Double Degree Master Thesis in

Management and Innovation and Industrial Management

Gamification in Secondary Education

A User-Centered and Interdisciplinary Approach

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June 2020

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Abstract

The present study concerns an innovative approach to education; applying game elements as a blended learning strategy in secondary education. An exploratory case study of a gamified mathematics course in a secondary school in Sweden was conducted. The implementation lasted for seven weeks and consisted of a blended learning approach, were traditional education was combined with a gamified Google Classroom. The present study aimed to investigate student and teacher experiences of the implementation. Two semi-structured interview sessions were conducted with all three teachers involved in the implementation. Three semi-structured interview sessions were conducted with 12 of the 88 students involved in the implementation and two surveys were sent out to all the students for descriptive statistics purposes. The results were analyzed from a user-centered and interdisciplinary approach combining gamification design, motivation psychology and adoption of innovation approaches. The results showed that teachers and students experienced different but positive behavioral and psychological outcomes. Student motivation was related more to extrinsic motivation than intrinsic motivation. For the teachers there were difficulties in identifying the effects of the implementation. In addition, the teachers highlighted the need for sufficient resources and to clarify the use of gamification. From the findings presented, implications for research and practice are discussed.

1. Introduction

1.1 Innovation in Information Technologies

Information technologies (IT) are employed in organizations today to maintain or to gain a competitive advantage (Vial, 2019). IT is in constant development, affecting the type of jobs available, how and where we work, as well as the role of management in organizations (Cascio & Montealegre, 2016). The societal impact of IT increases as physical and electronic spaces merge, and with the potential to create optimized environments, in which people, computers, networks and objects are interlinked (Cascio & Montealegre, 2016). Despite this, IT investments have been found to produce varied economical outcomes in organizations, with the need to understand what factors affect the success of different technologies in specific contexts (Khallaf et al., 2017). Therefore, adopting information technologies can be seen as vital for organizations, but it is also of importance to adopt the right type of information technologies and to gain understanding of how the adopted technology works. Innovation in the field of information technologies occurs on the technological level but also in the intersection to other sciences. Interdisciplinary knowledge has a positive effect on technology development and is increasing at a rapid rate (Su & Moaniba, 2017). One trending example of an innovative technology that requires an interdisciplinary approach is gamification, the use of game elements in a non-game context (Deterding et al., 2011).

Gamification can be seen as a tool to motivate users to certain goals, combining knowledge from game design, psychology and the field it is applied to. Compared to the related concept of serious games, that is games with the purpose to educate rather than entertain (Michael & Chen, 2005), gamification includes parts of a game, in a non-game context, instead of the entire game (Deterding et al., 2011). Thus, the playing field in gamification does not lie in the system but transcends into the real world, using technology or other means to symbolize and reward desired behavior. Real world examples of gamification include awarding badges in the military and loyalty programs such as frequent flyer points and status differentiating colors on cards (Zichermann & Cunningham, 2011). Previous research has found that by simply framing a task as a game, participants perceive a decrease in the length of the task (Collmus & Landers, 2019) and an increase in interest and enjoyment (Lieberoth, 2015). This implies the potential of

gamification to alter and change the way work is perceived and conducted in education institutions and other organizations.

1.2 The potential and pitfalls of Gamification

Successful information technology companies have achieved significant market-shares while employing game elements on their platforms. One example is Facebook and similar social media applications, where game element of points in the form of social networking scores (i.e. likes, followers and number of comments) are used as indicators for social ranking (Zichermann & Cunningham, 2011). In Duolingo, a language learning application, other game elements are present, including experience points, achievements, store and leaderboards. In Duolingo the user gains achievements and points by completing language learning modules, with the option to compete with other users' progress displayed in leaderboards. The points can in turn be used to buy different upgrades and virtual outfits in a store. Fitness apps, including Run-keeper and Nike Run Club, also use game elements in the form of progress-bars, challenges and leaderboards to motivate their users to reach their goals.

The research field of gamification is a rising trend with the most common research application being education (Hamari et al., 2014; Kasurinen & Knutas, 2018; Bozkurt & Durak, 2018; Dichev & Dicheva, 2017). In different disciplines such as health and well-being (Johnson et al., 2016; Sardi et al., 2017), sustainability (Johnson et al., 2017), and business (Wanick & Bui, 2019) the potential benefits of gamification have also been explored. Despite the emerging trend and successful applications of gamification, reviews on the effects of gamification show varied results, with different studies indicating mostly positive and mixed, but also negative effects (Hamari et al., 2014; Koivisto & Hamari, 2019). The outcomes from the literature thus suggest that gamification does not always have a positive effect but has the potential to lead to positive outcomes when designed right.

1.3 Gamification in Education

Previous literature in gamification related to education has focused mostly on gamification in higher education (Limantara et al., 2019; Subhash & Cudney, 2018) or in online learning environments (Antonaci et al., 2019). In higher education gamification has been shown to lead to increased student motivation, performance, attitude and engagement (Limantara et al., 2019;

Subhash & Cudney, 2018). However, the interdisciplinarity of gamification in education has led to a fragmented research field with scattered results (Freitas, 2018), and gamification has shown mixed effects regarding student performance, motivation and engagement in an educational setting (Antonaci et al., 2019). The effect of gamifications can be seen as context dependent, where each game element needs to be chosen carefully in order to lead to desired results (Antonaci et al., 2019). Points, badges and leaderboards are the most common game-element used in gamification related to education (Alomari, Al-Samarraie & Yousef, 2019; Subhash & Cudney, 2018) but to gain engagement and produce results, mindlessly using these elements is not sufficient (Chee & Wong, 2017). Specific game elements affect learners differently (Alomari et al., 2019) and there is a lack of understanding to what game elements drive desired behaviors (Dichev & Dicheva, 2017). Dichev and Disheva (2017) highlight the importance of not looking at if gamification works or not, but instead focus on what game elements are effective for a specific learner within a specific activity. For gamification to work, previous research has proposed that it is necessary to create a design that gives students sufficient information (Alomari et al., 2019), that includes hedonistic (i.e. enjoyable) elements that create engagement and supports autonomy which enables intrinsic motivation (Chee & Wong 2017).

To a lesser extent than in higher education and online learning environments, gamification has been applied to secondary education. Since gamification is dependent on the context and the psychology of the user (Hamari et al. 2014), the results from a higher education environment and online learning environment cannot be transferred to a secondary setting but need to be studied independently. The studies that have been conducted on performance outcomes in secondary education have indicated that gamification has a significant positive effect on performance (Haruna et al., 2018; Jo et al., 2018; Lo & Hew, 2018; Otero-Agra et al., 2019; Puritat, 2019). However, other studies have found a lack of significant positive performance results (Papadakis & Kalogiannakis, 2018; Stoyanova et al., 2018). Studies on psychological outcomes in applying gamification in secondary education have found positive effects on attitude and interest (Papadakis and Kalogiannakis, 2017; Stoyanova et al., 2019), as well as engagement (Haruna et al., 2018; Applegate et al., 2015).

From a performance perspective, the role of a user-centered design and a knowledge-based approach can be found in previous research in applying gamification to secondary education. In studies that apply gamification to secondary education during one learning session instead

of throughout a longer course period (Purita, 2019; Otero-Agra et al., 2019), it was found that gamification could directly enhance motivation. However, the studies that showed positive performance outcomes and that were conducted throughout an entire course (Haruna et al., 2018; Jo et al., 2018) were developed from a user-based and knowledge-based perspective. In the study by Haruna et al. (2018) gamification and game-based learning were developed from a design-based perspective taking experts and students views into consideration. In the study by Jo et al. (2018) the game-elements included where chosen from the gamification design framework by Zichermann and Cunningham (2011), which took user motivation into consideration. This was not true for the studies that where conducted throughout an entire course and did not lead to performance outcomes. These studies were instead based on already developed gamified platforms (Papadakis and Kalogiannakis, 2017; Stoyanova et al., 2019).

Digital approaches, which are commonly used to apply gamification, are becoming more common and offer both challenge and opportunity for teachers in the classroom (Fransson, Holmberg, Lindberg & Olofsson, 2019). Educational change and innovation are dependent upon what teachers think and how they behave (Fullan, 2001). Previous research has identified teachers to perceive gamification as having a positive impact in pre-school, primary education, secondary education and higher education. Positive aspects mentioned in previous studies include enhanced motivation, increased communication and social skills (Martí-Parreño et al., 2019; Sánchez-Mena & Martí-Parreño, 2017; Zou, 2020), increased self-regulation (Martí-Parreño et al., 2019; Zou, 2020), increased collaboration (Martí-Parreño et al. 2019; Sánchez-Mena & Martí-Parreño, 2017), and increased competition (Baldauf et al. 2017; Sánchez-Mena & Martí-Parreño, 2017) Teachers have also clarified important aspects to be taken into consideration regarding gamification, such as curriculum fit (Adukaite et al., 2017; Sánchez-Mena & Martí-Parreño, 2017) and the time, effort and resources required (Baldauf et al. 2017; Brooks et al., 2019; Martí-Parreño et al., 2019; Sánchez-Mena & Martí-Parreño, 2017; Zou, 2020).

1.4 The present work

Gamification research has shown varied results with a limited amount of studies conducted in secondary education. The outcome from the previous studies highlight the importance of user-centered design, and the need to understand secondary education students' perspective and

motivation toward gamification. In light of this, the present work intends to evaluate an implementation in which gamification was applied to a blended learning approach in a mathematics course in a practically oriented secondary school in Sweden. Blended learning is an approach in which face-to-face instruction is combined with computer-mediated instruction (Graham, 2006) and focuses on the individuality of the learner through providing several forms of learning tools (Singh, 2003). The present work intends to gain an in-depth understanding of how a gamification implementation is experienced by students and teachers and what they consider as important aspects to take into consideration when implementing gamification in the classroom. This contributes to the gamification field since there has not, to the authors knowledge, been done any in-depth qualitative studies in secondary education exploring student and teacher experiences. To gain a broad and unbiased view of the students' and teachers' experiences the present work takes an exploratory approach to answer the following research question:

RQ: How do secondary school students and teachers experience a gamified implementation of a mathematics course?

The research question is answered based on qualitative semi-structured interview data complemented by student surveys. Due to the qualitative approach, the aim is not to gain generalizable outcomes but instead generate hypothesizes that can later be tested in more controlled environments. To gain a deeper understanding of gamification and its potential outcomes, the field of gamification, gamification design, motivational psychology and innovation are presented in the following chapter. The method is later explained, followed by the results guided by the research question and not by theory to have an unbiased approach. Finally, in the discussion, the theories presented are connected to the results based on the research question before practical implications are drawn in the conclusion.

2. Theoretical Framework

Here, gamification is first explored in a greater extent than in the introduction and two frameworks for understanding gamification are presented. This is followed by a presentation of gamification design based on game design to understand the reason behind the gamified experience. Motivational psychology related to gamification is later presented to understand the mechanisms and the goal of gamification. Finally, adoption of information technology and technology acceptance are presented to understand factors related to the use of the gamified system. In the discussion of the results, the framework is used as a base to understand the students and teachers' experiences of the gamified mathematics course.

2.1 Gamification

Detering et al., (2011) define gamification as using game elements in a non-game context and distinguish it from other related concepts (Figure 1.). Compared to serious games, constituting entire games, gamification applies game elements that are common in most but not all games (i.e. involves parts of and not whole games). Gamification also involves gaming, which compared to playing, includes an explicit rule system and competing elements toward certain goals (Deterding et al., 2011). Huotari and Hamari (2012) instead define gamification as a process to enhance a service with gameful experience, such as provoking joy, challenge and expense, in order to support the user's value creation. Compared to the definition of Detering et al. (2011), the definition of Huotari & Hamari (2012) puts the subjective experience of the user in the center and suggests that the same application can be seen as gameful for one user while simultaneously not being seen as gameful for another. In the present work, gamification is defined as Deterding et al. (2011) proposes (using game-elements in a non-game context), due to the difficulty in understanding the subjective experience of the user, making it problematic to understand what constitutes as gamification or not. Huotari & Hamari's (2012) definition is however considered from the purpose behind what gamification intends to elicit in the user when designed well.

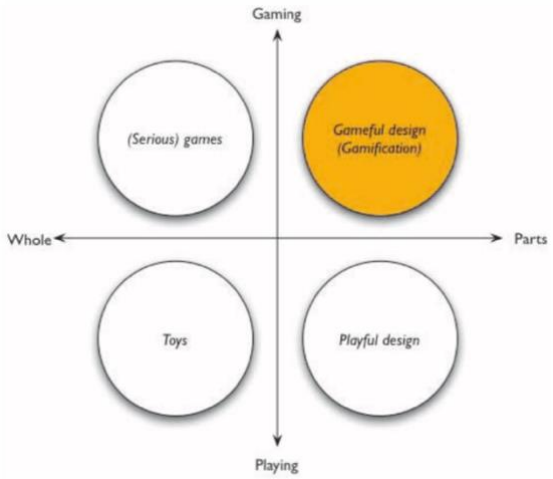

Figure 1. Gamification (p.13, Deterding et al., 2011)

Two of the most cited frameworks for understanding gamification are presented by Hamari et al., (2014) and Liu et al. (2017). The framework by Hamari et al., (2014) (Figure 2.) depicts the process behind gamification. The included game elements (here motivation affordances) create psychological outcomes that in turn lead to behavioral outcomes (Hamari et al. 2014). The framework offers an understanding of how game-elements should be combined in a way that is connected to the intended behavioral outcome and underlying psychological outcome. The game elements need to be designed to attract the user to the system and elicit a certain psychological outcome, whereas the psychological outcomes in turn need to be considered in a way that is related to the intended behavioral outcomes (Hamari et al. 2014).

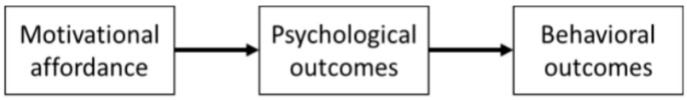

Figure 2. Gamification (p. 3026, Hamari et al., 2014)

Liu et al. (2017) presents a more holistic framework, considering gamification as a system (Figure 3.). The game elements are chosen to meet a target system, consisting of the user, the task and the technology. The user then interacts with the system, the system responds to the user, and the users interact with each other. This results in a meaningful engagement consisting of the interaction between experiential (related to the experience of interacting with the system) and instrumental (related to the usefulness of interacting with the system) outcomes.

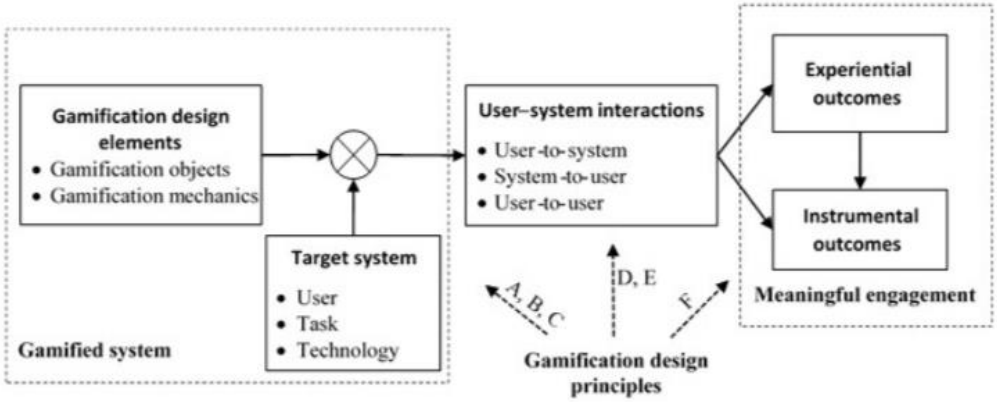

Figure 3. Framework for design and research of Gamified systems (p. 1015, Liu et al. 2017)

The user does not interact with the system in silos, instead the task and technology are seen as part of the gamified system (Liu et al., 2017). Furthermore, it is not only the users' interaction with the system that is of importance but also the way the system interacts with the user and the way in which the users interact with each other. It is highlighted that the experiential outcomes will affect the instrumental outcomes (Liu et al., 2017). The relationship and importance of both experiential and instrumental outcomes is supported by meta-analyses on predictor effects of gamification. Hamari & Keronen (2017) found attitude to be the strongest predictor of game use and that both usefulness and enjoyment are important factors in games with both utilitarian and hedonistic purposes. In another meta-analysis Baptista & Oliveira (2019) found several significant predictors and their effects on gamification and serious games, showing the importance of enjoyment and usefulness on attitude and intention to use the gamified system. From the framework presented above it is of interest to explore how to work with and design gamification in a way that promotes both experiential and instrumental outcomes and drives the desired behavioral outcomes.

2.1 Gamification Design

Gamification design derived from game design were a commonly used framework is the MDA framework (Mechanics, Dynamics and Aesthetics). The MDA framework offers an iterative process of game design and development (Hunicke et al., 2004). Games in the MDA-framework are seen as dynamic systems that build behavior via interaction. Mechanics symbolize the components of the game (comparable to game elements in gamification), Dynamics is the interaction between the game and the user, and the Aesthetics is the user's emotions. By observing and adjusting the mechanics it is possible for the game designer to change the

behavior of the player that result in certain Dynamics and Aesthetics (Hunicke et al., 2004). Despite gamification concerning parts of and not entire games (Deterding et al., 2011), it is important to consider how the game elements affect the dynamics, or interactions, between the user and the system, and the aesthetics, or emotions, it provokes.

In a review, Deterding (2015) explores methods related to gamification design, identifying six main requirements for creating a gameful design, including instrumental and experiential outcomes. The first involves designing from need satisfaction based on self-determination theory, that is creating experiences that provide competence, autonomy and relatedness (this will be discussed in further detail in the motivational psychology section). The second involves designing around skill-based challenges that are already involved in the user activity, without adding excess complexity. The third involves designing from the emergence of enjoyment, motivation and challenge in a systematic way that considers gamification as one system. The fourth involves identifying the goals, needs and challenges that the user phases in the activity. The fifth involves including the incorporation of the users' goals, needs and challenges into the ideation and evaluation of gamification design ideas. Finally, the sixth requirement of a gameful design involves operationalizing the knowledge into the design. From this, Deterding (2015) derives the five following steps for creating a gameful design:

1. Strategy: designing target outcome and metrics, users, contexts and activities and identifying constrains and requirements
2. Research: translate user activities into behavior chains, identify the users' needs, motivation and hurdles and determine design fit
3. Synthesis: identify and formulate activities and feedback loops for the user
4. Ideation: brainstorm ideas, prioritize, create storyboards, and evaluate and refine concepts
5. Iterative prototyping: build prototype, test, analyze, and ideate changes and repeat until the desire outcome is reached (Deterding, 2015).

A more specific suggestion for how to use different game elements to create a gameful design is suggested by Zichermann & Cunningham (2011). Zichermann & Cunningham (2011) explain important aspects of the design of different game elements (Points, Level, Progress Bar, Leaderboards, Challenges, and Badges) and for the gamification system. The foundation of gamification is, according to Zichermann & Cunningham (2011), points, since it enables the designer to value and track every move the player makes. Level woks as a signal for the user

about his or her position over time and should be balanced related to difficulty and progress through starting at a simple level and becoming more complex over time. Progress Bar works similarly as level and visualizes how far the user has progressed. Leaderboards offer users to compare their progress with other users, here it is important for the user to not get stuck at his or her position or fall off the leaderboard. Challenges can add meaning to the user and involve cooperation. Badges can be seen as a way to signal status or social promotion and mark progress in the system. Important aspects of the gamification system include the onboarding process, where the user should be able to explore the site and gain initial awards; allowing for customization, where the user should have the possibility to make a small number of well-placed choices; creating feedback and breaking the bigger goal into smaller and achievable pieces and creating an experience where the user feels like he or she is winning (Zichermann & Cunningham, 2011).

Several other works investigate how gamification should be designed to lead to desired effects. One approach, used by Morschheuser et al. (2017) and Shahri et al. (2019) concerns expert interviewing and literature searches to understand which factors are important to take into consideration. Morschheuser et al. (2017) highlight that in designing gamification the user needs to be understood and involved in the ideation and design phase. Furthermore, the objectives with gamification should be clearly defined to guide and assess the success of the project. Ideas should be tested as early as possible and there should be continuous monitoring and optimization of the design. Gamification should be seen from a holistic perspective, including knowledge about human motivation and gamification design, as well as considering key stakeholders. Lastly, cheating should not be possible within the gamification design since it can lead to reversed effects (Morschheuser et al. 2017). Shahri et al. (2019) propose that the game elements should be aligned with the context of implementation (i.e. the end-user, business objectives and culture) and with the managerial style. Furthermore, adaptation and change of gamification design should be possible from the assessed effects, and gamification should never become the goal in itself but instead support the goals that the user and organization try to achieve (Shahri et al. 2019).

The studies above highlight the fact that gamification needs to be human centered and context dependent. Both in the sense that it should be designed from the user-perspective and to include a broader view of the system in which it takes place and the people involved and affected. Furthermore, the studies suggest that gamification should concern an iterative design process

and assessment. To understand the user and create successful gamification design it is of importance to consider the broader view of motivational psychology and what drives certain behavior.

2.2 Motivational Psychology

The word motivation comes from the Latin world *movere* (to move) and involves being moved to do something (Kleinginna & Kleinginna, 1981). Among the many theories that focus on motivation, the theories presented here are some of the most common ones in the gamification literature. One of the most cited theories to date of human motivation is Self Determination Theory, identifying the three basic needs autonomy, competence and relatedness, that provide motivation and personal growth (Deci & Ryan, 2000). However, it is not only the amount but also the orientation of motivation that matters, i.e. if the motivation derives from the activity itself (intrinsic motivation) or if the motivation derives from the activity's instrumental value (extrinsic motivation) (Ryan & Deci, 2000). Extrinsic motivation has been found to undermine intrinsic motivation, decreasing the enjoyment of the activity, depending on the extent to which the extrinsic motivation is seen as controlling the behavior (Deci et al., 1999). Intermediating effects to if extrinsic motivation override intrinsic motivation includes if the context is seen as controlling or non-controlling, if cues and feedback are provided with signals of competence instead of directive instructions (Deci et al., 1999). Deterding (2015) argues that the motivation behind why games are so popular can be described by Self Determination Theory (Deci & Ryan, 2000). This since progressing through a game with relevant feedback mechanisms in place gives the user a sense of competence, while the voluntariness of using the game and exploration offers autonomy, and the option to interact with other users offer relatedness (Deterding, 2015).

2.2.1 Intrinsic Motivation: Connected to intrinsic motivation, flow theory is another theory mentioned by Deterding (2015) as a motivational theory connected to gamification. Flow is a state in which the activity becomes the full locus of one's attention, dissolving the sense of time and self-consciousness (Csikszentmihalyi, 1991). Csikszentmihalyi (1991) argues that activities that require learning of skills, set up goals, provide feedback and make control possible are often those assosiated with the state of flow. Flow lies inbetween the state of anxiety and boredome, where challenges correspond to one's skill level (Csikszentmihalyi, 1991). This is relevant in the field of game development and gamfication design since the

activities in games and in gamification can provide the user with the conditions of skills, goals, feedback and control that flow activies require. Furthermore, to retain users, the designer should opt to create a progression through the game or gamfication design that combines the challenge level with the skill level of the user. This is aligned with other motivational theories such as goal setting theory, proposing that motivational goals that lead to higher task performance are specific and challenging in relation to ones skill level (Latham & Locke, 1991).

2.2.2 Extrinsic Motivation: Classic examples of driving behavior through external rewards come from behaviorism. In 1883 Pavlov introduced reinforcement conditioning, proposing that by presenting a stimuli behavior can become reinforced through associating the stimuli with the consequence (Pavlov, 1997). Skinner (1963) extended Pavlov's theory by introducing operant conditioning, where a behavior is seen as eliciting a consequence in the environment. A behavior can thus be strengthened by being paired with a preceding stimulus or with an expected later reward. Furthermore, behavior that is reinforced will repeat whereas behavior that is not repeated will diminish (Skinner, 1963). This is connected to expectancy theory which proposes that a specific behavior will be chosen from its likelihood to lead to the desired outcomes (Vroom, 1964). In connection to gamification, it is of importance to understand what behavior should be reinforced and add reward mechanisms related to the intended behavior that is of relevance for the user. Furthermore, it is important to connect the behavior to the goal in a clear way for the user and that the rewards are aligned with what is valuable for the user.

The abovementioned motivational theories offer insight into important aspects to consider in gamified solutions, such as creating a feeling of autonomy; creating feedback mechanisms that provide a feeling of competence on a continuous basis; providing relatedness to other users; putting the purpose and the importance of the goals into context; having specific and challenging goals adapted to the users skill level; and having desirable rewards with clear links to the intended behavior.

2. 3 Technology adoption and acceptance

Gamification can be seen as an innovation in the field of IT. Creativity involves individuals or groups who create novel and useful products or services as defined by the social context in which they take place (Plucker et al., 2004). However, for a product or service to be seen as an

innovation, the novel and useful aspect is not sufficient. The aspect missing is the reduction of practice, i.e. the commercialization of what has been created (Freeman & Soete, 1997). For an innovation to spread and commercialize, research and theory have since long seen that other factors than usefulness and novelty are at play. One other factor studied is the adoption of the technology itself and the technology acceptance of the user. Related to gamification, this is of importance since it can offer an understanding to if a user will interact with the system to begin with or not.

2.3.1 Diffusion of innovation: Diffusion of innovation, how a new idea is communicated through certain channels over time in a specific social system, takes a central role in the acceptance and spread of innovation (Rogers, 1995). Characteristics of the innovation that explain the rates of adoption include the relative advantage of the technology, i.e. perceived advantage to predecessor, the compatibility with existing values, experiences and needs of the adopters, the complexity to understand and to use, triability before adoption, and observability of outcome (Rogers, 1995). In regards to communication, Rogers (1995) also highlights that the objective evaluation is of less importance compared to the subjective evaluation by adopters similar to oneself. The time in which one adopts the new technology is also of importance, with the five different categories of adopters (innovators, early adopters, early majority, late majority and laggards) adopting innovation at different stages. The rate of adoption, that is the relative speed of adoptions, varies but follows the same S-shaped pattern, of taking off slow exponentially increasing and finally declining (Rogers, 1995). The social system in which the diffusion of innovation takes place is also of importance, with norms guiding what behaviors are acceptable, and with opinion leaders inside the system and change agents outside the social system influencing the decision making within the system. (Rogers, 1995).

Moore & Benbasat (1991) extended the diffusion of innovation theory to the adoption of IT innovation and found eight constructs related to the perception of using an IT innovation. These constructs include:

- Relative advantage; perceived as better than predecessor
- Compatibility; perceived as consistent with values, needs and past experiences
- Ease of use; perceived as difficult to use
- Result demonstrability: perceived outcome, seen as observability and communicability
- Image: perceived as enhancing social status

- Visibility: perceived use of others using the system in the organization
- Trialability: degree of experimentation before adoption
- Voluntariness: use perceived as being voluntary (Moore & Benbasat, 1991).

2.3.2 Technology Acceptance model: The Technology Acceptance model (TAM) is another approach to why users accept or reject information systems. First developed by Davis (1989), TAM proposes that perceived usefulness and perceived ease of use is a function of the system design features, which affect the attitude toward using the system and actual system use (Figure 4.).

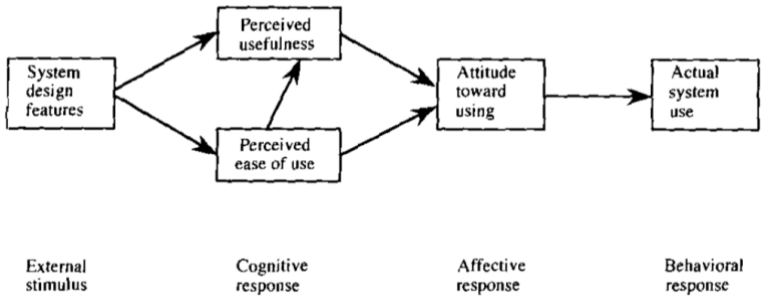

Figure 4. Technology Acceptance model (p.476, Davis, 1989)

Perceived usefulness is the degree to which the job performance of the user is believed to be enhanced due to the system and perceived ease of use is the degree the system is being seen as free from physical and mental effort for the user (Davis, 1989). Davis (1989) proposed that ease of use has a direct positive relationship to the usefulness of the system but not vice versa.

2.5. Implications from theory

The theories presented above highlight the importance of a user-centered and interdisciplinary approach to gamification design. There is a need to create a design that provokes instrumental and experiential outcomes for the user by combining game elements in a way that produces psychological outcomes which in turn leads to the intended behavioral outcomes. To do so, it is important to trigger motivational aspects and state whether the intention is to provide the user with extrinsic or intrinsic motivation and to clarify the strategy needed in which to reach this goal. These aspects are fundamental to take into consideration when understanding student and teacher experiences of gamification in the classroom and offer understanding of how

gamification can be designed in a more effective way. Furthermore, adoption criteria and technology acceptance should be consider. Adoption criteria for IT involves relative advantage, compatibility, ease of use, result demonstrability, image, triability, and voluntariness (Moore & Benbasat, 1991), and technology acceptance involves perceived usefulness, perceived ease of use and attitude toward use (Davis, 1989). These aspects are important to consider since they have been found to affect users' system use.

The evaluation of the student and teacher experiences will later be done in light of the abovementioned theories related to gamification, gamification design, motivational psychology and technology acceptance and adoption. The theories of gamification and gamification design offer a framework for understanding the experience of gamification. Motivational psychology theories are used to understand the outcomes and consequences of the implementation and technology acceptance and adoption theories are used to understand factors that can affect the use of the system.

3. Methods

To assess students and teachers experience of gamification applied to secondary education an exploratory case study was applied through a longitudinal mix-methods approach. A case study can be defined as a method that studies a phenomenon within a real-world context and relies on multiple datapoints for analysis (Yin, 1992). A lack of control and the implementation's embeddedness within the context in this study created relevant conditions for applying such an approach. In this case, the phenomenon is how the students and teachers experience the course. To be able to understand the teacher and student experience and explore potential hypothesizes that can be tested in more controlled and generalizable settings the findings are connected to theory in the discussion section. Compared to an evaluation cases study, which involves testing hypothesizes through a case study design (Yin, 1992), this study concerns theory building; through defining a broad research question and exploration from multiple datapoints before connecting the results to previous theory and research (Eisenhardt, 1989). The mixed method, combining qualitative and quantitative data, provides the opportunity to verify findings through exploration and confirmation simultaneously (Pole, 2007), and is therefore a relevant methodology in the present study. Here, the main study objective was a qualitative approach through semi-structured interviews combined with complementary surveys used for descriptive statistics and confirmation of findings. In this chapter, the gamified implementation will first be presented followed by a more in-depth explanation of the data collection and analysis.

3.1. The gamified Implementation

In a practically oriented upper-secondary school in Sweden, five classes with 88 students in total took part in a mathematics course that consisted of a blended learning environment with digital components and gamification added to the traditional education. Three teachers where involved in the gamified implementation. One of the teachers was a 33 year-old male who had been working as a teacher for five years, the other was a 48 year-old female who had been working as a teacher for thirty years, and the third was a 50 year old male who had been working as a teacher for fifteen years. Two of the teachers were in charge of two classes each and one teacher was in charge of one class. The implementation was conducted over seven weeks, covering a part of the mathematics course that ended with an exam. The whole course lasted throughout the academic year, starting in August and ending in June the next year. The implementation took place in the middle of the semester, from the beginning of November to

mid-December. During the implementation there was a communication channel between the teachers and the gamification designers, to be able to solve any arising technical issues. The aim of the implementation was to increase the throughput of the students passing the course, since the low throughput rate had resulted in students previously having to retake the course. Therefore, the gamification implementation was designed to increase the number of students passing the course and not to increase the performance or grades of the students taking the course. The digital component consisted of a Google Classroom that was built by the teachers at the beginning of the course and entailed exercises, videos and digital links related to the coursework. The gamified add on was implemented through the API (Application Program Interface) Gamify the World Engine (GWEN).

3.1.1 GWEN and Google Classroom: GWEN is a platform solution developed by the gamification as a service company (GaaS) Insert Coin. GWEN can be integrated into an already existing software product (Palmquist, 2019), in this case google classroom (Figure 1.), offering the possibility to create individual gamification designs based on customer needs. The gamification design was decided from an initial workshop with the teachers involved in the implementation together with the gamification designers at Insert Coin. In the workshop, gamification as a concept was explained, the needs of the students from the teachers' perspectives were assessed and the technical possibilities where discussed. The workshop resulted in a gamification design including the game-elements achievements, levels, avatar and a store with rewards. The achievement part consisted of different challenges and exercises for the students to perform and get points for. Through collecting points, the students could level up and earn coins to buy exam-points with for the upcoming exam. The digital components were voluntary for the students and during the lessons the students got the option to work either in the book or on the computer. At the end of each lesson the students did an "exit ticket" on the computer, with exercises related to the material presented during the lesson.

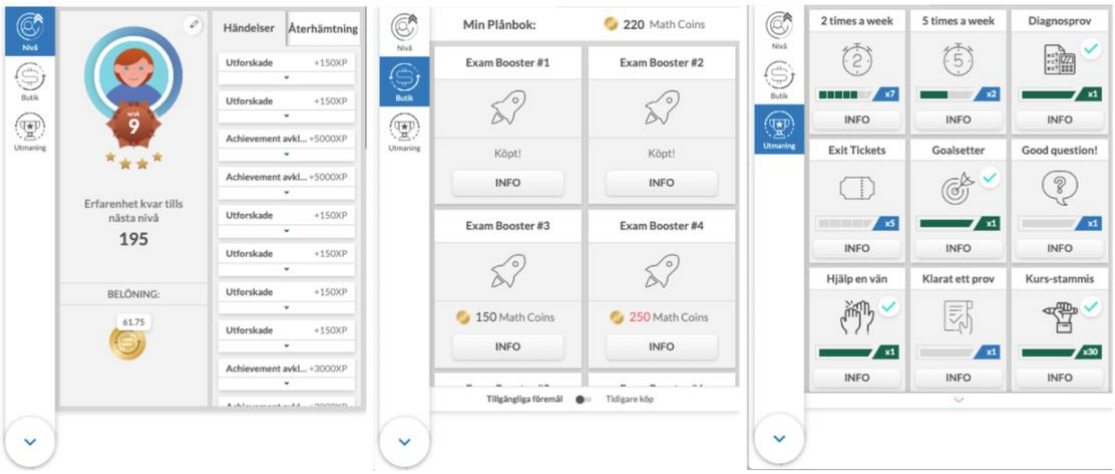

Figure 1. Gamification Layout

3.2. Data collection and analysis

Semi-structured interviews were performed with twelve of the students (14% of the total number of students) over three periods during the semester and with all of the teachers (n=3) during two periods over the semester. The sample of students was chosen in advance to be around 10%. This was to get a representative view of the student but at the same time not spend more time than necessary on data collection and analysis from too repetitive data. The students were chosen by the teachers who had an understanding of which students where more talkative and could provide more detailed answers. The sampling method can thus be seen as a judgement sample, i.e. chosen by the researcher to be the most productive sample to answer the research question (Marshall, 1996). Before the interviews an interview guide was developed in collaboration with a researcher at Insert Coin. Between each interview session the interview guide was assessed and changed to better fit the participants. The student interviews were complemented with two surveys which provided descriptive statistics.

3.2.1 Teacher and Student Interviews: The student interviews were conducted at the school, with students being brought out one at a time from the mathematics class to perform the interview which lasted 7-15 minutes. The interviews with the teachers took place online, via Google Hangout and lasted 20-30 minutes per interview. During the interviews the participants were informed about the reason behind the interview, i.e. evaluating the new structure of the mathematics course. The participants were told that the answers would be anonymous and were encouraged to give as honest answers as possible. All participants agreed to the interviews being recorded.

The first interview session was conducted approximately two weeks after the start of the implementation, to gain the students initial experiences and expectations after the students had had a chance to be introduced to and try out the gamified implementation. During the first interview session with the students, questions were asked about previous use of Google Classroom and digital games. In addition, the students were asked about their initial feeling of gamification and the digitalized mathematics course and about expectations. In the second interview with the students, after the student had had a chance to try the gamified implementation more, approximately four weeks after the start of the implementation, the focus was on their actual perception of the gamified course and of potential improvements that could be made. Finally, the last interview was conducted approximately six weeks after the start of the implementation, this was done to capture the final experience of the students in the end of the implementation but before the exam to not create bias depending on the result of the exam. Here, the students' motivation was taken into consideration as well as engagement and overall perception.

In the first interview session with the teachers, three to four weeks after the start of the implementation, questions were asked about the situation at the school and about their experience of the introduction of the gamified implementation. In the second interviews, conducted after the completion of the implementation, questions were asked related to how the gamified course and the change was experienced, about the effect it had on their work and how it seemed to affect the students.

3.2.2 Qualitative data analysis: The data from all of the interviews were transcribed and analyzed through thematic coding following the method of Gioia et al., (2013), through finding first order concepts, second order themes and aggregated dimensions. The transcription was made word for word for all of the interviews. This was followed by the transcriptions of the interviews being read through once before the coding began. Within the coding process the opinions of the students and teachers in regard to the research question were summarized and written down as individual first order concepts. The first order concepts were marked with a number for each student or teacher to keep track of how many students or teachers mentioned similar aspects. The first order concepts were thereafter studied and grouped by moving related concepts closer to each other and by moving non-related concepts further apart. From clusters created by the first order concepts, second order themes where highlighted as a summary of the

main concept themes. The process was repeated when moving from second order themes into aggregated dimensions, with the second order themes first being clustered from relatedness and the later summarized into aggregated dimensions.

3.2.3 Descriptive Survey Data: Survey data collected from the students was included to get a broader and more descriptive view of how gamification was used and perceived in the classroom. Two surveys were designed and sent out to the students during the implementation, In the first survey, which was sent to the students four week after the start of the implementation, questions were asked about the general perception of the course and the importance of passing, getting good grades and learning. The gender and age of the class in general is not known, however of the 59 students that answered the survey, three were female, two did not want to disclose gender and the rest were males. Of the students who answered the first survey the age ranged between 15 and 19 years old. The second survey was sent out approximately six weeks after the implementation, included questions about overall perception and more specific motivational aspects. The answers in both surveys consisted of 5-point Likert scales, from strongly disagree (1) to strongly agree (5). In the first survey some of the items related to the game elements were multiple choice questions. The data from the surveys was analyzed from descriptive statistics to get an overall understanding of the students' perception of the course.

3.3 Methodological limitation

The research design empathizes a qualitative approach through exploring students and teachers' experiences. Therefore, statistical representativeness was not the main objective (Mays & Pope, 1995). This due to the fact that samples (as in this case) are often small, the characteristics of the population is often not known and because values, beliefs and attitudes (as studied here through experiences) are often not normally distributed within the population (Marshall, 1996). Furthermore, the case study design inquires to expand theory as opposed to reaching generalizable conclusions (Yin, 2018). Therefore, the results presented in the present work should not be seen from a generalizability point of view but instead through explaining the experiences of the students and teachers in the specific context of the school. The findings could also guide further research in gamification with a more quantitative approach were generalizability is the main objective of analysis.

The methodology can instead be evaluated from reliability through the documentation of the process of analysis, and validity through triangulation and gaining participants view of the representativeness of their experience (Mays & Pope, 1995). The methodology in the present work is reliable due to a detailed explanation of the process. To increase reliability, more than one researcher could have done the coding to compare the results of the process. The validity is higher due to including both students and teachers' perspective but could have been higher if the participants had been asked to evaluate the representativeness of their experiences, which was not the case here. Finally, there are some limitations in the sampling technique chosen. The participants were chosen through judgement sampling. This can be seen as relevant since the participants were used as informants to enable the exploration (Mays & Pope, 1995) of the students and teachers experiences However, thorough the teachers choosing the student participants bias could arise through the teachers' desirability to choose students who were more positive toward the implementation.

4. Results

The results are organized in three main parts; 1) Student interviews, 2) Descriptive survey data and 3) Teacher interviews. The interview data is divided for each interview session by the aggregated dimensions (in **bold)** and second order themes (in *cursive*), following the method of Gioia, Corley and Hamilton (2013). Furthermore, each concept and citation are marked with a number in parenthesis, which indicates who mentioned each aspect. The tables summarizing each aggregated dimension with related second order themes and first order codes can be found in Appendix 1.

E.g. The following example from the first teacher interview; "*If we are discussing the building and construction students, they do not really do any homework, almost none of them…" (3),* is coded as the first order concepts: Few students do homework on their free time. This is combined with other similar concepts into the second order theme *low performance and motivation* and combined with similar themes into the aggregated dimension **need and technology readiness.** Here, the (3) signifies that it was teacher respondent 3 who gave the comment. The following example from the first student interview "*Yes, it feels good, I think. To have this in math. It can make you get extra points to the exam, which I think is good" (1),* it coded as the first order concept: It is good that you can get extra points to the exam, and grouped into the second order theme *gamification becomes attractive because you could collect points for the exam.* Combined with other themes the overall aggregated dimension formed is **positive attitude and expectations toward gamification**. Here the (1) signifies that it was student respondent 1 who gave the comment.

The student interviews were of a shorter format and included twelve participants. Thus, the student results are viewed from how many students mentioned similar aspects and citations are presented for each aggregated dimension. The teacher interviews were of a longer format with three participants and are therefore presented in a more extensive and subjective way including citations for each theme.

4.1 Student interviews

From the first interview with the students, the expectations of the students and their initial perception of gamification was taken into consideration. In the second interview session their actual perception and potential improvements was investigated. In the final interview session,

the questions focused on the students' motivation, engagement and overall perception. Each theme was formed from at least two first order concept and each aggregated dimension was formed from at least two themes, and stand-alone concepts were excluded.

4.1.1 First student interview: The first interview session included expectations and initial perceptions of gamification. Three aggregated dimensions emerged related to the experience and considerations. The first is the students having a positive attitude and expectations toward gamification, the second is technology and suggested improvements, and third is a blended learning environment. One of the recordings failed, and thus only the first 11 interviews are included below.

Positive attitude and expectations toward gamification: The first dimension of expectation and initial perception includes students having a positive attitude and expectations toward gamification. Here, ten of eleven students mentioned that *gamification becomes attractive because you could collect points for the exam*. This was mentioned as something that makes the course more fun and leads to higher motivation. Gamification was seen as *providing enjoyment and was seen as something positive*. Students also mentioned that gamification provided *repetition and feedback* and *lead to challenge and comparison*. The *expectations regarding the implementation included higher learning and better results*: "*Yes, it feels good, I think. To have this in math. It can make you get extra points to the exam, which I think is good." (1)*

Technology and suggested improvements: The second dimension, technology and suggested improvements, includes the aspects the students had found troubling or problematic in the initiation of the gamification together with their suggestions of improvements. This entails the *need for higher difficulty*, where one student mentioned the importance of deserving the points and another student suggested that it is too easy to get points which can lead to boredom. *Improvements through clarification and creating interest* was another aspect mentioned by the students. Two of the students had mentioned that they did not understand what they were supposed to do and how to get points. Another student, who had previously expressed a high interest in gaming also suggested ways to make the gamification more interesting, through interesting challenges, good rewards, including story elements and possibilities to cooperate with friends. The same student also mentioned that the gamification should be better integrated into the platform and to better follow the google classroom design. The *importance of*

technology and fairness was also mentioned, with three students expressing frustration about exploits in the system and their expectation that the technology should work. Another aspect mentioned here includes that previous technological experience might affect the gamification experience. The students mentioned that if you are used to gaming you might be more skeptical toward the gamification due to high design expectations and that individual differences might arise due to differences in technological knowledge: *"It does not feel like a challenge, you become bored, don't really understand the reason behind doing it." (5)*

A blended learning environment: The final dimension, the role of a blended learning environment, covers how the students use both the mathematics book and the computer to study. *The book was seen as a main learning tool*, with three students highlighting this aspect through mentioning that the book is needed to learn, that the digital aspects should not take up too much time from the lessons, and an initial skepticism to working with the computer. However, *the computer was preferred* by most of the students, with seven students highlighting that they and the others in the class are more prone to use the computer or that they like it better than studying in the book. Finally, *the need for variation* was mentioned, with eight students saying that they are positive towards doing something new: *"I am not a fan of sitting and writing in the book every math lesson, you want variation. I would have liked it even if you did not get points to the exam because it would have been fun anyways, to vary a little." (6)*

4.1.2 Second student interview: The second interview session included the students' perception and improvement. Three new dimensions emerged. The first is the overall perception of gamification, the second is perceived effects and motivation of gamification, and the third is how gamification was used and worked.

Overall perception of gamification: The first dimension of overall perception and improvements is the overall perception of gamification. This includes *gamification leading to more variation and providing an alternative learning tool* in which the students noted that the computer provided variation compared to previously only having studied in the book. The students also mentioned that *initially the add-ons felt different, but they soon became a natural part of the cours*e. Several students mentioned that it was natural part of the course while others mentioned that it felt different in the beginning but that eventually you got used to it. The students experienced a *general positive experience of the gamification and digitalization in the course*, with positivity toward using the computer and to the specific game-aspects. Lastly, the

students *wanted similar set-ups in further courses*. Here, the students were positive toward having the same set-up in further mathematics courses. For other subjects some students were positive, and others were skeptical: *"It is different in a good way, because then I learn more and it is fun." (8)*

Perceived effects and motivation of gamification: The second dimension is perceived effects and motivation of gamification. *Gamification was seen as leading to higher effort and learning*. It was also mentioned that it *was easier to find information and understand the questions on the computer*. The *main motivation behind gamification was collecting points to the exam*. Gamification was seen as *providing feedback and context*. The *repetition aspects have been appreciated and led to higher focus*. *Gamification was seen as interesting because the students could compete, compare and cooperate*. The *students were in general not stressed but some said that they had become less stressed in the gamified course*: *"I think it differs because you try harder because it is more fun, and then it becomes automatically more fun and then people become more interested and work more and better." (10)*

How gamification was used and worked: The third and final dimension is how gamification was used and worked for the students. *Gamification had a varied use in the classroom and at home*. The students' answers varied but in most cases those who had not studied in the book at home, now used the computer to study at home. Some of the students mentioned that they finished the exercises they had on the computer at home if they did not complete it during the lesson, to get the extra points for the exam. *Specific game-element improvements* were also mentioned such as more options in the store, cheaper in the store or easier to gain incremental points, including a friend system, and making it clearer when you reach a new level. There were also some *problems and misunderstandings that the students experience* in the course including technical issues such as bugs, having difficulties in understanding how everything works and finding the game-elements. This was mainly with understanding the point system and how the store worked and where to find it.: *"I do not usually study actually. I did not use to bring the math book home, because if you would forget it at home it would not be good. But if I decide to do a little math, then I do the game part." (3)*

4.1.3 Third student interview: The third interview session included the students' motivation and final perceptions. Six aggregated themes emerged including the students' attitude toward

digitalization and gamification; motivational effects; study habits; time and collaboration aspects; improvement areas; and positive aspects with specific game elements

Attitude toward digitalization and gamification: The first dimension of motivation and final perception includes the students' attitude toward digitalization and gamification. The students had a *positive attitude toward gamification* in general and saw it as something that was fun and could lead to positive effects. Furthermore, they *appreciated the variation and the newness in the course*, liking that it differed from other courses and that it provided alternative ways to learn. *The computer was in itself seen as useful and more fun to use when studying*. To have parts of the course on the computer was itself appreciated, seen as fun, motivating and leading to better understanding than just using the book. Finally, the students also saw gamification as *something they would like in other courses*, with some mentioning that they wanted it in other courses in general and others saying that it would be most applicable in math: *"We have had it for some time now, and I have collected points that I can use for the exam, and it is really nice that we can have this, I like it. It is also a little more fun to do it on the computer, that we have challenges on the computer that we can log in and do." (12)*

Motivational effects: The second dimension is the motivational effects that the students mentioned. This was related to *mathematics being seen as more fun compared to before*, related to higher engagement. One student also mentioned that gamification was seen as more fun because the course had become more of a challenge and that it felt good to get all the answers right. The students saw gamification as leading *to higher focus, effort and learning* and as something with the *potential to lead to higher performance*. For most students, however, performance was something that was seen as always doing your best. Some students also mentioned *confidence increasing* with gamification while others mentioned that it was the same. A couple of the reasons behind the higher confidence was higher collaboration, the course being easier in general, and higher understanding: *"I feel more confident with math and believe that I will succeed/…/because I feel more confident after the gamification." (7)*

Study habits: The third dimension is study habits. The *students used both the book and the computer to study* at home, during the lesson and for the upcoming exam. They also mentioned that they *studied more in general* during the course compared to previous courses. This was attributed to gamification, to having a better teacher, to mathematics feeling easier, and to being

able to use the computer while studying: *"When I come home I usually watch a video and answer the exercises that are connected to the videos." (6)*

Time and collaboration aspects: The fourth dimension is the time and collaboration aspects. There is a theme of *positive aspects emerging over time*. Here, the students mention that that the positive aspects they experienced were not always present to begin with, but instead were recognized later during the semester. *The game aspects had been discussed but more in the beginning of the semester,* explained as due to the fact that it was new and interesting, and toward the exam. *Collaboration was also explained as being higher but more in the sense of giving each other the right answer* and not helping each other with explaining the process behind the answers to each other, instead this is something that the students help each other with more when studying in the book: *"We did not speak about it (gamification) that often, but in the beginning we did. In the first week we spoke about it." (3)*

Improvement areas: The fifth dimension is improvement areas. The two main areas of improvement are organized into two themes; *information about how the gamification work has been lacking* and *the store needs to be made more interesting with more options*. With the lacking information the students mentioned that they did not understand how the point system worked, or that they did not understand what to do in the beginning and needed explanations about the store. The fact that the store needed to be more interesting is indicated by a lack of interest to visit the store and several of the students mentioning that there should be more options in the stop such as for example an option to buy in order to make it easier to level up. With the *other areas of improvements* two students mention that it is too difficult to level up when you get to the upper levels. Two of the achievements were also questioned by one of the students meaning that visiting the site five days in a row is too much and that the achievement of asking a question during the lesson is problematic because the teacher needs to report it. Another student mentioned missing a leaderboard and that it was frustrating not to be able to log into another google account and at the same time be logged into the school account for the gamification to appear: *"You could have added another currency to buy other stuff, like for example a frame or other profile pictures, nick-names and such, to make it more fun to come back to." (2)*

Positive aspects with specific game elements: The final dimension is positive aspects with specific game-elements. The student mention that the *store was perceived as positive* since it

gave you the possibility to buy points for the exam and that *the level in itself is seen as motivating*. The students mentioned gaining something from the level and being motivated by reaching the highest level possible. Furthermore, the *achievements were appreciated* by some of the students because it enabled you to focus on one goal at a time and because the exit tickets provided repetition: *"It is good (to be able to level up), because it makes you want to play. It feels like you gain something from it then." (11)*

4.2 Student Surveys

In the first survey, the items were based on a 5-point Likert scale and addressed the students' general perception of the course and the importance of passing, getting good grades and learning in the course. From the general student perception and the importance of mathematics (Table 1.) more students agreed than disagreed (M = 3.47) to the course helping to develop the students' school work. Furthermore, more students agreed than disagreed on the statement that the digital course helped with succeeding in one's studies (M = 3.25). This was not the case for the item on becoming more engaged toward mathematics thanks to the course (M = 2.97), were the students on average neither agreed nor disagreed. In regard to the importance of passing, getting good grades and learning in the course, it was of high importance to the students with the mean answer being between agree and strongly agree.

Table 1. General perception and the importance of mathematics

Question	Mean
The digital math course helps me develop in my school work	3.47
I have become more engaged toward math thanks to the course	2.97
The digital course helps me succeed with my studies	3.25
It is important to me to pass the math course	4.85
It is important to me to get good grades in the math course	4.24
It is important to me to learn what we do in the math course	4.61

In the second survey, items addressed student perception and motivation (Table 2.). The students mostly agreed to wanting similar set-ups in other courses (M = 3.34), seeing the activities on the computer as a good complement (M = 3.6), to becoming more active in the course (M = 3.34), learning more (M = 3.34), becoming more motivated (M = 3.11), and to getting better grades thanks to the set-up to the course (M = 3.28). On average the student neither agreed nor agreed to the set-up of the course inspiring you to work more during the

lessons (M = 3.02). The students mostly disagreed to the course inspiring you to work more at home (M = 2.38) and to the set-up leading to higher interest in mathematics (M = 2.87).

Table 2. Perception and motivation

Question	Mean
I would like similar set-ups in other courses like the one we had in the math course	3.34
What we do on the computer is a good complement to what we otherwise would have done in math	3.6
The set-up makes me more active in the course	3.34
I learn more thanks to the new set-up in math	3.34
The course set-up makes me more motivated	3.11
The set-up of the course inspires me to work more during the lesson	3.02
The set-up of the course inspires me to work more at home	2.38
The set-up of the course makes me more interested in math	2.87
The set-up of the math course helps me get good grades	3.28

4.3. Teacher interviews

The first interview session with the teachers focused on the current situation in the school, how the teachers viewed change, their expectations about gamification, the initiation of gamification in the classroom, and initial effects on the students.

4.3.1 First teacher interview: The first interviews with the teachers produced four dimensions explaining how the teachers experienced gamification as part of their teaching and important considerations of implementing gamification in the classroom. This include need and technological readiness toward gamification, important aspects of gamification implementations, potential effects of gamification on students, and barriers and solutions for gamification in the classroom.

Need and technology readiness: The teachers experienced a need and technology readiness, expressed by the low performance and motivation at the school, a previous traditional approach to education, the change being good in itself and an understanding for the connection between education and gamification.

The *low performance and motivation* among the students were expressed through the teachers mentioning that the performance and motivation had previously been low with a high rate of failing grades, especially in the mathematics course. Homework was not common for the students and there was a need for higher confidence and clarifying the importance of studying to the students: *"If we are discussing the building and construction students, they do not really do any homework, almost none of them…" (3)*

The approach within the course had *previously been traditional with low levels of technological implementation*. The structure of the course had remained similar year to year with incremental changes from year to year. Two of the teachers had never heard of gamification before the implementation while the third had heard of it previously and had tried including gamification aspects but lacked technological competence to be able to implement it in the classroom.

The teachers experienced a *change as something good in itself.* All the teachers where positive toward making a change in the course and none mentioned resistance or doubt about changing the way the course was conducted. Change was seen as good since it provided variation in the teachers work: *"I believe that it is positive, that someone comes from the outside with a new though, a new idea. Then we get to rethink and hopefully that is what makes it better in the end, setting words to what has worked or not. Even if it might not be gamification, to at least study what we have done right and what we can change." (1)*

The *link between gamification and education was understood*. One of the teachers mentioned that the psychology behind gamification already exists in high-school. Another teacher mentioned that the concept of games could be applied to a school context and the third teacher said that the connection between education and gamification was understood but that the connection was not always clear for the students.

Potential effects of gamification on students: The teachers experienced various effects that gamification could have on the students including offering the students alternative ways to learn, preferred and expected outcomes, an initial positive response and individual differences for students:

The teachers experienced that the students where provided with *alternative tools to learn* including giving them access to more learning opportunities and material. The computer was

seen as being more motivating for the students to use at home or during the lessons when the book became boring. Furthermore, gamification was seen as a complement and not a substitute to the remaining traditional education: *"We have added more material and created better conditions for the students to study at home, with a system that is more fun. So, I have a hard time imagining that it would be negative for anyone, even if someone chooses not to do it, they do not miss anything." (2)*

The *preferred and expected outcomes* that gamification can have on students was explain as those related to a higher performance, students becoming more motivated and learning more, students becoming more independent, seeing and understanding progress, comparing results, getting feedback and enabling repetition: *"I hope that the students see that they become part of their own learning, that is the long-term intention." (1)*

The teachers had also perceived the initial effects of the gamification to have a *positive effect on the students*. It was mentioned that all the students did not use gamification but that it seemed to have positive effects for those who did. One of the teachers had experienced that the students started discussing the gamification aspects during the lessons. Another teacher had gotten positive feedback about the gamification directly from a student: *"I have one example of a guy in the class that said, "this is really fun, I like it", and he usually does not do that much during the lesson. So, if he works with gamification, he learns a lot more than if he doesn't, because he does something." (3)*

The teachers also identified *differences in the potential effects* that gamification can have on the students such as students of higher ambition, higher knowledge, higher computer experience as well as higher feeling of competence and competition, could tend to spend more time on the platform and gain more from its effects. The students that already study and do what they are supposed to, are also the ones that tend to use the digital and gamification aspects.

Important aspects of gamification implementations: The teachers mentioned important aspects of the gamification implementation as important considerations when implementing gamification in upper-secondary. This includes the teachers having autonomy and control, the importance of explaining the platform, its purpose and voluntary aspect, and including purpose, progress and reward in the gamification design.

In having *autonomy and control*, the teachers mentioned being able to change the design of the platform and to access students' progress and responses directly. Another concept was gaining insight into what the students are doing on the computer: *"I want to see how much they do and how they are progressing/…/, I can walk around and see how it goes in the classroom as well, but then I just see a screen. When they work in the book I can see exactly where they are, so I would like to see something similar on the screen. After the lesson at least, so I know if they spent their time on Facebook or Google Classroom." (3)*

Another aspect is the *importance of explaining the platform, it's purpose and its voluntary aspects*. The teachers introduced gamification through making sure that the technology was working, giving an overview of the platform and highlighting that it was voluntary. It was highlighted that gamification was provided as something voluntary that the students could use it if they preferred, but also that there was a need to remind the students to check their results: *"I started with showing them (the students) the google classroom view, how it looked, where you logged in, that this was the classroom, that the exercises are here. So that they got an overview. I explained how it was going to work/…/ and that the purpose was that it would go as well as possible for them. I also said that the quizzes were not mandatory but a voluntary part. Later I asked them all to take up the computer and log in to classroom/…/the rest of the lesson they got to play and explore, look and ask questions, and the ones that had problems had the opportunity to get help. After that it was pretty intuitive." (2)*

Finally, the *importance of purpose, progress and reward* was mentioned. This included making the context of gamification clearer by visualizing the game better with a path leading to the overall goal of the game; creating a clearer indication of progress; showing the connection between effort and results clearer; and making the store more interesting through including more options.

Barriers and solutions for gamification in the classroom: Lastly, the teachers mentioned barriers and solutions for gamification in the classroom as considerations when implementing gamification. This included the importance of the preparation phase and introduction phase, barriers toward working with technology, and using students as a resource.

The importance of the *preparation phase and introduction phase* was highlighted by the teachers mentioning several barriers such as creating extra work-load and planning in the

beginning of the semester, and not understanding how to work with gamification and technological difficulties. Solutions taken within the preparation and introduction phase included making more time for planning, making sure that the technology works from start and providing initial examples of gamification: *"We had very short time to plan this, it was almost panicky in what you were support to do. We would need more time to plan/…/ we would have needed double the time at least, and now if we are going to do it again, I will like time to sit down and go through all the (gamification) parts." (2)*

Next, *barriers toward working with technological add-ons* was mentioned. The technical support was low and to not understand how the technology worked led to higher work stress. One teacher mentioned that some classes are more difficult to work with than others and that it can be more challenging to implement technological add-ons in the difficult classes: *"So, I was one of them (the teachers) who was not that involved in it (gamification), so it became a bit messy. When we could not start something, when it did not work, then I cannot run and get someone else since that also have lessons at the same time." (3)*

The *students were seen as a resource* to support the technological parts of the implementation. One of the other teachers mentioned that the students were good at finding and pointing out bugs in the system that had occurred, indicating that the students could help in finding potential problems early. Another teacher mentioned that the students helped in understanding how the technology worked: *"The youth are good at adapting/…/they understood rather quickly how they could solve what did not work and I could not solve. If someone could not log in or it did not change (the gamification), they managed to figure it out." (3)*

4.3.2 Second teacher interview: The second interview session with the teachers concerned the overall teacher experience of the implementation and the effect it had on students and teachers. The interviews produced four more dimensions including the impression of the implementation, improvements of the implementation, perceived student consequences and teacher consequences and needs.

Impression of the implementation: Within the impression of the implementation the teacher experience included that they had a positive view toward the implementation, doubt concerning the effectiveness of gamification and that they saw the effects as difficult to measure.

The teachers had an overall *positive view toward the implementation*. One teacher mentioned that gamification worked as expected and that the positive view of gamification had remained throughout the implementation. Furthermore, gamification was seen as exciting, as providing more than it takes and as not having any negative effects. Working with the digital aspects and google classroom was also appreciated.

At the same time there was *doubt about gamifications effectiveness* expressed by two of the teachers. Both teachers expressed that the students did not seem as interested as expected. One of the teachers experienced that gamification did not change a lot, that it did not produce as many advantages as expected and that there was uncertainty towards if it had worked or not. The other teacher mentioned that the students had not discussed gamification as much as expected and that they were not motivated by leveling up. In response to if gamification worked as expected one teacher said: *"Not as much as I had expected. Or not as much as it could have been. It could have been more. They (the students) have not become; we need to collect points." (2)*

The last aspect mentioned by the teachers in the impression of the implementation was that it is *difficult to distinguish if the implementation had led to any change*. Two of the teachers mentioned this by saying that it is difficult to measure the real reason for improvement and that since class groups differ so much results can be misguiding: *"We have two groups and one of the groups, they are in the same program, but one of the groups sit quiet for maybe fifty minutes and count, and the other cannot sit quiet for five minutes. If I had only had the second class, I would have thought it (gamification) was amazing, but now it is hard to say. But I know that a lot (students) asked why they did not get points for this etc., and updated the page to get points, so I am not sure, but I believe that it is positive. But it is hard to say." (1)*

Improvement of implementation: The teachers also mention improvements that should be considered when implementing gamification in the classroom. This includes need for understanding and clarification, need for integration and specific gamification improvements.

The *need for understanding and clarification* includes student and teacher perspectives. The expectations of what gamification was and how to work with it was unclear for the teacher who did not have any previous experience of gamification, with one teaching believing that gamification would be more of a game. There was a need for more information about

gamification to understand it and to be able to present it to the students in a comprehensive way. Thus, the teachers expressed that clear examples of gamification should have been presented to them in the initiation of the implementation and should be presented to the students initially as well:*" I did not understand anything since I got into it (gamification) a little late, so it would be (an improvement) if I knew more what it was about. It is also difficult before you have done it maybe, before you have seen a clear example of how it looks maybe, because then you could have mentioned it differently for the students in the beginning. It became confusing for them as well when I tried to stand there and explain something that I did not really know what it was." (2)*

Another improvement area was the need for *integration of gamification in the classroom*. Creating better integration included taking the students more into account, having a positive introduction, creating continuity and more integrated class experiences: *"Take more into account what the students know and believe, now we just threw it in front of them. They did not get any chance to think or reflect, it became more here and now. Now we start with this. And maybe we were not that knowledgeable about how to start, what to say, what value it has, it could be good to know, what to use it for, so that the students clearly could see the value of it. Now it was short in time, you could have started it in the beginning of the semester for it to become a natural part of the education." (3)*

Within specific *improvements to gamification* the teachers mentioned that it should have been made more visible on the platform when a student reached a new level and where to find the gamification, with effort and results being related to progress in a clearer way. Two of the teachers also mentioned including rewards that were related to the program in order to increase motivation.

Perceived student consequences: In how the teachers had experienced the implementation consequences on the students where mentioned. The students were seen as having a positive attitude toward gamification, performance was seen as increasing, student motivation was considered as being higher, self-organization and responsibility increased and the students gained higher accessibility and variation.

The *attitude of the students was seen as positive* with the students being comfortable with the set-up of the course and accepting and getting used to gamification fast. The students liked the

change and appreciating working on the computer: *"From the students' side, they accept it fast and get into it fast, and also realize if it disappears fast/…/they learn fast so to say, and it has worked really well." (1)*

The teachers mentioned that the *performance had increased* on the test this year compared to previous years. Two of the teachers mentioned that performance was better and the third mentioned that the situation at the school had improved.

The teachers perceived that the *motivation of the students* increased. This was connected to extrinsic motivation, persisting for longer, doing more on the computer, increasing the motivation for the less motivated students and making the students realize the consequences of their actions better: *"When they have not had the energy to do more, they manage to do a little more on the computer, you can get a little more out of them, which is good, because they do not always have that much energy." (2)*

Another theme was that the students got *more self-organization and responsible*. This was expressed as the students' responsibility to study more, having the opportunity to check progress, keep track of what they missed and visualizing what was expected from them. One of the teachers brought up responsibility as something that is not always positive, since the students tend to do what they are instructed to do. The teacher said that exit ticket worked since it became like a mandatory part of the course, but that the students did not spend time on gamification since they do what they are told: *"I get the feeling that sometimes you need someone to tell them: do this and do this now, instead of doing it from their own initiative." (3)*

Finally, all the teachers mentioned the positive aspect of *accessibility and variation*. This included that the students had access to more material and thus where provided with more opportunities to learn, that the digital aspects made the material more accessible for the students to study after the lessons, and that the students had realized that digital tools can aid them in their studies: *"They (the students) are more used to using classroom as a digital platform/…/for some it has meant that you can get help via YouTube, we have linked to YouTube, so if it is something that they do not understand they can access it on YouTube." (1)*

Teacher consequences and needs: The teachers experienced consequences and needs related to their work environment and the collaboration and workload consequences, innovation in work and need for technological competence and support.

Concerning the *collaboration and workload consequences*, the teachers collaborated by dividing the material they had to create equally among each other and mentioned that their work had become more collaborative and integrated. The workload was higher initially, with the teachers having to produce new material and the need for more time in this stage was expressed. It was, however, mentioned that the workload was seen as diminishing over time when the material had been created. A potential issue was the risk of failure if all the teachers had not done their parts: *"Problems with the set up could have occurred. If, for example, I did not do my part of the planning, on part would be missing, since it had to be published in classroom. But this did not happen (in this case)." (1)*

Innovation in work was expressed as another consequence with the change providing a new way to think and to work: *"It is exciting that you get to do this, I did not know a lot about it before and I am not sure if I know that much more about it know. It is mostly that it is good to get a new way to think, and maybe we got that." (3)*

The final aspect in the teachers need as consequences was related to the *need for technological competence and support*. The teachers with the highest technological competence had taken responsibility and helped the other teachers as well as staying in contact with the gamification company. One of the other teachers mentioned the need and appreciation of having such a person in the team, The teacher with the highest technological competence mentioned that the communication with the technical team at the gamification company had been good, but suggested the need for having more teachers with digital competence, getting more support with the workload and planning, getting research based advice in how to structure the planning from the system, and higher technological support or a more intuitive system: *"One of the other teachers did the most (of the technical parts), (s)he is the one who built a lot (in Google Classroom). Having a driven person, or a driven team, makes it easier. So, there must be a technological competent person who wants to take on a higher workload maybe." (3)*

5. Discussion

This chapter intends to combine the dimensions and themes that emerged from the previous chapter with previous research and the theoretical framework presented in chapter three to answer how the teachers and student experienced the gamified implementation. The chapter is divided into three main parts related to the theoretical framework, that is; gamification benefits and design considerations; extrinsic and intrinsic motivation; and technology acceptance and adoption. Dimensions and themes that emerged from the students' and teachers' experiences are grouped into the different parts. Some aspects of the respondents' experience that belong to different parts are mentioned more than once, e.g. collecting points was seen as a perceived student benefit from a benefit and design consideration but is also relevant in discussing student motivation.

5.1 Gamification benefits and design considerations

5.1.1 Student benefits: During all the interview-sessions, the students mentioned several positive psychological and behavioral outcomes. This is aligned with previous research on gamification having positive effects on secondary education students with regards to attitude, interest (Papadakis and Kalogiannakis, 2017; Stoyanova et al., 2019), and engagement (Haruna et al., 2018; Applegate et al., 2015). The students mentioned collecting points for the exam as the aspect they liked the most. Other aspects included being provided repetition, feedback and context, competition and collaboration, higher effort, focus and learning, and mathematics considered being more fun in itself. Similar aspects could be seen in the survey data were the students agreed on average that the set-up of the course had helped them to develop in their school work, succeed in their studies and get good grades, learn more, as well as making them more active and motivated. Designers and researchers of gamification implementations should take this into consideration as potential perceived student benefits to understand and adapt the design to student preferences, as well as include more reliable measures of these outcomes to be tested in controlled settings.

From the teacher's perspective, the effect on the students was related to a positive attitude, higher performance, higher motivation, more self-leadership and responsibility as well as access and variation. The students had also mentioned aspects related to attitude, performance

and motivation but had not mentioned the self-leadership and responsibility benefits. Previous research on teachers perception of gamification have also shown self-regulation as a positive student consequence of gamification (Martí-Parreño et al., 2019; Zou, 2020). This could have varied explanations. The students might not have experienced such changes, or it might not have been as important of a consideration for the students as it was for the teachers. To understand this relationship better there is a need for further comparative studies investigating the difference between teacher and student perception of gamification.

5.1.2 Student Improvements: Improvement areas were mentioned in the student interviews including the need to clarify how gamification works, making achievements more interesting, and including more options in the store and friend systems or leaderboards, making it clear when a new level is reached and to provide a higher challenge level. These results indicate the need for a user-centered designing from students' perceptive, in order to create challenges and achievements that are of interest for the students. Furthermore, the students saw the benefit of including more options in the store than those related to increasing the grades. Reward in itself, that goes beyond its instrumental value, might thus be valuable for the students. Creating experiential outcomes through desirable rewards was also highlighted by the teachers. Including virtual rewards might not increase the instrumental value for the students but instead increase the experiential value for the students. As in previous studies (Liu et al., 2017; Chee & Wong 2017) this highlights the importance of including both experiential and instrumental aspects in gamification design. These findings can be used as a base for understanding what students might find important in gamification and aid in a more user-centered design based on the experience of secondary education students.

The fact that the students wanted a friend system or leaderboard can indicate social relatedness to be of importance to students in gamification implementations, which could according to self-determination theory (Ryan & Deci, 2000), increase motivation as well. Finally, the challenge level could be better adapted to the students, this by offering the students more exercises with increasing challenge level. From a flow theory perspective this is supported since adapting the challenge level in relation to ones skills are involved in increasing motivation (Csikszentmihalyi, 1991). In the long run gamification could thus offer the potential to individualize the learning process and create higher motivation. The role of an adapted challenge level should also be investigated further in more controlled settings.

Another related aspect that was problematic was that the students mentioned in the last interview that collaborated was accomplished by the students giving each other the right answer instead of explaining the learning process. The aspect of not enabling cheating has been recommended before (Morschheuser et al. 2017). Here, this may be mitigated by developing a larger set of exercises so that the students can be provided with individual exercises, which answers could not be copied to other students.

5.1.3 Teacher Improvements: The teachers mentioned improvements to implementing gamification in the classroom from their perspective. This included providing the teachers with higher autonomy and control through being able to design lessons and check student progress. The loss of control to what the students were doing when they worked on the computer compared to the book was mentioned. Furthermore, the teachers wanted to make gamification a more integrated part of the course; including gamification from the start of the semester. This is aligned with previous that has shown curriculum fit as a factor being important for teachers when implementing gamification (Adukaite et al., 2017; Sánchez-Mena & Martí-Parreño, 2017). Specific improvements toward gamification were also suggested by the teachers such as expressing the purpose of gamification to the teachers in the beginning of the implementation, visualizing the link between effort and progress better for the students and including rewards that were desirable for the students. Therefore, giving teachers autonomy and control when working with gamification and other digital implementation should be considered in research and practice. The extent in which explicit explanation of purpose behind gamification is needed should also be considered in a design perspective.

5.2 Extrinsic and Intrinsic Motivation

Similar to previous studies (Sánchez & Trigueros, 2019; Zou, 2020; Martí-Parreño et al. 2019), the teachers saw gamification as being related to enhanced student motivation. However, in the present work the teachers experienced the students' motivation as being related to extrinsic rewards and to the blended learning environment. From the first survey the students did not agree as much with the statement that mathematics had become more engaging. The same was prevalent in the second survey where the students on average disagreed that the set-up had led to more interest in mathematics. These results highlight that the implementation led to more

extrinsic than intrinsic motivation, i.e. the students were motivated to work more because of being provided extrinsic reward than from mathematics becoming more interesting in itself.

Increasing extrinsic motivation more than intrinsic motivation can be problematic since extrinsic motivation can undermine intrinsic motivation (Deci et al., 1999). Deci et al. (1999) found that positive feedback mechanisms can enhance free choice behavior and self-reported interest whereas reward instead can decrease interest (Deci et al. 1999). Further gamification implementation done in education should thus question whether or not rewards should be included or not, and for which tasks or achievements rewards should be present to not diminish intrinsic motivation. Gamification design in a school context should instead focus on providing the students with autonomy and self-directed learning through positive feedback mechanisms that can increase intrinsic motivation. With higher self-leadership and responsibility students could be provided with autonomy that creates higher intrinsic motivation. However, one of the teachers questioned self-leadership and implied that too much responsibility can lead to less effort for the students. The balance between offering autonomy and the effort that the students put in should therefore be considered when designing for higher autonomy and intrinsic motivation. As mentioned previously, the aspect of self-leadership and responsibility should therefore be included in further studies. This through evaluating if gamification can lead to higher self-leadership for students but also if an increased responsibility would provide positive or negative consequences for students in secondary education.

5.3 Technology adoption and acceptance

In relation to technology adoption and acceptance, dimensions and themes emerged in the teachers' and students' experiences related to the students' acceptance of the gamified system and the teachers and students' adoption of gamification as a tool in the classroom. The adoption factors related to the relative advantage of a blended learning environment compared to traditional education; results demonstrability of the implementation; and compatibility with the need for resources.

5.3.1. Student acceptance of gamification: In the last interview positive aspects with the specific game elements were mentioned. The store was seen as positive since you could buy points for the exam, the level was seen as motivating in itself and the achievements were appreciated. The students mentioned that they wanted gamification in other courses as well which was also

prevalent in the survey data where the students agreed on average that they would like similar set-ups in other courses. This indicates that the students had a positive attitude toward using gamification which, from the technology acceptance model (Davis, 1989), is associated with behavior intention to use and actual system use. This was also mentioned by the students; there had been a varied use of gamification in the classroom and at home, with some students using it mostly in the classroom and others studying at home. The students used both the book and computer to study but studied more in general during the course compared to before. This could however be due to other conditions that was present such as a new school, course and teacher. From the survey data it was seen that the students on averaged disagreed that the set-up of the course had led to more time studying at home. Gamification may therefore be seen as a tool that has the potential to be accepted by students in the classroom and at home, but more studies should investigate how gamification can increase student motivation toward studying outside the classroom. The students did not mention aspects related to ease of use or perceived usefulness. To better understand how these aspects relate to student attitudes and use, future studies should include measurements of ease of use and perceived usefulness.

5.1.4. Relative advantage: An interesting aspect was the students reporting that it was important for them to pass, learn and get good grades in the course. This indicated that it is not necessarily about the students not being interested in passing, learning, and performing in a course, but that instead they might not have been provided with the right tools to do so. The blended learning environment was appreciated by the students and there was a need for the newness and variation that the implementation provided. Therefore, the blended learning can be seen as having a higher relative advantage compared to the previous more traditional education. The book was seen as being important, while the computer was mostly preferred. The computer was seen as a useful tool and the students mentioned that it was easier to find information and understand the questions on the computer. This was also seen in the survey data where the students agreed on average to the statement that the computer was a good complement. These results indicate that a blended learning environment can enable students to become more motivated since it provides a new way for them to study. The implementation had also required some time to understand and the positive aspects had emerged over time. These findings should be considered in further implementations, studying how to make the onboarding process to gamification as smooth as possible for the students to be able to access potential benefits early on in implementations. At the same time, gamification was discussed more in the beginning when it was new, indicating that a novelty effect, i.e. the user experiencing a higher but

declining excitement to new features introduced (Koivisto & Hamari, 2018), might be at play. Previous gamification studies have identified that enjoyment and usefulness can decline over time (Koivisto & Hamari, 2018). Since the novelty effect has been found in some studies (Seaborn & Fels, 2015) but not in others (van Roy & Zaman, 2018), it should be further investigated how gamification can be designed to lead to more long-term enjoyment and motivation.

5.3.2. Result Demonstrability: The teachers experienced a need and openness toward the change and saw potential in gamification. After the implementation, gamification was seen as positive, but there was some doubt of its effect and uncertainty due to the difficulty in measuring outcome. The need and openness toward gamification and the positive view of gamification in the classroom can indicate that secondary school teachers are open toward a more digital environment and gamification. This is in line with previous work that has been done with secondary teachers and their view of gamification (Bahauddin & Setyaningrum, 2019; Baldauf et al., 2017; Saleh & Sulaiman, 2019). Compared to what these studies have shown, the results here indicate that there is doubt about the effectiveness of gamification especially due to the difficulties in measuring results. This might depend on the fact that the teachers could not see what the students had done on the platform and thus could not see if gamification had been of interest for the students. From an adoption standpoint this may be crucial for the adoption of gamification. To enable less doubt about effects and gain more control the teachers should be provided with statistics of use and be able to check student progress.

5.3.2. Compatibility with needs: Aligned with results from previous studies (Zou, 2020; Martí-Parreño et al., 2019; Brooks et al., 2018; Baldauf et al. 2017; Sánchez-Mena & Martí-Parreño, 2017), the present study showed that gamification required resources, time and effort to implement. This was further clarified in the present study by identifying that more time and effort was required in the planning phase, that technical support was required as a resource, and that the students and technical competent teachers could be used as a resource to overcome the technical challenges. This can be seen as highlighting the importance of creating compatibility with the needs of the teachers in implementing gamification in the classroom. In line with the article by Zou (2020), teachers saw the implementation as requiring an initial higher workload that was expected to decrease over a longer time period. Increased student collaboration has been mentioned in previous studies (Sánchez-Mena & Martí-Parreño, 2017) but in this study the collaboration benefits also translated into the teachers own work environment. Furthermore,

the results of the present study noted that the change enabled new ways for the teachers to work and plan their course. Thus, gamification and other digital implementations can be viewed as positive since they may open up to a more innovative environment for teachers to think about work. Again, more studies are needed for results to be generalizable.

6. Conclusions

The present work evaluated an implementation in which gamification was applied to Google Classroom in a mathematics course in secondary school with a blended learning approach to distinguish student and teacher experiences. In line with previous research, findings suggest that teachers and students experienced the gamification implementation as positive, but that several factors are important to considered. Due to the research design of the present study, there is a need for more controlled studies to validate the effects of gamification and gain understanding about the findings' generalizability. Here, the findings suggest the importance of designing for intrinsic motivation through the following; enabling progression though skill and challenge; adding relatedness aspects; including enjoyable aspects in the platform such as virtual rewards; and expressing the purpose behind gamification. Furthermore, a blended learning environment can be seen as positive since it offers a relative advantage to previous traditional education, and results demonstrability and compatibility with needs might be of importance for teachers to want to adopt gamification in the classroom.

6.1 Research Implications

The present study supports previous research in the positive attitude toward gamification. Similar to other studies it was also found that both experiential and instrumental outcomes are of importance to include in gamification design, that cheating should be prevented, the need for curriculum fit, that gamification might be connected to a novelty effect, and that resources, time and effort are required in implementing gamification in the classroom. To adapt the challenge level, include autonomy and relatedness, and balance extrinsic and intrinsic motivation was also mentioned, which support motivational theories related to gamification. The new findings presented here should be viewed as hypothesizes to be tested in more controlled settings. First, potential positive outcomes related to gamification in secondary education include extrinsic motivation, repetition, feedback and context, competition and collaboration, higher effort, focus and learning, and intrinsic motivation. Second, there might be a difference in perceived outcomes for students and teachers with teachers highlighting self-leadership more. There is also a need to study the consequences of providing students with higher self-leadership. Third, autonomy and control in working with gamification, and collaboration aspects are important to consider from teachers' perspective. As a final note, preconceived notions about students being

unmotivated and teachers not being adept to technological change should be questioned and studied further. The present work shows that the students wanted to perform and learn and that the teachers were positive toward working with technological innovation, but that they needed the right resources to do so.

6.2 Practical Implications

From the present study several recommendations about implementing gamification in secondary education can be offered. Firstly, in the design phase, gamification should be designed in a way so that the purpose and the link between effort and progress is made clear and include several rewards that are seen as desirable for the students. The experience for the students should both be experiential as well as instrumental, that is, gamification should provide an enjoyable gameful experience as well as provide practical use. In the design phase it should also be clear if gamification is supposed to elicit extrinsic or intrinsic motivation and how much autonomy the students should be provided with. Secondly, in the introduction of gamification, a visual representation of gamification should be provided to the teachers and its benefits should be made clear. In addition, how to introduce gamification to the student and continue working with it in the classroom should be thoroughly explained. The teachers and students should be provided with sufficient resources and support and it should be easy to understand and work with gamification initially. Thirdly, in the implementation phase, the teachers and students should be provided with support and the possibility to check progress in a clear way to notice the results of working with gamification.

7. Acknowledgements

The author would like to thank the students and teachers who took their time to participate in the interviews. Adam Palmquist for his support with setting up interviews and interview guides, as well as proving general support and guidelines. Elena Bruni, for initial encouragement, feedback and advise about the research process. Daniel Ljungberg, for timely and detailed comments about improvements. Jannis Kallinikos, for feedback and guidance in creating coherence. Fabian Homberg, for taking time to provide comments in the final stages. Finally, the author would like to thank the team at Insert Coin for answering any technology related questions and for the opportunity to conduct the study.

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8. Appendix

8.1 Aggregated Dimension: Student Interviews

8.1.1 Student Interview session 1

Aggregated dimension: Positive attitude and expectations toward gamification

1st Order Concept	*2nd Order theme*
It is good that you can gain extra points to the exam (1) Gamification is fun, because it is fun to play games, level up and get points (2) Gamification makes studying fun since it makes it more fun to study, by getting points (3) Gamification is fun because and easier because you can collect points to the exam (4) Wants to do the gamification part to get points and not because it is a game (5) Sees gamification as something appealing since it can lead to more free points which makes it more interesting (6) It is good to be able to gain points to bring to the exam, especially at a school where students find the courses difficult (6) Gamification is positive because you can do exercises during the lesson and get extra points to the test, making it more motivating to study (7) The points are seen as a motivation to do the exercises (7) Gamification will make people work more because of the repetition of exercises in the end of the lesson and because it is more fun to gain points (11) Believes that gamification will work since it leads to variation and makes it possible to collect points for the exam (11) Gamification will work because it is more fun since you can collect points to the exam and learn more (10) Expects the course to be more fun and for it to help with the grades because you can collect points throughout the semester (10) Gamification is motivating to do than the book since it gives you extra point to the exam (8)	**Gamification becomes attractive because you can collect points for the exam**
Expects gamification to make the course more fun than usual (3) Positive attitude towards gamification, something that can make the course more fun (4) Would like it in other subjects as well (7) Most people in the class seem to perceive gamification as something fun (7) The digital add-ons and gamification can lead to higher concentration and happiness (9) Gamification as something good to have in math (1)	**Gamification is seen as something fun and positive**
Gamification provides feedback and repetition to what you did during the lesson (6) Thinks that it is fun and provides a tool for repetition and feedback (11)	**Gamification provides repetition and feedback**
Believes gamification can make school more fun and challenging (8) Believes that gamification will lead to a more competitive environment in the classroom, comparing points with each other (8) Gamification is motivating because you start comparing with each other and become driven towards improving, you do not want to be in the bottom (11)	**Gamification can lead to challenge and comparison**
Believes the setup of the course can lead to a higher understanding and better grades (2) Expects gamification to lead to better results and to learn more (8)	**Expects learning and better results**

Expects it to lead to better results on the test and higher learning (6) Expects gamification be fun and lead to higher learning (7) The digital add-ons and gamification lead you to not have to work as much at home (8) Gamification enables you to get out more of the course (3) Perceives math as easier in the course (3) The setup of the course makes it easier (1)	

Aggregated dimension: Technology and suggested improvements

1st Order Concept	*2nd Order theme*
Does not know if gamification helps because it is a game or because it is easier. Finds it very easy to gain points (5) If gamification is too easy, it is not seen as challenging, you become bored, and do not understand the purpose behind what you are doing (5) Wants more challenging and difficult exercises (5) It is important to deserve the points, so that they are associated with learning (9)	**Need for higher difficulty**
Does not really understand how you get points (8) Does not always understand what you are supposed to do (10) For gamification to work it has to be interesting, the challenges need to be good and the rewards need to be perceived as rewarding (9) Wants to include the story aspect in the gamification as well, doing challenges and following a story line, collaborating with friends to progress (9) Sees the gamification add-on as something that does not become a natural part of google classroom, should be designed to better fit the style of google classroom (9) Could use full lessons dedicated to having bigger games with story elements (9)	**Improvements through clarification and creating interest**
Bug of updating the page can lead to negative experiences (5) Exploits and technological bugs should not exist (9) Expects it to work on a technological level (6) If you play games at home gamification might not work since it is not as fun as the games that you play at home (5) Individual differences can arise due to differences in technological knowledge (5)	**Importance of technology and fairness**

Aggregated dimension: A blended learning environment

1st Order Concept	*2nd Order theme*
It is good to combine the math book with the game, to learn from the math book and then test your knowledge and level up in the game (4) Positive that it does not take up too much time from the lessons, sees the book as the main learning tool (9) Initially skeptical to working with the computer and not just the book (11)	**The book as a main learning tool**
Believes it will result in better grades, people do not study so much in the book but most people tend to do the exercises on the computer (7) Prefers the computer to the book because it makes it easier to understand (2) Development is necessary and the phone and computer can lead to making school better since people already use and like their phone and computer (11) Easier to do exercises on the computer than in the book (5) Digitalization is better and more fun than just using the book (9) Most people in the class seem to do the exercises on the computer (5) Would prefer working on the computer than the book (10)	**Computer preference**

It is positive to test something new (5) Development and introducing new things is always fun (4) Gamification is positive since it leads to variation, not only sit with a book and do exercises (6) Gamification is seen as something good because it provides variation (7) The course is good since they are testing new things (1) The setup to the course is good because it provides variation (11) Digitalizing courses is good because you get alternative ways of learning, through looking at films and doing quizzes (10) The digital add-ons and gamification make it more fun because it provides variation (8)	**Need for variation**

8.1.2 Student Interview session 2

Aggregated dimension: Overall perception of gamification

1st Order Concept	*2nd Order theme*
More variation and easier than usually (1) When the book becomes boring the computer and game can be used instead (2) When the book becomes boring it is easier to use the game than not doing anything (2) The gamification part feels different but fun with variation (9) The setup of the course is good since it includes more variation (11) The set-up of the course is good because you vary between the book and the game (11) Learned a lot from the movies online but also from the lessons, learns different things from both (8)	**Gamification leads to more variation and provides an alternative learning tool**
The technological add-ons have been a natural part of the course (1) The technological add-ons feel like a natural part of the course (2) The digital aspect felt different than usual in the beginning but became a natural part of the course quickly (3) The digital add-ons have been a natural part of the course since they have been included from the beginning (4) The digital add-ons have been a natural part of the course (5) The digital parts are seen as a natural part of the course (6) The digital aspects have felt different and new but not as an unnatural part of the course (7) The digital part of the course feels natural, in the beginning it felt different but fun (10) In the beginning you had to learn how everything worked but after a while the digital add-ons felt like a natural part of the course and a habit (11) The digital add-ons have felt like a natural part of the course (12)	**Initially the add-ons felt different but soon became a natural part of the course**
Sees the gamified parts as motivating (8) The math course is more fun compared to previous courses; it becomes more motivating since it is a game (9) Perceives the game as something good (3) Perceives the course as a little more fun than previous math courses (7) Is very satisfied with the set-up of the course (8) Everything feels better in this course compared to previous courses, but could be because the teacher is good and that the new elements of the course are fun (9) The course is perceived as more motivating due to less exams and less exercises (1) Not that big of a difference in this course compared to other, but it is more fun (5) It is more interesting and easier to study on the computer than the book (10) Since you are more used to the computer it is easier to think and write the answers to the exercises on the computer (12)	**General positive experience of gamification and digitalization in the course**

The digital add-ons will affect the students because you become more inspired to study at home (10)	
Would like similar setups in other courses (1) Would like to have all courses setup in a similar way since they would become easier to keep track off (4) Not sure how gamification would work in other courses, but believes it works the best applied to math (7) Believes that it could work in other courses but that it is more natural to have it in math (8) Wants all courses where connected to the same gamified system, with a competition at the school, sub levels in different subjects but an overall level for all subjects (6) Wants to have it in other courses because it helps you understand what you know and that it was not for nothing (5) Want the same setup in other courses since people are motivated by doing the exercises (10) Would like to have a similar approach in other courses (11)	**The students want the same setup in other math courses and some students want it in other subjects as well**

Aggregated dimension: Perceived effect and motivation of gamification

1st Order Concept	*2nd Order theme*
The course differs from other courses because you learn more and put in more effort because of the game aspect (2) Math becomes more motivating due to the game, because you can put in more effort and level up (2) The game-part is more fun than studying on the book and makes you study more (4) The course is different than other course because people put in more effort because it is more fun, which makes it more fun and people become interested and put in more effort (10) The course has been more interesting, it makes you want to do study more (6) Gamification feels less like studying, so you learn more, but it feels like you study less (9) This course has been more fun and led to more learning compared to other courses (8) The gamification part differs from the rest of the course in a good way because it has led to more learning and been more fun (8) The setup of the course has led to more studying and learning (8) Studies much more because it is more fun (12) People in the class study more because they are more comfortable with using the computer (12)	**Gamification leads to higher effort and learning**
Easier to understand because it is formulated in a better way than in the math book (1) Feels more motivated in the course since it is easier to understand (7) Believes it will lead to more studying because it is easier to understand in the game than in the math book (2) It is easier to find information and understand when you have the computer because you can search for information (4)	**Finding information and understanding the questions is easier on the computer**
The best part of the game is the store with the option to buy points (2) The most interesting part of the game has been that you can buy points to the exam (4) The coins are the most motivating part about gamification (6) Would rather do homework on the computer since you have a reason to do it when you get coins (7) Gamification is a little more motivated but not a lot, getting points and buying stuff is motivating but usually does not focus that much during the lesson (3)	**The main motivation behind gamification is collecting points to the exam**

Does not believe people would play if you did not get points in the exam (9) The gamification makes it more motivating because you feel like you gain more from doing it because you get points for the exam (10) The course is more fun than previous math course since you can get points for the exam (11) The game part is motivating and interesting because you can collect points to the exam by doing exercises (9) Gamification makes you try harder because you want the points for the test (3) The most interesting part of the gamification is the coins and progressing in level (10)	
Gamification gives you insight into what you need to learn (3) Can check progress after each lesson, see what you need to study more on (direct feedback) (3) The course has been more fun because you can see that you have learnt something (6) The math course is easier to keep track of compared to other courses because it is on the computer (4) Gamification helps you understand the purpose behind what you did during the lessons (5)	**Gamification provides feedback and context**
Gamification leads to higher learning; you can repeat what you did during the lessons The gamification part has been helpful because it is like a repetition at the end of the lesson, and you focus more because you want the points to the exam (10) The math course if more fun than other courses because if you focus during the lessons you can solve the exit tickets and get the right answer (11) Focuses more during the lessons to solve the exit tickets (11)	**The repetition aspects have been appreciated and led to higher focus**
The most interesting part of the course is that you can progress in level and compare with your friends (8) The level part is interesting because being at a high level is like a competition (9) Math feels more motivating now because it is on the computer and you can cooperate more with your friends (12) The gamification has been easier and lead to more cooperation with friends (12)	**Gamification is interesting because you can compete, compare and cooperate**
Does not affect stress because is not stressed to begin with (3) The course is seen as less stressful since it is easier to keep track of (4) Stress is not affected by the set-up of the course (5) Never been stressed about math (6) Is not stressed towards school in general (7) Does not experience stress (8) Less stress toward math since it is more motivating to study (2) Never been stressed about math (10) Does not experience stress (11) Is less stressed now because you are more confident in your answers (12)	**The students are in general not stressed but some say that they are less stressed in this course**

Aggregated dimension: How gamification was used and worked

1st Order Concept	*2nd Order theme*
Did not spend a lot of time on the gamification part, does not do it at home (1) Uses gamification during the lessons but not at home (8) Studies mostly in school, during the lessons and at home (11) Does not study at home (6) Has mostly used the game-part during the lessons (4) Has only studied during the lessons, put plans on using the book and the computer to study for the upcoming exam (9) Has tried the game part a couple of times at home and only uses the computer to study math at home (2)	**Varied use of gamification in the classroom and at home**

Has done some exercises at home on the computer (10) Usually does not study but uses the game-part when studying at home (3) Has done the game part at home several times, to complete the challenges (3) Does the exit tickets but does not look at the rest of the game parts (6) Does the exercises at home on the computer, never brings the book home (7) Does not bring the book home with the risk of forgetting it during the lessons (3) Has done all the exercises in the game, it is fun that you can buy points to the exam and learn a little at the same time (9) Tried to log in five days in a row but forgets during the weekend (7) Has done almost everything in classroom and in the gamification part (10) Looks at the gamification part when you get points (11) Studies more on the computer but uses the book sometimes as well (12) Studies in school mostly because if you finish the exercises in school you have nothing to do at home (12) The exercises is the most interesting part, did not look at the store yet (12) Notices that you level up sometimes but focuses more on doing the exercises (12) Has not looked at the store or levels because it has not been of interest, is not a person interest in math or computers (5)	
Does not look at the challenges that much because you know what you need to do to get points (10) Has not looked at the achievements, knows what is there but it is not that interesting (7) The store should contain more options, such as a frame, profile pictures or nicknames (6) The gamified system should have two different kind of coins, one to buy points for the exam and one to buy other stuff (6) The gamified system should contain more options for profile pictures or being able to add your own (6) Should have one option for buying points to the exam, and that the price becomes higher each time you buy it (6) The store is interesting to look at because then you know what you have learnt (8) Would like it to be cheaper in the store module, to get points easier (9) The gamified system should contain a voluntary friends' system, where you can have a leaderboard together with your friends (6) Wants to add option in the store, for example to buy more boosts (2) The "ask a question" challenge is unnecessary because sometimes you do not have to ask a question (7) Wants the store to be made easier, it takes too much time before you get points, instead it would be better to get less points bur for everything you do so that you better see your progress (11) Wants it to be clearer when you achieve a new level (12)	**There are specific game-element improvements that can be made**
Does not get points from leveling up (7) The store is confusing since the options have different price but give equal points in the end, wants it to be clearer what you are actually buying (3) A lot of the answers to the exercises are wrong in the system (7) It is complicated that you can give the wrong answer and still pass the exercise (7) Believes it is important to test better for bugs before it is used (7) In the beginning it was a little difficult to understand how to gain level but after a while you understood everything (9) Could improve the course by explaining the digital exercises during the lessons (8) The design of the gamification add-on should fit in with google classroom better, the experience is okay, but it is problematic with bugs (6) The gamified ad-on does not show up if you are logged in to your own google account simultaneously. To change you have to log out from the computer and log into the school account (6) A little difficult to understand how everything worked in the beginning but understood it after a while (10)	**The students experienced some problems and misunderstandings in the course**

It was difficult to understand when to get the points in the beginning, and that you got points when you achieved a new level (10) Wants more exercises on the computer to be able to work more at home (10) Does not know where to find the store (12)	

8.1.3 Student Interview session 3

Aggregated dimension: Attitude toward digitalization and gamification

1st Order Concept	*2nd Order theme*
The course has been fun, has collected points to the exam and appreciates that you can have it (12) The gamification has been as motivating from the beginning (4) Perceives gamification as something good, started by learning how everything worked and later got going with it (5) Gamification is perceived as positive since it has been fun, good, and easy to understand (6) Has not looked at the gamification a lot but can see how it affects others since it is a fun to reach accomplishments, it makes you work more (2) A little more fun before since you get points but not a lot (2)	**Positive attitude toward gamification**
Would like to have gamification in more courses since it is mote motivating and leads to higher variation (4) Math has become more fun with this course due to higher variation (5) Has a positive view of gamification since it leads to variation (5) The course felt like a new experience where you could try something new (8) It helps to understand when you get tools from difference sources, both in the book and on the computer (12) Gamification makes you experience math in a different way, it is more fun and you get to do stuff you otherwise would not have done in math (8) The math course has been fun with new challenges and exercises (7)	**Appreciates the variation and the newness in the course**
Sees the course as a little more engaging than previous courses, it is easier to do exercises on the computer (3) It is more motivating to study math at the computer than in the book, despite not being interested in gaming in general (1) Math has become more fun than before; it is more fun and easier to use the computer because it is easier to orient and avoid losing the book (7) The digital add-ons have been fun with the exercises, quizzes and with being able to collect points for the exam (4) You understand better when studying on the computer (9) Studying on the computer is more fun than studying in the book (12)	**The computer is useful and more fun to use when studying**
Gamification is something that can work but better in math than in other subjects (3) Every school should have gamification because it feels like it makes you understand more (9) Would like to have gamification in other subjects (9) Math feels like the most applicable subject to have gamification in (10)	**Students are positive to gamification being applied in other courses, mostly in math**

Aggregated dimension: Motivational effects

1st Order Concept	*2nd Order theme*
Math feels more fun compared to before (12) Perceives gamification as something that makes you want to study more and that makes it more fun (11)	**Math is seen as more fun compared to before**

Gamification is perceived as something that makes it more fun than tradition education (7) Math is a little bit more fun than before (11) Perceives gamification as something good because people seem more engaged toward math than before (8) Feels more engaged toward math now because it is the last years of high-school and because of the gamification (9) Math has felt more fun with the game, made math easier and lead to higher engagement (8) Math feels more fun and motivating in this course compared to previous courses (4) Math has become more fun in this course, does not usually like math but in this course it has become more fun because it feels like a challenge and it feels good to get all the answers right (10)	
Puts in more effort in this course compared to previous courses since it gives you the opportunity to buy points for the exam (6) Puts in more effort since the digital exercises are more liked than the ones in the math book (7) There has been a higher focus since the gamification (9) You are more focused to put in an effort when you level up (9) Math is easier now which makes it easier to get higher grades, so you want to put in more effort compared to previous math courses (10) The course has been fun, and you have learned a lot (6) You learn a lot in the math game (6) It has been easier to understand math in this course compared to before (5) Gamification is good because it can help students understand things they have missed (12)	**Higher focus, effort and learning with gamification**
The gamification makes you perform better when you get extra points for the exam (8) No difference in wanting to perform in math (11) No difference in wanting to perform in math (3) Always strives toward good grades, no difference in this course (5) Always wanted to do well in math, no difference now (2) The gamification helps you remember more math (5) Always want to perform in math, feels like the performance will be better now (4) Extra motivated to achieve a higher grade because the points can help you (1)	**Gamification can lead to better performance but wanting to perform is in general the same**
No difference in confidence about math (1) No difference in confidence level in this course compared to before (3) No difference in confidence toward math (11) Good performance at exams leads to higher confidence (4) Higher confidence since math feels easier now (2) Feels more confident in math because gamification makes you collaborate more with your friends and discuss the exercises (7) Feels more confident about the answers to the exercises compared to previous math courses (8) The math in general and the gamification makes it easier than before leading to higher confidence (9) Feels more confident in math now because you have an answer-key and you know if an answer is right or wrong and can figure out why (10) The challenges help with the confidence since it helps you understand in a better way, by for example visual representations (12) The films have helped to understand what to do and to gain confidence (6)	**The confidence in math has increased for some students but remained the same for others**

Aggregated dimension: Study habits

1st Order Concept	*2nd Order theme*

Uses the computer to do exercises, watch films, does quizzes and diagnoses at home to study for the exam (1) Uses the book and the computer to study (5) Mostly studies at the lessons but sometimes studies at home using the book and the computer (4) Has done the exit tickets and watched the films, but usually studies the most in the math book (5) Will use the math book and the computer in studying for the upcoming exam (8) Will study on the computer and in the book for the exam (9) Plans to study on the computer at home and the book in school (11) Plans on studying with the computer and the book for the upcoming exam (12) Uses the computer to study, mostly through watching films and doing related exercises (6)	**The students use both the book and the computer to study**
Studied math in previous courses when you were behind, now you study more when you do not have anything else to do (1) Does math at home now at least once a week (1) Studies more now because the teacher is better and because of the game (4) Has studied more at home compared to previous courses, because you can study with the computer (3) Studies more in this course compared to before (6) Has a positive feeling about gamification because it makes you study more at the lessons and at home (1) Previously only studied during the lessons, now studies at home and during the lessons (9) Studies more during the lessons in this course compared to before because math is easier, and it feels like a new start at a new school (10) Did not study at home before, but studies a little at home now and only on the computer (11)	**The students study more in general during the course**

Aggregated dimension: Time and collaboration aspects

1st Order Concept	*2nd Order theme*
Skeptical to the gamification in the beginning, did not do that many exercises in the game, but realized in the end that it gave a lot with the repetition aspects (1) Understands and got started better with math now compared to in the beginning of the semester (12) During the course the gamification has become more like a habit and felt like a more natural part of the course (5) In the beginning the digital aspects felt different compared to the book but now it is more fun than the book (7) The course has become better during the semester since you get a feeling of being able to do this and then you can ger points and buy exam-points (10) Doing exercises has become easier over time with the setup of the course that is different from usual (8)	**Positive aspects have emerged over time**
In the beginning, when people had around the same level, people talked a lot about which level they were at and competed with each other (1) During the lessons people talk about it through comparing progress with each other (2) People talked more in the beginning but less in the end about the gamification aspects (2) Talked about the gamification parts the most in the beginning and now in the end before the exam (1) People in the class do not talk about the gamification aspects outside class, believes it would help to have a friend-system (2) Talked about the gamification during the first week, but not that often anymore (3) Does not talk a lot about the gamification aspects but when it happens it is about the extra points for the exam and about the who has the highest level (4)	**The game aspects have been discussed but mostly in the beginning when it was new**

Talked more about the level in the beginning of the course and now before the exam (4) Talked more about the game in the class in the beginning when it was new, now it is more individual (5) Has talked with friends about buying points to the exam (6) Talked a lot about the gamification aspects in the beginning, but less over time (6) People in the class do not discuss the gamification part, instead you do the exercises individually and hope for the best (7) Discusses the digital exercises but not the gamification aspects in the class, more in the beginning of the course than in the end (8) In the class they discuss the level aspect, has done it as much during the semester (9) Mostly talked about the points in the beginning because it was something new, still talks about it but not as much (11) Talks about the level from time to time but does not discuss the gamification aspects usually during the lessons (10)	
People help each other during the class but mostly though giving out the right answer (3) Has not collaborated with others during the lessons (2) Has helped friends more in this course than previous math courses because compared to the other students you know more in this class compared to the previous school (1) Collaborates more with exercises now compared to before (9) People help each other more in this course especially during the exit ticket, mostly gives the right answer and sometimes explains the process (10) In the book people just help each other by explaining the process behind the answer (10) Cooperates more with friends now compared to in previous courses (11) Cooperates and help each other in the class, has not changes throughout the semester (12)	**People collaborate but more through giving the right answer than explaining the process**

Aggregated dimension: Improvement areas

1st Order Concept	*2nd Order theme*
There should be more information buttons to better understand how everything works (3) Easy to understand and start with the digital-add-ons, but still does not understand the point system (3) The concept of level is good but only if you understand the points system (3) Did not understand the point system in the beginning, but now that you understand it is good (1) In the beginning of the course it was difficult to understand what you were doing but when you understood what and why you were doing it, it was fun (10) It is unclear which option in the store is the best to buy, they all are worth the same, but they have different prices (10) Would like better explanations to what you are actually buying (10) In the beginning of the course it was a little difficult to orient on the platform and know what to do, but now it feels good and easier than before (11)	**Information about how the gamification works has been lacking**
Wants the store to have more options with different currencies and that the points you buy for the exam are in the same place (2) The store contains too few options (9) Has not bought anything in the store yet, instead focused more on doing the exercises (5) Would like an option in the store to make it easier to level up (10) Has not bought anything in the store but plans on doing it before the exam (11)	**The store needs to be made more interesting with more options**

The last points for the exam are a bit expensive (4) The level part of the gamification is good but the higher you get, the harder it us to level up, which is frustrating, the feeling of being stuck and not knowing how to reach the next level (10) The challenges should not be too easy because then it is not fun (10) The achievement of asking a question during the lesson is problematic because you do not know if the teacher will do it or not (3) The achievement of visiting the site five times in a row is too much, would be better if it was during less times to be more achievable (3) Positive perception about gamification to begin with, and beliefs it works but that it frustrating that you have to switch accounts (2) Positive towards the concept of gamification, feels that the school has "finally done this" but that it loses its affect when you do not have a leaderboard (2) Does not study on the computer at home because you have to switch accounts, would have used it more if you could be logged into two accounts at the same time (2)	**Other improvement areas suggested**

Aggregated dimension: Positive aspects with specific game elements

1st Order Concept	2nd Order theme
The store is good because it is not too easy to gain the points for the exam, beliefs that if you do everything you should get all the points but otherwise not (1) The store is fun because you can buy points for the upcoming exam (6) Likes the store because you can buy points to the exam if you need an extra point to pass the exam (8) Clicked on the pop-up the other day in reaching a new level and found the store, thought it was fun to the able to buy stuff and know your progress on the exercises (7) Grateful about being able to collect points for the exam (12)	**The store is perceived positive since it gives you the possibility to buy points for the exam**
To level up is the most fun aspect of the game (6) Level is good because you become more engaged when you want to reach the highest possible level (9) It is motivating to gain level and reach the others' level (12) Likes levels because it makes you want to study, since you gain something from it (11)	**The level in itself is seen as motivating**
The achievements are fun because you can focus on a goal at a time and try to achieve it (7) Achievements have been good and fits together with what you want to do in math (7) Likes the achievements because it becomes like goals (11) Likes the exit ticket since it offers an opportunity for repetition and check if you understood what was said during the lesson (5) The quizzes and the challenges have been the most fun (4)	**The achievements are liked**

8.2 Aggregated Dimension: Teacher Interviews

8.2.1 Teacher Interview session 1

Aggregated dimension: Need and technological readiness

1st Order Concept	2nd Order theme

Previously low performance in course (1) High rate of failing grades previous years (3) Math as the most common reason for not graduating at the school (2) Students do not study at home (1) Few students do homework on their free time (3) Important to encourage the students and strengthen their confidence (1) Students do not work until they understand the reason for why they need to (1)	**Low student performance and motivation**
Traditional way of structuring the course (1) No previous knowledge of gamification (1) Was not aware of gamification before (3) Tried to implement gamification but lacked technological competence (2)	**Previous traditional approach to education with low levels of technological implementation**
Change is good since it enables assessments and change in the current way of working (1) Work becomes boring without change; it is fun to try something new (3)	**The teachers saw change as good in itself**
The psychology behind gamification exists in high-school already (2) Believes the concepts of games can be applied in a school context (3) Understand the connection between gamification and education (1) Does not think the students understand the connection between gamification and education (1)	**The teachers understand the link between education and gamification**

Aggregated dimension: Potential effects of gamification on students

1st Order Concept	2nd Order theme
Gamification offers the potential of more learning opportunities (1) The more material available for the students, the better (3) The gamification platform provides more material and the potential to train (2) Gamification as an alternative to do something during the lesson when the book becomes too boring (3) Students who do not work during the lessons at least do something on the computer (3) Higher probability for students to study on the computer than the book at home (3) Sees gamification as a complement and not a substitute to traditional education (3) The effect of gamification is not negative since it is used as a complement to what is already there (2)	**Gamification offers alternative ways for students to learn**
Expects higher performance as a result of the gamification (1) The goal of the gamified implementation is that it will lead to higher performance and engagement (2) Gamification is a good idea since it can make some students get hooked and learn more (3) The goal of the gamified course is that it should lead to more independent students (2) Gamification in education is about more clearly understanding progress (3) One of the strengths with gamification is that you can see your own improvement (2) Having an avatar that advances can make it easier to understand your own progress (3) One main goals of gamification is for the students to talk and compare results with one another (2) The thought and purpose behind gamification is instant feedback (1) Gamification becomes a natural part of the course through using it as a tool of repetition (1)	**Preferable and expected outcomes of gamification**

Not everyone is using the gamification and digital option, but it is a positive complement for those who do (2) Students started comparing the gamification results with one another (2) Already heard positive feedback from some students (3)	**Initial positive response in the classroom**
Ambitious students are more prone to do the gamification exercises (1) The students who are away a lot risk becoming less engaged and not use the platform (2) The students with higher basic knowledge are more prone to use the gamified platform (2) The students with higher computer experience are more prone to use the gamification platform (2) The gamification can potentially affect students differently depending on how much they like computers (3) Gamification has the potential of being effective for those who are driven by progress, competition and for those who feel competent (1)	**Individual differences for students**

Aggregated dimension: Barriers and solutions for gamification in the classroom

1st Order Concept	2nd Order theme
The implementation requires extra pre-work for the teachers (1) The implementation required more time in the planning of the course (2) Need for a higher preparation and understanding of how the gamification platform works (3) It is important to make more time for planning in the implementation phase (2) In the initial implementation there where some technical difficulties that needed to be solved (2) Problematic with implementing gamification due to low initial knowledge of how it works (3) Should be able to see how the platform will look and work before it is implemented (3) Gradually understood what gamification was during the implementation (3) If the gamified solution does not work properly from the beginning the whole implementation risks failing (2)	**The preparation phase and introduction should be considered in implementing gamification**
Low technical support during the lesson if something is not working (3) Not understanding how the technology works leads to job stress (3) Difficult to pursue technological add-ons if the class is difficult (1)	**Barriers to working with technology**
Students are good at finding potential bugs in the system (2) The students can assist in how to make the platform work because of their adaptability (3)	**Students as a resource to help with technical implementations in the classroom**

Aggregated dimension: Important aspects of gamification implementations

1st Order Concept	2nd Order theme
The gamified solution should enable teachers to make changes in the design of the game and more easily create missions (2) Should be able for the teachers to see and collect student responses (3) The gamified solution should offer the possibility to check the students' progress and check hand ins (2) Only working on the computer leads to teachers not knowing what the students are actually doing (3)	**The teacher should have autonomy and control**

Initiated through making sure the technology was working and showing the students of how to check their results (1) Introduced through giving overview of the platform, how it works, what the purpose is and that it is voluntary (2) Gamification as something voluntary that the students can try and see if they like it (3) Need for the teachers to remind the students of checking the results (1)	**Importance of explaining the platform, its purpose and its voluntary aspect**
The gamified solution should contain the context of the game better and include a path to the overall goal of the game (2) The gamified solution should show a clearer indication of progress (2) The students cannot clearly see the connection between what they are doing and its results (technological separation between exercises and progress bar) (1) The effort and progress need to have a clear connection (1) The store should contain more options (2)	**The platform should include purpose, a clear link between progress and reward and several reward options**

8.2.2 Teacher Interview session 2

Aggregated dimension: Impression of the implementation

1st Order Concept	2nd Order theme
Gamification works as you expect (1) Is as positive toward gamification as in the beginning of the course (1) The teachers have been positive to the change (2) Gamification is perceived as something exciting (3) Gamification gives more than it takes (2) Gamification is not seen as having any negative consequences since it has been a complement (2) Believes that the digitalization has been good (3) Working with google class room was appreciated (2)	**Positive toward the implementation**
Gamification did not change a lot (3) Gamification did not produce as many advantages as expected (2) Is not sure about if gamification work (2) Gamification was not seen as interesting by the students as expected (2) Does not think a lot of student where interested in the gamification aspect (3) The students have not discussed the gamification parts as much as expected (2) Understands the point of gamification but does not believe the students are motivated by leveling up (2)	**Doubt about gamifications effectiveness**
Difficult to measure the reason for improvements (2) Difficult to see if improvements have been made with change (1) Comparison with previous years is difficult since class groups differ significantly (1)	**Difficult to measure**

Aggregated dimension: Implementation improvements

1st Order Concept	2nd Order theme
Expected gamification to be a math game (2) Initially did not understand what gamification was about (2) Did not understand what gamification was to begin with (2) The teachers should have had more information about how to work with gamification and the value of it (3) Wants a walkthrough of the different gamification parts with clear examples in future implementations (1) Could present an example of gamification in the beginning to make it clearer (2) Need to understand gamification before it is introduced to the students (2) The teacher needs to understand gamification to explain it to the students (2) The students need to understand that gamification is there to assist them. (3) The technology should be designed for the students to understand the value (3) It is important for the students to understand the value and enjoyment of gamification (3) Should have presented and showed the gamification to the student in the beginning (2)	**Need for understanding and clarification**
Should have taken the students more into account in the beginning of the implementation (3) For gamification to work the introduction of gamification and a positive initiation is important (3) Could make gamification to a more continuous part of the course (1) The implementation should have started in the beginning of the semester to create higher continuity (3) Wants more interactive class exercises in the future (1) Can do more planned and tested interactive lessons in the future (1)	**Need for better integration in class**
Gamification could have been made better through making it more visibly clear (2) The exercises and results (gamification) should be more integrated (3) The students did not see the connection between effort and progression (3) Real rewards and better lessons could provide higher motivation for the students (1) Wants physical rewards related to construction (1)	**Gamification Improvements**

Aggregated dimension: Perceived student consequences

1st Order Concept	2nd Order theme
The students were comfortable with the set-up of the course (1) The students accept and get used to gamification fast (1) Most student liked the change, those who have not had the option to ignore it (2) The students appreciated working with the computers (2)	**Positive attitude from the students**
Statistically the result of the exam felt better than previous years (1) Performance was better this year (2) Believes gamification helped the situation at the school (2)	**Increased performance**
Gamification creates extrinsic motivation (1) Gamification and digitalization make students persist for longer (2) The student where more prone to do math on the computer (1) Gamification and digitalization make it easier to make someone study who is not motivated to study (2) The students become motivated when they realize the consequences of their actions (3)	**Higher student motivation**

Gamification makes students study more and take more responsibility (1) Despite not always doing it (gamification) the students got the opportunity to check their progress (3) Gamification enables the students to keep track of what they missed (2) Gamification gives the students the opportunity to visualize what they need to do to pass the course (1) Gamification is good if it makes the student study more (2) Gamification can in the long run, with the mission module and linear progression, lead to higher clarification about expectations (1) The students did not do gamification because they do what they are told (3) The student did the exit tickets because they were told to (3)	**Students self-organization and responsibility**
Gamification can make studying more easily accessible (2) The students have had more material and opportunities to learn with the digital add on in the course (2) The students got a bigger opportunity to study and repeat at home (3) The students have had the opportunity to work more (2) Gamification and digitalization make studying more easily accessible (2) Digitalization makes the content more accessible for the students (3) The students have realized that digital tools can aid them in their studies (1)	**Accessibility and variation**

Aggregated dimension: Teacher consequences and needs

1st Order Concept	2nd Order theme
The implementation made the teachers work more coherent and collaborative (1) The teachers became more integrated in their work (3) The implementation meant a higher initial work load in the beginning (3) Higher stress from doing all exercises and mistakes that arose (2) The implementation led to a higher workload (2) Wanted more time to produce better material (1) The workload is higher in the beginning but lessens on a longer time period (2) In the long run it can lead to less work (3) Potential planning issues could arise if the teachers did not do their parts (1)	**Collaboration and workload consequences**
Change leads to thinking about new ways to work (3) Gamification provided a new way to think and work (3) With the implementation the teacher got a new way to think about the set-up of the course (3)	**Innovation in work**
It was valuable to have a driven person (teacher) that had a high technological competence (3) More teachers with digital competence make the implementation easier (1) Wanted stronger support with the work load (1) Wants more support in planning for future implementations (1) Wants advise from the system during the planning and implementation phase based on research (1) Wants internal technical support or a system that is intuitive enough not to require support (1) In the implementation more time was needed for planning of gamification elements and material (1) Good communication channels with the technical team (1)	**Need for technological competence and support**

Summary

Innovation in the field of information technologies (IT) can occur on many levels; in the development of the technology itself but also in the combination with other fields. One such example is gamification, the use of game elements in a non-game context (Deterding et al., 2011). Gamification can be seen as a tool to motivate users to certain goals. Compared to related concepts, gamification includes parts of a game instead of the entire game and is involved with a goal driven gaming approach as opposed to a playful approach (Deterding et al., 2011). The playing field in gamification does not lie in the system but transcends into the real world, using technology or other means to symbolize and reward desired behavior. Real world examples of gamification include awarding badges in the military and loyalty programs such as frequent flyer points and status differentiating colors on cards (Zichermann & Cunningham, 2011).

The research field of gamification is a rising trend with the most common research application being education (Hamari et al., 2014; Kasurinen & Knutas, 2018; Bozkurt & Durak, 2018; Dichev & Dicheva, 2017). Despite the emerging trend and successful applications of gamification, reviews on the effects of gamification show varied results, with different studies indicating mostly positive and mixed, but also negative effects (Hamari et al., 2014; Koivisto & Hamari, 2019). The outcomes from the literature thus suggest that gamification does not always have a positive effect but has the potential to lead to positive outcomes when designed right.

In education, previous research has mostly focused on higher education (Limantara et al., 2019; Subhash & Cudney, 2018) or online learning environments (Antonaci et al., 2019). To a lesser extent, gamification has been applied to secondary education. Since gamification is dependent on the context and the psychology of the user (Hamari et al. 2014), the results from a higher education environment and online learning environment cannot be transferred to a secondary setting but need to be studied independently. Outcomes from the previous studies in secondary education highlight the importance of user-centered design, and the need to understand secondary education students' perspective and motivation toward gamification. In light of this, the present work intends to explore an implementation in which gamification was applied to a blended learning approach in a mathematics course in a practically oriented secondary school in Sweden. Blended learning is an approach in which face-to-face instruction is combined with

computer-mediated instruction (Graham, 2006) and focuses on the individuality of the learner through providing several forms of learning tools (Singh, 2003).

The present work intends to gain an in-depth understanding of how the gamification implementation is experienced by students and teachers and what they consider as important aspects to take into consideration when implementing gamification in the classroom. This contributes to the gamification field since there has not, to the authors knowledge, been done any in-depth qualitative studies in secondary education exploring student and teacher experiences. To gain a broad and unbiased view of the students' and teachers' experiences the present work takes an exploratory approach to answer the following research question:

RQ: How do secondary school students and teachers experience a gamified implementation of a mathematics course?

The research question is answered based on qualitative semi-structured interview data complemented by student surveys. Due to the qualitative approach, the aim is not to gain generalizable outcomes but instead generate hypothesizes that can later be tested in more controlled environments. To gain a deeper understanding of gamification and its potential outcomes, the field of gamification, gamification design, motivational psychology and innovation are explored before being connected to the results based on the research question.

In the theory section, gamification design, motivational psychology, technology adoption and acceptance are discussed. Gamification design derives from game design were a commonly used framework is the MDA framework (Mechanics, Dynamics and Aesthetics). The MDA framework offers an iterative process of game design and development, where games are seen as dynamic systems that build behavior via interaction (Hunicke et al., 2004). Mechanics symbolize the components of the game (comparable to game elements in gamification), Dynamics is the interaction between the game and the user, and the Aesthetics is the user's emotions. By observing and adjusting the mechanics it is possible for the game designer to change the behavior of the player that result in certain Dynamics and Aesthetics (Hunicke et al., 2004). Despite gamification concerning parts of and not entire games (Deterding et al., 2011), it is important to consider how the game elements affect the dynamics, or interactions, between the user and the system, and the aesthetics, or emotions, it provokes.

In a review, Deterding (2015) explores methods related to gamification design, identifying six main requirements for creating a gameful design, including instrumental and experiential outcomes. The first involves designing from need satisfaction based on self-determination theory, that is creating experiences that provide competence, autonomy and relatedness (this will be discussed in further detail in the motivational psychology section). The second involves designing around skill-based challenges that are already involved in the user activity, without adding excess complexity. The third involves designing from the emergence of enjoyment, motivation and challenge in a systematic way that considers gamification as one system. The fourth involves identifying the goals, needs and challenges that the user phases in the activity. The fifth involves including the incorporation of the users' goals, needs and challenges into the ideation and evaluation of gamification design ideas. Finally, the sixth requirement of a gameful design involves operationalizing the knowledge into the design.

Among the many theories that focus on motivation, the theories presented here are some of the most common ones in the gamification literature. One of the most cited theories to date of human motivation is Self Determination Theory, identifying the three basic needs autonomy, competence and relatedness, that provide motivation and personal growth (Deci & Ryan, 2000). However, it is not only the amount but also the orientation of motivation that matters, i.e. if the motivation derives from the activity itself (intrinsic motivation) or if the motivation derives from the activity's instrumental value (extrinsic motivation) (Ryan & Deci, 2000). Extrinsic motivation has been found to undermine intrinsic motivation, decreasing the enjoyment of the activity, depending on the extent to which the extrinsic motivation is seen as controlling the behavior (Deci et al., 1999). Intermediating effects to if extrinsic motivation override intrinsic motivation includes if the context is seen as controlling or non-controlling, if cues and feedback are provided with signals of competence instead of directive instructions (Deci et al., 1999). Deterding (2015) argues that the motivation behind why games are so popular can be described by Self Determination Theory (Deci & Ryan, 2000). This since progressing through a game with relevant feedback mechanisms in place gives the user a sense of competence, while the voluntariness of using the game and exploration offers autonomy, and the option to interact with other users offer relatedness (Deterding, 2015).

Gamification can be seen as an innovation in the field of IT. Creativity involves individuals or groups who create novel and useful products or services as defined by the social context in which they take place (Plucker et al., 2004). However, for a product or service to be seen as an

innovation, the novel and useful aspect is not sufficient. The aspect missing is the reduction of practice, i.e. the commercialization of what has been created (Freeman & Soete, 1997). For an innovation to spread and commercialize, research and theory have since long seen that other factors than usefulness and novelty are at play. One other factor studied is the adoption of the technology itself and the technology acceptance of the user. Related to gamification, this is of importance since it can offer an understanding to if a user will interact with the system to begin with or not. Moore & Benbasat (1991) extended the original diffusion of innovation theory to the adoption of IT innovation and found eight constructs related to the perception of using an IT innovation. These constructs include:

- Relative advantage; perceived as better than predecessor
- Compatibility; perceived as consistent with values, needs and past experiences
- Ease of use; perceived as difficult to use
- Result demonstrability: perceived outcome, seen as observability and communicability
- Image: perceived as enhancing social status
- Visibility: perceived use of others using the system in the organization
- Trialability: degree of experimentation before adoption
- Voluntariness: use perceived as being voluntary (Moore & Benbasat, 1991).

The Technology Acceptance model (TAM) is another approach to why users accept or reject information systems. First developed by Davis (1989), TAM proposes that perceived usefulness and perceived ease of use is a function of the system design features, which affect the attitude toward using the system and actual system use. Perceived usefulness is the degree to which the job performance of the user is believed to be enhanced due to the system and perceived ease of use is the degree the system is being seen as free from physical and mental effort for the user (Davis, 1989). Davis (1989) proposed that ease of use has a direct positive relationship to the usefulness of the system but not vice versa.

In sum, the theories presented highlight the importance of a user-centered and interdisciplinary approach to gamification design. There is a need to create a design that provokes instrumental and experiential outcomes for the user by combining game elements in a way that produces psychological outcomes which in turn leads to the intended behavioral outcomes. To do so, it is important to trigger motivational aspects and state whether the intention is to provide the user with extrinsic or intrinsic motivation and to clarify the strategy needed in which to reach this

goal. These aspects are fundamental to take into consideration when understanding student and teacher experiences of gamification in the classroom and offer understanding of how gamification can be designed in a more effective way. Furthermore, adoption criteria and technology acceptance should be considered. Adoption criteria for IT involves relative advantage, compatibility, ease of use, result demonstrability, image, triability, and voluntariness (Moore & Benbasat, 1991), and technology acceptance involves perceived usefulness, perceived ease of use and attitude toward use (Davis, 1989). These aspects are important to consider since they have been found to affect users' system use.

The methods used in an exploratory case study with a longitudinal mix-methods approach. A lack of control and the implementation's embeddedness within the context in this study created relevant conditions for applying such an approach. In this case, the phenomenon is how the students and teachers experience the course. Compared to an evaluation cases study, which involves testing hypothesizes through a case study design (Yin, 1992), this study concerns theory building; through defining a broad research question and exploration from multiple datapoints before connecting the results to previous theory and research (Eisenhardt, 1989). The mixed method, combining qualitative and quantitative data, provides the opportunity to verify findings through exploration and confirmation simultaneously (Pole, 2007), and is therefore a relevant methodology in the present study. Here, the main study objective was a qualitative approach through semi-structured interviews combined with complementary surveys used for descriptive statistics and confirmation of findings.

Semi-structured interviews were performed with twelve of the students (14% of the total number of students) over three periods during the semester and with all of the teachers (n=3) during two periods over the semester. The sample of students was chosen in advance to be around 10%. This was to get a representative view of the student but at the same time not spend more time than necessary on data collection and analysis from too repetitive data. The students were chosen by the teachers who had an understanding of which students where more talkative and could provide more detailed answers. The sampling method can thus be seen as a judgement sample, i.e. chosen by the researcher to be the most productive sample to answer the research question (Marshall, 1996). Two student surveys were included to get a broader and more descriptive view of how gamification was used and perceived in the classroom.

The research design empathizes a qualitative approach through exploring students and teachers' experiences. Therefore, statistical representativeness was not the main objective (Mays & Pope, 1995). This due to the fact that samples (as in this case) are often small, the characteristics of the population is often not known and because values, beliefs and attitudes (as studied here through experiences) are often not normally distributed within the population (Marshall, 1996). Furthermore, the case study design inquires to expand theory as opposed to reaching generalizable conclusions (Yin, 2018). Therefore, the results presented in the present work should not be seen from a generalizability point of view but instead through explaining the experiences of the students and teachers in the specific context of the school. The findings could also guide further research in gamification with a more quantitative approach were generalizability is the main objective of analysis.

The methodology can instead be evaluated from reliability through the documentation of the process of analysis, and validity through triangulation and gaining participants view of the representativeness of their experience (Mays & Pope, 1995). The methodology in the present work is reliable due to a detailed explanation of the process. To increase reliability, more than one researcher could have done the coding to compare the results of the process. The validity is higher due to including both students and teachers' perspective but could have been higher if the participants had been asked to evaluate the representativeness of their experiences, which was not the case here. Finally, there are some limitations in the sampling technique chosen. The participants were chosen through judgement sampling. This can be seen as relevant since the participants were used as informants to enable the exploration (Mays & Pope, 1995) of the students and teachers experiences However, thorough the teachers choosing the student participants bias could arise through the teachers' desirability to choose students who were more positive toward the implementation.

The results produced several codes, themes and dimensions related to gamification benefits and design considerations; extrinsic and intrinsic motivation; and technology acceptance and adoption. During all the interview-sessions, the students mentioned several positive psychological and behavioral outcomes. The students mentioned collecting points for the exam as the aspect they liked the most. Other aspects included being provided repetition, feedback and context, competition and collaboration, higher effort, focus and learning, and mathematics considered being more fun in itself. Similar aspects could be seen in the survey data were the students agreed on average that the set-up of the course had helped them to develop in their

school work, succeed in their studies and get good grades, learn more, as well as making them more active and motivated. From the teacher's perspective, the effect on the students was related to a positive attitude, higher performance, higher motivation, more self-leadership and responsibility as well as access and variation.

Improvement areas were mentioned in the student interviews including the need to clarify how gamification works, making achievements more interesting, and including more options in the store and friend systems or leaderboards, making it clear when a new level is reached and to provide a higher challenge level. Furthermore, the students saw the benefit of including more options in the store than those related to increasing the grades. Reward in itself, that goes beyond its instrumental value, might thus be valuable for the students. Another related aspect that was problematic was that the students collaborated was accomplished by the students giving each other the right answer instead of explaining the learning process. This may be mitigated by developing a larger set of exercises so that the students can be provided with individual exercises, which answers could not be copied to other students.

The teachers also mentioned improvements to implementing gamification in the classroom from their perspective. This included providing the teachers with higher autonomy and control through being able to design lessons and check student progress. The loss of control to what the students were doing when they worked on the computer compared to the book was mentioned. Furthermore, the teachers wanted to make gamification a more integrated part of the course; including gamification from the start of the semester. Specific improvements toward gamification were also suggested by the teachers such as expressing the purpose of gamification to the teachers in the beginning of the implementation, visualizing the link between effort and progress better for the students and including rewards that were desirable for the students. Therefore, giving teachers autonomy and control when working with gamification and other digital implementation should be considered in research and practice. The extent in which explicit explanation of purpose behind gamification is needed should also be considered in a design perspective.

The teachers saw gamification as being related to enhanced student motivation. However, in the present work the teachers experienced the students' motivation as being related to extrinsic rewards and to the blended learning environment. From the first survey the students did not agree as much with the statement that mathematics had become more engaging. The same was

prevalent in the second survey where the students on average disagreed that the set-up had led to more interest in mathematics. These results highlight that the implementation led to more extrinsic than intrinsic motivation, i.e. the students were motivated to work more because of being provided extrinsic reward than from mathematics becoming more interesting in itself. Increasing extrinsic motivation more than intrinsic motivation can be problematic since extrinsic motivation can undermine intrinsic motivation (Deci et al., 1999). Deci et al. (1999) found that positive feedback mechanisms can enhance free choice behavior and self-reported interest whereas reward instead can decrease interest (Deci et al. 1999).

An interesting aspect was the students reporting that it was important for them to pass, learn and get good grades in the course. This indicated that it is not necessarily about the students not being interested in passing, learning, and performing in a course, but that instead they might not have been provided with the right tools to do so. The blended learning environment was appreciated by the students and there was a need for the newness and variation that the implementation provided. Therefore, the blended learning can be seen as having a higher relative advantage compared to the previous more traditional education. This was also seen in the survey data where the students agreed on average to the statement that the computer was a good complement. The implementation had also required some time to understand and the positive aspects had emerged over time. Gamification was also discussed more in the beginning when it was new, indicating that a novelty effect, i.e. the user experiencing a higher but declining excitement to new features introduced (Koivisto & Hamari, 2018), might be at play.

The teachers experienced a need and openness toward the change and saw potential in gamification. After the implementation, gamification was seen as positive, but there was some doubt of its effect and uncertainty due to the difficulty in measuring outcome. The need and openness toward gamification and the positive view of gamification in the classroom can indicate that secondary school teachers are open toward a more digital environment and gamification. This is in line with previous work that has been done with secondary teachers and their view of gamification (Bahauddin & Setyaningrum, 2019; Baldauf et al., 2017; Saleh & Sulaiman, 2019). Compared to what these studies have shown, the results here indicate that there is doubt about the effectiveness of gamification especially due to the difficulties in measuring results. This might depend on the fact that the teachers could not see what the students had done on the platform and thus could not see if gamification had been of interest for the students. From an adoption standpoint this may be crucial for the adoption of

gamification. To enable less doubt about effects and gain more control the teachers should be provided with statistics of use and be able to check student progress.

The present study supports previous research in the positive attitude toward gamification. Similar to other studies it was also found that both experiential and instrumental outcomes are of importance to include in gamification design, that cheating should be prevented, the need for curriculum fit, that gamification might be connected to a novelty effect, and that resources, time and effort are required in implementing gamification in the classroom. To adapt the challenge level, include autonomy and relatedness, and balance extrinsic and intrinsic motivation was also mentioned, which support motivational theories related to gamification. The new findings presented here should be viewed as hypothesizes to be tested in more controlled settings. First, potential positive outcomes related to gamification in secondary education include extrinsic motivation, repetition, feedback and context, competition and collaboration, higher effort, focus and learning, and intrinsic motivation. Second, there might be a difference in perceived outcomes for students and teachers with teachers highlighting self-leadership more. There is also a need to study the consequences of providing students with higher self-leadership. Third, autonomy and control in working with gamification, and collaboration aspects are important to consider from teachers' perspective. As a final note, preconceived notions about students being unmotivated and teachers not being adept to technological change should be questioned and studied further. The present work shows that the students wanted to perform and learn and that the teachers were positive toward working with technological innovation, but that they needed the right resources to do so.

From the present study several recommendations about implementing gamification in secondary education can be offered. Firstly, in the design phase, gamification should be designed in a way so that the purpose and the link between effort and progress is made clear and include several rewards that are seen as desirable for the students. The experience for the students should both be experiential as well as instrumental, that is, gamification should provide an enjoyable gameful experience as well as provide practical use. In the design phase it should also be clear if gamification is supposed to elicit extrinsic or intrinsic motivation and how much autonomy the students should be provided with. Secondly, in the introduction of gamification, a visual representation of gamification should be provided to the teachers and its benefits should be made clear. In addition, how to introduce gamification to the student and continue working with it in the classroom should be thoroughly explained. The teachers and students should be

provided with sufficient resources and support and it should be easy to understand and work with gamification initially. Thirdly, in the implementation phase, the teachers and students should be provided with support and the possibility to check progress in a clear way to notice the results of working with gamification.