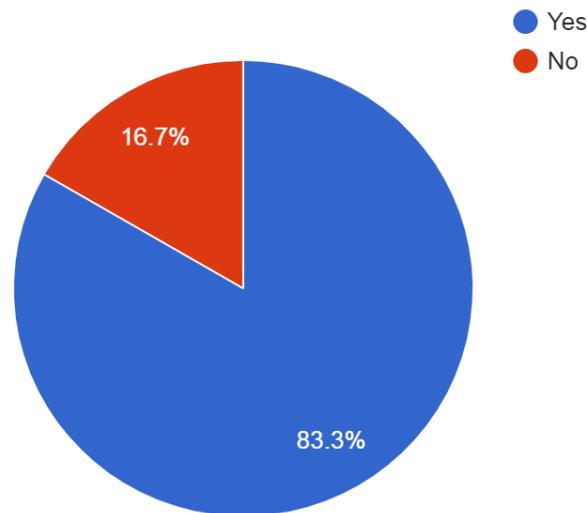


Figure 18. Stats indicating responses to 'Has the presentation of findings in such a game-like fashion raised your interest in open data?'

This is the result of the 24 respondents that answered the survey after having played the game as well. 20 of them responded to having had their interest raised after playing a serious game that involved open data.

6 out of 7 people who played the game as the Points only version provided a 'Yes' to the question, likewise being done so by 11 out of 13 players of the Points-plus-Quotations version, while 3 out of the 4 players provided a similar response for the version lacking both. And though the number of responses for the latter version were rather limited, the general trend among players of all three of the versions of the game depict a positive response to such a manner of open data presentation.

The last question in this section of the survey asked how much having data presented to them in such a manner would motivationally incline them towards actually researching and gleaning information from the data they would be presented with and subsequently try to come up with solutions such as those having been highlighted in the game.

If open data were available in such a format (i.e. serious game style), how interested would you be in researching and possibly developing solutions for problems such as those highlighted in this game?

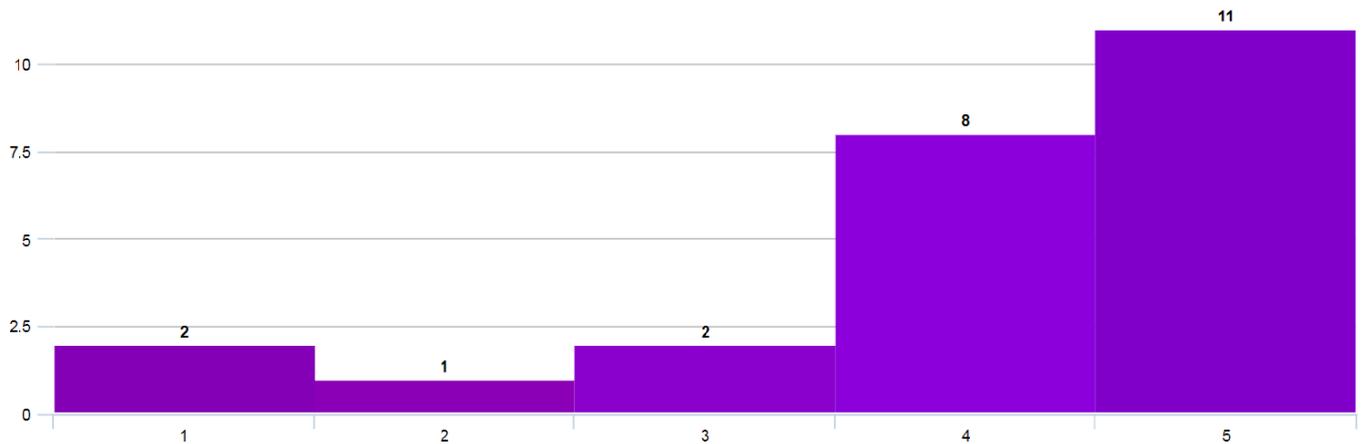


Figure 19. Stats indicating responses to 'If open data were available in such a format (i.e. serious game style), how interested would you be in researching and possibly developing solutions for problems such as those highlighted in this game?'

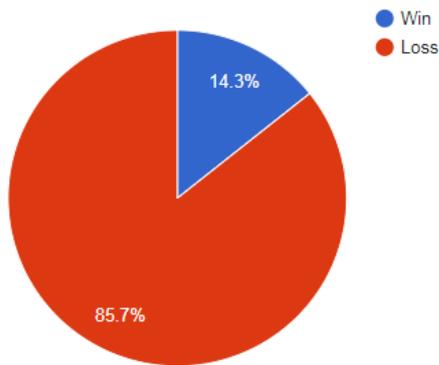
The majority of the responses, 19 out of the total 24, responded by saying that they would be interested or highly interested. 2 individuals responded by saying that they would be neither interested nor disinterested in such a consideration, while 1 individual responded with being disinterested and 2 stating that they would be against any such consideration whatsoever.

6.3. Questions Regarding Data Retention

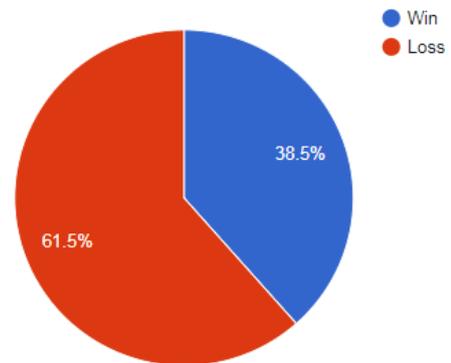
In this section of the survey, questions related to some of the specifics of the game were taken into consideration. This was so that each of the three versions of the game were put into the limelight and comparisons could be made as to whether certain types of gamification strategies had a more profound effect in helping the learning process with such games or not.

Among the users of the games, those that could be accounted for in the game and the survey both, there were 4 individuals out of 7 that had completed the Points version of the game. 10 out of 13 players of the Points-plus-Quotations version finished the game, while all 4 out of the 4 players of the version that lacked both gamification strategies completed the game.

Points Version



Quotations Version



Without Points Version

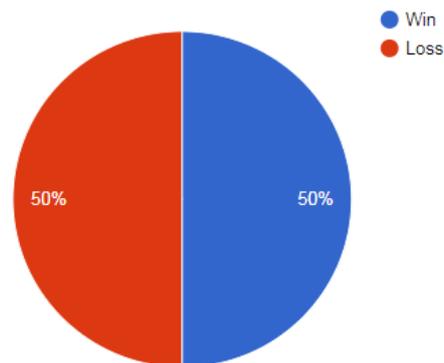


Figure 20. Success rate for all versions of the game

For the Points version, the average time spent on the game by the individuals was approximately 208 seconds per session, with only one completed victory out of the 4 individuals that were able to reach the endpoint. This makes it a percentage of only 14.29%.

For Quotations Version of the game, the average time spent was calculated to be approximately 210 seconds per session, with five victories. This shows the win rate at being 38.46 percent, which is considerably better than for the version with the Points gamification element.

For Non-Points-Non-Quotations Version, total time spent per session by each individual was 87.75 seconds, much lower than those of the other two. And with the results of only four people being considered, with 2 wins taking the win percentage to 50%, this shows the highest rate of winning along with the least amount of time having been spent upon it.

Taking into consideration the questions within this section of the survey, the questions and results for each of the three queries into how much the individuals were able to retain is as follows:

Would you take your friends to Lepola or Uus-Lavola for a scenic outing?

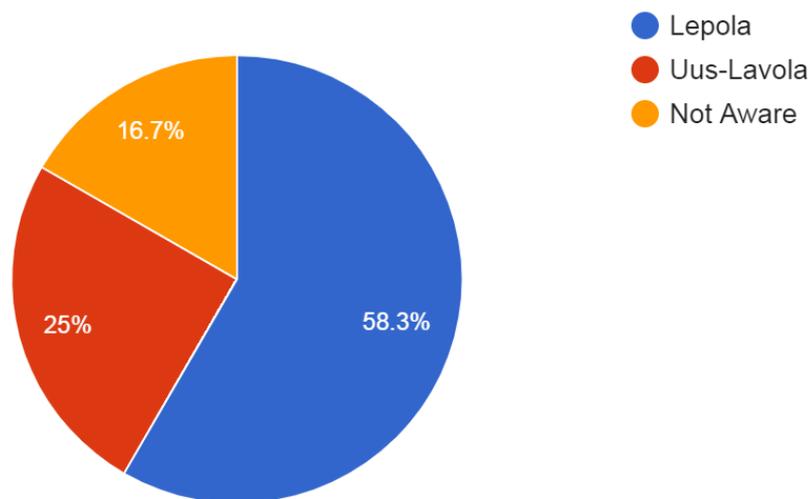


Figure 21. Stats indicating responses to 'Would you take your friends to Lepola or Uus-Lavola for a scenic outing?'

With the total results of the first question being shown in Figure 21 and the Version-wise results of this question shown in Figure 22, the game in general was shown to have provided the accurate answer over fifty percent of the time. The negatives were 25 percent of the time, while those that did not remember the answer came to about 16.7 percent of the total game and survey takers.

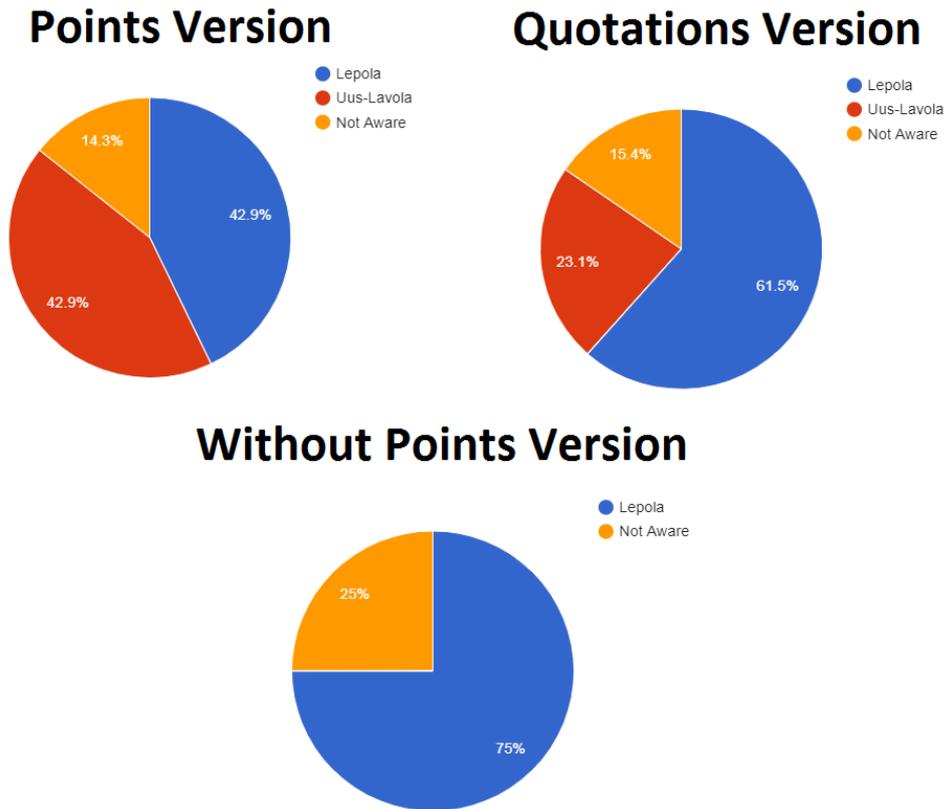


Figure 22. Victory rate for all versions in Question 1 of the second part of the survey

Considering the Version-wise answers, the people who took part in the Quotations were far likely to achieve a positive response as compared to those who had been part of the Points version. But as far as the best response for this question went, the Version without points took the cake with 75 percent of the answers being correct.

Is Keskusta more invaded by the floral species or Kivisalmi?

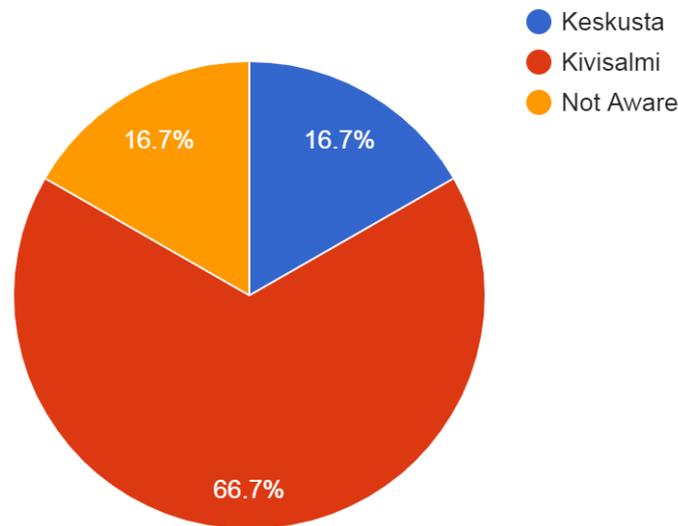


Figure 23. Stats indicating responses to 'Is Keskusta more invaded by the floral species or Kivisalmi?'

The next question to follow was whether Keskusta had more Invasive Species or Kivisalmi. The correct answer in this case was Keskusta, but in general, this was not a question that had been answered correct by most of the participants of the game, any version considered.

66.7 percent of the answers were wrong, which may allude to the fact that this attribute was not really that highly considered by many of the individuals as it correlates to the answers of the question asking whether people were interested in finding out where the Invasive Species were coming from and how.

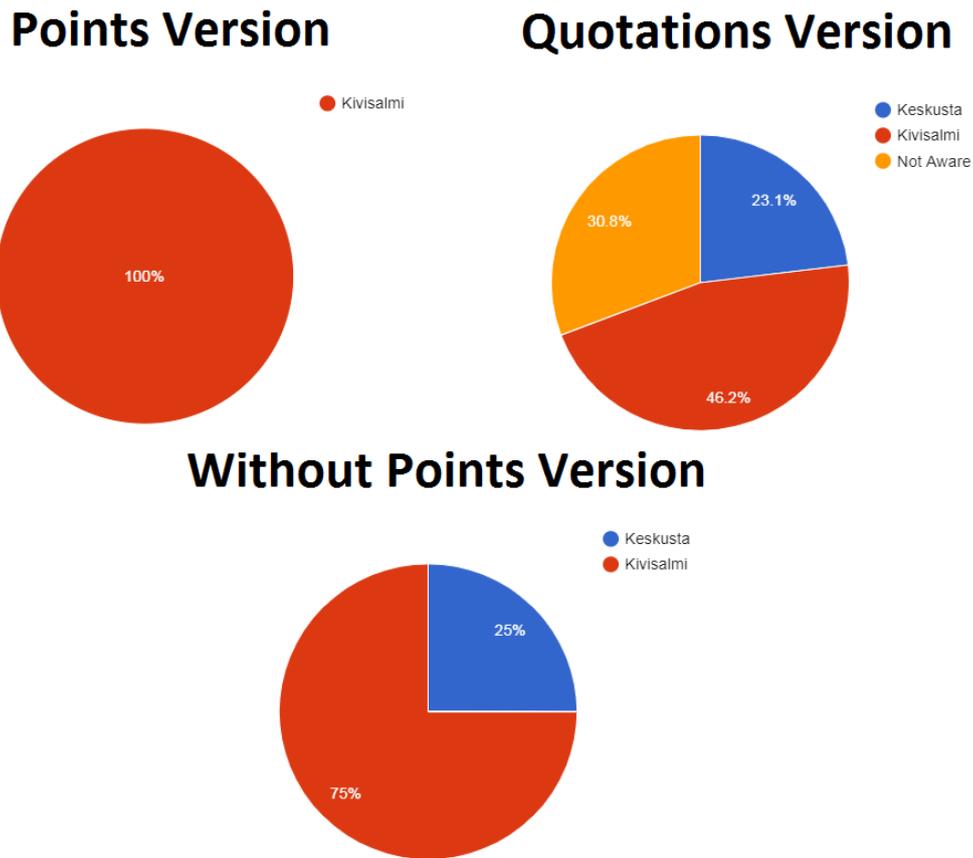


Figure 24. Victory rate for all versions in Question 2 of the second part of the survey

The charts in Figure 24 show that the Points based game resulted in 100 percent incorrect answer, while the quotations one and the without points version were better, but compared to one another, there was not much of a difference when successful answers were considered.

Would you rather go to Kuusimäki or Pajarila if you were afraid of losing your wallet?

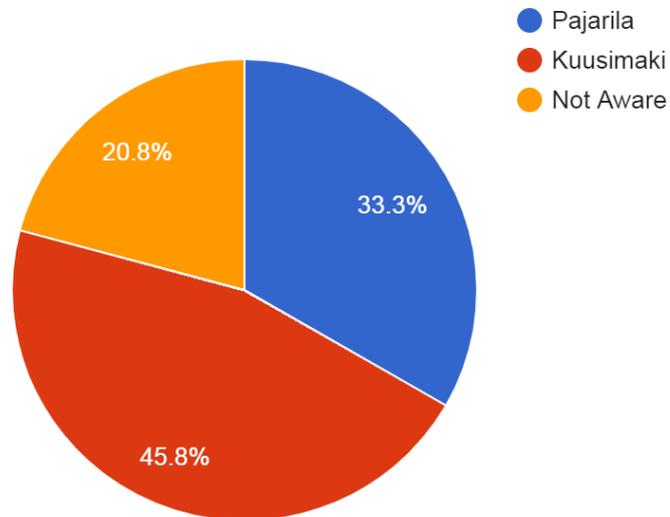


Figure 25. Stats indicating responses to 'Would you rather go to Kuusimäki or Pajarila if you were afraid of losing your wallet?'

Though this question also held more incorrect answers than correct ones in general, the various versions of the game provided interesting results, as are shown below in Figure 26.

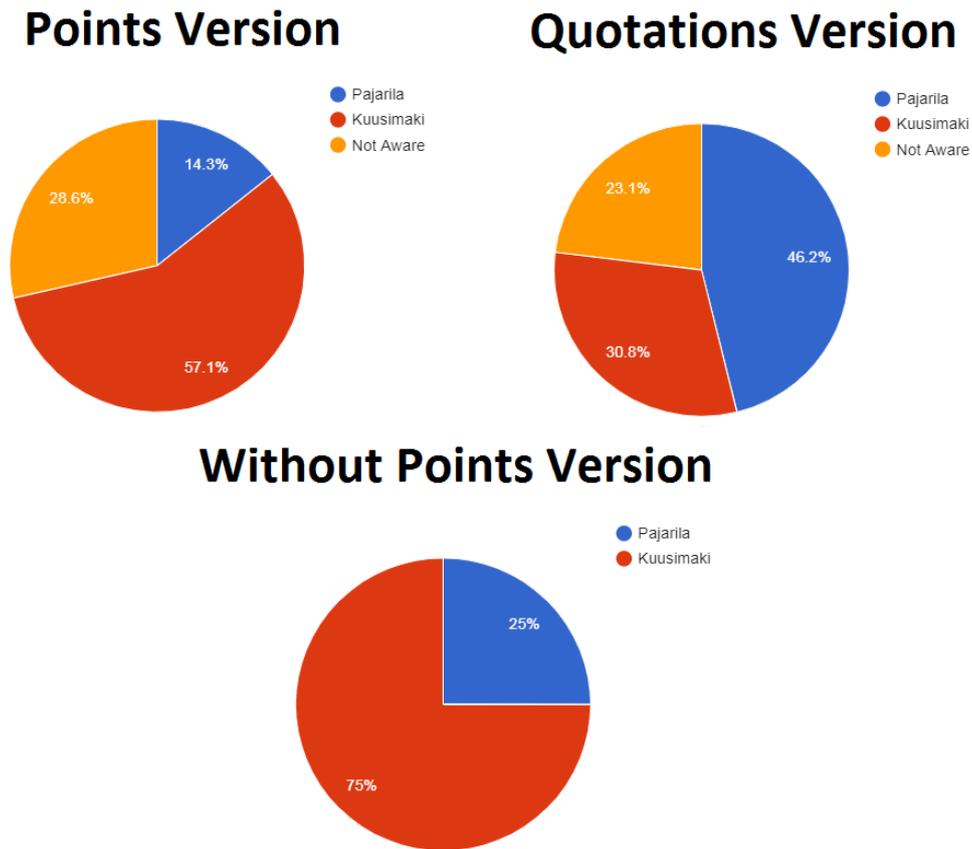


Figure 26. Victory rate for all versions in Question 3 of the second part of the survey

The charts in Figure 26 show that the version without both the gamification strategies held the most incorrect answers at 75 percent, while the Points version came at second place with 57.1 percent incorrect answers. In this question, the Quotations version was the most successful with 46.2 percent correct answers and 30.8 percent incorrect answers.

6.4. Information on Playing Habits

In the case of Hexad Player Types, the total number of respondents of the survey was taken in order to gauge a more general idea of the types of people coming towards the survey. The results are as follows.

It makes me happy if I am able to help others.

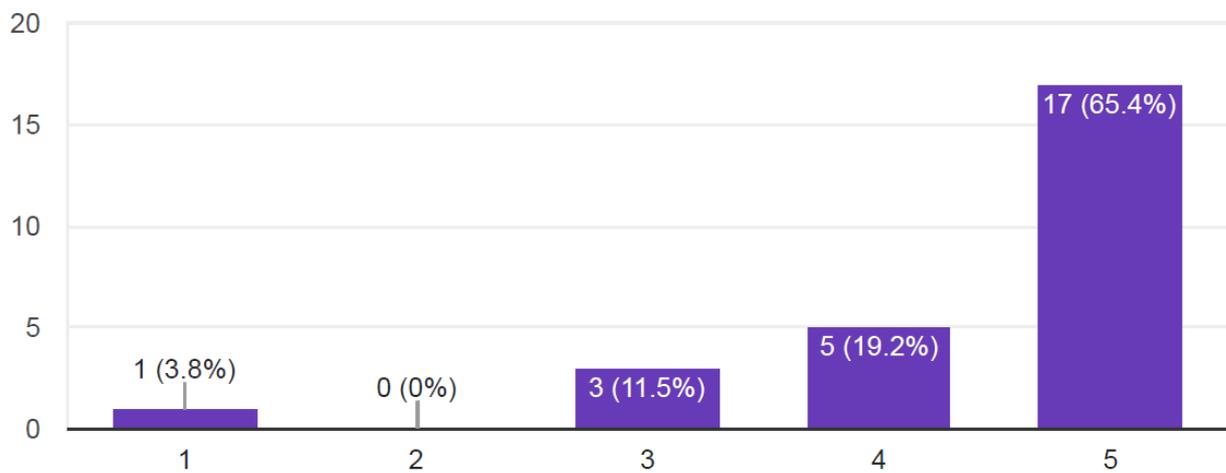


Figure 27. Stats indicating responses to 'It makes me happy if I am able to help others.'

The graph in Figure 27 shows the proclivities of the survey takers towards a philanthropist personality trait when considering the various users from a gamification point-of-view. Out of the individuals that took part in the survey, over approximately 65 percent of the people said that they agreed immensely with the fact that if they were able to help other people, it would make them happy. This is a philanthropic view, which means that just being able to help people was enough to prompt them to help other individuals out. Only one out of the pool of applicants showed proclivities towards the opposite end of the spectrum.

Interacting with others is important to me.

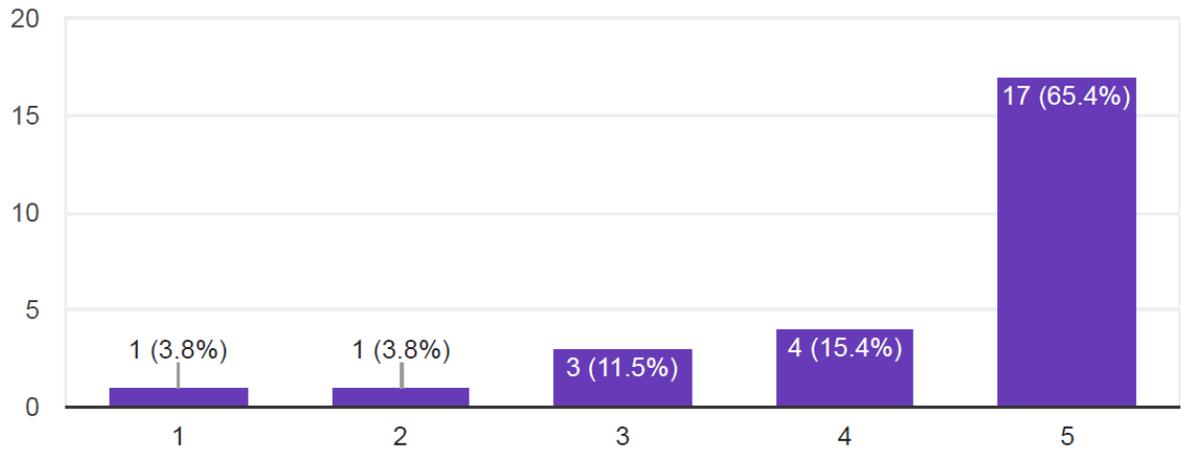


Figure 28. Stats indicating responses to 'Interacting with others is important to me.'

Those who agreed with this statement wholeheartedly show the tendencies of that person being a socializer. A socializer is one who likes to spend their time mingling with others and spend their time in the presence of other people. Many of the individuals tested agreed to this statement with a few not being overly fond people.

I often let my curiosity guide me.

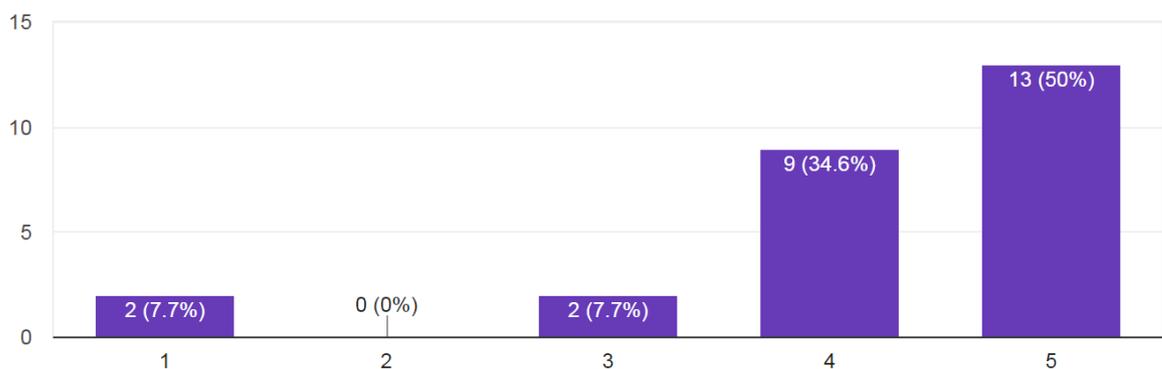


Figure 29. Stats indicating responses to 'I often let my curiosity guide me.'

The next question was about whether the users of the gamified system were Free Spirited individuals or not, letting their interests and their curiosities guide them through whatever may come before them. This is indicative of people who love to explore the world's they take part in when playing games and who have the will to go out into the world and explore.

I like mastering difficult tasks.

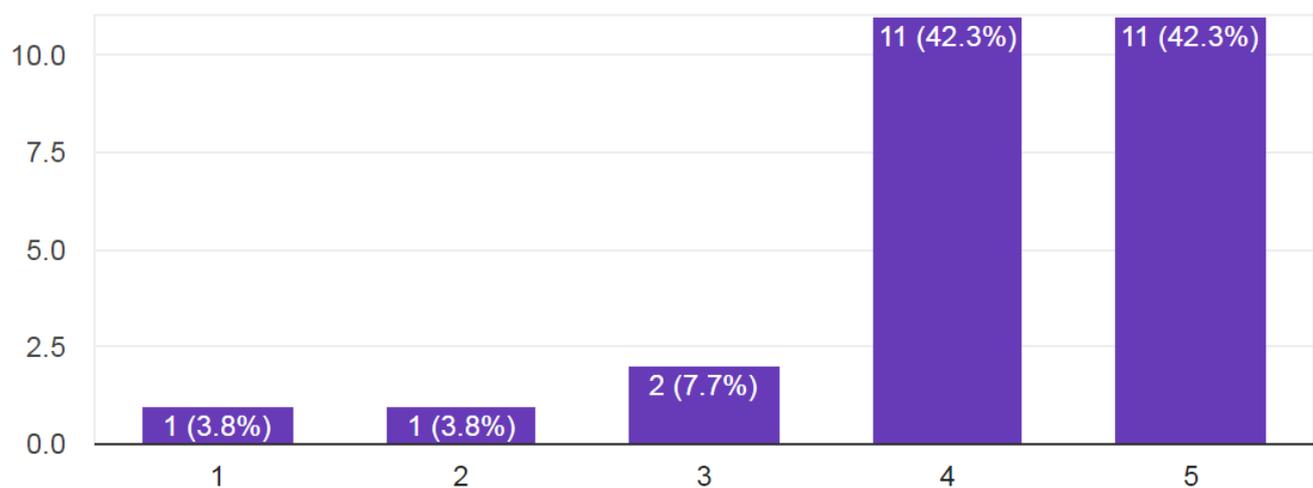


Figure 30. Stats indicating responses to 'I like mastering difficult tasks.'

Mastering of abilities and overcoming immensely obstacles difficult obstacles in order to reach the pinnacle in a certain field or aspect of a game shows that the person has the leanings towards being an Achiever. Among the people tested for this trait, there were 11 people who agreed to this statement and there were 11 who highly agreed with the statement. Then there were 2 people who reported to being neutral in this situation, whereas there were one of each for disagreeing and highly disagreeing with the statement.

I like to provoke.

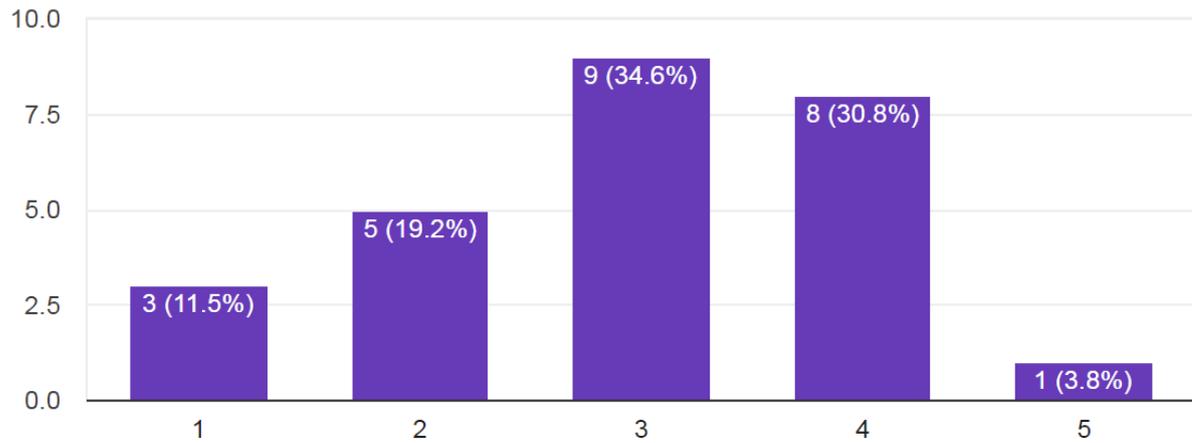


Figure 31. Stats indicating responses to 'I like to provoke.'

This statement is one of the most effective declarations from the Hexad Player Type Survey Questions which help identify a person who is known as a Disruptor: A person who, rather than simply play according to the rules of the game and play fair and do everything by the book, they instead try to find the chinks in the armor and try to push the limits of the various systems that they take part in. This can be seen as a good thing as well as this can be seen as a destructive force. And as can be seen in the responses above, this has the most splayed out result out of all of the statements regarding the Hexad Player Type inquiries, with the most people being neutral to the statement while an almost equal amount of people lay on either side of the neutral zone.

Rewards are a great way to motivate me.

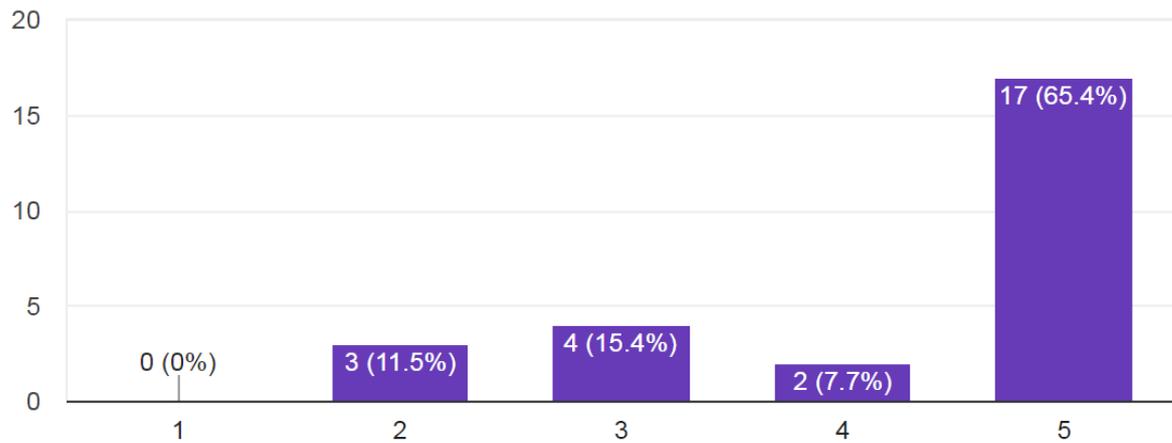
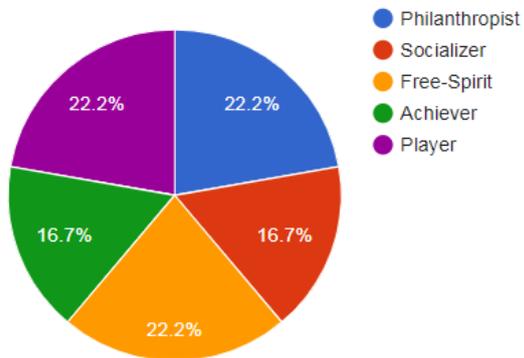


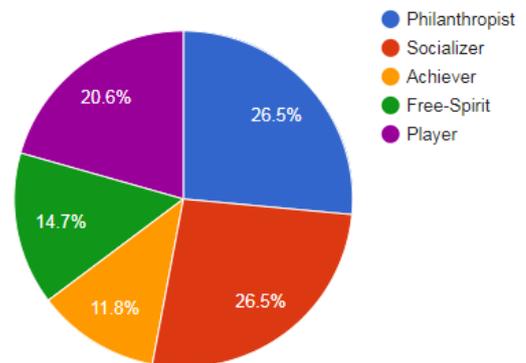
Figure 32. Stats indicating responses to 'Rewards are a great way to motivate me.'

When coming to those that had played the game, the Hexad Player Types was considered for only the 24 users. Among them, it was checked to see how many of the people associated themselves with which type of player type. The following was the finding:

Points Version



Quotations Version



Without Points Version

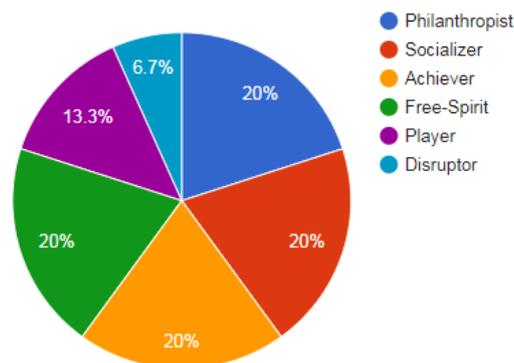


Figure 33. Percentage of Hexad Player Types found in the users of all the versions of the game

Among the various versions of the game played by the numerous people, the division of users that associated with the various player types was not exactly, but roughly the same. In most cases, the division of player types among the numerous players was around the 20 percent range, with the Disruptor type appearing dominantly in only one case.

In the analysis, it was seen that there were instances where the individuals surveyed associated themselves with more than type of player type. That is not an uncommon scenario, as there may be tendencies of more than only one player type in any individual tested.

There was even a case where one individual responded by highly agreeing with all of the Hexad Player type questions asked of them in this survey. Though this may very well possibly be the case, but further investigation may even yield different results if the entire Hexad player type survey were to be implemented without having the worries of user fatigue and the various other considerations that were necessary to be taken during the experimentation of this current thesis.

And considering the division of player types among all the versions, as Figure 33 shows, compared with Figure 20, it shows that the Non-Points Version was the winner in helping people in retaining data, with the Points and Quotations version coming in at second place with the Points version coming in third. This shows that the various versions have different reaction rates.

When comparing the player types to the answers provided in the questionnaire regarding the user's motivation, taking the averages of all the responses per player type and computing the results, the following information was captured. Most of the users showed a positive response rate for each of the questions, except for in a few cases.

Points:

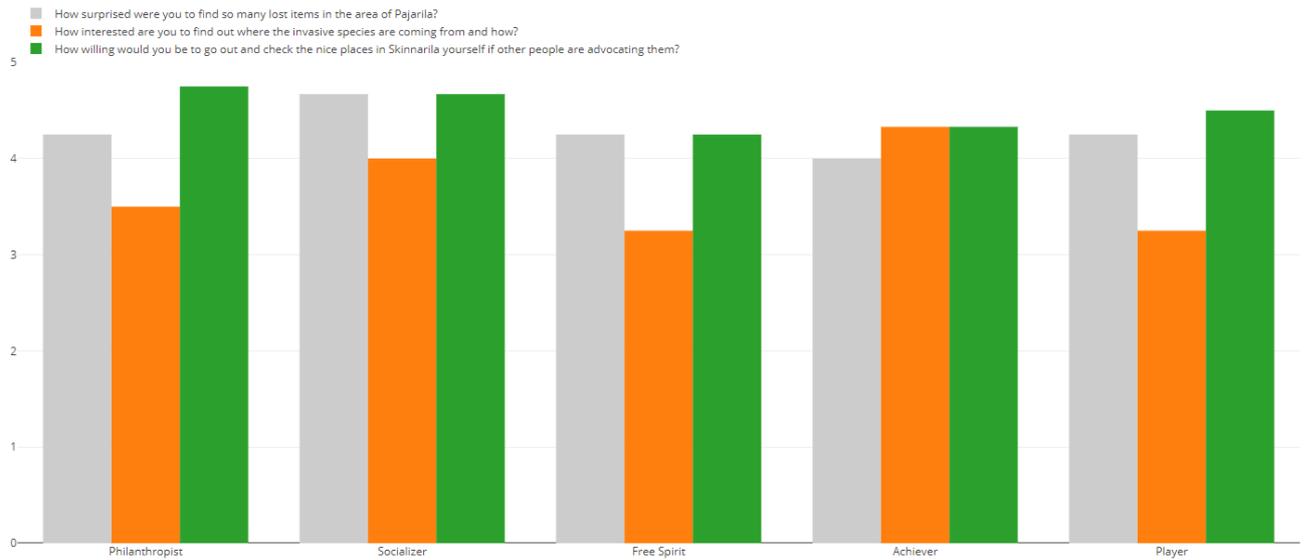


Figure 34. Response averages for each Hexad Type in the Points version of the game

Regarding the drops in motivation, it was seen for only the question that dealt with Invasive Species, in the case of three Player Types; namely, Philanthropist, Free Spirit, and Player, as shown in Figure 34.

Quotations:

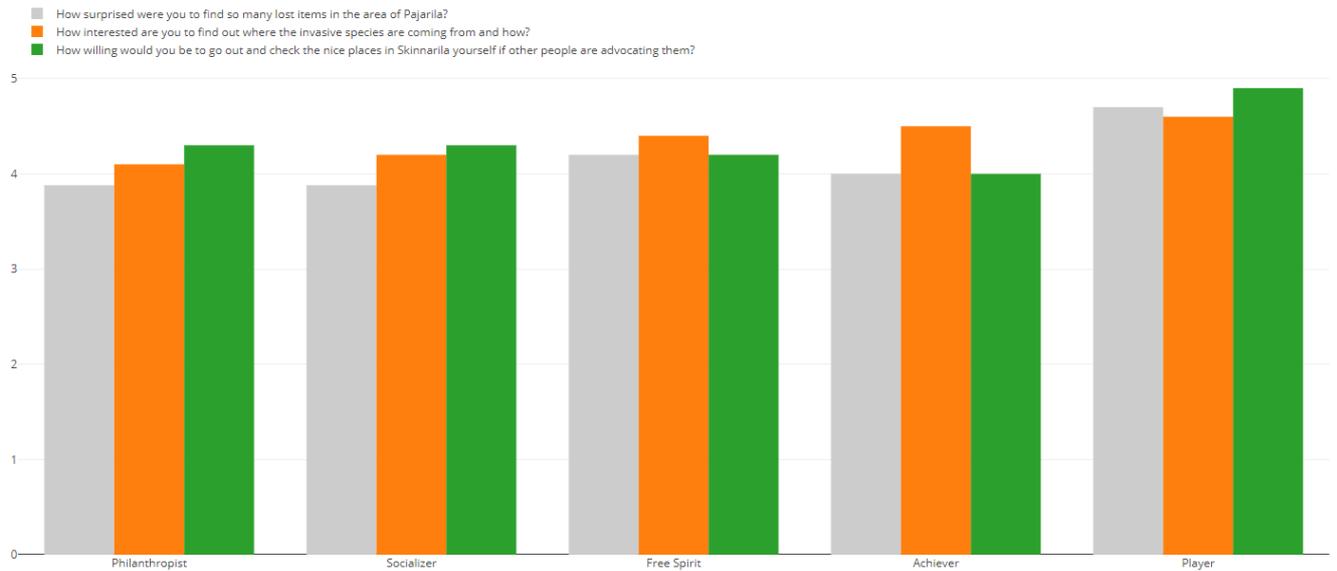


Figure 35. Response averages for each Hexad Type in the Quotations version of the game

For Philanthropists and Socializers, the fact that there were many lost items was not something held with as much interest as the other departments.

Without Points:

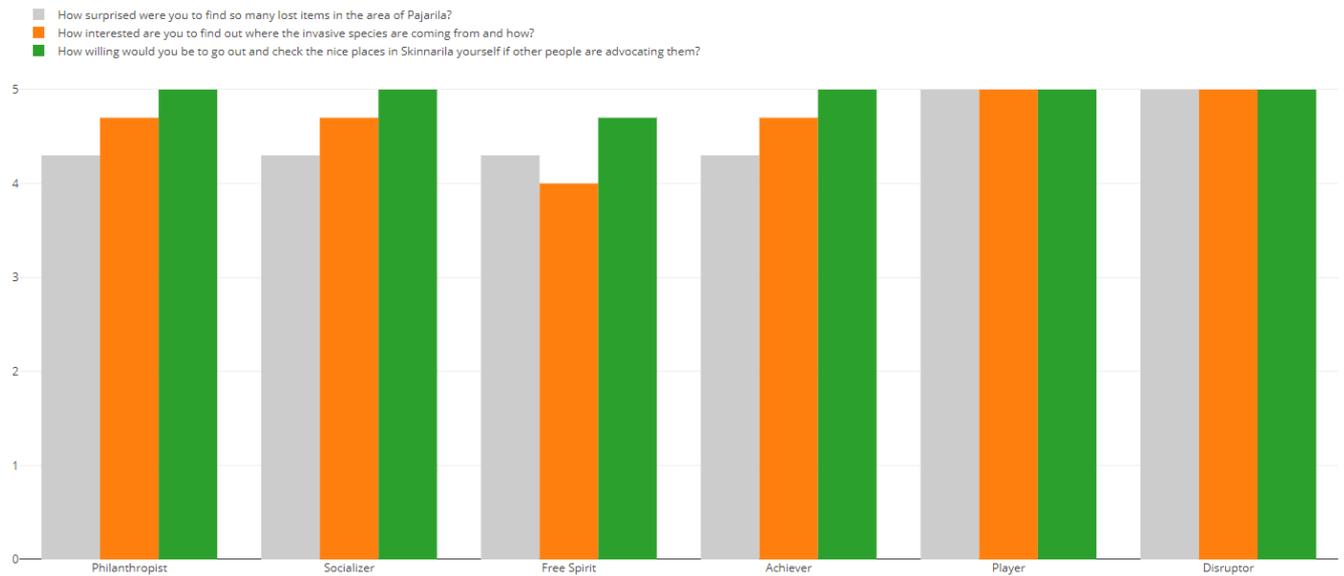


Figure 36. Response averages for each Hexad Type in the Without Points version of the game

For the players of the version that did not hold points nor quotations, the answers were predominantly in the high range, with those identifying themselves as Players and Disruptors showing maximum interest in all the questions.

From the responses as per the Hexad profiles, it appears such that the Non-Points-Non-Quotations Version of the game, stripped of almost all the basic gamification features, proved to be the most interest raising version, followed by the Quotations version which had narratives attached to the cards, and the simple Points version being the least motivational of the three versions.

6.5. Discussion

So what do the analyses tell us about the findings of the research? One of the findings from it is that the research had been prompted under the assumption that serious games can help in providing a good interface for open data to be shared among people so that open data is begun to be used more prevalently than its currently underutilized state. The results of the survey indicated that most people would be interested in pursuing open data if it were more easily accessible and readable to the average human being as the game was. Thus, serious games provide exactly such a window into the world of datasets that have been provided but have not been utilized as effectively till the current moment, and if implemented, the world of open data may see a lot more interaction from the general public and consequently the world will be able to see many answers to questions plaguing society that currently do not have or have suboptimal solutions.

There was, however, a discrepancy with regards to how the actual gamification of the serious games would possibly be able to bear results. Beginning the research under the assumption that the various gamification strategies would be able to improve the learning outcome and consequently the responses to the data retention questions in the survey, and the strategies would get people to more meaningfully and for a longer time engage with the game which would result in a better learning (Hamari, et al., 2016). But the results show the versions of the game where people engaged for longer with the system did not have as good scores as those where the people were interacting without the gamification strategies implemented in the system and where interaction with the game was almost half of the other two. This is contrary to the ‘more engagement equals more learning’ concept outlined.

Another interesting takeaway from this research is that the people who were identified as a certain Hexad player type (or a multitude of Hexad player types), the average of each player type tended to follow a similar pattern in any game. That is, whether they played the game with the Points gamification strategy, the version with the Narrative and Points strategies, or whether they played the version that did not have any of those two strategies involved. The pattern was that when a certain type of gamification strategy was implemented, certain player types did not seem to view a certain attribute being tested with as much importance as the other attributes

being tested for, as could be gleaned from the information collected from the survey. And that attribute, and the relevant player types, were different in each version of the game implemented. This shows an interesting dimension that in certain types of settings, if there are multiple pieces of information on offer, the same player type may respond to one piece of information differently than had they come across the same piece of information in another setting with another strategy in place.

The first research question, which was to explore whether serious games involving open data could motivate people to advance from data illiteracy towards data literacy, has been found to have a positive result and that this can be an avenue that can yield greater results than yet seen with open data.

Regarding the question as to the relative efficacy of some gamification strategies on people accessing serious games, it has been shown in the findings that the results were not as initially hypothesized, since the results of the relatively un-gamified Points-less version was seen to record the most positive scores and the Narrative version coming in at second place.

And finally, regarding the exploration of whether people of certain gamification player types are more motivated by serious games in relation to open data than others, the yielded data points towards the affirmative, though the inclination being context and gamification strategy dependent.

7. Conclusion and Future Work

After taking into consideration the various aspects of the results and the data collected from the game and the survey, it is to be concluded that Serious Games with user accessible interfaces incorporating open data such as the various models of the game made for this research can be used in order to motivate individuals into taking a step towards data literacy and accessing open data with positive potential outcomes.

Along the same note, it has also been seen that different versions of the game produced different results, and though the sample size was a little small in at least one version of the game, it pointed in the direction that different strategies used can yield different outcomes.

Finally, using the various versions of the game and analyzing it through the Hexad profiling system, it is evident that the different profiles interacted with the games at a different level, with the version stripped to the bone with regards to the elements of Gamification being the game that proved best with regards to increasing the individuals' interest in the game, though not necessarily increasing the time spent.

For the question of which strategy works better, the very small sample size for the Without Points version, coupled with the very low average time taken by the participants, may need further investigation. Does not having any points or quotations make for a more seamless and less distracting gameplay due to which the game was played faster and with a more dominant win rate? And does the low sample size actually tell the entire story or is there more to be seen with a greater sample size? Does the lower gameplay sessions for the Without Points version show more immediate immersion in the gameplay, versus the longer times taken during the other games? How does the concept of Flow and increased engagement factor into the shorter time frames per certain games?

There is also a further need of being able to distinguish whether the particular types of attributes in question have an effect on the Hexad player types and the gamification strategies used. As

with the Points version of the game, the generally lower interest rate for the Invasive Species can be investigated in order to find out whether it was the attribute itself that individuals lacked an interest for, compared to the other attributes, or did it have something to do with the Hexad profiles and the gamification manner of the game.

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Appendices

Appendix A – Code

Available on:

<https://github.com/MyKhan/MastersThesis>

Appendix B – Survey Questionnaire

Information Related to the data on the cards

Open Data and Serious Games are terms used in this survey, and for the purpose of this research, they are explained below:

Open Data is the data that is available on the web for free, provided by governments and big corporations.

Serious Games are games with the main focus to get the user to perform a specific goal or develop a particular habit.

Q) How surprised were you to find so many lost items in the area of Pajarila?

- Very Unsurprised through Very Surprised

Q) How interested are you to find out where the invasive species are coming from and how?

- Very Uninterested through Very Interested

Q) How willing would you be to go out and check the nice places in Skinnarila yourself if other people are advocating them?

- Very Unwilling through Very Willing

Q) Did you know about open data being available on the internet for you to use? *

- Yes
- No

Q) If yes, do you interact with the data?

- Yes

- No

Q) If no, do you not interact with the data because you find the data's presentation difficult to understand?

- Yes
- No

Q) Has the presentation of findings in such a game-like fashion raised your interest in open data?

- Yes
- No

Q) If open data were available in such a format (i.e. serious game style), how interested would you be in researching and possibly developing solutions for problems such as those highlighted in this game?

- Very Uninterested through Very Interested

Information retention from the game

How much do you remember?

Q) Would you take your friends to Lepola or Uus-Lavola for a scenic outing?

- Lepola
- Uus-Lavola
- Not Aware/ Do not remember

Q) Is Keskusta more invaded by the floral species or Kivisalmi?

- Keskusta
- Kivisalmi
- Not Aware/ Do not remember

Q) Would you rather go to Kuusimaki or Pajarila if you were afraid of losing your wallet?

- Kuusimaki
- Pajarila
- Not Aware/ Do not remember

Information on your playing habits

What kind of a player are you?

Q) It makes me happy if I am able to help others.

- Strongly Disagree through Strongly Agree

Q) Interacting with others is important to me.

- Strongly Disagree through Strongly Agree

Q) I often let my curiosity guide me.

- Strongly Disagree through Strongly Agree

Q) I like mastering difficult tasks.

- Strongly Disagree through Strongly Agree

Q) I like to provoke.

- Strongly Disagree through Strongly Agree

Q) Rewards are a great way to motivate me.

- Strongly Disagree through Strongly Agree