Master Degree Project

UNIVERSITY
OF SKÖVDE

GAMIFIED LAYER FOR GOOGLE CLASSROOM TO IMPROVE THE USER EXPERIENCE AND ENGAGEMENT OF STUDENTS WITH ADHD

Master Degree Project in Informatics
One year Level 22.5 ECTS
Spring term 2017

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Abstract

The implementation of a Course Management System into an educational institution oriented to students with learning disabilities such as ADHD, represents a big challenge since these students experience persistent impairments in attention (or concentration) that impact negatively on their learning outcomes, engagement and motivation. It's crucial to adapt and enhance these environments having in consideration the students' special learning needs, in order to improve their user experience and engagement during their learning process. This thesis address the design and development of gamified layer that brings a current analog gamification practice into a Course Management System Environment, Google Classroom (GC). The prototype developed retrieves, transforms and shows the GC data in form of game elements such as points, badges, and progress bars, among others. After using the prototype during three weeks, the students showed an easy familiarization with the gamified layer of GC and an active participation and persistence during their course activities.

Keywords: Gamification, ADHD, Learning Management System, Course Management Systems, Google Classroom

Acknowledgments

To Per, who believed in me. For his kind personality and professionalism. For his support during this project with valuable and opportune feedback and advices. For giving me the opportunity to continue my studies in the master program of serious games, being a volunteer in the Swedish Game Conference and for promoting me as a nominee for the Global Swede Award.

To Danya, always by my side. Cheering me in my moments of weakness and celebrating achievements together. For all her support and patience. For all her love.

To my dad, Gilberto. For his unconditional love and support. For being there when I needed him most.

To Adam Palmquist who gave me the opportunity to learn more about the problems of children with learning disabilities and gamification, subjects that interest me so much. For all his help to carry out this project.

To Erik Dornerus who was always kind and disposed to help during this intervention providing valuable insights about his teaching process.

To Mikael Johannesson. For his incredible example of professional commitment. For helping me to understand the beauty of research.

To Matilda Petterson. For her creativity in the graphical design of the medals used in Magelungen spel and her advices for the construction of the user interface.

To Viktor, Christopher and Emilia who helped me to translate different texts into Swedish.

To University of Guadalajara. For bringing me the opportunity and help me with resources to study abroad.

I want to give a special acknowledgement to the University of Skövde for its hospitality, quality, opportunities and commitment with education.

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1 Introduction

Video games are one of the most popular cultural tools of our modern society and there's no doubt that one of their more compelling characteristics are the high motivation and engagement levels that its users can develop, no matter the obstacles presented during gameplay (Morris, Croker, Zimmerman, et al., 2013). Several researchers (Morris et al., 2013; Sitra, Katsigiannakis, Karagiannidis, et al., 2017), have acknowledged this ability to keep users engaged and motivated as one of the key video games' features that can be used by educators as another educational tool along with books, paper, computers and pencil. Morris et al. (2013) suggest that videogames have a motivational scaffold among other, that consist in feedback, rewards and flow states that engage students, and this is exactly the point that captivate researchers around the world to use these elements in real world contexts with the aim to achieve similar results than videogames in terms of motivation, engagement and user experience. This approach is best known as Gamification that, during recent years, is gaining abundant attention in research because this strategy seeks to motivate users to achieve behavioral or psychological outcomes, for instance, to increase attendance to lectures, use an application frequently, complete their personal profile (Matallaoui, Hanner & Zarnekow, 2017). In chapter 2, the gamification concept will be defined and described along with its relationships with the MDA Framework used in game design discipline.

Information systems are becoming ubiquitous in our daily life but there are certain important contexts such as work or education in which, unlike videogames, their use is a merely a necessity rather than an appealing experience. This could lead to demotivation, low acceptance and unwanted behavior among their users (Matallaoui, Hanner & Zarnekow, 2017). In educational settings, the Learning Management Systems (LMS) and its derivatives such as the Course Management Systems (their definitions and differences will be discussed in chapter 2), are part of the most popular information systems to support the teaching and learning process, enabling the possibility to develop and deliver electronic learning materials, offer courses electronically and test and evaluate students (Paulsen, 2003). However, besides the aforementioned problems regarding to its use by necessity, the implementation of this kind of systems in schools where the students have learning disabilities such as Attention Deficit and Hyperactivity Disorder (ADHD), represents a big challenge due their several impairments that affects their scholar achievement (Kendall, Taylor, Perez, et al., 2008). For this reason, it's necessary to enhance these systems with the goal to improve the user experience and engagement of the students to motivate them, using strategies such as gamification which has the potential to keep them engaged and motivated (Farcas & Szamosközi, 2016; Bul, Franken, Van der Oord, et al., 2015).

This thesis is a case study where a Course Management System (Google Classroom) was "enhanced" with a gamified layer designed and developed as a web application. This gamified layer retrieves the contents of Google Classroom and displays them in form of game-like elements such as points, badges, themes and progress bars. The goal of this gamified layer is to provide a better user experience and user engagement to the students from a Swedish educational institution called Magelungen School which provides education for children with ADHD and other learning disabilities. This thesis also aims to contribute as a behavioral strategy for the non-pharmacologic interventions, that is based on rewards and goal setting under educational environments, in order to address the special learning needs and the lack of motivation of these students.

The participant students in this case study have taken a course about music history using Google Classroom and the gamified layer named “Magelungen spel” during three weeks. Their teacher was the direct observer during the time of the intervention and he provided several reports during and at the end of the course, regarding the responses and perceptions of his students regarding their interactions with the gamified layer.

The analysis of the information gathered from the client, teacher, and students involved in this case study shows that the gamified layer was well designed according with the requirements of the client and was easy to implement and to use. The students easily got familiarized with the game elements and were very participative giving useful feedback for improvements in the prototype and some of them showed more persistence in their assignments trying to get a better badge. The results were analyzed and interpreted following an explanatory approach.

This thesis is organized in seven chapters: in the second chapter, all the definitions of the relevant concepts used in this case study are addressed. The third chapter describes how gamification is currently used in Magelungen and which problems this school is facing during the implementation of Google Classroom. Also, the followed methodology is presented along with the research questions that guides this case study. The fourth chapter describes the origin of the project and how the gamified layer was designed and developed. In the fifth chapter, all information gathered through reports, interviews and surveys will be presented and in the sixth chapter the results will be analyzed following the structure of the research questions. The last chapter will conclude this thesis summarizing the findings, weaknesses, limitations of this case study. Lastly, some recommendations for future work will be presented.

2 Background

This chapter describes the ADHD and its negative impact in the academic life of children that suffer for it, besides, a detailed definition about the concepts of engagement, motivation and user experience and how are they related. Gamification will be explained along with its relationship with the game design discipline. The Learning Management Systems will be also described along with its derivate Course Management System. Lastly, a brief summary about the previous research that combines the fields of study: ADHD, gamification and Learning Management Systems.

2.1 Attention Deficit / Hyperactivity Disorder (ADHD)

Alterations in the attention span were documented for first time at the end of the seventeenth century and described as "the incapacity of attending with a necessary degree of constancy to any one object" (Crichton, 1798 cited in Lange, Reichl, Lange, Tucha, & Tucha (2010). Since that time, the negative implications in education were observed: "... and has a very bad effect, inasmuch as it renders him incapable of attending with constancy in any one object of education." (Crichton, 1798 cited in Lange et al., 2010, p. 242). Currently, the American Psychiatric Association (2013) stills reports that the functional consequences of ADHD are reduced school performance and academic accomplishment, besides social rejection.

Presently, the Attention Deficit / Hyperactivity Disorder is known as a common childhood psychiatric disorder, characterized by persistent impairments in attention (or concentration) and/or symptoms of hyperactivity and impulsivity according with the American Psychiatric Association (2013). ADHD is also defined as an "heterogeneous behavioral syndrome" (Kendall, Taylor, Perez, & Taylor, 2008, p. 35), in which the symptoms (hyperactivity, impulsivity and inattention) could tend to cluster together, but some people could have a predominance of inattention while others could experience a combination of impulsivity and hyperactivity.

According with American Psychiatric Association, (2013) some of the symptoms of inattention related with school performance includes avoidance and dislikes to engage in tasks that requires high mental effort such as homework, school reports, essays or have difficulties to remain focused during lectures or lengthy reading.

2.1.1 Other ADHD conditions

The symptoms of the ADHD could coexist with other conditions such as disorders in motor control, communication, anxiety, learning and behavior (Kendall et al., 2008). These different conditions have several negative implications in the everyday life of children with ADHD, causing them social problems and affecting their academic achievement (Weiss et al., 1985; Mannuzza et al., 1993; Weiss and Hechtman, 1993 cited in Kutcher et al., 2004, p.12).

Unfortunately, these symptoms could persist along their adulthood, developing personality disorders, social and emotional difficulties, unemployment and even, involvement in crime (Kendall et al., 2008). The impairments and symptoms of children with ADHD are related with deficiencies in their multiple executive functions (EF), such as working memory, inhibition or cognitive flexibility, which entails a lack of motivation (Dovis, Van Der Oord, Wiers, et al., 2015).

2.1.2 Behavioral Treatments

There are two main treatment categories focused to deal with their target symptoms (hyperactivity/impulsivity and inattention): psychostimulant medications and non-pharmacologic interventions (Kutcher et al., 2004). The stimulant medication treatments are highly effective in the reduction of the core symptoms for most children with ADHD according with the Subcommittee on Attention-Deficit/Hyperactivity Disorder & Management (2011), however, this treatment category is out of the aim of this research project.

Even though the non-pharmacologic interventions such as the behavioral modifications, have less pronounced effects than medications, have shown to be effective in a short-term span a short-term efficacy (Kutcher et al., 2004). The common goal of this behavioral interventions is to modify the physical and social environment to alter or change their behavior (Subcommittee on Attention-Deficit/Hyperactivity Disorder & Management, 2011).

The most common behavior therapy is the behavioral parent training which includes strategies such as step-by-step approach, goal/target setting, rewards and daily report cards, among others. These strategies have been developed, as well, to train teachers to handle ADHD students in classroom environments (Kutcher et al., 2004) and according with the Subcommittee on Attention-Deficit/Hyperactivity Disorder & Management (2011), the typical outcomes include improvements in attention during instruction, disruptive behavior decrease, work productivity improvement and better compliance with classroom rules. Also, the Subcommittee on Attention-Deficit/Hyperactivity Disorder & Management (2011) points out that behavioral therapy do not require an specific diagnosis.

The gamification approach could be suited as a tool that can contribute into the field of non-pharmacological interventions since both shares some common strategies used into the behavioral parent training approach such as goal/target settings and rewards.

2.2 Engagement and Motivation

In this section, these both concepts will be defined and explained along with its similarities and how they are related.

2.2.1 Engagement

Engagement is one of the most studied aspects of videogames, education (O'Brien & Toms, 2008), and psychology (Shernoff, Csikszentmihalyi, Schneider, et al., 2003). The term "engagement" could have different meanings depending of the contexts where it's used, for instance, from business perspective, the engagement is the connection between a customer and a product or service, but, in a romantic couple's relationships, the engagement is the period in which they are preparing and planning to spend their lives together for the rest of their lives (Zichermann & Cunningham, 2011).

From a more general perspective, engagement is an enjoyable state of mind in which the attention is willingly given during a period of time (Rozendaal, Keyson & de Ridder, 2007, p. 182; Zichermann & Cunningham, 2011). O'Brien & Toms (2008) suggest that engagement has attributes such as focused attention, awareness, novelty, feedback, control, interactivity and intrinsic motivation. At this point, it's relevant to highlight that attention is a term commonly used by the authors' engagement conceptualizations, and also "concentration", which is an important component of the flow theory (Shernoff, Csikszentmihalyi, Schneider, et al., 2003).

The following definition of engagement is based on a wide synthesis from different motivation theories such as flow, play, aesthetic and information interaction and its applications in several areas such as videogames, education, among others:

"Engagement is a quality of user experiences with technology that is characterized by challenge, aesthetic and sensory appeal, feedback, novelty, interactivity, perceived control and time, awareness, motivation, interest, and affect." (O'Brien & Toms, 2008, p. 949).

Table 1 Definitions of the attributes of engagement. All definitions with citation are cited in the work of O'Brien & Toms (2010).

Attribute	**Definition**
Aesthetics	Visual beauty or the study of natural and pleasing (or aesthetic) computer-based environments (Jennings, 2000).
Affect	"The emotional investment a user makes in order to be immersed in an environment and sustain their involvement in the environment" (Jennings, 2000); "The user's emotional response to the system" (Stone, Jarrett, Woodroffe, & Minocha, 2005, p. 483).
Focused Attention	The concentration of mental activity; concentrating on one stimulus only and ignoring all others (Matlin, 1994).
Challenge	The amount of effort experienced by the participant in performing an online task.
Control	How "in charge" users feel over their experience with the technology.
Feedback	Response or reaction from the task environment or system that communicates the appropriateness of the users past actions or demonstrates progress toward a specific goal; serves as a basis for future action ("Feedback," Penguin Dictionary of Psychology, 1995); "Information that is sent back to the user about what action has been done or what result has been accomplished" Stone et al., p. 613).
Interest	The "feeling that accompanies or causes special attention to an object or class of objects" ("Interest," M-W Online).
Motivation	Elements that bring about focus or a desire to proceed with an activity (Jennings, 2000).
Novelty	Variety of sudden and unexpected changes (visual or auditory) that cause excitement and joy or alarm (Aboulafia & Bannon, 2004); Features of the interface that that "users find unexpected, surprising, new, and unfamiliar" (Huang, 2003).
Perceived Time	Users' perception of estimated time spent on task.

For Webster & Ho, (1997), engagement is influenced by challenge, feedback, control and variety and for Zichermann & Cunningham (2011) is comprised by interrelated metrics such as frequency, duration, virality and ratings. These metrics may vary depending of the type of business, for example, in a coffee shop, frequency matters more than duration, but, on the

other hand, in a dating app, the duration in the interactions should have priority in order to be successful.

The engagement conceptualization could seem similar to motivation because it shares several attributes of theories of motivation such as the Flow Theory (condition "in which people are so involved in an activity that nothing else seems to matter; the experience itself is so enjoyable that people will do it even at great cost, for the sheer sake of doing it" (Csikszentmihalyi, 1990 cited by O'Brien & Toms, 2008)). Focused attention, feedback, control, interactivity and intrinsic motivation, are those shared attributes between flow and engagement, however, the main differences are that flow requires intrinsic motivation, but on the other hand, an engaging experience could occur without a voluntary use of a system (O'Brien & Toms, 2008).

This case study will address the term "user engagement" defined by O'Brien & Toms (2012) as "a quality of user experience that describes a positive human-computer interaction". User engagement is focused in the individuals' satisfaction, attitudes towards the systems, thoughts, feelings and their degree of activity during the use of a system (O'Brien & Toms, 2012).

2.2.2 Motivation

As mentioned before, engagement and motivation are two closely related concepts. For some researchers, such as O'Brien & Toms, (2008), motivation is considered an attribute necessary for the engagement process, but on the contrary, from the Deci's & Ryan's, (2000) perspective, intrinsic motivation is an active engagement with activities that people perceive as interesting. Taking into account both of these previous approaches, it could be inferred that motivation and engagement have a bidirectional relationship, which means, that motivation could lead engagement and vice versa.

In general terms, motivation is a "psychological process involved in the direction, vigor, and persistence of behavior" according with Eccles, Wigfield, & Schiefele, (1998); Wigfield & Eccles, (1989) cited in Moos & Marroquin (2010).

Murphy & Alexander (2000) consider that motivation is an important non-cognitive force needed to create effective learning environments and move the students forward to competence or proficiency. Motivation has several constructs that could define it in different ways depending of the inquiry needs (Murphy & Alexander, 2000). Precisely in the work of Archer (1992) cited in Archer (1994), motivation is addressed under a goal's perspective in academic settings, where a goal is defined by the author as a pattern of believes, attributions and affect that triggers behaviors to respond and engage into activities of achievement-type.

Different types of goals are described in Archer (1994) such as performance goals (succeed the most of the activities with the minimum effort), mastery goals (perform activities with the aim of developing competentences and understandings) and the academic alienation (work avoidance, where having success with the minnimun effort evidences high ability but not the contrary). Also, Archer (1994) points out the relationship between motivation and meta cognitive strategies where the mastery-oriented students use to ask themselves if the activities make sense, but performance students tries to demostrate competence using strategies such as focusing only in examination questions. Lastly, Archer (1994) addresses the simultaneous achievement goals which suggests that students combine performance and mastery goals depending of the kind of activities, for example, if mastery-oriented students face a dull activitie, they would be coaxed to participate using rewards or competency.

In psychology, motivation is categorized in two groups: intrinsic and extrinsic (Zichermann & Cunningham, 2011). Intrinsic motivation is defined by Banfield & Wilkerson (2014) as an action performed for pleasure or satisfaction, unlike extrinsic motivation, that is a "construct that pertains whenever an activity is done in order to attain some separable outcome" (Ryan & Deci, 2000, p. 60).

Skinner (1953) cited by Deci & Ryan (2000) emphasizes that intrinsic motivation does not depend on reinforcements because an interesting activity itself is intrinsically rewarding. Deci & Ryan (2000) suggest that intrinsically motivation behaviors requires autonomy, competence and relatedness to be maintained and these behaviors are freely engaged without the necessity of separable consequences.

The autonomy, competence and relatedness are those psychological needs to maintain intrinsically motivated behaviors and they are addressed in the Self Determination Theory (SDT) of Deci & Ryan (2000). The competence is the feeling of satisfaction when people realize that are becoming more prepared for new situations, contexts or challenges, through the development of new potentialities, talents, specialization or mastery; autonomy is the human characteristic related with self-regulation and self-organization in which their actions are self-organized respect to their inner and outer circumstances such as needs and available capacities, regardless the external pressures; and lastly, relatedness, which is the social part of the SDT, that is explained as the tendency to have social coherence, to feel connection and caring, belongingness and coordination with others to ensure an effective knowledge transmission and social organization (Deci & Ryan, 2000).

According to Deci & Ryan (2000), extrinsic motivation is associated with the external regulation in which people behavior is influenced by external contingences such a tangible rewards or failure avoidance. This type of motivation could be predictable in terms of cause and effect, and it can be experienced both as enjoyable and as unpleasant, depending of the circumstances of how the motivation was triggered.

Given that motivation has a close relationship with engagement and involves psychological needs, goals and rewards, motivation will be addressed in this project as "a persistent behavior triggered by psychological needs or external circumstances with the aim to achieve a goal".

Having in mind the previously proposed definition, this project has the aim to motivate students through external circumstances, in this case, through the use of game elements such as badges, points and progress bars (rewards), therefore, if they get engaged with these elements it could inferred that they will be motivated due the bidirectional relationship among engagement and motivation.

2.3 Gamification

Gamification is commonly defined as "the use of game design elements in non–game contexts" (Deterding, Dixon, Khaled, & Nacke, 2011) and is focused on "exporting good aspects of video games to non-gaming educative contexts" (Domínguez et al. 2013, p. 381). The common objective of gamification is to increase the user engagement and user experience with a system (Domínguez, Saenz-De-Navarrete, De-Marcos, et al., 2013) and problem solving (Zichermann & Cunningham, 2011).

Notice that the aforementioned definitions have in common the word “game”, this is because gamification is derived from games (Salen and Zimmerman, cited in Deterding et al. 2011, p. 11). Zichermann’s & Cunningham’s (2011) defines gamification from a purpose-oriented perspective, but Deterding's & Dixon's, (2011) conceive it regarding on the context in which the game elements should be used in order to be called gamification.

Gamification could be seen as the extraction of the engagement layer of a game to implement it in different context foreign to the game. The engagement layer of games is the one that corresponds to game mechanics and dynamics, and could be extracted from one existing game without affecting the core of it. For example, in football, the game mechanics such as goals and rules and dynamics such as the strategies, player stats, weather conditions, turns the game fun, but, there exists a higher layer of game mechanics that turns the football more engaging, this layer contains game elements such as points, rewards (i.e. trophies, medals, money, status), ranking systems (i.e. leagues, tournaments, championships, the best player of the season) fan culture, clubs, status, and avatars (i.e. jerseys, logo), among others.

The previous example suggests how football can be played only with its core mechanics and still be fun, however, adding the game mechanics such as points, leaderboards and rewards, turns the activity of running behind a ball more engaging and worldwide popular. In other words, the engagement layer of football brings another dimension of complexity to the game. Hamari, (2011, p. 17) also conceive the approach of gamifying games.

There are several examples about how Gamification has been successful in behavior driving and engagement in educational contexts. Akpolat & Slany (2014) performed a study with software engineering students applying gamification in an extreme programming course and they observed several positive effects of gamification as: “the students engaged themselves more with a certain topic when the topic was the challenge of the week” (p. 150), “once a specific practice was the topic of the weekly challenge, the usage of the practice never dropped below the usage before the challenge” (p. 150) and from the student perception’s perspective “the students rated their learning success as very good or good with gamification compared to other similar university programming courses without gamification” (p. 151).

2.3.1 MDA Framework

Since gamification involves game design elements, particularly, mechanics such as points, badges, leaderboards, levels among many others, it’s particularly relevant to mention and understand this framework, which could be a useful tool to achieve a better understanding of what the game elements are, and how these could be effectively selected depending of the outcomes sought with gamification.

In game design, the popular MDA framework (Hunicke, LeBlanc & Zubek, 2004) is known as a formal approach to describe, analyze and understand games through their Mechanics, Dynamics an Aesthetics (MDA). These three abstraction levels link the gaps from game development and game design processes, to technical game research and criticism (Hunicke et al., 2004).

The MDA framework discomposes the game design process in three interdependent elements: mechanics, dynamics and aesthetics and how players and designers interacts with these elements (*Figure 1*).

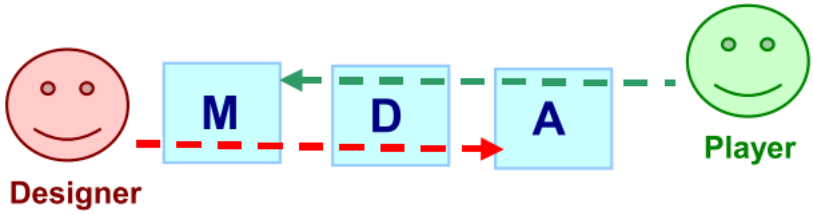

Figure 1 Designer and player perspectives in MDA Framework (Hunicke *et al.*, 2004)

The game mechanics are the lowest level of abstraction of a game. This level is where algorithms and data representation are described, also called rules (Hunicke et al., 2004), for example, in chess, the game mechanics are the different shapes of the pieces, the design of the board layout, quantity and colors of the squares, the movement rules of each figure of the game, winning condition (checkmate), among others. In accordance with Zichermann & Cunningham (2011), the primary mechanics are points, levels, leaderboards, badges and challenges/quests and if these are designed and used correctly, it could lead promising responses from the players in terms of aesthetics (i.e. fun, emotions, desires satisfaction).

Bunchball.com (2017) suggest that the common desires of different users include rewards, status, achievement, self-expression, competitions and altruism. *Figure 2* shows how some of the common game mechanics used in gamification practices are related with these human desires emphasizing with black dots which are the most suitable mechanics to satisfy each one.

	Human Desires					
Game Mechanics	**Reward**	**Status**	**Achievement**	**Self Expression**	**Competition**	**Altruism**
Points	●	○	○		○	○
Levels		●	○		○	
Challenges	○	○	●	○	○	○
Virtual Goods	○	○	○	●	○	
Leaderboards		○	○		●	○
Gifting & Charity		○	○		○	●

○ Suitablemechanic

● Most suitable mechanic

Figure 2 Human desires X game mechanics (Bunchball.com, 2017)

The game dynamics are the run-time behavior of the game mechanics when the player interacts with them (Hunicke et al., 2004), for instance, backing to *Figure 2,* points are usually just a numeric value but, when this number increase when the player performs a desired

action, the “number” becomes meaningful for the player, this time as a reward. If the player accumulates a certain predefined amount of points, she levels up. Similarly, to points, levels are commonly a numeric value, but this time represents a new status on game, that if is compared with another players’ level, would represent a better (or worst) status that can be represented using another mechanic such as a leaderboard. Even though the game mechanics from the previous example (points, levels and leaderboards) are basically numbers, they have different behavior and meaning, but all of them depends of player’s actions.

Lastly, game aesthetics are those that influences the emotions of players when these interacts with the system (Hunicke et al. 2004). A good example of aesthetics is that excitement of a soccer player after scoring a goal, or the frustration of a chess player when a bad move was performed. Hunicke et al. (2004) proposes a set of terms to go beyond the words “fun” and “gameplay” to describe the aesthetics, which are: sensation, fantasy, narrative, challenge, fellowship, discovery, expression and submission.

It’s important to consider the principles of this framework during the design process of a gamification implementation can be helpful to choose, balance and test the mechanics appropriately towards an effective user experience to the desired objectives with gamification.

2.4 User Experience

User experience (UX) is a concept widely used in Human-Computer Interaction (HCI) community and industry (Law, Roto, Hassenzahl, et al., 2009) that according with the ISO 9241-210:2010 (2010) is the “person's perceptions and responses resulting from the use and/or anticipated use of a product, system or service”. *Figure 3* shows some examples of things that can be experienced, narrowing down the ones that are part of the UX.

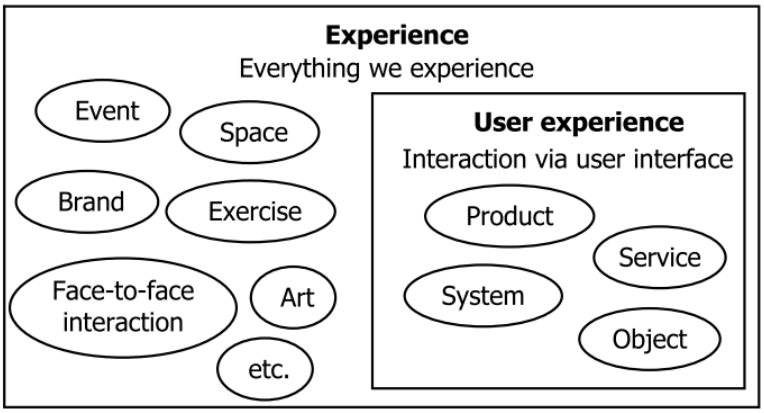

Figure 3 UX in relation with other experiences (Law et al., 2009)

Law et al., (2009) emphasize that UX goes beyond usability because the latter is limited to user cognition and performance, on the other hand, UX highlights non-utilitarian aspects such as the user’s affect and sensations of their everyday life interactions. These aspects give to the UX a more subjective, dynamic and context-dependent dimension, as it’s understood by many user experience researchers and practitioners (Law, Roto, Hassenzahl, et al., 2009).

The relevance of the user experience concept into the gamification field emerge from the same multi-disciplinary nature of gamification which commonly involves the driving of psychology aspects of the users (sometimes called players, customers, students, regarding the context)

such as motivation, behavior, engagement through their interactions with user interfaces. These interactions are made frequently using a system (but not exclusively) such as mobile apps, web applications, videogames, etc. There are several authors (Domínguez, Saenz-De-Navarrete, De-Marcos, et al., 2013; Hamari, Koivisto & Sarsa, 2014), that also conceive gamification as an utilitarian strategy oriented to improve the user experience besides motivation and engagement.

Hence, under the game design perspective of gamification, the UX fits conceptually into the Aesthetics part from the MDA framework since aesthetics address the player's emotions, sensations and is also considered the hedonic aspect of games (Matallaoui, Hanner & Zarnekow, 2017). This aforementioned characteristic is also a variable of the UX (Law, Roto, Hassenzahl, et al., 2009) and lastly, a player is also considered a user (Hunicke et al., 2004).

The above interpretation is arisen from a UX definition from Desmet. P. M. A. & Hekkert. P. (2007) used in a survey developed by Law et al., (2009, p. 723) which states that UX is "the entire set of affects that is elicited by the interaction between a user and a product including the degree on which all our senses are gratified (aesthetic experience) the meanings that we attach to the product (experience of meaning) and the feelings and emotions that are elicited (emotional experience)". Even though this UX's definition is product oriented, it can be seen that it's also addressing the senses, emotions, feelings and aesthetics resultant from an interaction of a user with a product (i.e. videogame, web application, mobile app, website, etc.).

UX is also related with engagement, it is enough to recall some words from the definition of engagement of O'Brien & Toms (2008, p. 949) in which the authors state that "Engagement is a quality of user experiences with technology …". *Figure 4* shows how all these previously addressed concepts are related when gamification is applied using technology (i.e. web applications, mobile apps, LMS, etc.). In this figure, can be appreciated that gamification influence UX and engagement directly, generally with the aim to improve them through the use of game elements and game design techniques. If the user during her interactions perceives the application to be sufficiently easy to use, fun and appealing it could lead to the desired engagement attributes of O'Brien & Toms (2008). These perspectives include computer interactions such as challenge, aesthetic and sensory appeal, feedback, novelty, interactivity, perceived control and time, awareness, motivation, interest, and affect. Those attributes of engagement can also be driven through the use of game elements and lead to an improvement of both UX and motivation. Lastly, motivation can be seen as a stand-alone attribute of engagement because motivation can be intrinsic, which means that it does not depend on reinforcements because an interesting activity itself is intrinsically rewarding (Deci & Ryan, 2000), however, the figure convey a bidirectional relationship between engagement and motivation, because the external circumstances such as the use of game elements in a non-game setting, can lead to engagement and perhaps, develop motivation.

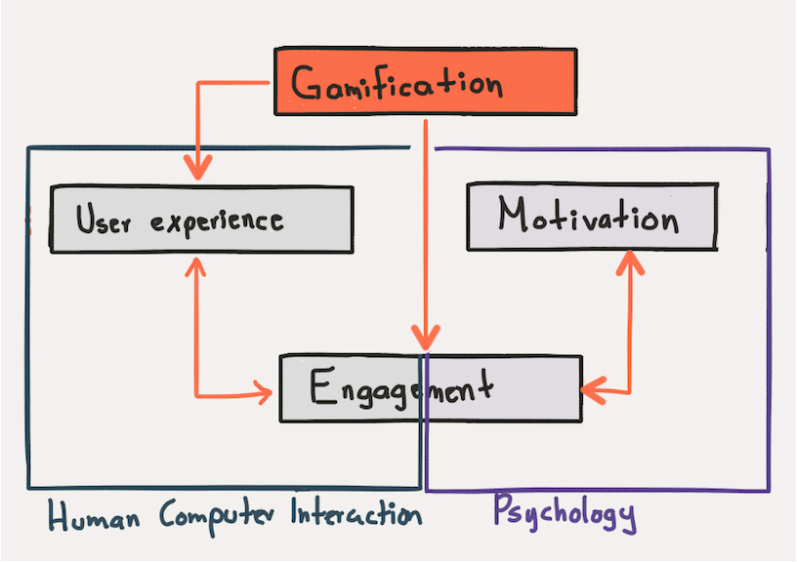

Figure 4 Gamification concepts' relationship (own construction, 2017)

For the present work, under the gamification perspective, UX will be addressed as the person's perception and response resulting from the interaction with a gamified system through a user interface. This definition is just a specialization of the one from ISO 9241-210:2010 (2010).

2.5 Learning Management Systems and Course Management Systems

A Learning Management System (LMS) is "the framework that handles all the aspects of the learning process" (Watson & Watson, 2007, p. 28). However, in accordance with the same author, there exist a debate and misconceptions about the concept of Learning Management System and their differences with other terms that involve software in the learning process management. The article of Watson & Watson, (2007) intends to clarify this misconceptions through an historical background and terms definition comparisons of LMSs.

Hall (2003) cited in Paulsen (2003, p. 134), defines LMS as a software that automates the administration of training events and manage users, course catalogues, data from learners and reporting. Basically, a LMS is an integrated platform used to facilitate the communication process between teachers and students (Azmi & Singh, 2015).

According with Avgeriou, Retalis, & Skordalakis, (2003), the LMSs have diverse usage scenarios in relationship with the educational institution needs, such as:

- Create, operate and administrate an online course.
- Support collaboration between students and provide motivation and resources for team building.
- Create and deliver questions and test for assessments.
- Organize educational, financial and human resources.
- Administer virtual, distributed classes where the students are geographically scattered and communicate via the Internet.

These scenarios have derived several categories of Learning Technology Systems (Avgeriou, Retalis & Skordalakis, 2003) including General Systems (also called Course Management

System), Course Management, Class Management, Communication tools, Student tools and Content Management.

The Course Management System (CMS) category is also described along with the different terms related with LMS in the article of Watson & Watson, (2007). A CMS is a computer application "used primarily for online or blended learning, supporting the placement of course materials online, associating students with courses, tracking student performance, storing student submissions and mediating communication between the students as well as their instructor." (p. 29). This is the most accurate definition for a wide variety of management systems that are defined as "LMS" when, in fact, they are not because "the scope of their functionalities does not encompass the entire organization" and "the course-focused nature of the applications is not systemic" neither (Watson & Watson, 2007).

Without pretending to contribute to the misconceptions related with LMS definition, it's convenient to clarify that the use of this term has the purpose of generalization in order to categorize this research project within the widely-used term (LMS), even though this project involves just a CMS (Google Classroom), however, a CMS could be seen as a subcategory of a LMS as Watson & Watson, (2007) states.

2.6 Previous research on Gamification and Learning Management Systems for students with ADHD.

A few studies were found in which serious games or gamification were implemented as a tool to improve executive functions, engagement, response quality feedback, working memory training in people diagnosed with ADHD (Craven, Young, Simons, et al., 2014; Dovis, Van Der Oord, Wiers, et al., 2015; Bul, Franken, Van der Oord, et al., 2015; Craven & Groom, 2016; Farcas & Szamosközi, 2016; Reimeringer, 2016). However, there are fewer studies combining games or gamification and Learning Management Systems for ADHD students (Ibrahim, Prasad, Alsadoon, et al., 2016; Mancera, Baldiris, Fabregat, et al., 2011; Sitra, Katsigiannakis, Karagiannidis, et al., 2017).

Even though the research publications that combine the subjects of study LMSs, Gamification and ADHD students are scarce, and the outcomes of some of them are not representative (Sitra, Katsigiannakis, Karagiannidis, et al., 2017) due their small number of students involved during the experimentation phases, or the lack of information in regard to the experimental phase (Ibrahim, Prasad, Alsadoon, et al., 2016; Mancera, Baldiris, Fabregat, et al., 2011), these previous cited works are helpful to lay the foundations for the continuity of the contributions for the learning process and for the non-pharmacological interventions for ADHD students.

Ibrahim, Prasad, Alsadoon, & Pham, (2016) did a research in which they study what has been done with advanced technology to provide an adaptable learning experience for students among 6 and 18 years old with ADHD, particularly, focusing in LMSs enhancements.

Based on their findings, they proposed a virtual classroom architecture as an LMS enhancement in which the main components are synchronous learning (through audio/video conference system), virtual collaborative environment where students could interact among them regardless their location, assessment tools and test to identify the symptoms of the ADHD students, among other characteristics (Ibrahim, Prasad, Alsadoon, et al., 2016). However, this enhancement proposal represents high economical and logistical costs of

implementation although teacher training implication, which is certainly a consideration for any kind of educational organization.

Farcas & Szamosközi, (2016) performed a meta-analytic review focused in the Working Memory Training (WMT) of children with ADHD between 5 and 14 years old, through the use of game elements such as feedback, upgrades, thermometer, competition, exploration and external feedback system. The authors (Farcas & Szamosközi, 2016) found in their results that the training of WMT with game elements showed little clinical impact due limited number of analyzed samples and failed to provide clear benefits for ADHD children. It is important to denote that the aim of the Farcas & Szamosközi, (2016) analysis was only focused on the WMT, but not in engagement benefits of gamification, however, during their analysis, they found that the use of game elements in WMT improved the motivational level and cognitive functions of children with ADHD.

Among the studies analyzed by Farcas & Szamosközi, (2016), the one performed by Dovis et al., (2015) in which the ADHD students' Working Memory (WM) was trained using a game called Braingame Brian, had an interesting finding in its outcomes: the compliance criteria (the students that completed all the 25 training sessions of the treatment) was high (93.3%). Even though the study wasn't aimed in the improvement of engagement, the students seemed to be persistent during the game sessions until the end of the experiment. The use of the game during the training leaded a sort of positive side effect in the students' engagement. Another recent study related with WM training for ADHD students through a serious game, was performed by Krča (2016). This study was focused to develop a serious game sufficiently attractive both, from the medical perspective, as from game design perspective, but also, that could capture more attention from children with ADHD and look for the most efficient mechanics and challenges to motivate to children. His recommendation after his findings is that all the task for ADHD children (in videogame environments) should be very easy from the very beginning and getting harder along the time.

The most relevant case study for this research was performed by (Sitra et al., 2017), in which a badge-based gamification strategy was implemented in an academic course through the popular LMS, Moodle (2017). The goal of this case study was to observe the effect of badges on the engagement of children with special educational needs, such as dyslexia, mild intellectual disabilities and ADHD. Positive findings were found, particularly "in the case of the student with ADHD, because "the gamification element was incentive enough to make the student concentrate for much longer than usual", and for the other "students with different special educational needs perceived badges as sufficient enough for evaluating a course as more interesting than a conventional face to face teaching activity" (Sitra et al., 2017).

The findings of Sitra et al. (2017) could contribute to reinforce the evidence of the notable gamification effectiveness on ADHD students, however, the case study has methodology weaknesses to take in consideration, such as the scarce number of subjects of study (i.e. five students and just one of them diagnosed with ADHD), the use of an isolated game element (badges) and missing information about the quantitative results of Moodle's integrated statistical tools.

Even though the study of Sitra et al. (2017) was not based in a large sample of students, it is relevant to have in mind the effectiveness that badges had for the ADHD student. This slight evidence could guide further researches towards an effective gamification designs for children with attention deficit and LMSs.

3 Problem

This chapter addresses the problem that Magelungen School is facing in the implementation of a new digital platform (Google Classroom) in its educational practices for ADHD students. The context of this case study will be the starting point in order to address this problem, describing Magelungen School, where and how they operate and why they decided to implement a CMS. Google Classroom will be generally described and it will be explained why this platform is categorized as a CMS, along with its advantages and disadvantages regarding its use by students with learning disabilities. Finally, it will briefly describe how the gamification strategy is currently applied at the Gothenburg campus of Magelungen School and how they intend to bring this current analog strategy to a digital environment in order to address the challenge that the interaction with Google Classroom represents for the students of Magelungen.

3.1 Magelungen School

Magelungen (2017) is a Swedish organization that provides several educational services such as elementary school, summer camp activities, training apartments, gymnasium and research among others. This school operates at different cities along Sweden such as Gävle, Göteborg, Helsinborg, Jönköping, Nacka, Solna, Stockholm, Södertälje, Uppsala, Västerås and Örebro.

Most services of Magelungen (2017) cater students with special educational needs who can't success in mainstream schools. Even though the institution attend children and teenagers with different special needs, this study is aimed on the students that has been diagnosed with Attention Deficit Hyperactivity Disorder (ADHD), which is, also, the majority kind of students.

Magelungen (2017) has different improvement programs with the aim to increase the students' learning and create the best possible conditions for their development. The institution's core ideas to achieve successful and effective learning are conceptualized in the MUST framework, acronym constructed with the Swedish words Meningsfull (meaningful), Utvecklande (developing), Stimulerande (stimulating) and Trygg (safe), the main purpose of MUST is to support the development of the school.

3.1.1 Magelungen Datatek

Magelungen Datatek is oriented in the creation and adaptation of digital tools to support their students that have different learning conditions helping them to keep their desire to learn and assist them whenever they have difficulties (Magelungen, 2017).

In order to follow and achieve the goals of the MUST framework and Datatek's particular objectives, Magelungen (2017) is implementing different digital platforms, which provide services and tools such as digital learning materials for replacing textbooks, Course Management Systems and digital games.

Google Suit for Education is one of the different digital tools that Magelungen implements on its educational practices along its different campuses. Google Suit for Education is a toolset that provides solutions such as email, calendar, messaging and, particularly relevant for this case study, Google Classroom.

3.2 Google Classroom

Google Classroom (GC) is one of the many tools of Google Suit for Education, GC is defined as a web-based platform that helps teachers to create and receive assignments of their students without the need of using paper (Google, 2017a).

GC has several advantages to help teachers to save time regarding the process of content sharing; creation, revision and grading of assignments; and communication with the students and their tutors, from an only place. Likewise, students can have a better organization of their class assignments, due dates and access of all the class materials from an individual Google Drive folder.

GC cannot be categorized as a stand-alone Learning Management System, however, it implements several of the Open LMS *application-specific* components proposed by Avgeriou, Retalis, & Skordalakis, (2003, p. 192) such as:

- User Management (registration in system, courses and groups, groups creation, authentication, access control with different views, student tracking, student profile management).
- *"Limited"* Courseware authoring (web page editing, design templates).
- Course Management (creation, customization, administration and monitoring of courses).
- *"Limited"* Assessments (on-line quiz or exam, project deliverables, self-assessment exercises)
- Help Desk (on-line help, user support), provided by Google through documentation content.
- System administration (backups, security, systems operation check, resource monitoring, etc.) which are inherent to all Google services.

Therefore, is convenient to refer to GC as a Course Management System (CMS) instead of a LMS, because GC is just "… a set of tools and a framework that allows the relatively easy creation of online course content and the subsequent teaching and management of that course including various interactions with students taking the course" according with EDUCAUSE (2003) cited in Watson & Watson, (2007, p.29).

3.3 Google Classroom implementation issues for ADHD students

Providing education through the use of tools such as GC to students with learning disabilities represents a big challenge because ADHD students need special learning tools (Ibrahim, Prasad, Alsadoon, et al., 2016). The latter statement is particularly true in the case of Magelungen because according with an interview with Palmquist (personal communication, 17th May 2017) one of the big issues of GC is that the students with ADHD, due their problems with their working memory are enfacing many difficulties regarding the use of Google Classroom because "when they are integrating into GC it takes a lot of energy to enface the projects and see what's going on in GC". Even though GC it's simple, "people with learning disabilities thinks that GC is unengaging", besides, motivation in ADHD students is particularly low (Palmquist, personal communication, 2017).

Magelungen School has the goal to implement Google Classroom as the common Course Management System for being used by all their campuses along Sweden, therefore, it's

important to take into account the special learning needs of its students in order to engage them into their online interactions, and also try to provide a more appealing user experience.

Since attention and concentration are important attributes that are needed to experience flow and engagement in an activity (Shernoff, Csikszentmihalyi, Schneider, et al., 2003) it's likely that the students with ADHD could have engagement problems when they found themselves facing academic activities in a totally new online learning environment (Google Classroom), in which their teachers or parents would often not be present.

Additionally, according to a personal interview with Palmquist (2017), the main problem of Magelungen's students is their lack of motivation. Dovis et al., (2015) suggest that this lack of motivation in children with ADHD could be attributed due they require a high frequency and amounts of rewards and tend to be less stimulated by this kind of reinforcements, probably due a dopaminergic deficit.

Even though Google Classroom (GC) is a minimalistic course management system and has an important set of features such as mobile version, calendar, notifications, messaging system, etcetera, it lacks of an explicit reward system, having instead, a conventional grading system based on a numeric value. The grading system and the messaging functionality in which teachers could provide feedback to their students, are the only (but not less important) GC's reward features.

The aim of this research project is to design and develop a gamified layer for Google Classroom as an enhancement, intended to improve the user experience and engagement of Magelungen's students during its online interactions with the courses. However, given that GC is not an open source platform that can be modified or enhanced directly, it's necessary to use its API[1] instead, which brings the possibility to access and retrieve information from GC externally, such as courses, assignments, grades, due dates, students' profiles, among other course related information. A web application was developed in order to retrieve the required data for the gamified layer development.

3.4 Current gamification practices at Magelungen

During several conversations with the client Palmquist (personal communication, 2017), who is a teacher from Magelungen, ICT educator, gamification lecturer and development manager of Datatek's improvement program, has mentioned that he has been implementing gamification in his teaching practices at Magelungen during the last three years, using different analog tools such as printed badges which he designs using a digital badge creator on internet. He also remarked that motivation of his students with ADHD is usually low.

[1] Application Programming Interface https://en.wikipedia.org/wiki/Application_programming_interface

3.5 Research questions

In this section, the research questions on which this case study relies are presented and explained, along with the instruments and methods for answering them.

3.5.1 How can an analog gamification design be brought to the Course Management System "Google Classroom"?

One of the main objectives of this case study is turn a currently analog gamification design implementation into a digital form with the goal to help to the Magelungen's students to improve their user experience and engagement with their interactions with Google Classroom.

The answer to this question will be presented in three parts: the description of the design and development of the prototype (chapter 4) where all the software architectural and design matters considered to fulfill the client's requirements are detailed and explained; the client's opinions about the implementation's accuracy of his gamification design into the prototype; and lastly, the teacher's comments regarding his experience using the prototype during his teaching.

3.5.2 How does a gamified layer over Google classroom affect the user experience of the students during an academic course?

In order to know if the use of the gamified layer improved the students' user experience, the gamified prototype will be evaluated from two perspectives: subjective usability, their behavioral intentions to use the prototype again (Kujala & Miron-Shatz, 2013), and the immediate consequences of the use of Magelungen spel.

The usability will be measured using the usability metric of Finstad (2010) composed of four items that measures the following usability components: effectiveness, satisfaction, overall experience and efficiency of Magelungen spel. This metric was selected due its small number of items (just four questions) which could be less demanding for students with ADHD that used to be hyperactive or lose its attention easily. Another reason for choosing this measurement instrument is its reliability as a standalone subjective usability metric (Finstad, 2010).

Since UX goes beyond usability, the students were also asked in the last section of the survey, to rate their enjoyment during the course and how willing they would like to take a course similar to this. Both question were based on Archer (1994) research. Also, the immediate perceptions and responses of the students towards the gamified layer will be evaluated taking in consideration the comments of the students and the direct observations of the teacher during the intervention period. Law, Roto, Hassenzahl, et al. (2009) suggest that evaluating the UX in the early phases of development of a product is very valuable to support the further development, even without having an actual working system. This is the case of the gamified layer prototype, that, even though it is a working Minimum Viable Product, aims to introduce to the students to a "gaming" experience in their online educational context (Google Classroom).

3.5.3 How does a gamified layer over Google classroom affect the user engagement of the ADHD students during an academic course?

The measurement of engagement is not an easy task due its multidimensional nature and because the outcomes are neither visible nor physical, besides, only the user can evaluate their own experience during an interaction with an application, therefore, it's needed a subjective

approach for its measurement (O'Brien & Toms, 2012). A proper measurement of the user engagement through scales such as the User Engagement Scale of O'Brien & Toms, (2010) could be an exhaustive task due requires the administration of a large number of items (i.e. 31 survey's items), which is not suitable for being implemented for students with ADD, ADHD or other learning disabilities due their impairments in attention and other executive functions.

Another limitation for the engagement measurement is that the number of participants in this case study is very small, besides, there's no control group to compare statistically any variation of engagement with respect to the experimental group, therefore, a qualitative approach will be used with the aim to identify which of the attributes of engagement (challenge, aesthetic and sensory appeal, feedback, novelty, interactivity, perceived control and time, awareness, motivation, interest, and affect) proposed by O'Brien & Toms (2008) were affected by the implementation of this gamified layer.

Summarizing, in order to answer this question, I will analyze and describe which factors of engagement were affected in the students after using the gamified layer, rather than measuring the whole spectrum of engagement itself. Additionally, I will evaluate which implemented game mechanics were most satisfying for the students.

3.6 Method

This study was performed as a case study due the small number of students recruited for the intervention. This is a common problem in the field of special education because is particularly difficult to have a sufficient number of students with similar special needs (Mazurek and Winzer, 1994 cited by Sitra et al. 2017), besides, 50% of youngsters with ADHD are comorbid with several conditions such as Conduct Disorders, Oppositional Defiant Disorder (Wolraich et al., 1996; Angold et al., 1999 cited by Kutcher et al., 2004), in addition to anxiety, depression, tic disorders, mental retardation, among others (Kutcher et al., 2004). All these comorbid conditions complicate the recruitment of homogeneous groups even when a significant number of participants with ADHD could be reached.

A group of four male students with 14, 15, 16 and 17 years old participated in the project, the average age of the group is 15.5 years old. According with Dornerus (personal communication, 24th May, 2017), who was their teacher during this course, all the participant students have Attention Deficit Disorder (ADD) as the common disorder and "most of them have multiple diagnosis".

This group of students took a course of music history using Google Classroom and Magelungen spel during three weeks in Magelungen School campus at Gothenburg. Their teacher was the direct observer during all the intervention and was in charge in sending reports about the perceptions and responses of the students about the gamified layer.

3.7 Comments

This study methodology has been partially based on the case study performed by Sitra et al., (2017) due the similarities on their research approach, where gamification, ADHD students and Learning Management Systems are involved. However, it was not possible to have direct personal interviews with the students because according with Palmquist (personal communication, 2017), Magelungen's policies do not allow that.

3.8 Data collection

This section will describe all the information sources and how they were gathered during and after the intervention in this case study. Most of the data comes from observations and interviews that the teacher who conducted the course, performed to the students that participated during this intervention. The quantitative data has just a descriptive character and is not representative nor generalizable.

3.8.1 Personal communication and interviews

Most of the information used during the different phases of the project was gathered through personal communication such as meetings, phone calls, interviews, emails and videoconferences by Skype. The persons that were providing information during this case study were two teachers that work for Magelungen, having two different roles within the school. One of the teachers is also the client, the other teacher is the one that performed direct observations of his students that participated in this intervention.

The interviews with the students were personally performed by the teacher due to the students are Swedish speakers and make good use of the trust environment that is already settled at school which facilitates the communication with them.

The data was gathered using both personal communication with a teacher from Magelungen and two surveys through Google Forms with scales and open questions. One survey was for the students (Appendix E) and the other one for the teacher (Appendix F). The interviews with the client and the teacher were audio recorded with their consent.

3.8.2 Surveys

A 17 items survey (Appendix E) was developed to gather descriptive information about the participants along of three sections. The first section has the goal to gather basic demographic information such as gender and age, besides of their prior familiarization with videogames and computers skills. The second section includes a question to know how frequently they entered to Magelungen spel to consult their progress of Google Classroom, and also, this section includes the items of the Usability Metric for User Experience (UMUX) of Finstad (2010). The last section consists in two questions, one of them regarding to how much did they like the course and the other one about their will to use Magelungen spel for other courses. All the text of the survey was translated to Swedish language.

3.8.3 Google Admin Console's reports

With these reports will be gathered the data about who logged into Magelungen spel and how frequently they did it. This is thanks to access token requests made by the application every time that a user logs in.

3.9 Ethical considerations

Since this research project involves teenagers, which in addition presents different learning disabilities such as neurodevelopmental disorder (ADD) and other comorbidities, it's important to take in consideration certain ethical considerations for this methodology.

The participation of each student from Magelungen in the experiment was totally voluntary, and the parents or custodians of the teenagers involved in this research were informed as is stated in the law on research ethics (Centre for Research Ethics & Bioethics, 2017). The

parents' and students' consent was gathered through a document in which they were informed about the usage of their information for research purposes, the guarantee of their anonymity and their right to withdraw the research at any time and without giving any reason. All of participants granted their consent. An example of the document used for this purpose can be consulted in the Appendix B.

It is important to clarify that this methodology did not involve any kind of medical or pharmaceutical treatment.

4 Design and development process of the gamified layer prototype.

In this chapter, the design considerations taken to develop a viable prototype will be presented, starting with a description of the requirements of the project, the original gamification design and implementation in Magelungen School. From the software development perspective, it will be described how these elements were brought to the web application, the architecture of the prototype and the technology chosen for the development of the gamified layer prototype.

4.1 Requirements

This project was one of the different options proposed for the students of Serious Games master's program of the University of Skövde during Spring term, 2017. The requirements for the project were obtained through an email (Appendix A) and personal communication with Palmquist (2017) who is the client and designer of the gamification strategy in which this gamified layer relies.

The original idea was to develop an application oriented to high school students that could allow to the teachers a flexible framework to plan and fill contents for their classes, build knowledge trees (skill trees), assign assignments, badges, provide feedback and reminders. Another requirement was that the application could be able to allow to the teacher to create their own badges in order to adapt them to a course. The students, in turn must be able to follow their progression and know how far is left in the course, having in mind the list of the different tasks. The app should be graphically appealing but something that suits the majority of users.

The idea was inspired in existing apps such as Class Dojo[2] which is oriented to elementary school education, where teachers can grant points to their students depending on their behavior in class, and students can share their course work in a timeline similar to Facebook, among other functionalities; or Super Better[3] app which is focused to help users to adopt new habits, beat depression and/or overcome life challenges through challenges, quest and bosses confrontations, however the graphical design of the app's user interface for Magelungen should be more neutral in order to be adequate for a wider range of students' ages.

After analysis, the requirements were categorized in functional and non-functional, and afterwards were validated by Adam Palmquist on 9th February 2017 during a meeting.

Functional requirements

- Progress tracking*
    - Points*
    - Levels*
    - Pending tasks (assignments)*
- Content management system (Google Classroom) *
- Course planning (Google Classroom)

[2] Class Dojo https://www.classdojo.com/es-es/?redirect=true

[3] Super Better https://www.superbetter.com/

    - Task tree (Skill tree) (creator and editor)
- Badge system*
    - Mozilla open badges
    - Google Play Game Services
- Badge editor
    - Credly editor
    - Custom developed editor
- Feedback system
    - Messages
- Reminders (Notifications app version)

Non–functional requirements

- Scalability (React JS, Node JS, React Native) *
- Attractive User interface for a wide range of student ages*
- Usability and user experience*
- Web version (React JS, Node JS) *
- App version for iOS and Android (React Native)
- The UI should be in Swedish language*

Due time limitations and reduced number of developers (just me), the requirements marked with asterisk were prioritized in order to develop the application prototype following the Minimum Viable Product (MVP) principle from the Lean start-up methodology. The principle is defined by Maurya (2009) cited in Reimeringer (2016), as the "smallest thing you can build that delivers customer value". The features for the MVP were prioritized taking into account the inclusion in the prototype the game elements that Adam Palmquist is currently using for his students at Magelungen School, besides the implementation feasibility and time investment.

Due the several limitations, it was decided to develop the prototype as a web application instead of a mobile app, due the fact that web environments are more ubiquitous than smartphones. Furthermore, choosing to develop a mobile platform imply the release of two versions of the app for the most popular mobile operating systems (Android and iOS).

4.2 Gamification design

The design of this gamification strategy relies, was provided by Palmquist (personal communication, 2017). He has been using the following game elements into his classes at Magelungen: points, badges, progression tracking and skill trees. Palmquist commented that those mechanics have been working satisfactorily. The implementation of that mechanics is currently analogic using printed badges designed with an online tool.

The mechanics implemented in this gamified application are points, badges, theming and progression tracking. Each game element will be described below.

4.2.1 Points

In accordance with Zichermann & Cunningham (2011), points are a fundamental requirement for any gamification system, and for this design, it was not an exception. Palmquist (2017) designed a point system in which the amount of points is related to the complexity of a task.

The difficulty is given by a series of instructions that the student should follow in her assignment in order to get the higher amount of points. *Figure 5* shows an example of one assignment under the points system.

Figure 5 Points system implemented by Palmquist (2017)

"Magelungen spel" implements the points using the assigned grades from an assignment of Google Classroom, adding up all the grades of a course and showing the total amount in the progress component.

4.2.2 Progression

The pie chart of *Figure 6* exemplifies how the progress mechanic is designed. The student's progress during the course is expressed as a percentage of completed and remaining tasks.

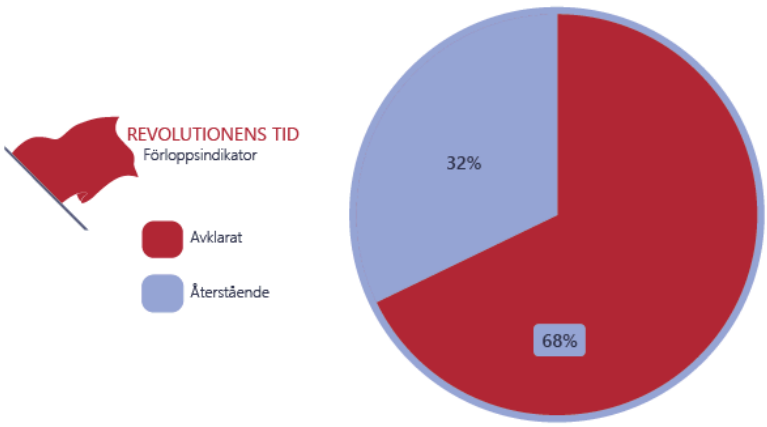

Figure 6 Progression visualization by Palmquist (2017)

Figure 7 is a screenshot of the course progress component of "Magelungen spel" in which a Google Classroom's course progress is summarized visually, making use of a progress bar and numbers, showing the total assignments of the course and the total completed ones by the student.

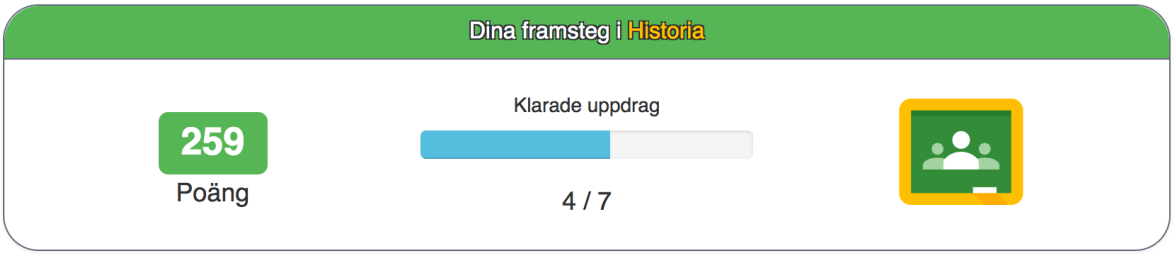

Figure 7 "Magelungen spel" course progress component

4.2.3 Badges

The badges are implemented in a medal shape, using the typical metallic colors such as gold, silver and bronze commonly used in the Olympic games. This badge system was designed to be combined with the points system, where the points earned by completing an assignment is a parameter to decide which medal will be earned. The calculation is made using the percentage of points earned with respect to the maximum, assigning the gold medal when the amount of points earned is superior to 90% of the maximum grade, silver medal when is between 75% and 89% and bronze medal when is less than 75%. *Figure 8* exemplifies how a mission looks after being completed, in this case, the golden medal and 140 points of 150 available have been earned.

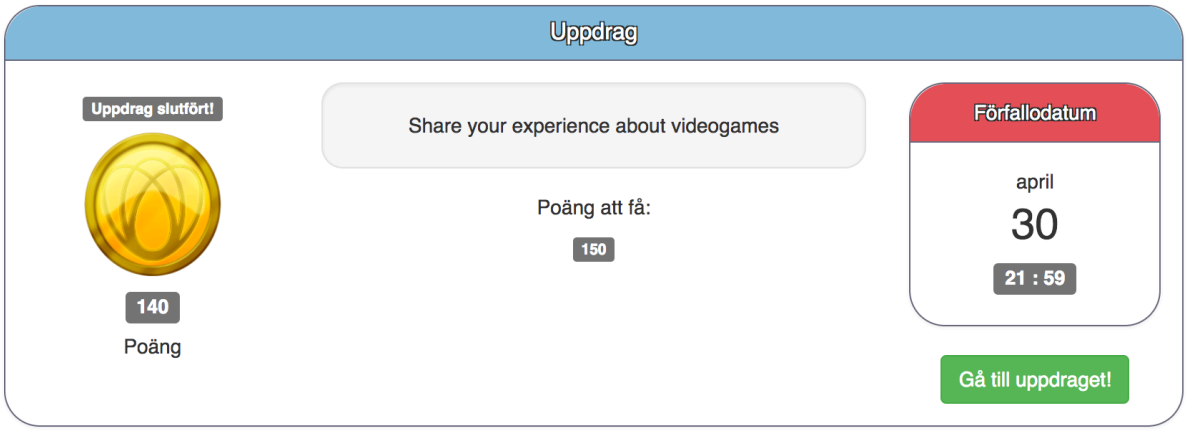

Figure 8 Mission component in Magelungen spel

4.2.4 Theming

This game element is not a full-fledged narrative, but instead, it uses words commonly used in games (i.e. missions, challenges, trivia, etc.) to replace the common terms used in Google Classroom namely assignment, multiple choice question and short answer question. *Table 2* shows how each game-like term is related with its corresponding in Google Classroom.

Table 2 Game-like terms used in Magelungen spel

Game-like term	Conventional term GC	Characteristics
Mission	Assignment	Mandatory assignment that has a limited time to be finished (due date).
Challenge	Assignment	Optional assignment, does not have time limit.
Trivia	Multiple choice question	Question with one or more options
Short trivia	Short answer question	Question for a short text answer

4.3 Web application architecture

Magelungen spel (MS) is a client-side web application prototype, that retrieves data from Google Classroom (GC) through RESTful[4] API calls, for then, display it in a gamified way. The data accessible through the GC API V1 is: courses lists, course works, student submissions, course students, course teachers, user profiles and guardians (Google, 2017b). All the data security logic is handle by the GC API, and the authentication process is handle by the OAuth2[5] authorization protocol. Thanks to OAuth2, the student can sign-in to Magelungen Spel using the same Google account that uses for GC.

In order to access to Magelungen spel, it is necessary to be enrolled at least in one GC course as student, otherwise, the application will not display any data besides of the profile.

This prototype consists basically of a dashboard with four sections: profile, courses list, progress and missions. The profile section displays the full name of the student, email and profile picture. The courses section shows a list of the courses where the student is enrolled and, whenever the student selects a course, the missions' section will be displayed deploying all the available missions of the course.

Due this is just a prototype application, it's recommendable to think about MS as GC gamified layer that displays the progress of the student in a more attractive way. This means that the app does not provide any kind of interaction beyond the login process, course selection and redirection button to the original assignment of GC.

The *Figure 9* shows the complete architecture design of the app. The highlighted corresponds to the architectural components currently included in the MS prototype. It can be appreciated how the student can access both Google Classroom as the dashboard of the gamified layer using her same Google account. The Google API is parsed with a series of game rules and then transformed in game elements ready to being displayed in the dashboard. Notice that at this

[4] RESTful (Representational State Transfer) - https://en.wikipedia.org/wiki/Representational_state_transfer

[5] Oauth2 - https://oauth.net/2/

stage, the student's actions are not affecting the data of their dashboard since Magelungen spel does not provide interaction yet.

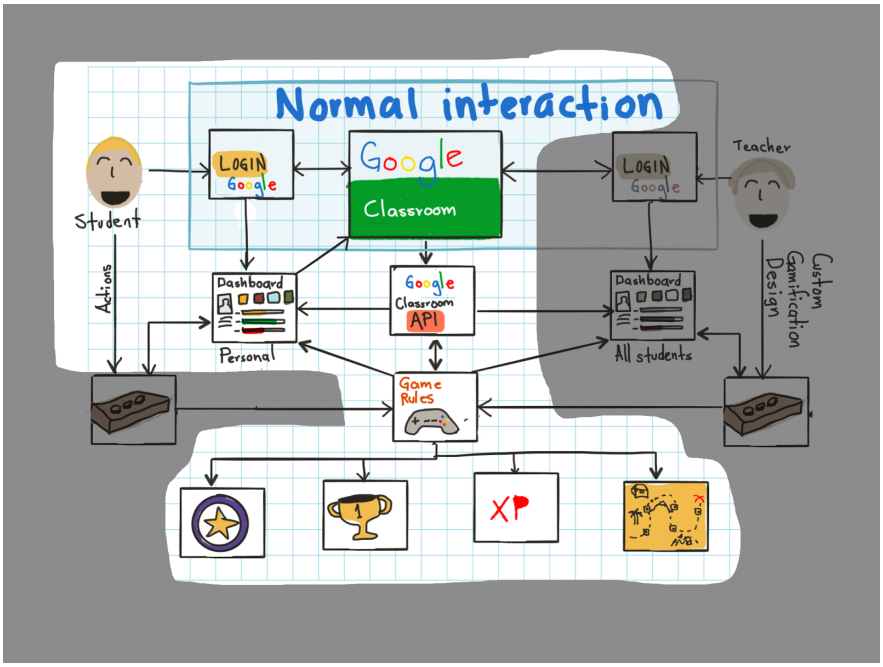

Figure 9 Magelungen spel complete architecture

4.4 Technology

One of the main non-functional requirements of the gamified prototype is scalability. Web environments have several advantages to accomplish this requirement such as the simplicity of implementation, the wide diversity of technology ecosystems, programming languages, frameworks and libraries both server side, as client side and the possibility to use wherever a browser that runs JavaScript is available.

Since this prototype was designed as a client-side app, React JS was chosen as the main library for developing the user interface. React JS[6] is a JavaScript library developed by Facebook based on components, declarative and one of the most important features of React JS is that its code can be rendered in server side through Node JS[7], and also in mobile apps through React Native[8] in a truly native way. Another advantage of React JS is that Facebook is currently developing, supporting and using this library, this fact provides a strong reliability in terms of longevity and further support of the library. The goal is to scale "Magelungen spel" implementing all the original requirements and afterwards create the version for Android and iOS reusing the existing React JS code.

All the source code can be found at the following repository of GitHub: https://github.com/ludilex/mag. This project is open source and all the interested developers are welcome to collaborate with it.

[6] React JS - https://facebook.github.io/react/

[7] Node JS - is a JavaScript runtime. https://nodejs.org/en/

[8] React Native - https://facebook.github.io/react-native/

The app is hosted in Firebase, another service of Google that provides hosting, real time databases, cloud storage among others. Firebase was chosen because is an easy-to-use modern web environment has some tools that makes the deploy process very simple and real time synchronization through all the apps connected to the same database.

5 Results

This chapter will present the participants profile, the "Magelungen spel" application prototype, the opinions of the client about the fulfillment of the requirements and the information gathered at the end of the intervention of this case study regarding the user experience of the students through the teacher's observations report. The communication with the client and the teacher was performed using different communication media such as emails, Skype calls and face to face meetings. There was not direct communication with the students due several factors such as the language barriers, geographical location and as Palmquist (personal communication, 2017) stated, the students with ADHD use to feel uncomfortable when they get interrogated by unfamiliar persons.

5.1 Gamified layer's prototype: "Magelungen spel"

This application prototype aims to answer to the research question "How to bring an analog gamification design to the Course Management System "Google Classroom"?". A single-page web application prototype was designed and developed with the aim of being the gamified layer for GC. This prototype was named "Magelungen spel" that literally means "Magelungen game" from its translation from the Swedish language. The web application can be reached at the following URL: http://magelungenspel.com. The complete design and development process of the prototype is detailed described in chapter 4.

Magelungen spel has a minimalistic user interface that consist in a dashboard with four sections: profile, courses list, course progress and the missions section. Magelungen spel allows the access to the students and teachers using the same Google account that they use to log-in into GC. The students can see almost the same information that they could consult into GC such as their profile picture, email address, the courses in which they are subscribed and all the course works associated with each course. There is certain data that is not reachable from GC due the limitations of its API, such as the internal messaging and the custom topics in which the course works can be organized.

As mentioned in the previous chapter, the gamified layer consists in the following game elements: points, badges, levels (expressed with badges), theming and progression bars. The points are associated with the maximum grade of each course work; the badges are associated with the status of completion of a course work; the levels are implemented using the color of the badges (bronze, silver and gold) and each color is defined calculating the percentage ranges of the points obtained with respect of the maximum points; the theming is a substitution of the original type's names of course works of GC in a more appealing game-like terms, namely missions, challenges, trivias rather than assignment, short answer question and multiple choice question; lastly, the progress bar is a simple relationship between the amount of course works and the completed ones. The *Figure 10* is a screenshot of the user interface of Magelungen spel.

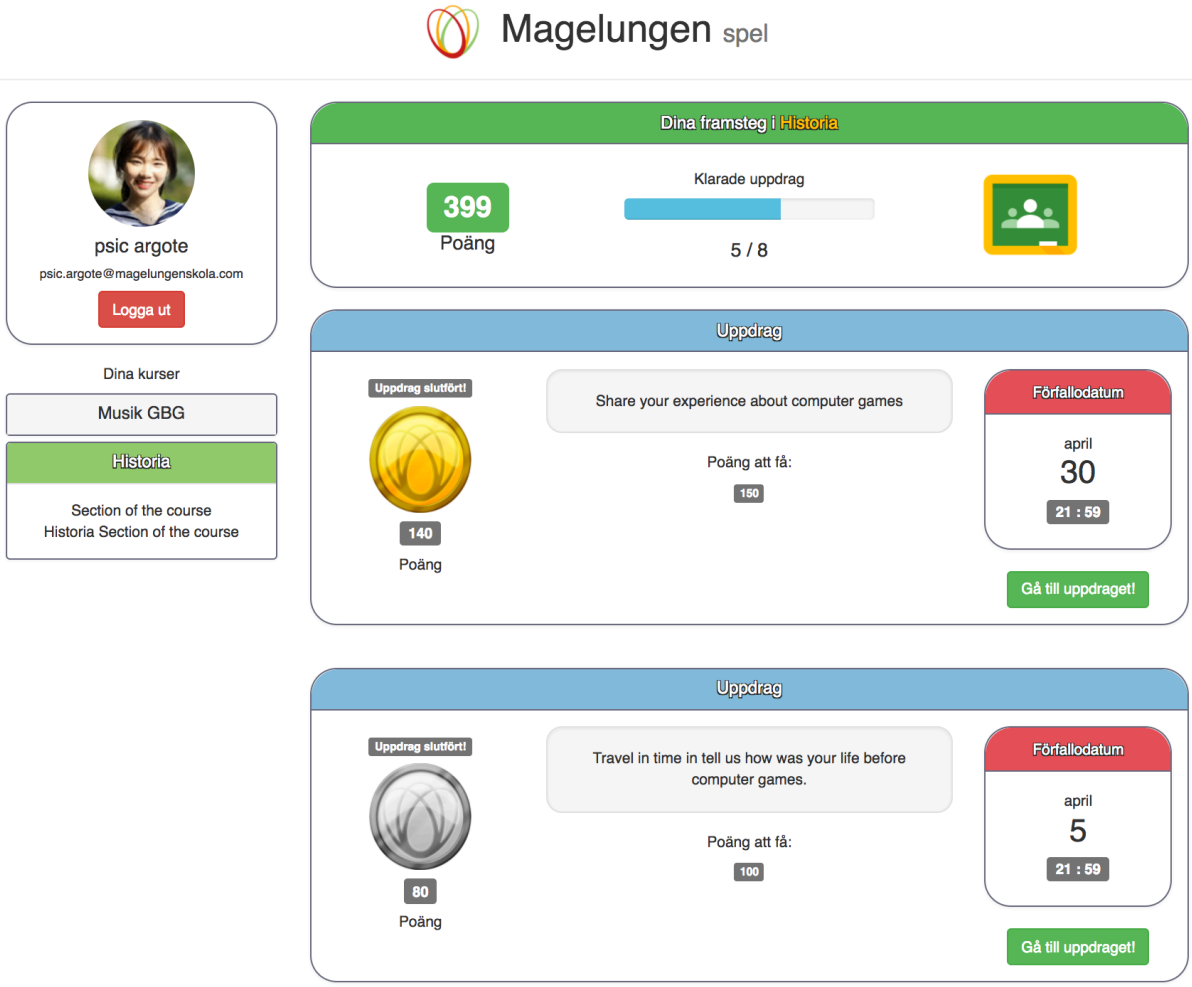

Figure 10 Magelungen spel user interface (with dummy data)

5.1.1 Gamification implementation accuracy in Magelungen spel

After the intervention was finished, another interview with the client Palmquist (personal communication, 17th May, 2017) was performed in order to know his opinions, perceptions and expectations about Magelungen spel regarding to the accuracy in the implementation of the game elements in which this prototype is based and that he is currently using in his classes.

The question launched to the client to assess the accuracy of the implementation was: "Which game mechanics implemented in Magelungen spel do you consider were the most accurate, based on your gamification design?". Regarding the implementation of the game mechanics from the original design requirements, Palmquist (personal communication, 17th of May, 2017) commented that the most accurately implemented were: "the progress bar, the missions and the challenges are almost the same as how I use them". Other important statements of Palmquist (personal communication, 2017) were: "when you use points connecting to the different kind of values of the badge …", followed by "… as the teacher of the group mentioned to you, this is very motivating, because when the people just got a silver badge, they worked motivated to do another round and to do over to make the golden badge". Palmquist (2017) pointed out "… that is one of the design techniques that are very important in gamification,

because in a normal class you just get one shot in making a test…", "…when you get a do over chance the students are more motivated to fix their faults and to get the gold badge …".

In order to know to what extent Magelungen spel fulfilled the expectations of the client, Palmquist (personal communication, 17th of May, 2017) was asked to assess this with a scale from 1 to 7, where 7 meant the higher expectations fulfillment. He gave a 7 arguing that: "when I saw when the kids were motivated in the way that they were motivated, it will be a 7…".

Palmquist, A. (2017) commented that "the students with learning disabilities and with ADHD had a blast, they had really fun, and when I talked with the teacher who wasn't so into gamification, but still thinks that it's very interesting, he said that the subject, that is music theory, it's not a super interesting subject, but still the people were super engaged".

Regarding the limitations of Magelungen spel, Palmquist (personal communication, 2017) argued that one of the missing parts that he would love to see in this prototype was the knowledge tree, which can be seen at *Figure 11* and consist and a categorization of the course contents and links among the topics. This requirement was not considered in the Minimum Viable Product development due the difficulty on its implementation and time limitations.

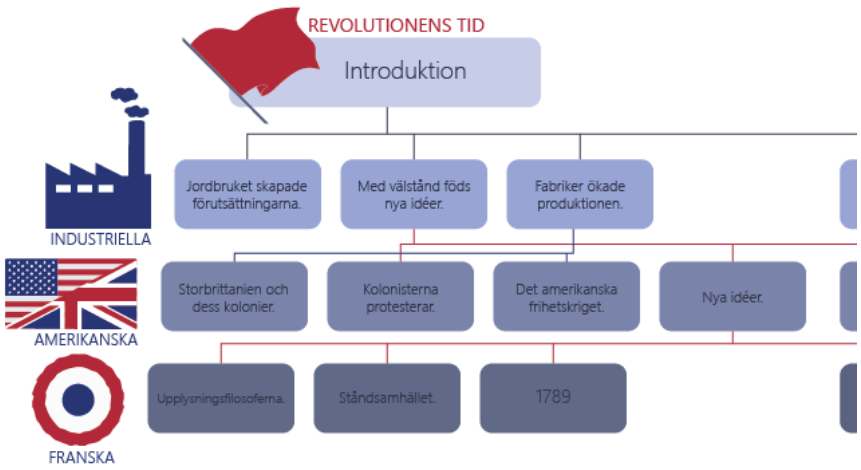

Figure 11 Knowledge tree (Palmquist, personal communication, 2017)

5.2 Teacher's observation reports

This section presents a brief profile of the teacher who was the direct observer during this intervention, along with his comments, thoughts and perceptions about his experience during his teaching practice using Google Classroom and Magelungen spel and how his students responded to this gamification implementation. The information was gathered through emails, a survey and an interview after the course was finished.

5.2.1 Teacher profile

Erik Dornerus is a relatively new teacher who has been working at Magelungen for about 8 months and this was his first time imparting the course about the history of music that the students took during this intervention. Since he indicated in the survey that he had a prior familiarization with gamification before this intervention, it was asked to him during the

interview to explain in which way he was familiarized. The teacher commented that he had attended to some lectures about gamification and he have applied some parts of it such as the "skill tree" for his courses, but he hasn't gone all into gamification, "I just scratched the surface before" he commented. He shared that "this was my first real time doing a fully gamified course" and he had never used Google Classroom before this intervention.

5.2.2 Emails

An email from the teacher Dornerus (personal communication, 28th April, 2017) was received with feedback of his observations after the very first class was ended, in that email he stated that the "students were motivated and enjoyed the class" and mentioned that "they wanted to be able to purchase things for their points and that they wanted levels of their overall achievements".

The experimentation phase ended on the 12th of May, 2017. The teacher sent a report by email expressing the answers of the students to the question "what could be improved in the app?".

The students suggested a color palette customization feature, a switch in the pointing system to experience points in order to reach levels with those points, also, they wanted the name of the levels to be "game-like". The students suggested that this points approach could simplify the understanding of them, instead to be related to any grades. Another suggestion is that the students would prefer to visualize their points as a progress bar.

At the end of the email, the teacher wrote "Overall they seemed to enjoy the app and were motivated by the points-system (they actually re-did some assignments if they didn't get the points they wanted)."

5.2.3 Survey

It was asked to the teacher to answer a short online survey in order to know about his prior knowledge about gamification and Google Classroom using binary questions of "yes" or "no". The teacher answered that he was previously familiarized with the concept of gamification but

Also, the teacher was asked to rate to what extent he considers that Magelungen spel improved the engagement of his students during the course activities, using a 1 = "Not at all" to 7 = "It strongly improved" Likert's scale. The teacher rated a 7.

Another 1 = "Not likely" to 7 = "very likely" Likert' scale was used to know how likely the teacher will use Magelungen spel for future courses. The teacher also rated the highest value. This time, the teacher added in the additional comment for the aforementioned question, that he is beginning to work more frequently in GC and he does not see the reason to not include Magelungen spel, he also stated that anything that provides further motivation for the students is a good thing.

5.2.4 Interview

This is not a full transcription of the interview, but a very detailed description of it. Since the teacher was the only observer during the intervention, it was considered relevant to present it that way in order to have a better reference about what happened in the classroom environment during the intervention.

An interview was performed with teacher Erik Dornerus (personal communication, 24th May, 2017) via phone call with the objective of gathering information about his personal profile, the

course imparted, his teaching practices, previous experience with gamification and more detailed information about his observations during the intervention.

At the beginning of the interview, the teacher allowed me to record the conversation for having a more accurate referencing of it, and he also allowed the use of his name for being included in this study to support their comments and opinions.

He was asked if he had difficulties applying the rules of this gamification approach in his course. He answered that he found it easier than he thought it would be, due the fact that he has been a gamer all his life and he easily recognized a lot of the elements. He stated that at the start was hard but it became easier after all, finishing his answer with the phrase: "now it feels like it's something that I want to apply fully to my teaching, actually".

The course of history of music has the objective to teach how history and music are tied together, and how historical events affected the music culture and what people listen to. His teaching practice is performed using videos, discussions, timelines, texts and lectures. He pointed out that he puts a lot of effort on that.

The teacher described how his class is structured for his students with ADHD. Each lesson is divided in segments: the students watch a video, then, they have to answer questions about it. Afterwards, he makes a timeline in the whiteboard and they talk about the difference between times and why the music sound like that in that ages. Lastly, at the end of the class, the students get an "exit ticket" (short answer question in GC) in which they have to describe what they have learn.

Another question asked was if he had to explain to the students how to use Magelungen spel. He commented that the only information that they got was that they will be "doing like a beta test of the app" and that they will try something new. The teacher also added that the students were familiar with GC so he put more effort to teaching them through it, and "they just caught Magelungen spel" … "they became familiar really fast".

After asking him whether the students had further questions about Magelungen spel during the course, the teacher said that rather than question, "… they just had some ideas like switching out the point system to experience system…", which Erik also thinks that is a great idea. He reaffirmed that his students really didn't had questions about the prototype, but "…they were excited about trying out and they wanted to keep on working with it…", "…they wanted levels and personalized colors…", closing with "… it seems that they really embrace it". He mentioned that the questions of the students were more related to the use of GC because they weren't familiar with that either.

The teacher answered to the question about how he made his observations, describing that he was just walking around when the students were behind their computer using Google Classroom, looking at what they wrote, talking with them, providing instant feedback with points and comments" …if they got some bad points for an assignment some of them asked if they can stay and go back and redo what they have done and they did it instantly…", "… I took notes about the verbal discussions we had, what they have done…".

At the closure of the interview the teacher asked if it is possible to still use Magelungen spel, and as additional comments he added that the kids were motivated and this was an easier way to get response from them, he argue that a lot of students usually have a hard time to give response both positive or negative and that can be a problem in the evolvement of the subject,

but this was an easier way to get feedback from them and "they were curious about the feedback", and "…I felt that they wanted to improve…", "…that was the biggest strength to me that the feedback system was easier than as usually is".

5.3 Students' perceptions and responses during the course

The students' perceptions regarding to their experiences during this gamified course, were gathered through a survey answered by all of them and through the interviews and observations performed by Erik Dornerus.

5.3.1 Profile

A survey was answered by four male students from 14 to 17 years old (M= 15.5) who interacted with "Magelungen spel". In the first section of the survey, all of them specified that they play computer games every day. Regarding to the skills in the use of computers, two of them consider that are very skillful, one of them consider himself skillful and the last one that is not.

Table 3 shows the log in events of Magelungen spel such were retrieved from the reports of Google Admin Console. It can be observed that that students logged in into Magelungen spel just once per week at Fridays, which was the day of the face-to-face class. Even though this result was expected because the prototype of Magelungen spel, at this stage, was just a gamified progression summary and there is no need to consult it often, it can be observed that the login time was almost simultaneous or with a short span of minutes of difference. This simultaneity could be because the grades of Google Classroom can be assigned by the teacher by batch and it's likely that the students access immediately after they were notified that the grade was granted in order to see their progression into Magelungen spel.

Table 3 Magelungen spel's access log

Student ID	Date	Time
1	2017-04-28	13:11
2	2017-04-28	13:11
3	2017-04-28	13:11
3	2017-05-05	13:08
4	2017-05-05	13:08
2	2017-05-05	13:09
1	2017-05-05	13:12

5.3.2 Usability results

The second section of the survey had the aim to evaluate the usability through the four items of the UMUX. The answers of the students are organized at *Table 4* represented with percentages.

The data was recoded following the instructions of Finstad (2010), in which the odd items are scored as [score – 1], and even items as [7 – score]. The preliminary maximum is 24 and in order to have parity with the System Usability Scale's range (Brooke, 1996) expressed as 0 – 100, the UMUX score was calculated multiplying the sum of the four items divided by 24, and then multiplied by 100. The results of the scale are shown at *Table* 5 ordered by age. The mean UMUX score is M=70.83 with a SD=12.73. The Cronbach's alpha for the four items of this scale was 0.77.

Table 4 UMUX students' answers

UMUX item	7 (strongly agree)	6	5	4	3	2	1 (strongly disagree)
"Magelungen spel" capabilities meet my requirements	25%	25%	50%	0%	0%	0%	0%
The use of "Magelungen spel" is a frustrating experience	0%	25%	0%	0%	25%	25%	25%
"Magelungen spel" is easy to use	50%	0%	25%	25%	0%	0%	0%
I have to spend too much time to figure out how "Magelungen spel" works	25%	0%	25%	0%	0%	0%	50%

It's important to point out that a modification was made to the last question of the UMUX: "I have to spend too much time correcting things with [this system]"(Finstad, 2010, p. 326) because the capabilities of Magelungen spel are not interactive at all in this prototype, therefore, there's no other use case, besides the login process, in which the students may be able to make any kind of corrections in the system during the interaction. Since this question aims to measure the efficiency component of usability, it was considered appropriated to measure this component in terms of how quick was the understanding of the functionality of Magelungen spel instead the time spent in corrections, with the following adaptation: "I have to spend too much time to figuring out how "Magelungen spel" works".

Table 5 Participant students' ages, computer skills, UMUX scores and opinions

Age	Computer use skills	UMUX score	Thoughts about MS	Improvement suggestions
14	Very skillful	50.0	"good"	"no"
15	Not skillful	66.7	"cool"	"I don't know"
16	Very skillful	75.0	"9/10"	"Make a real page and not done on google"
17	Skillful	91.7	"it's ok but can get a bit better"	"maybe names to the ranks that you get when you level up"

5.3.3 Students' opinions and suggestions

In the survey, two open questions were asked to the students in order to know their comments about what they think about Magelungen spel and how could be improved. In the open question "what do you think about Magelungen spel" they used the short phrases or words such as "good", "it's ok but can get a bit better", "cool" and one of them wrote "9/10".

For the question "what could you add to Magelungen spel to make it more interesting for you?" they also answered briefly with the phrases: "no", "I don't know", "maybe names to the ranks that you get when you level up" and "Make a real page and not done on google". All the aforementioned students' statements were translated from Swedish language.

5.3.4 Course enjoyment and prototype endurability

Figure 12 shows the students' responses ratings distribution for the last section of the survey which had two questions related to how much the students liked the course (scale from 1 = "Very little", 7 = "Very much") and if they would like to use Magelungen spel again in other courses (1 = "Not at all", 7 = "Gladly").

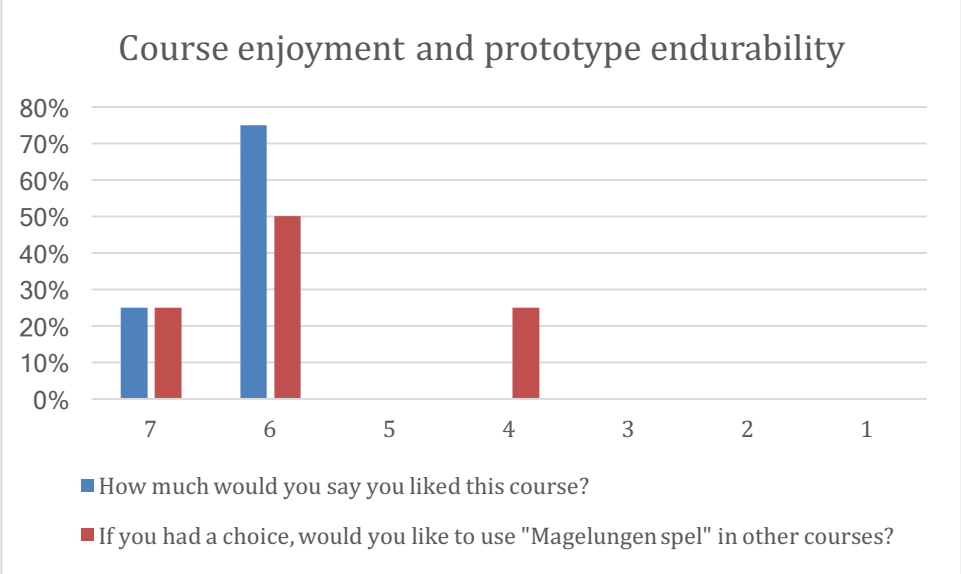

Figure 12 Responses distribution of course satisfaction and prototype success

5.3.5 Satisfaction regarding to the implemented game elements

Figure 13 shows how the students rated each of the main game elements (badges, progression visualization and points) of the original gamification strategy were evaluated in regard with their satisfaction when they were rewarded by the points and the medals, their progress visualization and their engagement during the course. It can be appreciated that the medals had the best rating.

Even though the points' mechanic was liked by the students, it seems to be insufficient. They wanted to have a more dynamic pointing system that had some benefit, as a currency or as a level progression, but instead the points were just a summary of their grades.

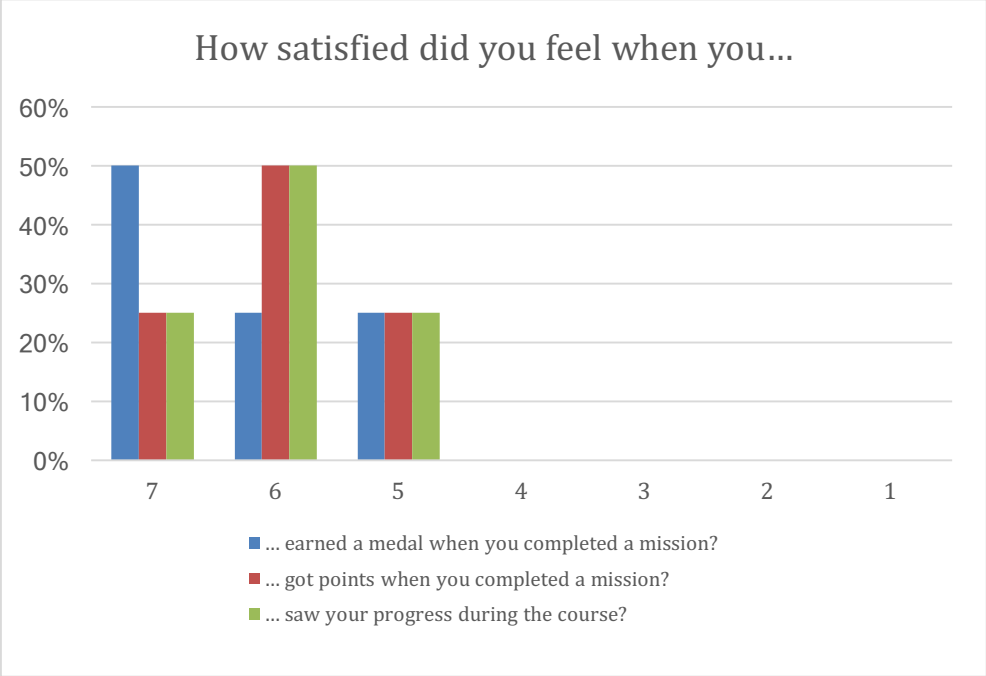

Figure 13 Student's ratings of used game elements

6 Analysis

In this chapter, all the data gathered through the different moments of the intervention will be qualitatively analyzed following an explanatory approach guided by the research questions, with the aim to answer each of them.

6.1 Research question 1: How can an analog gamification design be brought to the Course Management System "Google Classroom"?

This question is answered through the different phases of this project process, from the requirements analysis to the implementation phase. It is important to denote that during the early phase of the project evaluation, it was found that the requested flexible framework required of several high complexity features such as course planning, content management, assignments creation and feedback system that would be technically impossible to develop from scratch due the resources limitations such as time and programmers (just one).

It was identified that those aforementioned requirements corresponded to certain LMS characteristics and during a personal meeting with the client Palmquist (personal communication, 9th February, 2017), he was asked if Magelungen School was using any kind of LMS, finding that they were actually starting to use Google Classroom with the aim to be used on large scale in the institution.

The key point for the design of this prototype was the visualization of Google Classroom itself as the "already existing part of the framework" that fulfill the aforementioned requirements, that additionally provides the inherent features of any Google service such as authentication system, secure access, permissions management and the most relevant feature for this prototype: its public API.

Under that perspective and with the aim to fulfill most of the requirements of the client, the development approach was more oriented towards bringing the already successful gamification design into Google Classroom, rather than developing a complex stand-alone application. This is the reason of why Magelungen spel has been referred as a "gamified layer".

The following two supplementary questions will guide the arguments to evaluate if the prototype is a viable product to start implementing the current gamification strategy in a digital way in Magelungen, considering the perspectives of the client and the teacher.

6.1.1 Does the gamified layer fulfilled the client's requirements?

In the first section of chapter 5, this gamified layer was described along with opinions of the client about how accurate his gamification design was brought into the prototype. The client pointed out that the skill tree is one of the features that he would have liked to see included in this prototype, however, he stated that the progression visualization, the badges and the theming (missions, challenges) were pretty similar to his design. He made a good emphasis in the way of how the connection between the points (grades) with the different types of badges was performed and how this actually motivated to the students to re-make their assignments in order to obtain the golden medal. Lastly, the client gave the highest value in the scale in which it was asked to him to rate to what extend Magelungen spel fulfilled his expectations.

Given all these reasons, it can be considered that this prototype is a good digital approach of his gamification design.

6.1.2 Was Magelungen spel a useful tool for the teacher to implement gamification during his teaching practice?

The first comment of the teacher received in his very first report was "Had my first lesson with the app, and it worked wonderfully". In regard to usability, he commented that implementing Magelungen spel was easier than he had thought, besides, he also expressed that is something that he wants to apply fully in his teaching. He was worried about the further availability of Magelungen spel, statement that could denote a truly will to use it. Another advantage is that he didn't have the necessity to explain how Magelungen spel works because the students got familiar with it really fast.

The teacher shared that some of his students put more effort to re-make an assignment looking for getting the golden badge. He felt that his students really wanted to improve and it was easier for him to get feedback from the students due the curiosity that they had during their experience. These positive results could suggest that the gamification strategy was successful because the students improved certain behaviors such as persistence (make an assignment once again) and participation (rich feedback) that the teacher mentioned are hard to provoke in students with learning disabilities.

In summary, since Magelungen spel partially fulfilled the expectations and requirements of the client, the gamification implementation influenced the persistence and participation of the students and the teacher had a really good experience using it for his class, it can be suggested that the gamified layer succeeded the objective to bring an analog gamification practice to a digital experience and, even though this prototype is in an early stage of development, can be easily used by teachers who wants to apply gamification in their teaching practices for students from Magelungen.

6.2 Research question 2: How does the gamified layer over Google classroom affect the user experience of the students during an academic course?

Before answering this question, let's recall the operational definition of user experience used for this case study, where UX is "the person's perception and response resulting from the interaction with a gamified system through a user interface". This operational definition was narrowed to a particular kind of system with the objective to evaluate the responses and perceptions of the students regarding the gamified layer's user interface, rather than their overall experience with the gamification strategy itself.

6.2.1 Usability

After the measurement of usability through the UMUX, the results indicated that the average usability score of Magelungen Spel is 70.83 of a maximum score of 100, which could be interpreted as an "acceptable usability" for a prototype, but still has plenty room for improvements. There was also found a strong positive correlation ($r= 0.992$, $n=4$) between individual usability scores and the age of the participants. Even though Magelungen spel shows an acceptable usability, Finstad (2010) declare that the UMUX score should be treated just as a subjective evaluation of a system's usability and should be compared with more

objective test such as task timings and error rate. Unfortunately, Magelungen spel does not provide enough interactivity features to perform those suggested tests yet.

It's convenient to look back at the comments of the teacher in which he states that he didn't have to explain how Magelungen spel works. This could be considered a usability positive "side-effect" for the teacher, who was able to implement gamification in his course without too much effort.

6.2.2 Responses

Thereby, it was observed that the students got familiarized easily with the game elements implemented in the prototype. The students were giving improvement suggestions for Magelungen spel in a very specific way, for instance, they suggested to add levels based on points and naming each level. They also suggested to change the points to experience points, which is a common way to referring them in videogames. Some students wanted to have the possibility to use the points as a virtual currency to buy things in the application and they also wanted a mobile version. This also suggests that the students' expectations were high and, since the prototype did not provided any kind of interaction beyond the login process, the students didn't log on to the application after class because neither exist other kind of game mechanics to foster this action, nor course activities were designed for being performed at home. The diverse suggestions to improve the points system could be due a design weakness because in the prototype, the points were just the sum of grades displayed at the progress component, but they didn't provide any utility or extra reward. Also, some students recommend to visualize the points in form of progress bar instead of a numeric way.

The only comments received directly from the students regarding the gamified layer, were gathered through the online survey. In both opportunities to write an open answer, the students wrote just one word or very short phrases, this could be due "…most of the students usually have a hard time writing…" as Dornerus (personal communication, 28th April, 2017) suggest. Turning back to *Table 4* (usability results' section in chapter 5), it can be observed that the older students rated better usability scores, also, they were the ones that provided better feedback, which makes sense due the positive correlation of age – usability score. There's not enough information to assess why this correlation occurred.

6.2.3 Perceptions

The quick familiarization with the application and the aforementioned students' very specific suggestions about the game elements could be explained with the fact they usually play computer games every day as they have indicated on the survey, besides, the name of the gamified layer which literally means "Magelungen game" is pretty suggestive. There's not too much room to doubt that the students got the idea of the game elements and that these were connected with Google Classroom, however, it's important to notice that some students that provided direct feedback perceived the prototype as incomplete, through expressions such as "make a real page and not done on Google" or "It's ok but can get a little bit better". Surprisingly, they rated a higher score of Magelungen spel's usability.

In general, the introduction of Magelungen spel during the course was transparent and easy to implement for the teacher and easy to understand for the students. The analysis of the UX's elements addressed shows that, even though the prototype didn't fulfill the expectations of some students, it was able to bring to them a gamified experience in which they participated actively through valuable feedback.

6.3 Research question 3: How does the gamified layer over Google classroom affect the user engagement of the students with ADHD during an academic course?

Table 6 shows the definitions of the engagement factors from a generalized User Engagement Scale proposed in a more recent work of O'Brien & Toms (2012). Those factors will guide the analysis in order to answer this question. Some definitions were adapted with the aim of being congruent for this case study. In order to give a more concentrated analysis of each factor, the following labels will be used: not enough information, not affected, positively affected, strongly affected. The criteria for labeling each analysis will be explained with the arguments referring to the students' responses and perceptions about their experiences with Magelungen spel gathered through the survey and reports of their teacher.

Table 6 Factors of Engagement and their definitions based on O'Brien & Toms, 2012)

Factor	**Definition**
Aesthetic Appeal	The users' perception of the visual appearance of Magelungen spel User Interface (UI).
Endurability	Users' overall evaluation of the experience, its perceived success and likelihood to use Magelungen spel again.
Felt involvement	User's feelings of being draw in, interested, and having fun during the interaction.
Focused Attention	The concentration of mental activity (Matlin, 1994 cited in O'Brien & Toms, 2012) according with some elements of Flow such as focused concentration, absorption, and temporal dissociation (Csikszentmihalyi, 1990 cited in O'Brien & Toms, 2012)
Novelty	Users' level of interest in the task and curiosity evoked by the system and its contents.
Perceived Usability	Users' affective (e.g., frustration) and cognitive (e.g., effort) responses to the system.

6.3.1 Aesthetic Appeal

Magelungen spel has a minimalistic user interface that use panels for each component to provide a clean organization of the content, giving more emphasis to the missions, challenges and trivia's sections (see *Figure 14*). The colors' palette was based on Magelungen's logo with the aim to bring a consistent identity to the prototype, however there was no specific survey item or question for the student related to the evaluation of the UI appearance.

The only students' response regarding the UI was a suggestion to incorporate a feature that could bring the possibility to personalize the colors of the application, which could suggest that the colors weren't appealing for that student.

There's no possible to make a further analysis this factor given that there's no enough information to evaluate how much the students liked the UI.

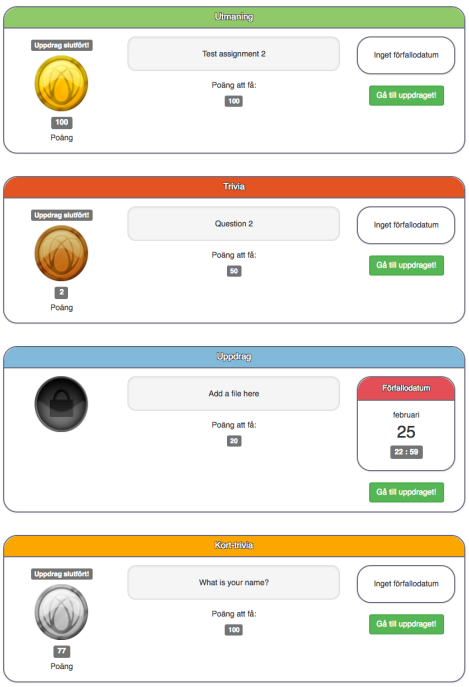

Figure 14 Magelungen spel UI example. Shows the colors used for missions, challenges and trivias (dummy data).

6.3.2 Endurability

Since most of the students (three of them) rated the higher value in the question about how likely they would like to keep using Magelungen spel for other courses and one of them rated neutral (see *Figure 12*, chapter 5 for reference) and the overall UX for the students was good due their easy understanding and familiarization of the game elements, this attribute can be considered positively affected.

6.3.3 Felt involvement

This is the engagement factor that showed more success among the students. The students were involved in a sort of way the game design of the prototype giving feedback regarding the game elements. This active participation suggests that students felt that they could help to improve their experiences during their interactions with Magelungen spel through expressing in which way they would like to see game elements in the UI. It can be suggested that Magelungen spel strongly affected the involvement of the students.

6.3.4 Focused attention

There's no way to evaluate neither absorption, focused concentration nor temporal disassociation in Magelungen spel because it does not provide interaction at all, therefore, this factor was not affected by the prototype.

6.3.5 Novelty

Recalling the comments of the teacher in which he states that "...they (the students) were curious about the feedback..." could indicate that the students were really interested in the

game elements presented through the UI of Magelungen spel. The relevance of the information displayed in the prototype also had an important role given that is mostly the same information than GC, but conveyed in a different way. Considering this, it can be suggested that novelty was strongly affected by the gamified layer.

6.3.6 Perceived usability

This factor was partially affected because the UMUX average score was 70.83 of a maximum of 100 which was interpreted as an acceptable usability for a prototype for different reasons expressed in the usability section from research question 2.

The following table shows in a summarized way how the gamified layer affected the different engagement factors of the students at Magelungen.

Table 7 Engagement factors concentrated analysis

Factor	**Grade of affectation**
Aesthetic Appeal	Not enough information
Endurability	Positively affected
Felt involvement	Strongly affected
Focused Attention	Not affected
Novelty	Strongly affected
Perceived Usability	Positively affected

With the aim to illustrate how these factors are related among them, this concentrated analysis has been tied to the Path Model of the User Engagement Scale (UES) of O'Brien & Toms (2012) showed at *Figure 15*. Even though this Path Model was built after testing the UES in an e-Shopping environment, is a useful framework to explain the reasons of why the students get engaged with the gamified experiences through the use of Magelungen spel.

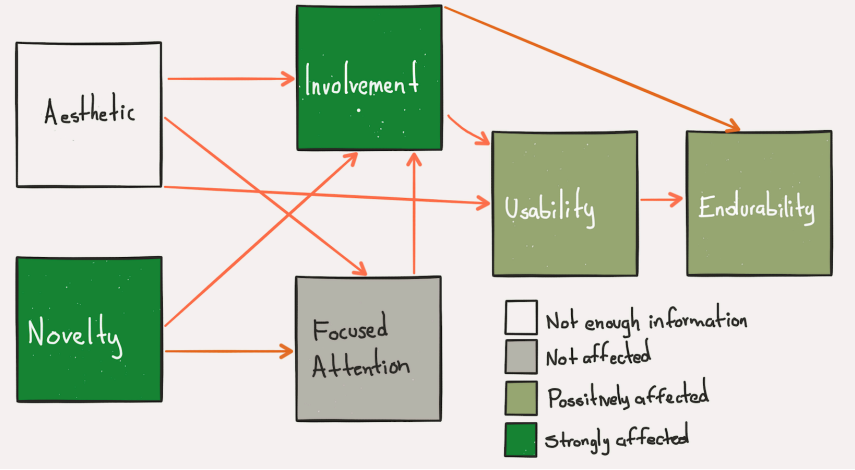

Figure 15 Path model of UES in e-Shopping domain (O'Brien & Toms, 2012)

According with O'Brien & Toms (2012), novelty, felt involvement, and endurability have a similar dimensions in the experience, statement which have congruency with this analysis given that those factors were the most affected according to the students' experience. The weakness in usability and endurability could be due Magelungen spel didn't affect the focused attention (and possibly nor the aesthetic) of the students.

This rises some new questions: how much interactivity should the application provide in order to being more used by the students? But, is the goal to focus the attention of the students in the application rather than the contents of the course?

In summary, the implementation of this gamification design through the gamified layer brought a novel experience for the students who felt involved giving feedback and recommendations probably due their prior experience with videogames. The transparency in the use of the prototype (no instructions, GC integration) facilitates the easy students' understanding and familiarization with the gamified layer and how these were connected with the GC assignments, which lead to a willingness to use again for future courses.

7 Conclusions

7.1 Summary

This case study aimed to develop and evaluate a digital flexible framework for teachers and students from Magelungen School, that could bring to the teachers the possibility to implement a pre-existing analog gamification strategy during their classes, along with features such as course planning, content management and assignments creation among other functionalities. In the framework, the students should be able to follow their progression during their courses in a more appealing way through the use of game elements such as point, badges, levels and progression bars.

The requirements analysis phase identified several problems such as that Google Classroom (GC) had been started to be used along the campuses of Magelungen and that the students who have tried it, have a hard time using it. These problems are due to several factors such as their impairments in attention and concentration and that GC lacks an appealing and rewarding system to provide a better UX by itself for students with learning disabilities. Another problem faced was the high complexity of some requirements for the application requested, mainly the ones related with the course management.

The key design point to achieve this goal was to take advantage of the GC inherent features and develop an application that could display the contents of a course in form of game elements through a minimalistic and easy to use user interface. The result was the gamified layer prototype: Magelungen spel.

The introduction of Magelungen spel in a real course was easy to implement for the teacher and easy to understand for the students. The teacher was able to bring to them a gamified experience and the students were actively participative providing valuable feedback. In general, the requirements and expectations of the client regarding the development of the requested flexible framework were partially fulfilled given that his gamification strategy was accurately brought into the gamified layer and the students showed persistence and participation in class, but there is still plenty room for improvements.

The students get easily involved with the gamified layer due the novelty and perceived usability of the prototype but this did not catch their attention beyond class hours. However, they enjoyed the gamified course and indicated that they would like to use Magelungen spel for future courses.

7.2 Discussion

Even though this case study wasn't aimed to study the effectiveness of the gamification design, it's very important to highlight that the badges were the game element that had more positive effects on the students in terms of satisfaction and attitude towards the course (and also the best rated by them). This result supports the findings of Sitra et al., (2017) even with older students (14 to 17 years old). This time, other game elements were added such as points, which caught the attention of the students but the way of how were presented in the application wasn't entirely of their liking, instead they expressed that they would like to see their points with progress bars and level-up using level names.

7.2.1 Weaknesses and limitations of the case study

The main limitation of this case study is the very small number of students that interacted with Magelungen spel and there was not possible to gather another group of students to perform an experimental approach. This limitation didn't allow to perform any further statistical test that could provide a more accurate analysis in this case study.

Even though the course was taking place during three weeks, the activities were designed to be performed during face-to-face classes, which didn't allow to observe further behaviors from the students such as login into Magelungen spel at home after receiving a new grade.

Students' first-hand information is very limited, most of the information about what happened during the course comes from the teacher's reports, therefore, it's important to consider the possibility of bias. Another matter to consider is that information about the feedback, comments and behaviors of the students was always generalized, which didn't allow to match each suggestion with a particular student nor how many students were providing such feedback.

It was no possible to gather the official diagnosis of the students about which type of ADHD they had or which comorbidities. This limitation was due Magelungen privacy policies.

7.2.2 Limitations of Magelungen spel

Even though the expectations of the client are partially fulfilled, it's important to point out that the client had not used Magelungen spel for any of his classes at the moment of the interview, therefore, some of his answers regarding the success of the implementation were only based on the observation reports from the teacher that was using the prototype during this intervention, which could represent a bias.

On the other hand, the teacher that was actually using the prototype had some difficulties during the setting of Magelungen spel (described in Appendix A), mainly because he hadn't prior experience in the use of GC and he had some difficulties to apply certain game elements and rules from the gamification design for the course activities.

Palmquist (personal communication, 17th of May, 2017) suggest that in order to implement a gamification strategy successfully, teachers should be able to break down skills into small pieces.

The lack of experience of the teacher in the use of Google Classroom and gamification practices, represented several limitations in the design of the course activities. As an example, the teacher did not name the assignments following the game-like theming (i.e. missions, challenges), instead, he named them using typical names such as "Music – history (Lesson 1)" as it can be seen at *Figure 16*.

Another limitation was that the challenges (optional assignments without deadline) were never used, therefore, was not possible to give to the students the possibility to do extra activities to gain extra points and evaluate the effectiveness of the implementation of that game element. Regarding the points, the maximum grade in a course's work of GC had always the default value of 100 in all the activities, which makes easier for the students to associate the points with the grades, which could break the game-like experience.

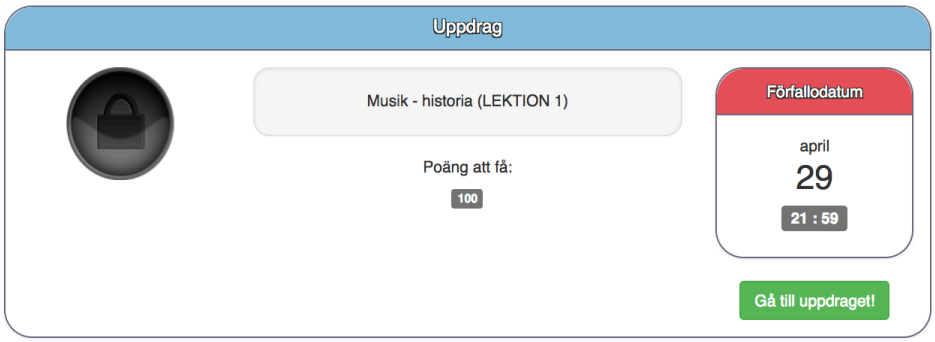

Figure 16 Screenshot of the first mission of the course

The progression's component had an important limitation because the current way of calculating the progression during the course is based on the relationship between the total course's works and the finished ones, therefore, the teacher should prior define all the activities in GC in order to provide to the students a clearly goal. The limitation arises if the teacher needs to add another assignment in GC during the course, which could lead a "carrot and stick" feeling in the students.

7.3 Future Work

Even though Magelungen spel can be used as it is, several modifications and improvements must to be performed taking into consideration the suggestions received from the students. The game mechanics that should be redesigned are the points system and progression bars. The points should have a more important role either as experience points (XP) useful for increase levels or as a virtual currency to purchase something in app (i.e. new colors to personalize the UI, avatar clothing, etc.).

Regarding the gamified layer's development, there are still many requirements to be fulfilled such as the incorporation of the Skill tree, reminders, messaging system, different kind of badges, a badge editor, integration with Mozilla Open Badges among others.

Thanks to the API of Google Classroom, Magelungen spel has potential to be substantially improved adding features such as allowing to the students to submit their assignments directly from the application rather than from Google Classroom and teachers to have their own dashboard in which they could see the progress of their students in a gamified way too and even manage all the course contents using Magelungen spel instead of GC.

Magelungen spel at this point is a good tool for teachers as a starting point to apply gamification in an easy way, however, it's necessary to scale the prototype carefully in order avoid breaking up this simplicity but at the same time provide enough features to keep students engaged and motivated through a good user experience, and to allow teachers to keep innovating in their gamification's design.

Palmquist (personal communication, 17th of May, 2017) also recommended for further development of Magelungen spel that: "...in the future, the teacher should just put in the assignments, then the app would be splitting for them...", and argues that teachers "do not have to have gamification knowledge and teachers just need to have the subject knowledge".

Lastly, it was asked to Palmquist (2017) to opine about the strengths and weaknesses about gamification practices, where he suggested that "the main weakness of gamification is the name gamification", he explains that "a lot of people thinks that is not serious enough for implementing in schools". Palmquist (2017) suggest that "gamifications shouldn't be for a whole semester, I think that the engagement level will drop…" and "…gamification should be implemented for four or five weeks and then breaks in order to start a new gamification". Palmquist supports his previous argument comparing gamification with some balancing mechanics from board games to encourage to players that are falling behind, and game masters of the MMORPGs[9] which constantly are "making the game start again or twist and twerk something".

There is needed to perform further studies at Magelungen with more students, different ages and longer implementation periods in order to observe if this combination of pedagogical strategies have long term benefits in their learning process. It's important to remember that students with ADHD are less stimulated by rewards, so what could happen if the badges or points are not enough to motivate them? What could happen when the novelty of a gamified course get lost?

Not only further studies with more students are needed, it is also important to change other variables such as the prior experience with computer games of the students, for instance, how a student with ADHD who is not familiar with computer games could experience gamification in class?

Regarding to data gathering, there is a need of different strategies to gather first-hand information from the students beyond the use of surveys. A combination of direct interviews with the students, teacher's observations and video recordings during class (having the prior consent from the students and parents) could contribute to have a better understanding of the reality. The main advantage of video recordings is that these can be observed by different relevant people for the research such as psychologists, parents and the researcher itself.

9 MMORP - Massively multiplayer online role-playing games

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Appendix A - Original email text of the project requirements (Swedish)

Pitch 1: den spelifierade skolappen

Idén är en app/program som är ett ramverk för en spelifierad form av skolans kursplanering för högstadiet och/eller gymnasiet. Vi vill ha ett flexibelt ramverk som lärarna själva kan fylla med innehåll. Det skall finnas möjlighet för läraren kunna konstruera kunskapsträd (skilltrees), dela ut uppdrag, ge märken (badges), ge återkoppling och påminnelser. Om det skulle finnas en möjlighet vore det intressant om lärarna skulle kunna konstruera egna badges så denne kan skräddarsy kursen - vad om primeras eller inte. Eleverna i sin tur skall kunna följa sin progression och se hur långt det är kvar av en kurs, ha kom-ihåg-listor för olika uppgifter eller liknande. Tanken är att läraren är en form av spelledare som delar ut uppgifter, feedback och så vidare under pågående kurs.

Inspiration till appen skulle kunna vara Class Dojo, fast med ett mer seriösare gränssnitt och mer framåtsyftande för eleven, eller Jane Mcgonigals SuperBetter fast med mindre plotter. Det får gärna vara grafiskt tilltalande men något som passar majoriteten av användarna.

Appendix B - Magelungen spel intervention setting

The intervention started at Friday 28th of April, which is the day that the course of was formally started and it last three weeks ending at Friday 12th of May 2017. In order to help to the teacher to have a better understanding about the use of Magelungen spel, how to log-in into the application and familiarize with its sections, a short video tutorial[10] was created and shared to him before the intervention. Additionally, an email was sent to the teacher with a detailed description of the gamification design, including the rules of the badges, the association of the points with the grades, the meaning and conditions for the missions, challenges, trivia and short trivia and some suggestions of how to design the activities.

Some difficulties were presented related to the application loading and about the general use of Google Classroom. The loading issues occurred due a permissions issue that didn't allow to the teachers' role to load and visualize the courses in Magelungen spel. This error occurred due the scopes of the GC API weren't correctly configured for the teachers' role; however, this wasn't a problem for the students' role. This issue was fixed in a new deploy of the application after the first class of the course.

The problems regarding the use of GC were due the teacher has never used GC before this intervention, as he pointed out in the survey that will be described below. The course lessons were mounted by the teacher in GC as a single activity, namely course work, which represented a course design problem. In order to solve this problem, it was asked to the teacher to split out the lessons in several amount and types of activities in order to simplify the course and provide to the students a better glance of how many "missions", "challenges" and "trivias" they need to face during the course. The progress bar's game mechanic depends of the relationship between the total number of course works and the completed course works in order to work properly. Since Magelungen spel is designed to present all the activities of a GC course in a separate way, it's important to take in consideration to split the lessons into several shorter ones, as a course design principle to be compatible with this gamification approach.

The teacher shared the URL to Magelungen spel into the course in an announcement with the following instructions:

"Use your Google Account to log in to: http://magelungenspel.com. Here you can see your success, your badges and my assessment of your answers" (translation from Swedish language).

[10] Magelungen spel tutorial - https://www.youtube.com/watch?v=jE_QohALi9g

Appendix C - Parents' and students' consent document example

MAGELUNGEN

Informerat samtycke till att uppgifter om mig/mitt barn används för forskningsändamål

Uppgifter som samlas in av Magelungen kan komma att användas för forskningsändamål och kan komma att ingå i verksamhetsrapporter, internationella publikationer och utbildningsuppsatser. Alla uppgifter om dig kommer att vara anonyma och kommer inte att kunna knytas till dig som individ, vare sig av de som bearbetar uppgifterna eller i en färdig rapport. Du har rätt att när som helst och utan att ange anledning avbryta deltagande i forskningen utan att detta påverkar den behandling och/eller skolinsats som du/ditt barn erbjuds av Magelungen.

Jag har informerats muntligt och skriftligt om Magelungens forskning och accepterar att uppgifter om mig/mitt barn samlas in och används för forskningsändamål.

Ungdom/Elev:

Ängered 20170517 _____

Ort Datum Namnunderskrift

Vårdnadshavare:

Ängered 20170517 _____

Ort Datum Namnunderskrift

Vårdnadshavare:

_____

Ort Datum Namnunderskrift

Tack för din medverkan!

Appendix D - Technology stack of Magelungen Spel

This appendix has the aim to serve as a point of reference to further developers interested on contribute in this project. The following table shows the main software dependencies and libraries used for the development of Magelungen spel.

Software	**Version**	**Description**
Node JS	6.10.1	JavaScript runtime
Firebase	3.7.3	Firebase library for Node JS
React JS	15.4.2	JavaScript library
React Redux	5.0.3	Predictable state container for JavaScript
Redux Thunk	2.2.0	React middleware
React Router	4.0.0	Declarative routing for React
Axios	0.15.3	Promise based HTTP client

Appendix E - Survey applied to the students

This text was translated from Swedish to English.

Section	Question	Type
About you	How old are you?	Short-answer text
	Gender	Multiple choice (Male, Female)
	How often do you play computer games?	Multiple choice (I don't play computer games, At least once a year, At least once a month, At least once a week, every day
	I am skilled with computers	Multiple choice (No, Not particularly, Little yes, Yes, Very
About Magelungen spel	How often did you enter "Magelungen spel" from home to see how it went?	Multiple choice (Never, Only once, Once a week, once per day, several times per day)
	What could you add to "Magelungen spel" to make it more interesting to you?	Long answer text
	What do you think about "Magelungen spel"?	Long-answer text
Usability Metric for User Experience (UMUX)	"Magelungen spel" meets my expectations	Likert scale (1=Disagree, 7=Strongly agree)
	Using "Magelungen spel" is a frustrating experience	Likert scale (1=Disagree, 7=Strongly agree)
	"Magelungen spel" is easy to use	Likert scale (1=Disagree, 7=Strongly agree)
	I have to spend too much time to figure out how "Magelungen spel" works	Likert scale (1=Disagree, 7=Strongly agree)
Game elements evaluation	How satisfied did you feel when you ...	
	... did you earn a medal when you completed a mission?	Likert scale (1=Not satisfied, 7=Very satisfied

	… got points when you completed a mission?	Likert scale (1=Not satisfied, 7=Very satisfied
	… did your progress take place during the course?	Likert scale (1=Not satisfied, 7=Very satisfied
	… were totally committed to something you had done?	Likert scale (1=Not satisfied, 7=Very satisfied
About the course	How much would you say you liked this course?	Likert scale (1=Very little, 7=Very)
	If you had a choice, would you like to use "Magelungen spel" in other courses?	Likert scale (1= Not at all, 7=Gladly)

Appendix F - Survey applied to the teacher

Section	Question	Type
Magelungen spel teacher's experience	Did you were prior familiarized about the concept of gamification before this implementation?	Multiple choice (Yes, No)
	Had you ever used Google Classroom before this implementation?	Multiple choice (Yes, No)
	(Optional) If you answered "Yes" to previous question: To what extent do you consider that "Magelungen spel" improved the user experience of your students with respect to previous courses using Google Classroom?	Likert scale (1= Not at all, 7=It strongly improved)
	What do you consider that was the best part of Magelungen spel?	Long-answer text
	From your perspective, what do you consider that was the weakest part of Magelungen spel?	Long-answer text
	How likely do you will use Magelungen Spel for future courses?	Likert scale (1=Nothing likely, 7=Very likely)
	Please explain why did you assigned that value to the previous question?	Long-answer text
	(Optional) Please, feel free to add additional comments below	Long-answer text