Does gamification engage students while learning JavaScript?

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Abstract

Gamification has become a staple concept in designing various systems, but its effects are not entirely agreed on. Gamification in online learning platforms has become increasingly common in the 2020s, but there is still the danger of not using proper gamification frameworks in system design phase and leaving gamification as an afterthought. In such cases gamification may not function as intended and could have unintended consequences on the learning behavior of students.

To promote gamification that makes students feel engaged, motivated and entertained, this thesis presents popular frameworks for designing gamification and inspects how individual elements of gamification affect the behavior of students with the help of the theory of gamified learning. To inspect how gamification affects the behavior of students in practice, a user test and an interview was organized using a gamified prototype platform for learning JavaScript that was developed for this thesis. The platform was developed using the 6D model and MDE framework and included a programming workspace where code was formed using connectable blocks.

The results showed that the levels were clearly the most engaging element to the testers, and the points were the most fun element to the testers. Notably, the levels element was the most immersive element that provided the user with an environment and control over it, which may have made it the most engaging element. All elements aside from points were clearly motivating to the testers.

The thesis could not find clear evidence for gamification increasing engagement, or fun, but clear evidence was found for gamification increasing motivation in the prototype platform. Some differences in preference were also found between first-year and older students, which suggests different levels of gamification could be utilized in different years of study. Most of the first-year students enjoyed programming using blocks, while older students found it less enjoyable.

Key words: Gamification, online learning, JavaScript, engagement, motivation, Theory of gamified learning, MDE framework, 6D.

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1 Introduction

Over the years, gamification has become a staple concept in UI, web and information system design. It is a design choice where game-like elements that are usually present in games are repurposed for utilitarian purposes such as learning (Koivosto & Hamari 2019). Despite being a popular topic of research, what constitutes as gamification and what are its effects are not completely agreed on because there are many areas of application and variations of gamification. This makes gamification an interesting area of research as there is a vast amount of knowledge surrounding this topic that could be adapted into more practical knowledge.

Gamification has been applied in learning contexts before such as in teaching programming, but the use of it has often been haphazard without enough attention being paid to proper gamification design for it to work in changing student behavior (Toda et al. 2018). Online learning has also become common enough in the 2020s that many students regardless of age have some experience with gamified learning. This means that there is a problem with how gamification is sometimes handled as an afterthought when designing learning systems. Another problem is that the effects it has are not fully known beforehand. As a solution, I inspect gamification through the lens of multiple psychological theories that are relevant to studying and present proper frameworks for designing gamification. With proper design, gamification can function better in its designed purpose when arbitrary use of gamification is avoided.

In this thesis, I investigate how purposeful gamification can be designed and how the elements of gamification affect the behavior of students in a computer science (CS) learning environment. Specifically, I chose to inspect the engagement, motivation and fun that gamification awakens in students. These are all outcomes of gamification in a learning setting that can be beneficial to the student in terms of making learning more engaging and thus indirectly leading to better learning outcomes.

The purpose of this study is to inspect how the power of gamification could be harnessed in CS learning using proper design. The best way to highlight this is to start from the beginning when students are still learning the basics of a programming language. The focus of engagement in gamified CS learning was chosen because gamification has become so common in online studies and because CS is the author's main subject of study. To inspect and highlight how gamification can affect the behavior of students, I developed a prototype of

an online gamified JavaScript learning platform for this thesis and held a user test and an interview that assessed the effects gamification had on students.

1.1 Research questions

There are two research questions that I attempt to answer in this thesis. These questions focus on engagement, entertainment and motivation in gamification. The research questions are:

RQ1: *Does gamification help students feel more engaged or entertained with a learning platform intended for teaching programming?*

The first research question focuses on how gamification can alter student behavior in learning and if it can keep students more focused and invested on learning tasks. This question does not try to answer if gamification ultimately improves learning results, but instead if it helps students better retain their attention and interest in learning.

Entertainment is another aspect that gamification can help provide in an otherwise serious learning environment because gamification borrows elements from games that are often made for entertainment purposes. Feeling entertained could also lead to more engagement from the students so it is worth researching.

RQ2: *Which ones of the common elements of gamification help students stay motivated?*

The second research question focuses on individual elements of gamification and how they affect students' behavior and motivation to learn. There are common elements of gamification that are often used in learning contexts. By choosing some of the most common ones, it is possible to inspect if gamification is helpful in learning as a motivator for learning new things.

1.2 Research methods

The research methods of this thesis include a literature review of the literature around gamification and its frameworks, a literature review around relevant psychological theories and a user test of the gamified learning platform that was developed for this thesis. I inspect the literature and history around gamification to define what gamification is, how it can be used in education, to present gamification frameworks for designing gamification and to present some of the most common elements of gamification that are relevant to this thesis. Then I inspect the literature around psychological theories related to gamified learning, such

as the theory of gamified learning, to assess how elements of gamification affect user behavior, and other relevant psychological theories, such as self-determination, presence, flow and goal-setting theory to provide tools for analysis of the test results. Finally, I developed a platform for user testing gamification in a university CS learning setting to highlight how to build gamification using proper frameworks and to test in practice the effects of gamification on students' engagement, motivation and fun.

1.3 Thesis roadmap

After the introduction chapter, I go over the background of the thesis in two chapters. The second chapter centers around gamification background and the third chapter centers around the psychological theories that are relevant to gamification in learning. The second chapter introduces what gamification is, how it can be used in learning and some of the frameworks and components that can be used to design gamification. The third chapter instead focuses on psychological theories such as the theory of gamified learning, self-determination theory, presence theory, goal-setting theory and flow theory.

In the fourth chapter, I explain the setting and design for the user test. This chapter explains the test structure, how the participants were recruited, introduces the hypotheses for the test and discusses possible biases in the test results. The fifth chapter is dedicated to introducing the test platform along its components of gamification and the design frameworks that were used.

In the sixth chapter I go over the test results and answer the research questions. I also compare the participants' reaction to each of the gamified elements to the hypothesis presented in the fourth chapter. After the results have been presented, I will discuss their significance in the seventh chapter by comparing them to relevant previous research results and inspect them in the light of the theories presented in the third chapter. The eighth chapter will conclude the thesis and summarize the relevant findings and information presented in this thesis. After the thesis has been concluded, the references and appendices with further information about the test procedures can be found at the end.

2 Gamification background

In this chapter, I inspect what gamification is, explain how it can be used in the context of learning, explore frameworks that help implement gamification in a purposeful way and take a closer look at some of the most common elements that are used in most gamified systems. The purpose of this thesis is to inspect gamification in a software engineering learning context so special focus is put on how gamification can be used in learning. There are several frameworks for designing gamification, but I will focus on the 6D and MDE frameworks that are used in the research part of this thesis.

2.1 Introduction to gamification

The concept of gamification has existed since the early 2000s (Werbach & Hunter 2012), but it was not until the beginning of 2010s that gamification started gathering more attention in research communities (Deterding et al. 2011; Koivisto & Hamari 2019). The term gamification was first used in a digital application context around 2010 (Koivisto & Hamari 2019). The most widespread definition of gamification is by Deterding et al. (2011) where it refers to the use of game design elements in non-game contexts (Werbach & Hunter 2012).

Gamification is a versatile design practice that is not strictly defined. It can be used in many different contexts with different arrangements of game elements and for many different purposes (Koivisto & Hamari 2019). With gamification, it is possible to use the motivational and engaging power of games in non-game applications to promote behavioral changes in users by implanting fun and "gamefulness" into the design. This way, entertainment-oriented technologies can be appropriated for productive use in information systems (Koivosto & Hamari 2019). The game-like experiences provided by gamification refer, for example, to feeling of enjoyment, flow, autonomy, accomplishment or mastery of a task. These experiences can help motivate the user to engage more with a system without the need for external motivators. This can also be used in helping users use a product the intended way or in helping create habits that are beneficial to the user (Koivisto & Hamari 2019). The usefulness of gamification can be determined by how well it succeeds in changing the user's behavior in a desired and beneficial way.

The reason gamification is so effective in altering user behavior is because it taps directly into motivational drivers by encouraging repetition of behaviors through reinforcements and by creating emotional responses to the gamified elements (Robson et al. 2015). In the end,

gamification creates habits for the user that make desired behavior an automatic response. The reinforcements can be extrinsic or intrinsic rewards, or simply the enjoyment found from using the application.

Gamification has been used in various application areas over the years, for example, in crowdsourcing (Eickhoff et al. 2012), commerce (Hamari 2017), health (Jones et al. 2014), work life (Warmelink et al. 2018), sustainability (Gustafsson et al. 2010), exercise (Hamari & Koivisto 2015) and education (Landers & Landers 2014). Most of the empirical gamification research has been conducted in the domains of education and learning, health and exercise as well as crowdfunding (Koivisto & Hamari 2019). In practice, the use of gamification centers around the use of game elements to help with user qualities such as motivation, performance and engagement with the system (Sailer et al. 2017).

Gamification has also been considered merely a fad in the past and occasionally, even a buzzword (Guy Boulet 2012). However, it has remained a topic of interest in research communities for over a decade since it was popularized and a part of service design in helping users create behavioral changes (Zichermann & Cunningham 2011). One of the reasons for skepticism has been the lack of empirical evidence of how gamification supports intrinsic motivation and engagement, so the practical effects of gamification have remained uncertain (Luarn et al. 2023). At times, gamification has even been claimed to have a negative impact, for example, on education because it was claimed that students were participating in gamified classes mainly out of curiosity (Berkling & Thomas 2013). There have also been claims of gamification turning intrinsic learning motivation into extrinsic that relies on scoring and rankings provided by the game elements (Hanus & Fox 2015).

2.1.1 Defining gamification

Zichermann and Cunningham (2011) have defined gamification as “the process of game-thinking and game mechanics to engage users and solve problems”. Another popular definition of gamification is simply the use of game elements in non-game contexts (Deterding et al. 2011). Game elements can refer to the building blocks of games that are characteristically found in games but can also be used in the design of other contexts. These elements provide “gameful” affordances that can enhance a service by motivating and supporting the user in the intended use of the service. It is important to pay attention to the selection and implementation of game elements to truly make a system more game-like (Werbach 2014).

The specifics of the definition can also differ depending on the application area where gamification is used, for example, in service design or web design. Gamification is not limited to digital applications, so gamification can be found in the design of real-world applications as well (Werbach & Hunter 2012).

Gamification specifically refers to the use of game elements and affordances intended for affecting user behavior rather than the use of a fully-fledged game for a non-entertainment purpose (Deterding et al. 2011; Robson et al. 2015). Games created for non-entertainment purposes are instead called serious games. Serious games are often mistaken for gamified applications because they can both use the same game elements for similar purposes. Serious games are also called learning games because their goal is to educate users instead of only being used for entertainment purposes like regular games (Landers 2015).

The biggest difference between serious games and gamification is that serious games are created for learning purposes while gamification is used only to influence the behavior of a user, and the behavioral change does not have to be defined beforehand (Landers 2015). Gamification also has an advantage of being more cost efficient to develop and more convenient to use over serious games if it is done correctly (Landers et al. 2017).

Gamification is also different from playful design or the experience of playing because playfulness is a broader category that contains many applications other than games (Deterding et al. 2011). For example, toys are objects made for playful purposes that can include simple elements such as narratives, characters, themes or metaphors in their design to achieve playfulness (Christopoulos & Mystakidis 2023).

However, gamification is not only about adding arbitrary game elements such as badges or experience points to a service or a product without greater thought put into it (Zichermann & Cunningham 2011). Certain types of game elements like leaderboards can even be off-putting to new users if they force the user into doing something or make them feel bad about their own performance (Werbach & Hunter 2012). Gamification is neither a solution for fixing faulty business design or a fix that makes an application immediately more engaging without greater thought being put into it. At its core, gamification requires game design to be successful, but at the same time the users are not using the service looking to get fully immersed in a game (Werbach & Hunter 2012).

Gamification has also been defined from the perspective of service marketing as a process of enhancing a service with affordances for "gameful" experiences to support users (Huotari & Hamari 2017). The service marketing perspective does not require the use of any specific game elements for gamification to be present because a clear set of game elements that makes gamification does not exist. Because of this, only the affordances that gamification elements provide are needed for gamification to take place. This means that gamification does not require specific game elements to be considered gamification but there still exists common elements that are used in most gamified services.

2.1.2 Gamification conceptualized

Gamification can be conceptualized as a process of enhancing services with motivational affordances to invoke "gameful" experiences that lead to psychological outcomes. These experiences then lead to behavioral outcomes that change how the user behaves (Hamari et al. 2014). The three parts of this conceptualization are motivational affordances, psychological outcomes and behavioral outcomes, which are all situated inside of a context that determines what type of behavior is desired and what game affordances are used (see Figure 1). The affordances are game elements and mechanics that are used in the services to create a gamified experience. For example, an affordance can be points. Psychological outcomes refer to psychological experiences that gamification commonly invokes in the user. These experiences include, for instance, engagement, enjoyment, competence, autonomy or relatedness (Koivisto & Hamari 2019). Behavioral outcomes instead refer to more concrete behavior and actions that the gamification supports. The behavioral outcomes could be, for example, increased time spent engaging in something beneficial, such as learning or physical activity.

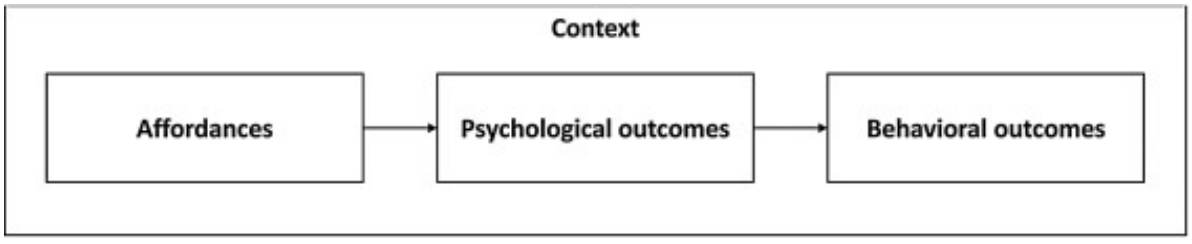

Figure 1 Gamification conceptualized (Koivisto & Hamari 2019; Hamari et al. 2014).

The key idea behind gamification is that an activity is done for the sake of engaging in and enjoying it (Koivisto & Hamari 2019). Gamification tries to capture the self-purposed nature of games to make the user enjoy engaging with a system more and drive them towards desired behavior. Gamification is interesting because of how techniques from hedonic entertainment focused systems are repurposed for use in utilitarian systems, such as education, where persistence with a task can help achieve better results. Games have become a mainstream form of entertainment that are known to engage people from all demographic groups. Playing games makes people experience enjoyment, immersion, competence and even the state of flow, which are all characteristic to intrinsic motivation (Koivisto & Hamari 2019).

Gamification is often used for the purpose of improving motivation, influencing behavior or enhancing user engagement (Werbach & Hunter 2012). The reason gamification is an effective motivational driver is because of both positive and negative reinforcement that encourage repetition and emotions (Robson et al. 2015). For this reason, gamification is an effective approach at motivating and engaging users in non-game settings. The motivational potential of games and gamification can be better examined with motivational theories such as self-determination theory where the psychological needs required for intrinsic motivation to take place are explained and the goal-setting theory that explains how goals can help improve performance (Koivisto & Hamari 2019). Game elements also provide attributes that help create immersion and enjoyment in a product or a service. These effects can be explained with psychological theories such as presence theory and flow theory.

2.2 Gamification in education

Education is one of the most researched applications for gamification (Koivisto & Hamari 2019). In education, the use of gamification means introducing game elements to the educational environment with the goals of improving properties such as student engagement, student motivation or learning outcomes. Gamification can be used in education to impact student behavior and tackle the problem of motivating students in their studies by using game elements such as points, levels or challenges (Mora et al. 2017). Research on the topic of gamification in education suggests that gamification can help increase students' motivation (Eisingerich et al. 2019). Well-designed gamification can enhance problem-solving, collaborative skills and resilience when facing challenges, which is beneficial in education as well as in many other fields.

The advantages that gamification can provide in a learning environment include boosting motivation and active participation in classes (Tsay et al. 2020), providing immediate constructive feedback and offering students more control over their own actions and choices (Christopoulos & Mystakidis 2023). The use of game elements provides great opportunities to learn from mistakes thanks to immediate feedback and many allowed attempts (Koivisto et al. 2016). Gamification can also help promote autonomy in students through self-paced learning with choices and challenges that give smaller goals for students to pursue (Christopoulos & Mystakidis 2023). One of the best ways to improve students' course outcomes is to increase student engagement or time spent on tasks and gamification has the potential to help especially those students who struggle with persistence in online education (Bell 2018).

2.2.1 The effect of student age on gamification

The targeted student's age and cognitive maturity should be taken into consideration when designing gamification to ensure optimal learning outcomes are achieved (Christopoulos & Mystakidis 2023). While students of different ages learn and are motivated in different ways, they also have different objectives to achieve in learning. In the earliest stages of education, gamification should be more focused on playful activities that enhance cognitive and motor skills like pattern recognition, matching and sorting with more story driven elements, puzzles and badges (Lamrani & Abdelwahed 2020). At primary school level, gamification should focus on developing foundational level academic abilities, such as grammar and basic problem-solving skills. On this level of education game elements such as progression bars, avatar customization and badges as rewards can help motivate students to engage more with the learning platform (Vrcelj et al. 2023).

After primary level education, gamification can take on a more sophisticated form that better aligns with the studied real-world subject (Vrcelj et al. 2023). On the level of secondary education, gamification should focus on developing the students' critical thinking and informed decision-making (Christopoulos & Mystakidis 2023). Student autonomy becomes more important on this level so the game elements can reflect it with more branching decision making and immersive challenges. Because students can choose what they study at this level of education, gamification should be used to promote deeper understanding of the subjects.

Finally, in tertiary level education, gamification takes on a more mature form by offering theoretical insights into real-world applications and mirroring real-world challenges of the subject (Subhash & Cudney 2018). On this stage of education, elements like leaderboards can

be implemented for more competition in education. Team-based activities are also possible for facilitating mutual learning and teamwork skills. Post-game debriefing becomes an important part of the learning process because educators can then facilitate discussion for dissecting strategies and sharing reflections of what was learned. Gamified environments should represent real-world applications and challenges more closely to better prepare students for real-world situations (Christopoulos & Mystakidis 2023).

2.2.2 Benefits of gamified education

Previous studies have found a strong relationship between the psychological needs introduced in the self-determination theory and gamified learning (Luarn et al. 2023). The basic psychological needs introduced in self-determination theory are autonomy, competence and relatedness (Ryan & Deci 2017). We will take a closer look at these needs in the next chapter. Gamification meets these needs by providing students with a feeling of control over their progress and performance in the gamified environment for their autonomy needs, by providing a positive feedback loop on performance for competence needs and by providing social features for users' relatedness needs (Luarn et al. 2023). The social mechanisms in gamification can help students meet their needs for social relatedness in education when sharing results with their peers. Intrinsic motivation can also be boosted through achievement features of gamification that give positive feedback to the user for achieving good results (Luarn et al. 2023). Gamification of education can help teachers avoid taking too much authority on class activities and provide more opportunities for students to lead their own educational activities.

Tailored game elements can also be used to maximize the results of gamified education. With tailored gamification, students' individuality is considered in making the application the best fit for them (Oliveira et al. 2023). In educational applications, tailoring can be done by considering the gamer and student types of the user as well as personality traits. Naturally, other factors, such as age, gender and the psychological state of users could be considered in tailored gamification as well. However, while tailoring services to individuals may have benefits, it also requires a lot of research to determine how and to whom elements should be tailored and automating the process also requires a lot of work.

2.2.3 Pitfalls of gamified education

The possible negative effects of using gamification in education have been presented in the work of Toda et al. (2018) called *The Dark Side of Gamification: An Overview of Negative Effects of Gamification in Education.* The effects were identified to be loss of performance, undesired behavior, declining effects and indifference. The lack of a framework in planning, proper methods in the deployment of the system and the absence of supporting theories, such as motivational theories, can cause these negative effects. Toda et al. (2018) did not confirm in their research that any single gamification element causes negative effects. To avoid negative impacts on student engagement, motivation and enjoyment, I apply gamification frameworks in designing my platform and include supporting theories such as the theory of gamified learning, self-determination theory, goal-setting theory, presence theory and flow theory in the study.

Loss of performance means that gamification hinders the learning process of students, for example, because of demotivating elements, focusing too much on gamified mechanics or the rules being too complicated. Gamified elements can also cause undesired behavior if they are not correctly designed and used for the right purpose. Undesired behavior can lead to frustration, not enjoying the system and unintentional ways to distract from learning. Declining effects instead lead to loss of motivation and engagement once the novelty of the system has faded away. Finally, there is indifference which means that gamification fails to have an impact on the students. This means it does not lead to any improvements or losses.

2.3 Gamification frameworks

Gamification promises many benefits such as increased motivation and engagement, but it needs to be designed and implemented in a proper manner that focus on making use of the fundamental elements that make games appealing (Domíniguez et al. 2013). Using a gamification framework helps in getting the full benefits of gamification. How the framework is chosen depends on the context where gamification is used and the type of change in user behavior that is targeted. There are several different ways to design a gamification framework that all have taking game elements to non-gaming contexts in common. (Deterding et al. 2011). Especially when designing gamification for learning, the education level needs to be considered because students of different age groups react to gamification differently (see Section 2.2.1).

2.3.1 Motivational target areas of players

The following description of motivational target areas is based on the description for motivation in video games from an article by Domíniguez et al. (2013). The motivational effect of games is related to their impact on the cognitive, emotional and social areas of players. These are fundamental elements of games that determine how games impact their players and should be considered when designing gamification. For the cognitive area, the game provides a system of rules with tasks that help the player master the rules. The tasks take place in cycles where the process of attempting short tasks repeatedly leads to achieving the necessary skill level to proceed in the game (Gee 2003).

The effect on the emotional side centers on success and failure, so games reward players with awards like points or achievements when they succeed in a task. On the other hand, players are expected to feel anxiety when failing a task, so some negative feelings are also part of the experience. Too much anxiety is not desired however, so the tasks need to be designed to fit the players' skill levels and the penalties for failing should not discourage the player from experimentation and repeating tasks. Well balanced tasks can keep the player in a state of flow where the amount of skill needed, and the challenge are just right and create a sense of an intrinsically enjoyable experience (Csíkszentmihályi 1990).

The last area is the social area where game mechanics implement interactions with other players to keep players motivated. These interactions can range from teaming up to achieve a common goal to competition or they can be simple interactions in game mechanics. The cognitive, emotional and social areas all form the base for player motivation, but they are not clearly separated, so a game mechanic can deal with more than one area at a time. It is not necessary to implement all motivational areas in a single gamified design, because the goal is to create a base for player motivation and using only some of these ideas is necessary to achieve that.

2.3.2 Review of gamification frameworks

A literature review of gamification design frameworks by Mora et al. (2017) found up to forty different gamification frameworks that had been used in scientific literature at the time. Majority of the frameworks were found in conference and journal papers, but works of smaller scale were also included in the review. The review states that gamification was used in application areas that included learning, business and health alongside other miscellaneous

topics. Notably, the review found the mechanics-dynamics-aesthetics (MDA) framework to be a key inspiration to many of the frameworks used in learning. The MDA framework is a well-known framework that is commonly referred to across games research. The framework helps bridge the gap between game design, development, criticism and technical game research through a formal structure that helps classify some of the most common elements found in games into mechanics, dynamics and aesthetics.

The review identifies three major approaches to designing gamification frameworks. These approaches are user-centered where the user and their goals are the focus, game-centered approach where the application of game design is the focus and technology-centered approach where the specific definition of the system used in gamification is the focus. User-centered frameworks were the most common out of all the reviewed works.

Other findings in the literature review include how most frameworks explicitly point to the importance of defining clear objectives at the beginning of the design process and the inclusion of a “gamification loop” to support the gamification design (Liu et al. 2011). Having unclear objectives is a common reason for failure in gamification design so it should be clear at the start of the design process what kind of behavioral changes are targeted. Several of the frameworks also consider the issue of endgame where the user should have other optional goals to strive towards after reaching the main goal and the issue of onboarding for the gamified system.

The frameworks studied in the review were researching different psychological phenomena. Things such as fun, motivation, behaviors and player taxonomy were the main considerations in different framework designs depending on the phenomena that was researched. Because gamification is applied to change user behavior, target behavior is a key concern in all gamification frameworks and should be considered throughout the design process. Notably, motivational factors serve as a core part of design in all gamification frameworks. The self-determination theory by Ryan and Deci serves as the dominant motivational theory, which makes it a notable theory when researching gamification. Fun is also an important factor to consider in the design of a framework because of the playful nature of gamification. Many of the frameworks also considered social interactions in the design process because social interactions are often present in gamified systems. While the frameworks are user-focused, they do not focus on the engagement of the user, which makes my research more relevant.

2.3.3 Gamification frameworks for learning

Some of the most popular gamification frameworks for learning in academic and professional research were the MDA framework, Fogg behavioral model, the Attention-Relevance-Confidence-Satisfaction framework (ARCS), Oktalysis framework and the 6D model (Christopoulos & Mystakidis 2023). These frameworks each have their use cases and essential elements that help in introducing gamification (see Table 1).

Table 1. Popular gamification frameworks in education.

Framework	Essential elements	Use cases
MDA / MDE	Mechanics, dynamics, aesthetics/emotions	Targeting specific emotions in users
Fogg behavioral model	Motivation, ability, prompts	Gamified engagement loops that lead to behavioral change
ARCS	Attention, relevance, confidence, satisfaction	Sustaining motivation for learning and forming a positive experience
Oktalysis	Epic meaning, accomplishment, empowerment, ownership, relatedness, scarcity, curiosity, avoidance	Optimizing user engagement with motivational drivers
6D	Objectives, activity loops, fun, deployment, target behavior, player profile	Sequential, iterative gamification

The MDA model is commonly used as a theoretical basis for other gamification frameworks, which originates from research on games. The framework defines mechanics, dynamics and aesthetics as the three essential structural elements for gamification of which mechanics are the actions players have available that are defined by the system rules and game elements present. The mechanics can be, for example, points or levels. Dynamics instead are a higher-level affordance created by the interplay of mechanics that are present and aesthetics are the emotional powers that affect the user (Hunicke 2004). Especially the Mechanics-Dynamics-Emotions (MDE) variant of it is intended for gamification design that targets specific user emotions, but it can be used for gamification design in general as well.

Fogg behavioral model is another well-known framework that is focused on designing gamified loops of engagement that aim to create behavioral change in the user (Fogg 2009). The structural elements of the theory are motivation, ability and prompts. The central idea of

this framework is that gamification mechanisms can be used to create loops of engagement because people tend to engage more in experiences that they find enjoyable and meaningful. In this framework, the difficulty of gamified actions needs to increase progressively in correspondence to the user's state of flow. In the state of flow, users are fully immersed and enjoy an optimally challenging experience that takes enough resources to challenge them in meaningful ways without being too challenging for the user and causing frustration (Fogg 2009). This framework is intended for creating engaging gamification loops that create behavioral changes in the user.

ARCS framework's structural elements are attention, relevance, confidence and satisfaction. It is a conceptual model intended for creating learning motivation and positive experiences in gamified learning. It enhances and sustains students' learning motivation by gaining the students' attention and establishing how the learning subject is relevant to them. After motivation and relevance have been established, the learning activities are arranged so that they can keep the students confident in clearing learning tasks and satisfied with their own efforts (Keller 2009). This framework is especially useful in creating motivation for learning a specific subject in students.

The Oktalysis framework organizes gamification around playful exploration, narrative exposition, choices, engagement with other learners, systems for feedback and information as well as reflecting on what is being learned to deepen learning (Economou et al. 2015). This model differs significantly from the other models.

2.4 The 6D model

The six steps to gamification (6D) with examples	
1. Define business objectives →	*List objectives, rank objectives, justify objectives.* (Building loyalty, increasing user retention or engagement, etc.)
2. Delineate target behaviors →	*What you want users to do?* (Sign up for an account, study for at least 30 minutes etc.)
3. Describe your players →	*Who are the people using your system and what is their relation to you?* (Customers, employees, students etc.)
4. Devise activity cycles →	*Create loops that keep the user engaging or progressing in the system.* (User gets rewarded for clearing a task and is given a new task or user gets levels etc.)
5. Don't forget the fun →	*Ask yourself if the users would participate voluntarily in your system.*
6. Deploy appropriate tools →	*Pick appropriate mechanics and components for your system and start developing it only now.*

Figure 2 The six steps to gamification.

Another framework that stands out as inspiration to other gamification implementations was the 6D model (Mora et al. 2017). The 6D model is a step-by-step model that provides instructions on how to design a gamified system in six steps (see Figure 2). Often just picking game elements that might be fun for your users will not result in gamification that benefits users, so including this process to the design phase can help create working gamification. Gamification elements are introduced only in the last step because this assures the elements that are picked are genuinely beneficial to the design of the gamification. The model is called 6D, because all the steps start with the letter D. The following description of the six steps in 6D framework is based on the book *For the win: how game thinking can revolutionize your business* by Werbach and Hunter (2012), which is a founding work of the 6D framework.

The first five steps focus on mapping available techniques that work in your specific situation. The first step is to *define business objectives*. This means listing all possible objectives, ranking them and removing ones that are only means to an end helps in this step. The goals need to be certain for gamification to succeed. These goals could be performance goals such

as increasing user engagement, improving motivation or increasing customer retention. This step ensures that the outcomes are what were sought after, because gamification elements can function without leading to the desired outcomes if the gamification is not designed well.

The second step is to *delineate target behaviors*. Ultimately, they should promote the goal defined in the first step, but they can lead to it indirectly. Producing several options is preferable so users can choose their activities based on their preferences. The third step is to *describe your users*. This step is important for determining what motivators work in the gamified system so the tasks in the system can be designed in a way that keeps your target users motivated. For example, if your users are students who lack the desire to use the system only for the sake of using it, engagement should be prioritized in the design. Depending on the system, there may also be subgroups that should be individually considered in the design. It is also worth considering the differences between new user needs and expert user needs.

The fourth step is to *devise activity cycles*, because games are operated as a series of loops that can include branching trees that lead to an end. Activity loops are actions that the user can tackle, which generally lead to another activity. Of the two types of activity loops, engagement loops are the actions that the player takes in the gamified components. This includes what the user's motivation for doing an activity is and how the system responds. The key element in engagement loops is the feedback that the system gives because seeing a visible response to their actions motivates the user. Progression stairs instead follow the user's journey from a macro perspective. Engagement loops are the basic processes of the gamified system, but the progression stairs are what track and give the user's journey meaning. Escalating difficulty is one of the main ways that progression can be seen. Generally, the onboarding needs to be simple and guide the user through tasks to get them engaged while later difficulty increases in varied rates. Segments often consist of steady increases in difficulty; a period of ease that lets the user catch their breath and a greater challenge at the end of each segment. The bigger challenges in games are often in the form of a boss fight that happens at the end of a level, and the easier parts let the user experience a sense of mastery for learning a skill.

The fifth step is *don't forget the fun!* It is important to consider if the overall gamified system is fun before implementing it because it is easy to lose sight of what makes gamification fun while implementing game elements and defining the goals and motivations of users that keep them coming back. If the system is fun to use, it is more likely that the users will keep coming

back to it, making it a successful gamified system. The final step is *deploying the appropriate tools for the job*. It is only at this point that mechanics and components are chosen and implemented into the system. This is the optimal point for choosing which elements are added because at this point you are aware of system goals, users and the activity cycles that can be used as a skeleton for the system.

2.5 MDE framework

The Mechanics-Dynamics-Emotions (MDE) framework describes three key principles of gamification that help achieve desired psychological and behavioral outcomes in gamified experiences (Robson et al. 2015). The MDE framework is based on Hunicke et al. (2004) game design research where the MDA framework was introduced. The MDA framework is a well-known framework in game research as it attempts to close the gap between game design and development, criticism and game research with a structuralist approach to understanding games (Mora et al. 2017). The MDE framework is similar to the MDA framework, but it is more focused on gamification specifically, so I use it in this thesis. According to the framework, games can be broken down into rules, system and fun, which are pointed to the mechanics, dynamics and aesthetics design components. The following description of the framework is based on an article by Robson et al. (2015).

Mechanics are the components of games such as algorithms and data representation (Mora et al. 2017). Mechanics can be broadly described as the gamified context, specified goals, rules, types of interactions available and limitations of the setting that act as boundaries. Mechanics are consistent so they do not change over time or between players and they are known before the experience starts. Mechanics is what creates gamification through the addition of game-like features to non-game contexts. Mechanics can be used as motivation for players and as an incentive to engage with the environment.

The three types of mechanics are *setup*, *rule* and *progression* mechanics. *Setup* mechanics define the environment of the experience, for example, where the experience takes place, if the playing happens in real time or is turn-based, the player limit etc. *Rule* mechanics instead define the goal of the experience like which actions are possible for the player and the limitations those actions have. Lastly, *progression* mechanics direct the reinforcement parts of the experience. They can signal the progression a player makes either through game elements like levels, score and resources or through rewards like badges, leaderboards or currency.

However, rewards should be desirable to the player to keep them engaged while other progression mechanics provide the player with feedback on their actions.

Mechanics are the foundation on which a gamified experience is crafted but they do not create engaging experiences that motivate change in user behavior by themselves. Instead, dynamics and emotions are also required as a part of gamification in the MDE framework.

Dynamics are the in-game behavior, interactions and strategic decisions that emerge from user actions that they input into game mechanics and from the system outputs during run-time. The dynamics of a gamified experience reflect the user's behavior, which makes it hard to predict what dynamics are relevant when designing an experience. The dynamics can be, for example, cooperation when multiple players are present, holding on to resources that could be useful later or strategizing how to clear a stage as fast as possible.

Emotions are the last part of the MDE framework. Emotions are the mental states and reactions of the users that take part in the experience. They are the product of the mechanics and dynamics that are formed through the process of how the user follows the mechanics and then generates dynamics from them. Emotions tell what a user feels when experiencing, which means it is desirable that the emotions are enjoyable and fun to make them want to continue engaging with the experience. Negative experiences like disappointment over losing or anxiety can also be a part of the experience for better or worse.

Robinson et al. (2015) also define five summarizing guidelines for designing gamification. The first guideline is defining the goal of the game. This means gamification should be driven by a goal and not be used just for the sake of using it. There should be only one goal, and it should direct what outcomes the mechanics, dynamics and emotions produce, such as the behavioral changes in users. Recognizing all roles is the second guideline. Most gamified experiences focus on the designer and the player roles, but spectator and observer roles should also be considered in the design of the experience. Third guideline is to consider that players will try to exploit gamified mechanics. This can lead to interesting dynamics as well, but the types of emotions caused need to be considered in design. The fourth guideline is to adjust the experience over time as its context changes and the fifth guideline is to design the endgame of the experience. This means the gamified experience should be designed with the final phase in mind so users can continue engaging with the experience even after achieving the main goal.

2.6 Elements of gamification

The components used as building blocks in creating gamification are often referred to as game design elements or gamification elements but there is no clear distinction between what constitutes as an element of gamification and what does not (Pedroso et al. 2019). Because characteristics of gamification can be arbitrary and subjective, gamification elements are also referred to as "gameful" affordances (see Section 2.1.2). However, there exist common gamification elements that are present in most gamification applications and research as well as in frameworks for establishing taxonomy to game elements, such as the MDA framework.

Game elements can be used to refer to mechanics, dynamics, aesthetics and individual components all at once (Werbach & Hunter 2012). I use the terms gamification elements and affordances in this thesis to refer to the components that include mechanics and bring dynamics to gamified applications through interaction with the user (see Section 2.1.2). I chose to do this so I can refer to MDA concepts separately from Werbach & Hunter's (2012) similarly named concepts. The elements can be tied to higher level concepts such as the attributes that are presented in the third chapter of the thesis.

Werbach and Hunter (2012) consider the interplay between points, badges and leaderboards (PBL) to be an important characteristic of gamification. This means that points are received for taking on challenges and can be exchanged for rewards, while badges are received from all sorts of activities and leaderboards compile these elements to show how the user is doing compared to other users (Werbach & Hunter 2012). This is an example of an extremely common dynamic in gamification, but it is not the only way or necessarily even the most effective way to use gamification. However, PBL is a good place to start when building a gamification toolkit (Werbach & Hunter 2012).

Commonly used gamification elements can be found in literature reviews surrounding gamification. Sailer et al. (2017) list seven typical game elements in gamification. These elements are points, badges, leaderboards, performance graphs, meaningful stories, avatars and teammates. These elements are more surface level elements that are directly visible to the user and easy to deactivate in an experimental setting. Other game design elements could include, for example, competition and progress which are more dependent on the mechanics of the application itself (Sailer et al. 2017). Game elements that are not present in the research of Sailer et al. include levels, clear goals, feedback and rewards (Hamari et al. 2014).

Another literature review by Koivisto & Hamari (2019) found 47 different game affordances in 273 empirical studies. The literature review refers to gamification elements as affordances. Some of these affordances were the same as the typical game elements in the study of Sailer et al. (2017). The affordances were grouped to achievement or progression, social, immersion, non-digital and miscellaneous types. The groups were formed depending on how the authors referred to the elements in their paper without analyzing the differences between elements in different papers, so the groupings are not exact (Koivisto & Hamari 2019). Because of this, the groupings are not fit to be used in detailed analysis, but they help give directions to sorting relevant elements.

Many of the most popular affordances are the same as the previously mentioned game elements but there were new affordances as well. These include quizzes, timers and increasing difficulty from achievement type, social networking features, competition and personalization from the social type as well as virtual worlds from the immersion type. Other less common and real-world affordances included physical play objects, real world reward, motion tracking, virtual helpers and currency (Koivisto & Hamari 2019).

Next, we inspect some of the most common gamification elements and affordances found in Koivisto & Hamari's (2019), Sailer et al. (2017) and Werbach & Hunter's (2012) works. I present these common gamification elements to explain what different elements are like, which elements will be chosen in the research part of this thesis and why. I use the affordance groupings from Koivisto & Hamari's (2019) review to choose the types of gamification elements that are inspected in this thesis. The elements from performance and immersion related groups were chosen because these included the most common elements found in the other research as well. These include some more social features such as leaderboards and avatars but other elements from the social group are omitted from this thesis due to social gamification elements not being the focus of the thesis. These social affordances include, for example, teamwork, social networking and competition.

2.6.1 Performance related game elements

Points are one of the most common forms of game design elements that are used in most games and gamified applications (Zichermann & Cunningham 2011). Points are typically a reward for doing something successfully in the gamified environment and they can symbolize the progress the user has made, the experience they have gathered, and they can give feedback to the user about how well they are doing (Werbach & Hunter 2012). Points can also be in the

form of experience points that show the what level the user is on, or they can be used as currency to buy something in-game (Oliveira & Bittencourt 2019). They can also determine the win state if the gamified application has one (Werbach & Hunter 2012).

Badges are another common element used in gamification that also represents progress. Badges are like a chunkier version of points, and the term badge is often synonymous with achievement in gamification (Werbach & Hunter 2012). They have been found to increase user activity (Hamari 2017). Badges are visual representations of achievements that are collectable and can be earned in the gamified environment by meeting required conditions (Werbach & Hunter 2012). The condition can be dependent on other elements like points or require successfully completing a specific activity. Badges function as feedback for success but they can also function as goals that directs future behavior and as virtual status symbols in a social context that makes players want to collect them (Zichermann & Cunningham 2011). Badges can be used to give more appreciation to active users, or they can function as smaller accomplishment during the process of achieving a goal (Oliveira & Bittencourt 2019). Badges can trigger reflection that help internalize learning (McDaniel & Fanfarelli 2016). Collection of badges typically is not necessary for progress, but they can be used as incentives for desired behavior in the gamified environment, direct users toward challenges and signify progress made. Badges tend to help students stay engaged and motivated in a learning context.

Levels and stages are an element that represent progress in a system (Oliveira & Bittencourt 2019). Levels can either refer to a numerical level that a player is rewarded with after clearing tasks or from collecting experience, or a stage type of level that represents a specific task in the system. Both types of levels tend to have an increasing difficulty that increases as levels are completed. Increasing difficulty that starts low can be used as a tutorial to get the user used to new tasks or elements in the system. However, leveling does not necessarily reflect the user's actual abilities (Oliveira & Bittencourt 2019). Progress can also be displayed with other elements such as a progress bar. In this thesis, I mainly refer to playable stages as levels.

Leaderboard instead is an element that ranks the relative success of multiple users to keep them engaged. Leaderboards let the user show their accomplishments, compare their performance with others and view high scores (Oliveira & Bittencourt 2019). The ranking is done using a performance metric that could be, for example, points or how little time is spent. (Costa et al. 2013). Leaderboards as an element are completely reliant on the social dynamics

of gamification because multiple users are required to implement them (Sailer et al. 2017). Leaderboards can be powerful tools for increasing motivation and engagement through social pressure and competition, but they can also have the opposite effect on other users who are not performing well at the ranks (see Section 2.2.1). They are also questionable in a learning context where motivation is important because they can discourage students who are struggling with studies.

Performance graphs are like leaderboards in that they compare the performance of the user but instead of comparing it to other users the performance of a user is evaluated over time. Performance graphs can help an individual focus on their points of improvement by displaying the performance of the user over time. This can affect the behavior of the user by creating mastery orientation that is beneficial in learning contexts (Sailer et al. 2017).

2.6.2 Immersion related elements

Stories are an aesthetic part of gamified applications that are not focused on the performance of the user. Creating a narrative for the game mechanics can help contextualize what the user is supposed to do and help them get interested. Stories are supposed to make the user want to complete tasks to unravel more of the story, but they can also act as a background for learning and help illustrate the real-life applicability of the concepts (Oliveira & Bittencourt 2019). Stories can help the user get immersed in game mechanics and give them more meaning, which can be used to incentivize completing activities in the gamified environment (Kapp 2012). In practical applications, narratives should not be distracting the player from the goal, for example, a narrative could distract away from learning goals.

Avatars are another aesthetic game element that lets the user have control over the environment and gives them an in-game representation. Avatars are the visual representation of users which are typically customizable to the preferences of the user (Werbach & Hunter 2012). Including avatars in a game or a gamified application lets the user take on a custom identity within the application and customize it (Annetta 2010). An avatar can be fully 3D or only a picture as an icon, and the customizable parts can also function as rewards to challenges.

In-game rewards are an efficient element for motivating users. Rewards can come in many forms such as new abilities for the user, upgrades to existing abilities, trophies or any other type of element that users could value. The scale of the reward and the timing of it can affect

player motivation (Raymer 2011). Generally, multiple small rewards act as a better motivator than one big reward at the end. Rewards should be given evenly throughout the process to give the user something to keep them motivated on each step (Raymer 2011). In a learning context, the rewards should be optional extra content and should not affect learning results.

3 Theory of gamified learning and psychological background

The theory of gamified learning is a theory that aims at unifying the literature around gamification in learning. It does this by defining gamification and its elements, by presenting a theoretical framework for game elements that can be used to improve learning outcomes and by presenting a psychological model of gamification in improving learning outcomes (Landers et al. 2017). The theory is a useful framework that creates a common language around game element categories to bridge different gamification and learning research together.

The purpose for using gamification in learning is to influence the behavior and attitudes of learners (Landers 2015). Research suggests that students who put more cognitive effort into studying and engage more in their learning activities achieve better learning outcomes (Carini et al. 2006). Therefore, using gamification to change the attitudes of learners towards more engagement in their studies is an ideal goal for gamified learning.

The components of the theory of gamified learning are instructional content, behaviors and attitudes, game characteristics and learning outcomes (Landers 2015). Gamification's role is to introduce game elements into the learning environment to change students' behaviors and attitudes to promote more engagement. The change in behavior will improve the effect of the instructional content and indirectly lead to better learning outcomes (Landers 2015).

The theory helps explain the relationship between gamification and learning. It can function as a model that explains which game elements are beneficial in certain types of learning contexts and it can also help understand what the role of gamification is in improving learning environments (Landers 2015). The theory hypothesizes that gamification only affects certain learning behavior instead of the learning outcomes directly. The targeted behavior is called the mediator when it influences learning directly and moderator in cases where the targeted behavior impacts the efficiency of existing instructional content (Landers et al. 2017).

One of the most important aspects of the theory is that gamification should not replace instructions in learning and should instead be used to improve them (Landers 2015). This means that effective and working learning instructions are a precondition for gamification to work and improve the learning experience (Landers 2015). Adding gamification to learning should not affect the existing instructional content or attempt to lead to learning by itself.

Instead, gamification works as the mediating process in changing behavior and attitudes towards more learning.

The relationship between game elements and learning outcomes is mediated by behaviors and attitudes of users, which means gamification does not directly lead to better learning outcomes. Instead, it leads to mediating factors that will improve learning outcomes over time (Landers 2015). For example, more fun and time spent engaging in learning activities will eventually lead to better learning outcomes, so gamification can be used to promote these targeted emotions and behaviors in students.

The theory of gamified learning uses a taxonomy of game attributes for learning from Bedwell et al. (2012) research to define how gamification takes form through game elements (Landers 2015). The attributes are useful for decreasing ambiguity between research on the topic of gamification and serious games (Landers 2015). The taxonomy is originally intended for direct comparisons between learning outcomes in serious games, but as gamification and serious games use similar elements in learning contexts, the taxonomy is useful in gamified learning as well for explaining the roles of game elements that are used (Bedwell et al. 2012). For example, it can help explain how some elements may work better in different learning contexts such as in a different subject or a different student age group.

3.1 Game attributes

There are nine different attributes in the taxonomy presented by Bedwell et al. (2012) The list of game attributes is not comprehensive, because it is only intended to be a collection of elements that are most likely helpful in a learning context (Landers et al. 2017). These attributes can help understand how gamification and serious games are built and help analyze how different elements of gamification affect learning. Each attribute category has a psychological theory related to it that best describes the intermediary psychological process from the used attribute to the desired learning outcomes (see Table 2).

Table 2. Game attributes and their corresponding psychological theories.

Attribute	Psychological Theory
Action language	Presence theory
Environment	
Immersion	
Assessment	The testing effect
Challenge	Goal-setting-theory
Rules	
Control	Self-determination theory
Game fiction	The narrative hypothesis
Human interaction	Social constructivism

Designing gamification does not require using all the attributes presented. It is even possible to use only a single game element from any of the attributes without the others being present (Landers et al. 2017). Gamification design differs from the creation of serious games because elements can be chosen without requiring the use of a full list of game elements. It is also possible for a game element to be a combination of different attributes. For example, a leaderboard element is a combination of rules, challenge and assessment attributes that serves as a mediator by having an impact on the time a student spends on a task and influencing learning behavior that way (Landers 2015).

3.1.1 Presence theory related attributes

Action language is a method for communication between the player and the game (Bedwell et al. 2012). A form of action language could be typing text using a keyboard or using a gamepad to control a game character. Basically, action language is the interface a player uses to communicate with a game. Action language attribute is associated with the presence theory. Creating a sense of presence in a virtual environment requires involvement and immersion (Landers et al. 2017). Therefore, environment and immersion attributes are also associated with presence theory. The benefit of creating a sense of presence in the game environment is to better capture the attention of learners and foster more engagement by making them feel included in the environment. Action language is an effective way to include a stronger sense of presence to the learning environment through technologies such as touchscreens and video game controllers (Landers et al. 2017).

Immersion is the second attribute related to presence. A feeling of immersion means that one feels included in the environment and that they get a continuous stream of stimuli from interacting with it (Witmer & Singer 1998). Immersion can be described as the user suspending their sense of disbelief in the virtual environment and acting in it as if it were real (Landers et al. 2017). Research has shown that stronger sense of presence improves learning outcomes in virtual environments, but it is not clear how big a role presence plays in non-virtual reality learning contexts (Ai-Lim Lee et al. 2010).

The third and last presence related element is environment, which represents the place where the activity takes place. The environment influences the rules and expectations of a game, and it can be either real, or fantasy (Bedwell et al. 2012) Environment can help induce a sense of presence when the activity fits the world that is surrounding it. Environment is especially important in virtual reality contexts where it can heighten the learners' sense of presence and thus affect learning (Landers et al. 2017).

Immersion, environment and action language are all related to the presence theory but their main benefit in learning is only found in cases where the learner is taken to a separate virtual studying environment, such as in virtual reality applications. Traditional learning environments and learning tools are not as well equipped to create a similar sense of presence, but digital learning interfaces can still induce a sense of presence through game attributes that are not as immersive. For example, avatars or dialogue that addresses the user directly can help create a sense of presence. Aside from player representation, sensory stimuli and the sense of safety can also create immersion (Bedwell et al. 2012). The benefit of designing separate virtual environments for learning is also context dependent as some studies might benefit from them more and it could be distracting in others (Landers et al. 2017).

3.1.2 Testing effect related attributes

The assessment attribute is a method that tracks studying progress. Common examples of assessment in gamification include points, badges and leaderboards. An assessment is often in the form of a reward such as a score at the end of a level or a badge that is awarded for successfully accomplishing a task. In a learning context, the assessment can be an award that is given after completing learning tasks to encourage more engagement with learning. A problem with assessment type elements is that they do not work if the learner does not value the assessment enough. For some learners, the addition of points and badges can be very engaging while for others they might lack meaningful value (Landers et al. 2017).

The assessment attribute is related to the testing effect psychological phenomenon. The testing effect means students remember learning material better when they are tested on it even if they do not receive feedback after it (Landers et al. 2017). Testing causes the learner to practice remembering information by trying to remember it after learning, which makes it easier to remember the information in the future. The assessment attribute can apply the testing effect, for example, by giving assessments like badges from participating in a practice task (Landers et al. 2017).

3.1.3 Goal-setting theory related attributes

The challenge attribute means there are problems that a player faces in the gamified environment. It is associated with the goal-setting theory (GST) because challenging game elements aim to start a self-regulatory process in the player so they could adjust their behavior by comparing their own performance to the goal of the challenge (Landers et al. 2017). Challenge attribute related game elements are, for example, achievements and levels.

Another GST related attribute is rules and goals which consist of the rules a player must abide by. Rules and goals are generally easy game elements to include in a gamification design because games tend to have rules that define the range of player actions and goals that the player tries to accomplish. In gamification, the rules can be used to influence targeted behavior. The behavior that rules influence can be easily targeted in the design of gamification (Landers et al. 2017). When setting rules and goals, they should be clear enough to facilitate learning but still allow a range of different actions to not make the experience too linear and boring for the player (Garris et al. 2002).

The GST is a motivational theory that explains how to improve performance by creating goals. According to the theory, the motivation found from setting a goal can be maximized by giving feedback while the player is still progressing towards the goal (Locke & Latham 2013). GST is a widely applicable way of increasing motivation and performance in a learning context (Landers et al. 2017). However, setting goals the wrong way can also lead to developing bad learning habits. For example, setting the goal of reaching a high score in a test can take the learner’s focus off learning and into chasing short term performance goals that do not directly improve learning results.

3.1.4 Self-determination theory related attributes

Control is the attribute formed from the amount of power the player has in altering the environment. For example, a player can have a lot of freedom to manipulate game objects (Bedwell et al. 2012). The control attribute is related to the self-determination theory where intrinsic motivation for doing an activity is found from autonomy, competence and relatedness. Intrinsic motivation contributes to the activity getting done because it feels satisfying and enjoyable to the actor (Ryan & Deci 2017). Control is similar to learning control as a concept, which is found in learning research (Landers et al. 2017). Learning control means that by giving learners more control, their need for autonomy can be satisfied, which leads to increased intrinsic motivation and potentially better learning outcomes (Colquitt et al. 2000).

Control in a gamified learning environment can be done either as control in the learning aspects such as freedom in setting the learning pace or in deciding the order of the learning content. However, research has shown that most control types in learning provide little positive effects in terms of knowledge retained (Landers et al. 2017). Only control over the sequence of learning content has a positive effect on learning results while other forms of control have either negative or no impact (Landers et al. 2017). The theory of gamified learning suggests instead that the relationship between learning control and learning results is mediated by motivation (Landers 2015).

The element of control is the most useful in gamified learning when combined with other game elements. Other elements that use control could be combined to include immersion and human interaction (Landers et al. 2017). For example, the elements a user has control over can include aesthetic elements of a learning environment or social features of the environment where a user can have control over what they share and with whom (Bedwell et al. 2012; Landers et al. 2017). Other forms of control can be, for example, an option for skipping learning material, an option for changing the order of the material, an option to add or skip assessments of skill or an option to receive additional guidance (Landers et al. 2017).

3.1.5 Narrative and social related attributes

Creating a narrative around the learning environment is a simple way to introduce the game fiction attribute. Game fiction is an attribute in the theory of gamified learning where a game world with a story is included in the learning process (Landers 2015). Narrative can be

introduced to gamified learning because the use of it can either directly or indirectly impact learning outcomes.

The narrative hypothesis suggests that information learned from a narrative text is better retained than information learned from expository or descriptive texts where it is presented as series of facts without a narrative (Graesser et al. 1980; Adams et al. 2012). Game fiction is considered a motivating element found in video games and it can also impact other variables in learning such as learning engagement (Adams et al. 2012). In game fiction, both the game world and its story can include elements of fantasy (Bedwell et al. 2012). The narrative hypothesis has had differing results in research surrounding it where laboratory tests suggest an improvement in information retention (Graesser et al. 1980), but field research has not found a difference in learning results through narrative (Cunningham & Gall 1990). It is also possible that narrative increases distraction in learning if it only adds irrelevant information to the learning process (Adams et al. 2012). For these reasons, I avoid using narrative in my research.

Human interaction is the last element of gamification. In this element, the interaction between players is what affects the learning process. Human interaction is already often present in traditional classroom learning, but gamification can help make use of it in a desired way (Landers et al. 2017). For example, teams can be formed for more close communication between learners, or a leaderboard can be added to increase competition. The social constructivist learning theory suggests that more human interaction in a learning process leads to better outcomes (Landers et al. 2017).

3.2 Self-determination theory

Self-determination theory (SDT) is a motivational theory that is one of the most referred to and important theories in gamification research. Because gamification often deals with user motivation, the SDT can help understand how gamification should be used to influence the user's behavior (Ryan & Deci 2017). Gamification is a vaguely defined concept that does not lead to satisfaction of psychological needs by itself but the use of different game elements that can be purposefully combined in a way that affects users' behavior can satisfy user needs (Sailer et al. 2017).

The core idea of using SDT in education is that more autonomous motivation leads to greater engagement, learning benefits and wellness for students. This type of motivation is created

especially through support from teachers and parents (Ryan & Deci 2020). The theory suggests that consideration of the three basic psychological needs in the design of learning platforms can help achieve better student engagement. Other studies have also found more benefits such as students feeling more competent, having greater self-esteem and achieving better grades (Deci et al. 1981; Guay & Vallerand 1997).

SDT defines three psychological needs that are key to finding intrinsic motivation in activities: competence, autonomy and social relatedness (Ryan & Deci 2017). Gamification can be used to encourage engagement and to create a state of flow in students that then affects learning motivation. SDT is often cited as an important theory in gamified applications and in gamification research because striving to meet the psychological needs defined in SDT helps gamification achieve its purpose of altering user behavior, for instance, towards more engagement. SDT should be considered in the design of gamified learning applications so that better learning outcomes can be achieved.

The SDT deals with intrinsic and extrinsic motivation in humans and appears often in research about motivation in education (Ryan & Deci 2017). It can be used in explaining the motivational potential of using games. Gamification has a high potential for improving intrinsic motivation of education systems because of design elements that promote autonomy through features like customization, competence through elements with feedback and purposeful challenges as well as relatedness with social features. Gamification also makes it possible to implement fun in the design. In gamified applications, it is the environment that is modified to better correspond to the psychological needs of the user. Covering motivational factors in gamified applications is necessary because increasing user motivation has the potential to increase user engagement as well (Sailer et al. 2017).

SDT also defines types of extrinsic motivations which are about behaviors done for reasons other than the inherent satisfaction from the activity. These are types of motivation that should be avoided according to the theory. Extrinsic motivations include rewards and punishments that make achieving autonomy harder and partially internalized motivations that act as internal rewards to avoid negative feelings associated with failure. There are also autonomous internal values that affect the person even if the activity itself is not satisfying or fun to the person. Last, there is amotivation which is a complete lack of value and interest for an activity. Amotivation is a negative property that needs to be avoided when striving for high engagement in learning (Ryan & Deci 2020).

3.2.1 The psychological needs

The need for autonomy means the need for having a feeling of ownership over one's own actions and the capability of taking initiative instead of just being controlled externally. Autonomy requires having psychological freedom where one can choose from several courses of actions according to their values. The feeling of task meaningfulness means that the chosen action is compatible with personal goals and attitudes (Sailer et al. 2017).

The need for competence instead refers to feeling of mastery and feeling like you can succeed in a task. Satisfying the need for competence means it is possible to achieve growth in a learning environment with optimal challenges and positive feedback. The need for competence is built on an assumption that a person strives to feel competent in their environment (Sailer et al. 2017). Lastly, the need for relatedness refers to the sense of belonging and feeling of connection in a social context (Ryan & Deci 2020). Relatedness includes the feeling of social belonging to a group of other people.

These are three basic needs that positively correlate with motivation in education. Ignoring any of these three basic needs negatively affects student motivation. However, motivation does not require an equal amount of them to be present (Ryan & Deci 2020). SDT focuses on the students' psychological growth and wellness instead of only on finding ways to control the learning environment to maximize achievements such as grades in learning. It claims that attempting to control outcomes directly through extrinsic rewards, sanctions or evaluations instead leads to lower student motivation and performance (Ryan & Deci 2020).

3.2.2 SDT in gamified learning

SDT regularly comes up in gamification research because it helps inspect how gamified systems affect the motivation of their users. SDT can be chosen as the leading perspective to studying motivation, because it covers motivational mechanisms broadly, while also overlapping with several other perspectives and emphasizing the importance of the environment (Sailer et al. 2017). It focuses on maintaining the intrinsic motivation of activities, which means the activity is done for its inherent interest or for the enjoyment of doing it (Ryan & Deci 2020).

In gamified education, it is also important to understand the perspective of SDT on grading. SDT posits that grades provide little feedback that is relevant to competence and instead they

function as a controlled way to let students know where they stand compared to others (Ryan & Deci 2020). Gamification instead has greater potential for giving different types of feedback in learning. Gamification can give users positive feedback through elements such as badges and achievements, which can help them meet their competence needs (Saputro et al. 2019; Luarn et al. 2023). Students' needs for autonomy can also be met using gamification elements such as meaningful stories and various forms of customization that allow users to express themselves and gives them a sense of control in the learning environment (Saputro et al. 2019).

As an example of using gamification to meet psychological needs, a study by Sailer et al. (2017) used different game elements to meet needs from the SDT. The need for competence used game elements that provided players with feedback on their actions. Different types of feedback included granular, sustained and cumulative feedback. Granular feedback can be directly connected to performed actions such as points that are given to the player according to how well they perform. Sustained feedback instead indicates progress and changes over time, for example, a performance graph that tells how a player's performance attributes have changed over time. Cumulative feedback is instead given after a series of actions. Elements that provide cumulative feedback are, for example, badges that can only be received after successfully completing a specific challenge or leaderboards that compare and show players in an order of their performance (Sailer et al. 2017).

Game elements that conform to the need for autonomy instead need to provide the player with freedom of choice or autonomy in the sense that the player can choose tasks that feel meaningful to them (Sailer et al. 2017). The feeling of autonomy can be provided to the player by using elements such as customizable avatars and other environmental customization. Volitional engagement can instead be found in the narrative where a player can feel like their actions have meaning on a grander scale.

The need for social relatedness using game elements instead requires a sense of relevance or a shared goal. Teammates can be used to provide a sense of relevance in a social setting, and a shared goal can also be found in the narrative. Sailer et al. (2017) had two versions of a gamified application in their study where the first study used badges, leaderboards and performance graphs that fostered feelings of competence, autonomy and task meaningfulness, while the second one had avatars, a meaningful story and teammates that caused more

feelings of social relatedness. However, they found that none of the tested elements affected the autonomy need regarding decision freedom (Sailer et al. 2017).

3.3 Presence theory

A basic definition for presence is “the subjective experience of being in one place or environment, even when one is physically situated in another” (Witmer & Singer 1998). Presence can also be defined in more detail as a “psychological state in which virtual objects are experienced as actual objects in either sensory or non-sensory ways” (Lee 2004). This definition implies that the feeling of presence comes from a psychological state of perceiving, manipulating and interacting with virtual objects as if they were real. Presence is considered as psychological similarities between virtual and real objects instead of as a phenomenon, because this also gives space to an individual’s sensory perception (Lee 2004). I focus on this definition because it does not limit presence to only high-tech scenarios such as augmented or virtual reality and instead includes more low-tech scenarios such as books as well.

Presence is relevant in the design of many media products and interfaces (Lee 2004). It allows for experiencing an interface through pure sensation where the virtuality of it goes unnoticed. A state of presence can be experienced in virtual reality and in regular computer interfaces, such as in a digital learning environment. In a technical interface, the user can either perceive, manipulate or interact with the environment and its objects (Lee 2004). This allows the user to feel different levels of presence in their experience. Merely perceiving an object in the environment lets the user make their own interpretations of it. Manipulating the objects lets the user make changes to the environment and brings their experience with the interface to a higher level (Lee 2004). The user can, for example, change the placement of an object and feel that their presence influences the environment. Last comes interaction with the environment where the objects also respond to the presence of the user in meaningful ways that have an impact on the user.

The term presence is often used to describe many different types of presence. Different types of presence include telepresence, virtual presence and mediated presence (Lee 2004). The first two of these are technology specific where telepresence achieves a feeling of being physically in a remote space via a teleoperating system (Minsky 1980) and virtual presence where the human operator achieves the feeling of being in a virtual space as if it were real (Sheridan 1992). Mediated presence is instead a wider concept where presence can be achieved through mediated perception regardless of the technology used (Lee 2004). This type of presence is

what will be discussed in this thesis which includes games and virtual interfaces that are not virtual reality. Determining the difference between real and artificial experiences as well as mediated and natural perception are out of the scope of this thesis.

3.3.1 Virtual presence categories

Virtual experiences of presence have three categories: physical, social and self (Lee 2004). Physical experience means experiencing objects in a virtual environment through subjective perception of multisensory cues in the virtual environment. Generally, virtual objects are experienced through visual or audio cues because these are most common sensory stimulus that are available in most modern technology such as smart phones and computers. Even though other stimuli are also possible in technology, such as haptic stimuli through rumble features, using only visual and audio stimuli already allows for creating a sense of presence because of the subjectiveness of human perception. Imagination and other information processing can also help create a compelling sense of presence because of cognitive stimulation (Lee 2004). For example, this is why people can get immersed in books with only written narratives.

Social experience refers to experiencing the presence of other social actors in the environment. Social experience most often means that there are other human actors, and social experience can be experienced virtually when the presence of others is experienced through technology. Social actors can also be artificially created in digital media to make virtual objects feel like other human actors (Lee 2004). Artificial actors can be superficial, where they only appear to be human if paid little attention to, or they can be more advanced using, for example, modern artificial intelligence and language models. As social animals, people tend to pay special attention to human-like cues such as voices and faces so it is also possible to stimulate the social cues of finding other social actors with little effort (Lee 2004).

People also experience themselves virtually when their presence is mediated through technology. A virtual self is either a close representation of the user in a virtual form or an artificial altered version of self that exists only in the virtual environment (Lee 2004). A virtual self can have a physical manifestation such as a full avatar or merely the partially visible hands in a first-person game. However, a virtual self can also manifest psychologically without a visible representation in the environment, if the environment reacts to the actor as if they were there, for example, by referring to them with a name (Lee 2004).

3.3.2 Presence in gamified learning

Creating a sense of presence requires immersion and involvement in the activity (Landers et al. 2017). In a learning context, creating a sense of presence means directing the student's attention from their physical environment to their subjective experience of the learning environment. Presence can be used as a mediator in gamified learning to affect learning.

The attributes from the theory of gamified learning that deal with presence are action language, immersion and environment (see Section 3.1.1). By making a student feel included in the environment, they can engage more with the learning platform. The importance of an environment in a gamified application depends on the context. For example, if the objective is to learn about animals that live in rainforests, a fitting environment should benefit learning. In other subjects such as mathematics or programming, the gamified application does not necessarily benefit from having more immersive environments that reflect the subject.

Different action languages have different properties depending on the context they are used in. A computer mouse is generally an intuitive way to navigate a computer interface, while a keyboard is more efficient in tasks that require typing and video game controllers are an ergonomic way to control a game. Gerling et al. (2011) found that unfamiliar action languages produce a greater sense of engagement with the platform, but they do not cause immersion in the experience. Instead, action languages that are easy to use and useful for the experience are considered better for creating a sense of presence. For example, a mouse is an easy-to-use action language. The benefit of using an uncommon action language could be the realness of it if specifically made for a real-life training purpose, such as for learning driving.

Using immersive game elements such as avatars can create a sense of presence but it is not clear how much immersion in non-virtual-reality applications benefits learning (see Section 3.1.1). However, game elements like sensory stimuli and player representation should contribute to a more immersive experience and thus impact learning (Landers et al. 2017). Virtual reality makes it easier to create immersive experiences that better create a sense of presence, but virtual reality is not necessary for achieving a sense of presence (Landers et al. 2017). A sense of presence can be induced with regular computer interfaces, and they can affect learning, but factors other than presence may still have a bigger impact on learning in this case (Ai-Lim Lee et al. 2010).

3.4 Goal-setting theory

Goal-setting theory (GST) is a motivational theory that explains how creating goals can improve performance. It deals with self-regulation where one continuously adjusts one's behavior to have their performance better meet the goals that they have set for themselves. Goal directed behavior is natural to people and has been built in through evolution to promote survival through taking actions that satisfy needs (Locke & Latham 2013). Game elements can influence learning through the mediational effects of self-regulation, which GST deals with. In general, using GST is an effective way of increasing motivation and influencing the target behavior (Locke & Latham 2013). The act of setting goals and striving to meet them forces one to self-regulate, which can lead to better performance and more purposeful engagement with a system.

A goal in GST is the object or the aim of an action (Locke & Latham 2013). Goals can be freely chosen but they are often related to performance when GST is discussed. A performance goal could be, for example, increasing stamina for running by a certain percentage. Goals have two attributes: content and intensity. Goal content refers to the object or the result that is desired, and goal intensity refers to the extent to which one is committed to achieving the goal and how much effort is needed in setting the goal. The core findings for goals in GST are that higher goal difficulty leads to better performance than with easy goals and that well specified, challenging goals lead to higher performance than vague and abstract goals (Locke & Latham 2013). The type of goals where the aim is to do your best are ineffective for performance because what constitutes performance is subjective, so while they can influence behavior, they might not lead to best performance.

GST also includes four mechanisms through which high goals help increase performance: direction, effort, persistence and task strategy (Locke & Latham 2013). They are mediating variables that lead to better performance in a goal. In the direction mechanic, a high goal orients one's attention towards activities that are relevant to achieving the goal and away from those that are not. The second mechanism is effort, which is a mediator to the goal-performance relationship. The effort that one puts towards achieving a goal varies according to how demanding it is, so more effort is put in when the task requires it. The third mechanism is persistence, which refers to the time spent on achieving a goal. Having a well specified high goal makes people work on a task for longer than vague and easy goals. Setting high goals can be used to make people engage more with a task.

The last mechanism is task strategy, which is more cognitive than the other three mechanisms. A high goal makes one draw upon extant knowledge or skill required to achieve the goal. This means that having too complex of a goal for the individual where the three other mechanics are not enough to guarantee good performance can result in tunnel vision where one tries to get immediate results rather than learning how to deal with the task. In cases where the goal is still too complex and uncertain, having a more vague and easier goal can lead to better performance (Locke & Latham 2013).

3.4.1 Setting beneficial goals and SMART goals

In the case of learning, merely setting performance goals without greater thought can also decrease learning by encouraging bad learning habits that lead to short term results, such as a high score in a test instead of truly focusing on learning (Locke & Latham 2013). Instead of setting performance goals for learning, it is better to focus on goals that truly increase learning (Winters & Latham 1996). For example, the goal could be learning multiple strategies for solving a problem instead of learning to solve it faster.

The moderator variables in the theory include ability, feedback to performance, commitment, task complexity and situational constraints. These variables affect how efficient a high goal or goal difficulty is in increasing performance. Ability should be considered when setting a goal because people cannot meet the performance goal if they lack the skills to complete it. Instead, people with higher level skills benefit more from goal setting (Locke & Latham 2013).

For this reason, goal setting could be left optional in a learning environment where lower skilled students can focus on learning the basics. Giving feedback is highly beneficial in GST because it lets one decide if more effort is needed or if a new strategy is needed for the goal. However, feedback does not help improve performance if it does not lead to setting goals and is ignored (Locke & Latham 2013). Commitment to achieving a goal has a positive effect on achieving more difficult goals (Locke & Latham 2013). Commitment originates from many different factors such as from peers, incentives like rewards or punishment and from making the goal public. Task complexity instead has the greatest effect when the task is more straightforward because people will lack the skills or knowledge to be efficient in too complex tasks. Situational constraints instead represent a more basic issue of lacking resources such as information or the materials to achieve a goal (Locke & Latham 2013).

Goal setting can be used to increase interest in repetitive tasks. By using a specific challenging goal, the mental focus on a task can be improved (Locke & Latham 2013). Successfully achieving a goal can also amount to greater satisfaction that keeps the individual coming back to engage with a task. SMART is a popular mnemonic for defining goals that help maximize outcomes. It stands for specific, measurable, attainable, realistic and time bound goals (Landers et al. 2017). With SMART goals, the goals are specific, high goals that contribute to the individual's motivation by not being too short term and having low expectations, while still being achievable goals that are not demoralizing to students by being too hard and time consuming to achieve or too vague to motivate. Setting SMART goals has been found to be efficient in helping with learning (Landers et al. 2017). Setting learning goals also tends to lead to higher satisfaction (Latham & Brown 2006).

3.4.2 Goals in gamified learning

GST can be applied with game elements by using rules and goals game elements or by using game elements that challenge the individual and make them set goals that lead to improvement. Feedback towards a goal in learning maximizes the benefits of goal setting because it helps students refocus on their learning efforts and better understand the problem needed to achieve the goal (Landers et al. 2017). Game rules instead can be used to create theoretical boundaries that help one realize under what conditions a learning concept applies and help one learn how it should be used. A key part to designing gamification in learning through rules and goals is to keep them optional and to keep them flexible so learners feel like they are engaging with the gamification out of volition (Landers & Landers 2014).

While clearness of goals is important, having too constrictive goals makes gamification no longer fun, which does not motivate learners to engage more with learning (Garris et al. 2002). Preserving freedom and the choice of strategy means the rules and goals do not turn into merely a part of the learning performance. Lastly, rewards can be connected to goals, so the learner is awarded with a small reward after achieving a goal to maximize the effect of GST. The specific value of the reward is not important because GST suggests just the existence of a reward is more important than the value of it (Landers et al. 2017).

The challenge game element instead is an effective element in learning contexts because it can help create SMART goals. The challenges can be created to be difficult but still attainable, so learners are motivated by the challenge. Too easy challenges are seen as trivial

and will not feel satisfying while too challenging goals are demotivating to learners, so the challenges should be crafted in accordance with the target learner's skill (Landers et al. 2017).

3.5 Flow theory and testing effect

Flow is a state of deep, enjoyable engagement where effort towards an activity feels compelling and achieving a goal feels possible (Csikszentmihalyi 2014). Flow can be defined as an intrinsically enjoyable experience that a person can experience by getting totally immersed in a task. The task feels worth doing for its own sake, which makes one want to continue the task because of the positive feedback they receive from it, even if no further goals are reached (Csíkszentmihályi 1997). In the state of flow, the experience becomes its own reward, and the individual gets to function at their full capacity (Deci 1975). The flow theory suggests that the right balance of perceived skill and challenge can be used to create deep engagement and immersion in experiences. This can be used in learning by design tasks in such a way that they create a state of flow, which makes students engage more with learning.

For flow to occur in learning, students need to experience concentration, interest and enjoyment in the activity (Csíkszentmihályi 1997). By its original definition, achieving a state of flow requires elements such as a challenge that require skills, clear goals, feedback, concentration on the task and the momentary loss of self-consciousness and forgetting of aspects unrelated to the task (Csíkszentmihályi 1990). Optimal challenges require that the person engaging in the task has all the necessary skills to succeed, and that the task is challenging enough to require their full attention. One of the most important factors of a flow experience is that the person can only pay attention to the task at hand. The person has a heightened sense of control over their own actions and the situation while those actions also become almost automatic. This makes it so actions can be performed spontaneously. At the same time, the person also loses their sense of time while concentrating on the task (Csíkszentmihályi, 1990).

The most important condition for achieving a state of flow is an optimal amount of challenge that matches the skills of the student. A state of flow can be reached when both student skill and activity challenge are balanced so that students can stretch their skills to the limits in pursuit of a challenging goal. Things to avoid while designing tasks with flow in mind are both too challenging and not challenging enough tasks. Individual skills need to also be considered (Csíkszentmihályi 1997). Not enough skill and a small challenge cause feelings of

apathy while a high skill in a small challenge leads to relaxation, which is not optimal in drawing out a state of flow. A too big challenge for an individual instead leads to feelings of anxiety (Csíkszentmihályi 1997). An ideal way to engage students with a state of flow is to provide challenging enough tasks and good opportunities for improving skills such as with immediate feedback and having tasks build upon previously learned skills incrementally (Csikszentmihalyi 2014).

Studies have shown that using suitable challenges and demands in teaching can create engagement in students that leads to a flow state (Hamari et al. 2016). Using the elements of flow, perceived challenge and skill, it can be hypothesized that engagement can be predicted (Hamari et al. 2016). The flow theory is often seen in game related research because it can help define engaging game experiences through activities that are enjoyable to the player, and it can help match their level of skill correctly (Huang et al. 2018). A state of flow can be achieved through gamification with challenges and levels that are fun but still challenging enough to keep the user focused.

While gamification is theoretically a perfect tool for creating a state of flow in students, it is unclear what kind of effect gamification truly has on students' flow experience. There is no consensus in gamification studies as to what elements should be used to create flow and the results of how they affect users' flow experience are still inconsistent (Oliveira et al. 2021). Recent studies have also not found that using gamification makes a significant difference in students' experience of flow, but they also have not found evidence against this. A study by Kaya and Ercag (2023) found that gamification had a small increase in students' flow experience, and that further research is needed (Kaya & Ercag 2023).

The testing effect is a phenomenon where learners remember learning material better after they are tested on it (see Section 3.1.2). The effect is especially relevant in tasks that require recalling over recognition (Rowland 2014). The testing effect does not require feedback to occur but feedback in initial tests does help with learning, because it allows for the correction of incorrect information (Roediger & Butler 2011).

Using testing effect in gamified learning is possible by letting learners complete related assignments while they progress through learning materials (Landers et al. 2017). Feedback from these assignments is not necessary for causing a testing effect but is still beneficial to learning (Roediger & Butler 2011). The testing effect is especially beneficial for recalling information in long term, which is the goal of learning (Landers et al. 2017).

Gamification can help cause the testing effect by using the right elements. The assessment game attribute can trigger the testing effect. Common components that use assessment include badges, points and leaderboards which are often used as a reward at the end of a task. The assessment elements need to be desirable to the learner for them to encourage more testing behavior (Landers et al. 2017). It is subjective how much a learner values a gamified reward, such as a badge, if it does not translate to any real-world value. Elements that cause testing behavior should provide opportunities to direct the learners' attention to remembering learned information so that they can improve learning results by practicing information retrieval.

4 Research design

To investigate how gamification affects students' engagement in a CS learning environment, I researched user engagement by using a gamified prototype JavaScript learning application created for the purposes of this thesis. The goal of the research is to inspect if different elements of gamification affect the engagement and behavior of students positively in a learning setting. The elements in this test refer to common components used in gamification that have been selected with the use of gamification frameworks and with the scope of the test in mind (see Chapter 1). The test attempts to measure how students feel the individual elements affect their engagement and enjoyment with the system as well as how students feel they would affect their learning motivation. This way I can determine which elements benefit students' motivation to engage with the educational system and if students prefer more, or less, gamification in the system. The test is held in the form of a test session with students that is followed by an interview of how the students feel. The results are inspected with the presented psychological theories in mind (see Chapter 3).

Engagement has various definitions, but I inspect factors such as students' motivation, immersion and enjoyment to measure how engaging students find the gamified elements in the application. Engagement is one of the most common reasons for implementing gamification because it helps tighten the relationship between the user and the system (Werbach & Hunter 2012). Engagement can be defined in various ways depending on the context. In a learning context, engagement can be defined as a state of elevated attention, interest and enjoyment in a task (Shernoff 2013). In short, engagement is the student's active involvement in a learning activity. I use this definition for engagement in my research because it fits the learning interests of my thesis. The feeling of engagement is desirable because it often leads to a feeling of success and enjoying the activity. Engagement is especially desirable in a learning environment because it can act as motivation for the students and help them achieve better learning results (see Section 2.2).

The overarching goal of a gamified system should be creating meaningful engagement that leads to both experiential and instrumental outcomes (Liu et al. 2017). The term meaningful engagement emphasizes the importance of fostering more than just engagement with the system from the user. Experiential outcomes can include, for example, the state of flow, immersion within the system, increased attention, more cognitive effort from the user and enjoyment (Liu et al. 2017). These are outcomes that can be used to describe engagement in a

learning context. Instrumental outcomes are instead more traditional goals for creating a streamlined system. These outcomes depend on what the system is designed for because they help the user complete the tasks within the system (Liu et al. 2017). To define the type of engagement I am looking for in this research, the outcomes of it are immersion within the system, increased attention and enjoyment or a state of flow.

4.1 Research setup

The test took place within a hypothetical learning application created for the purposes of this thesis that is used for teaching JavaScript programming basics to university students. Because of the target students' age, the test setting can be more like the real-world use case of programming (see Section 2.2). This means the programming exercises are more focused on creating normal JavaScript code instead of being playful exercises that avoid the direct use of programming concepts. The test itself was not focused on the learning material due to the scope of the thesis, so only basic JavaScript programming concepts were used in exercises. In the test, the participants tested the *JavaScript Gamified* webpage, after which they were interviewed on how they felt the gamified elements affected their hypothetical learning experience.

The application is a prototype of a gamified learning tool, so it uses different elements of gamification. The application is not designed to be a game but is designed to cause similar responses in users as games typically do (see Section 2.1.1). In this case, changing user behavior to increase engagement and motivation in learning and making the user experience more fun. The amount of gamification present in an exercise differs, so some of the elements are introduced only in later exercises. The exercises start with less elements of gamification and more elements are introduced in later exercises.

The interview questions focus on measuring the effects on engagement, motivation and enjoyment, which correspond to the immersion participants felt, how they feel the elements affect their learning performance and if they feel the gamified elements help them achieve a state of flow during learning (see Section 3.5). The questions used in the interview and the test scenario instructions are included in the appendix of the thesis (see Appendix A and Appendix B).

To not lose focus on how gamified elements connect to students' engagement, I applied the steps in 6D model to design my prototype application and categorized the elements according

to their intended purpose by using the MDE framework (see sections 2.4 and 2.5). This way I can more reliably inspect the behavioral changes that the gamification elements cause. With the help of the MDE framework, I can use the mechanics, dynamics and emotions taxonomy to describe game elements and apply them to a gamified setting. The Fogg behavioral model was also considered as a design framework for creating engaging gamification but was ultimately replaced by MDE framework in favor of inspecting individual elements of gamification more, and because the 6D model already helped devise activity cycles to keep the users engaged.

4.1.1 Participants

The target audience for this test were university students that had studied programming in university CS classes. The participants that were interviewed were recruited through an open invitation sent to the students participating in the Object-oriented programming course at the University of Turku. Seven students responded to the invitation and an eighth student was interviewed for practice. The number of participants could be kept low because the interview was in the form of a usability test, where most are generally detected with a minimum of five testers (Nielsen & Landauer 1993).

Among the students interviewed were students from different academic years and studying backgrounds as well as students with and without prior experience in JavaScript programming. Because the test exercises focus on JavaScript basics, the participants would ideally be students who are new to JavaScript. However, the focus of the interview was on measuring the effects of gamification so being completely new to JavaScript was not required. Half of the participants were first year students, and the other half were from different academic years. Most of the students were from CS or information technology studying backgrounds but there were also students from who studied mathematics, chemistry and health technology. Half of the participants had no prior experience with JavaScript programming, but all participants had experience programming using other languages.

4.1.2 Test structure

The tests were held both in person and remotely via Zoom video conference platform according to the participants' preference. In the case of remote testing sessions, the participants were given a link to open the testing platform on their browsers, and the participant shared their screen with the facilitator while they completed the gamified

exercises. For in-person sessions, the participants were given a laptop to complete the exercises with. The author of this thesis served as the facilitator as well as the observer of this test. The tests and interviews were held in Finnish, and the results were later translated to English for this thesis.

The test sessions lasted roughly 30 minutes and included an interview after the participant was done with the exercises. The test sessions started with an introduction of the test (see Appendix A) after which participants were given access to the platform. The introduction explained the focus of the test, how it is carried out and briefly how the platform functions. The tests were carried out according to the steps described in the test scenario where participants were given instructions on what to look for next (see Appendix B). The test scenario used eight steps that were used to help direct the participants' attention to the next exercise and the element of gamification that was introduced next.

The participants were encouraged to think aloud while doing the exercises, to better understand how they felt about each element of gamification. To avoid getting stuck in any of the exercises, the facilitator helped the participants by telling them how the exercises were expected to be completed, if the participant ran into any technical issues with the exercise solutions. This is not expected to affect the test results regarding gamified elements as the issues encountered were technical issues with the exercises.

After all the four exercises were completed, the participants were asked the interview questions on how they felt about each element of gamification present and how they felt the use of the platform affected them in a studying context (see Appendix C). Each gamified element had questions regarding the engagement, motivation and fun that the participant experienced when faced with the element in question. Other questions asked include, for example, demographic questions, what was the participant's favorite reward type, app usability and comments from the participant. The answers were written down during the interview and later analyzed. The data acquired from the answers were sorted into categories that correspond to the element of gamification in question and if the answer was about engagement, motivation or fun related to the gamified element (see Appendix D). The results also noted some of the comments made by the participants during the tests and the interviews that provide insight into how the participants felt the design decisions affected them and what could be designed better.

4.2 Results hypothesis

By using game attributes and their individual elements in ways that work accordingly to their respective psychological theories (see Chapter 3), and by using an established model to build the gamified application (see sections 2.4 and 2.5), it can be estimated that the test results in gamified elements would lead to students feeling increased engagement, motivation and enjoyment while completing exercises. Previous studies on gamification also suggest that using gamified elements in creating a platform for learning should lead to positive results in terms of increasing student engagement and motivation (see Section 2.2).

In practice, previous studies that tested the outcomes of gamification in education have found both positive and mixed outcomes. A study by Kaya and Ercag (2023) on the impact of challenge-based gamification on students' motivation and flow found that gamification is beneficial especially in distance learning and that it increases student participation and motivation in learning. The study shows that as self-determination theory implies, using gamified challenges increases students' level of confidence in succeeding in the course. The flow experience levels of students instead did increase in using gamification but not significantly. Other studies also suggest that challenge-based gamification, which includes many similar elements as the ones discussed in this thesis (points, levels and challenges), has a positive effect on student motivation and the learning results that follow (Legaki et al. 2020).

Focusing too heavily on rewards and competition can instead be a pitfall in designing gamification. Reward focused gamification systems have a negative effect on students' motivation over time. The combination of leaderboards, badges and competition elements may harm students' intrinsic motivation, which mediate with exam results (Hanus & Fox 2015). Relying on an extrinsic reward system or introducing competition in education can make students also feel less competent and less in control (Hanus & Fox 2015). Gamified systems should instead focus on creating engagement through elements that have a positive effect on students' intrinsic motivation (see Section 3.2). Gamified rewards could avoid clashing with students' intrinsic motivations by being noncompulsory and by making students have fun engaging directly with the learning content (see Section 3.4.2).

To see if gamified rewards have a negative impact on learning, I compare the effects that different types of internal gamified rewards have on students' behavior. Because I focus on

challenges instead of solely on rewards and competition in my system design, I expect that my gamified system does not have a negative impact on the intrinsic motivation of students.

For the individual elements, I expect that the block-based levels have the greatest impact on students because they let the student feel more in control of the system, which should help motivate them to engage more with the learning content. It also allows them to get more immersed in the learning environment and possibly enjoy completing assignments more.

Another element that I expect to have a positive impact on student engagement is the challenges in the system. These give the students the option to set goals in their studies that could positively impact learning results. The challenges also give the user more reasons for exploring the block assignments through rewards. To avoid the issues of reward focused gamification, the challenges do not impact on the learning content and are just focused on fun instead of competition.

4.3 Possible biases in results

Possible biases in results could be caused by, for example, the participants not fitting the target demography fully, such as the participants not being all from the same academic year or subject of study. The target demography was not set to be strict about academic years or subject of study so that motivated participants could be better found within the University of Turku courses.

In the case of this study, all the participants are from subjects that are close to technology or mathematics, and all the participants study programming, so this should not cause biases in the results. The participants are instead not all from the first academic year, but half of them are, which can make for an interesting juxtaposition, where the opinions of more advanced students are compared to the opinions of the first-year students. This should especially be considered when weighing the opinions on the visual programming style that does not require writing.

How familiar with gamification the participants are could also affect test results as they might have pre-existing opinions on certain elements. However, it is expected that most participants have some experience with gamification already as gamification is also used in the ViLLE platform[1] that some of the basic programming courses in the University of Turku use.

[1] https://www.trila.fi/en/ville-2/information-about-ville/

Therefore, it is expected that the participants may have pre-existing opinions or biases regarding gamification.

Another possible source of biases is whether the test results are reliably generalizable. The number of participants is relatively small, so their opinions on gamification may not fully represent the target audience, which is university students who study CS. However, the number of participants should be sufficient in determining how well the implementation of the gamified platform did in bringing out the benefits of gamification in learning. These results can then be compared to other studies where the effects of gamification in learning are studied.

Regarding the possible negative effects of gamification in education, in the case of this research, I do not focus on measuring learning performance, but motivation is measured, so loss of performance is not a concern (see Section 2.2.3). The research in this thesis is conducting a test for only a short time so declining effects cannot be reliably estimated either. Instead, I focus on the immediate effects of different elements. Because the system used in my research is only a mockup, it is likely to cause some indifference in participants, but the changing elements are expected to keep the participants engaged for the duration of the test.

5 Introducing research project design – Gamified learning platform

The learning application website has been created with React, a popular JavaScript user interface library, and Blockly[2], which is a JavaScript library that lets users create and run JavaScript code through a user interface with connectable drag-and-drop blocks. The programming exercises in the application use Blockly to create code that the browser then executes. The application design is focused on the frontend because the research focuses on the gamification of frontend elements that are a part of the user interface. Because of this, the application is only a mockup version made for the purpose of being used in the research of this thesis instead of being a finalized platform for education.

The architectural goals of the prototype were: a frontend that functions without relying on a backend, reusable UI components and that it can be hosted on the web as a single-page web application for the user interview. The frontend stores temporary information like user scores and rewards. The application does not require logging in, and an online connection is only required for accessing the website when it is hosted online. The application is intended to be viewed on a desktop web browser.

Blockly includes a workspace interface where blocks can be placed as well as tools for generating code for different programming languages. Blockly comes with predefined blocks that represent simple programming language concepts such as loops and variables, but it also supports custom-made blocks. In this project, the blocks represent lines of JavaScript code, but the names of the blocks are general programming concepts so prior knowledge of writing JavaScript is not necessary. The JavaScript code of the blocks is instead put in a text area after the code is run so the user can see what the lines of code look like in JavaScript.

The application lacks a backend that handles any processes after the application is launched, because the focus is on the gamified elements in the front end. The front end handles all processes used in the prototype with the help of ReactJS[3] JavaScript library that changes frontend component states in real time. By doing this, the front end reacts to changes caused by the user and changes component states accordingly without needing a backend to process

[2] https://developers.google.com/blockly
[3] https://react.dev/

requests. Many of the UI components are based on components found in MaterialUI[4] React component library, which offers ready UI components for React that can be easily customized and expanded.

The application is built using ViteJS[5] as a build tool for the development environment because of its synergy with the React framework. The online version of the application is instead hosted using a web hosting service called Render[6].

5.1 Design decisions through 6D framework

I use the six steps defined in Werbach and Hunter's 6D model to determine how to approach designing gamification in my prototype learning platform. This helps us create functional gamification that is designed for a specific purpose and targets its audience (see Section 2.4). Ultimately, the test setting is not a real learning platform that students must use in their everyday studies so creating truly functional gamification that understands its users may prove challenging, but I use the six steps for designing proper gamification to better emulate a real-world setting.

1. *Define the objectives*. My objectives for using gamification are to create a more engaging learning experience that helps students improve their motivation and have fun while studying. Naturally, one of the objectives is also to help complete the research in this thesis but that is ultimately not the reason for introducing gamification to the application.

2. *Outline the desired behavior*. The expected behavior is that students will feel more compelled to complete and explore their learning assignments because the objectives give them small goals to pursue and more enjoyment with the system. Having multiple options ready for different types of users helps with this so the assignments contain optional goals as well (see Section 3.4.2).

3. *Describe the users*. As previously mentioned, the users are testers in the research setting. The users are university students in the University of Turku who study CS.

[4] https://mui.com/
[5] https://vite.dev/
[6] https://render.com/

The ages or how many years they have studied are not specific, but they attend or have attended programming courses in university.

4. *Devise activity loops*. I focus on creating engagement loops instead of progression stairs because the system is only a prototype used in short form research so the effects of progression would be hard to measure (see Section 2.4). The research is also focused on engagement, so engagement loops are ideal for this purpose. The activity loops are completing block-based programming assignments and getting rewarded with elements such as stars and badges as feedback for how well the task was done.

5. *Don't forget the fun!* As previously mentioned, it is easy to lose track of what is important in keeping users coming back while implementing different game elements, which is creating a fun experience that the user likes (see Section 2.4). I use the MDE framework in the following step to help choose elements that make the experience more fun. Additionally, the block-based user interface should also help in creating a more entertaining experience in addition to more traditional gamification elements such as points and badges.

6. *Use appropriate tools*. I have already established the tools used in the development of the app (see Chapter 5). Next, I choose the appropriate mechanics, dynamics and aesthetics to be used in the application.

5.2 Gamified elements through MDE framework

With the use of MDE framework, we can distinguish which elements construct the rules, the system and the fun. By using this framework, I can choose game elements according to how I want them to affect the users' behavior (see Section 2.5).

5.2.1 Mechanics in the learning tool

The mechanics used in the learning tool prototype include points, levels, challenges, badges and rewards. I refer to these elements as mechanics in this section because of the connection with the MDE framework. These mechanics were chosen because they are commonly used in gamification, because they align with the research objectives of not being social mechanics and because they are plausible to implement for the prototype learning platform (see Section 2.6). The inclusion of these mechanics is the main way for introducing gamification to the

application, and the focus of the research is on measuring the effects that they have on students' behavior such as engagement and motivation.

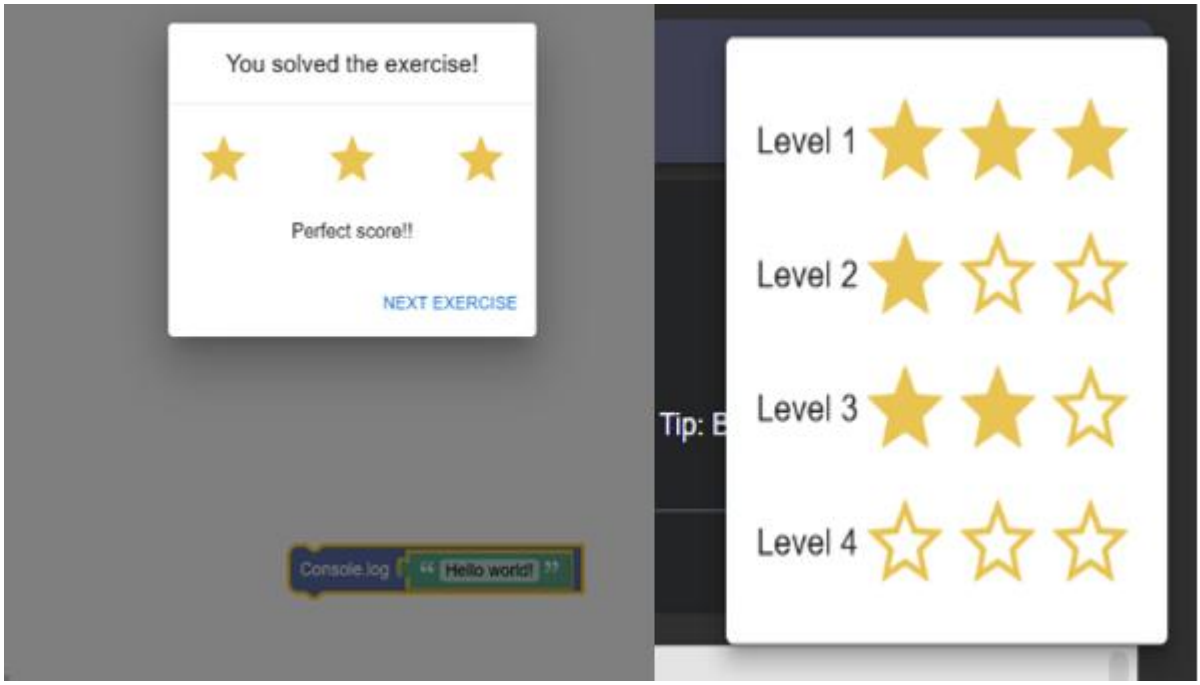

Figure 3 Points for completing a stage and the levels in the platform.

Points are exercise specific and are given in the form of stars. Each exercise has a maximum of three stars, and the lowest score for clearing an exercise is one star. Exercises that have not been cleared yet show that the user has empty stars on the exercise (see Figure 3). The stars are awarded to the user with exercise specific rules, where answers that follow the instructions more closely are awarded more stars. For example, in an exercise where the focus is on using loops, using less blocks because of a loop results in more stars.

Points are a typical assessment attribute element that encourages students to engage more in learning when they are given as a reward for completing tasks (see sections 2.6.1 and 3.1.2). Points act as a progression mechanic that represents the progress a student makes and helps them stay motivated through feedback (see Section 2.5). Points can help students achieve the testing effect to help them remember learning material better without more detailed feedback (see Section 3.5).

Figure 4 Blockly workspace used in the exercises.

Levels represent the learning exercises where difficulty rises with each level (see Section 2.6.1). Each level uses a Blockly workspace as a visual programming editor with different blocks in it. The Blockly levels provide the user with playful freedom that contributes to the fun of gamification. These blocks can be connected and used to generate runnable JavaScript code. Code can be generated by connecting available blocks in the workspace and pressing the *generate code* button. This makes the output code appear in the text field on the left. Blocks such as *Console.log* block also print text to the browser console, which can be used to determine if the code functions as intended. When the exercise is ready, *evaluate* button needs to be pressed to attempt completing the exercise (see Figure 4).

Levels are the main setup mechanic that is responsible for the environment and action language attributes. This means that they mostly define the appearance of the environment and determine the boundaries of the experience (see Section 2.5). The action language defines how the user interacts with the system. In this case it happens using drag-and-drop blocks with a mouse (see Section 3.1.1). These attributes help the user find a sense of presence by letting them interact with the elements in the environment intuitively and thus contributing to creating engagement with the system (see Section 3.3). The levels have a toolbox with level specific blocks that can have a limited number of uses. Both the blocks available and the number of blocks that can be used are exercise specific.

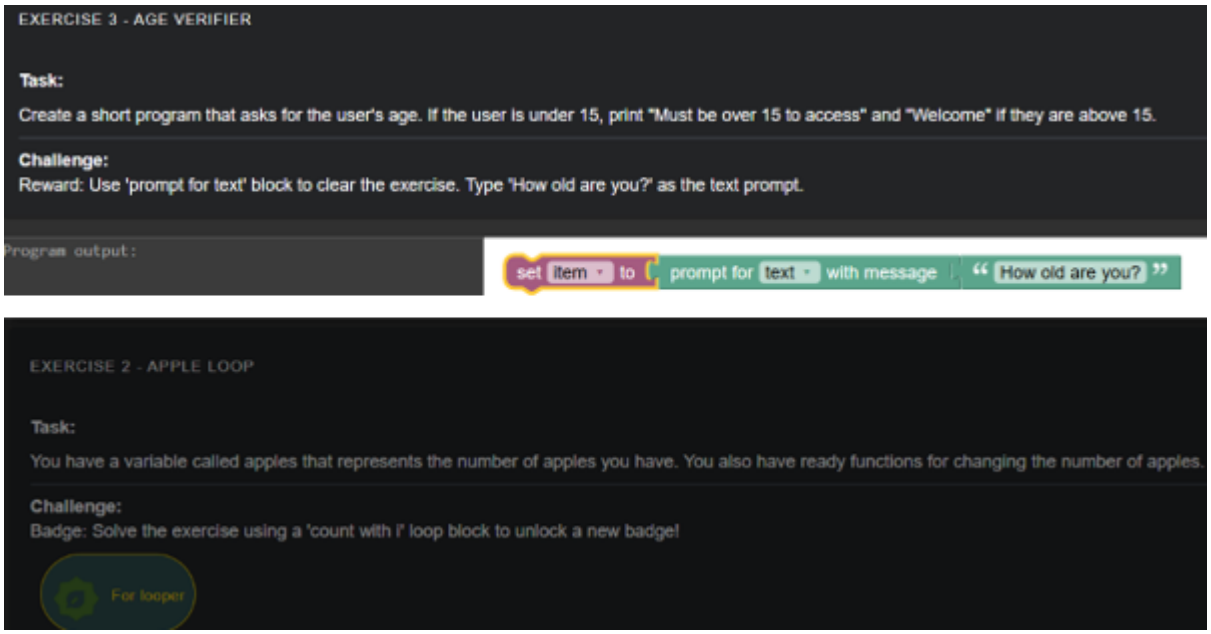

Figure 5 Different challenges with badges and other in-game rewards.

Challenges are special rules in the exercises that give the user optional goals to go after. Challenge and rule attributes in gamification contribute to the user setting goals, which gives them motivation to change their behavior in a way that facilitates learning (see Section 3.1.3). These challenges give the users small but tangible goals that help them focus on performance. They are left optional so that students with less knowledge can focus on the basics (see Section 3.4). The challenges are presented separately from the regular exercise task, and they notify the user in the exercise clear dialogue if the user successfully clears the challenge (see figures 3 and 5). The challenges are closely related to the reward mechanics, such as badges, because they are awarded for clearing challenges.

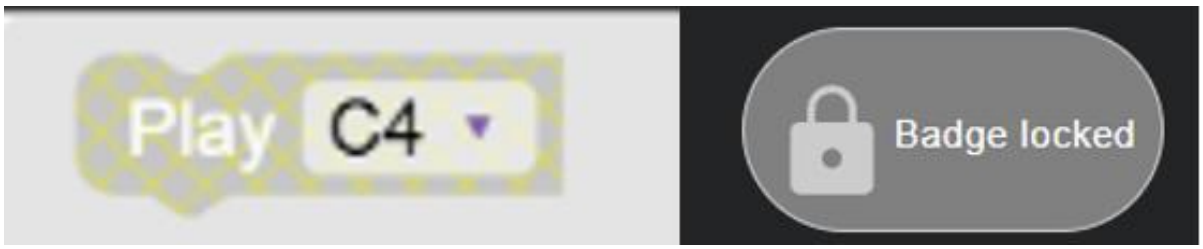

Figure 6 Reward block that plays sounds and a locked badge.

Badges and *in-system rewards* are both similar progression mechanics that are awarded when students complete a challenge. The badges are digital achievements that represent mastering an exercise (see Section 2.6.1). The in-system rewards instead are new blocks that can be played with. These blocks are not necessary for completing exercises and instead are only used to do entertaining things. For example, playing piano notes when running an exercise solution (see Figure 6). Both types of rewards can only be unlocked by clearing a challenge.

Badges can help students with self-determination needs such as competence (see Section 3.2.2). Badges act as cumulative feedback that makes the students feel competent and successful in learning. Students' autonomy needs are instead considered in making the rewards optional, and in making them achievable through multiple solutions. *Rewards* such as the note blocks also let the students freely exercise their autonomy.

5.2.2 Dynamics in the learning tool

The dynamics in the learning tool are formed from the behavior of users and the mechanics used. Creating dynamics is not as straightforward as including mechanics, because it is hard to anticipate what kind of behavior users show in the final product and what kind of dynamics benefit them the most (see Section 2.5). As it was difficult to predict how the dynamics in the learning tool will shape up in the end, the mechanics are a bigger focus. The types of dynamics that appear in the application include collecting, strategizing and discovery.

Strategizing and discovery are possibly the most prominent dynamics in the application because they are at center in all Blockly assignments. The user needs to use the blocks, for example, to discover values and how attaching blocks can create runnable JavaScript code. Discovering what blocks do in code is how the user is expected to learn. Strategizing happens instead when use of blocks is limited to require different types of solutions.

Collecting is a dynamic where the user gets to gather various reward elements. Some of these collectables are elements that directly act as feedback, such as the stars received for clearing exercises, trophies and collectable versions of blocks. Collecting is a dynamic that motivates the user to try and solve problems and achieve goals inside the application.

5.2.3 Emotions in the learning tool

The emotions are what the user feels when engaging with the tool. The goal is to create emotional responses that make the user want to keep engaging with the application. Some possible emotions that the learning tool would likely create in actual use include feeling of success, frustration, epiphany, enjoyment or boredom. The feeling of success is a key emotion that leads to the user feeling more competent, which helps them stay motivated in learning (see Section 3.2). Success is what the user may feel when mastering a task and reaching a goal in learning. Epiphany could instead be felt when the user reaches a high goal and learns something new by completing a learning task (see Section 3.4). Lastly, enjoyment is an important emotion in gamification because more fun generally means the user wants to keep engaging with the system and will eventually reach goals such as learning (see Chapter 3).

Negative feelings such as frustration, anxiety or boredom are undesired emotions that cause gamification to fail (see Section 2.5). These could be the cause of badly designed gamification or learning tasks that do not lead to benefits that gamification offers (see Section 4.3.1). As the flow theory suggests, tasks should be designed to be just challenging enough for the user to not cause anxiety (see Section 3.5). Frustration or boredom could instead be caused by the gamified elements if they are seen as unnecessary or too complex to use.

The aesthetics of the application are simple and minimalistic because it is only a prototype version and it is meant to represent a learning tool in university education, so a vibrant and innovative aesthetic might come off as unprofessional (see Section 2.2.1). Because of the focus on learning, a wide range of emotions is not desired as they might get in the way and shift the user’s focus away from the learning context. The use of gamification should not change the learning instructions (see Chapter 3). Total apathy is not desirable either, because then the application fails to reach the goal of using gamification, which is behavioral outcomes through psychological changes in the user (see Section 2.1.2).

6 Results

Next, I will introduce the results of the gamified learning platform user tests and interviews (see sections 4.1 and 5). The results include the opinions and comments of the participants on each of the five elements of gamification that were used in the gamified platform and general opinions on how well the platform functioned as a learning platform. The answers for each element are separated into three categories: engagement, motivation and fun where the participants evaluate if they think the element increases the attribute and into general comments regarding the element. These comments are separated into positive and negative reactions.

First, we revisit the hypothesis, after which I will go through each element and analyze how they performed in terms of being engaging, motivating or fun. I will also go over the participants' comments regarding the elements. After going over the data and the results, I will make the concluding remarks and attempt to answer the research questions.

The hypothesis is that the general use of gamification in a learning platform will increase engagement felt by students and help them feel motivated in their studies. The application is also expected to make students feel entertained because of the gamified elements (see Section 4.2).

As for the individual elements, the levels that include the learning tasks in block exercises are expected to be one of the elements that contribute the most to students feeling engaged, because it gives them more control over the environment and lets them feel more immersed in the task. The challenge element is also expected to contribute strongly to the motivation that students feel because it helps students engage differently with the learning content (see Section 4.2).

6.1 Participants' response to elements

Overall, the response for all elements was mostly positive and only one category got a response that was mostly negative (see Table 3). The test results were acquired by interviewing the participants and asking them if the element succeeded in being engaging, motivating or fun. Only categories where at least 75 percent of the participants agreed that the element contributed positively were considered clearly positive results that are significant as test results. Contrarily, categories where less than half of the participants agreed that the

contribution was positive were considered to have a negative response because these were clear outliers from the rest of the results (see Table 3). These results are illustrated with green color for clearly positive response, yellow for neutral and red for mostly negative (see Table 3).

Table 3 Participants' response for each element.

Colors:	Clearly positive	Neutral or slightly positive	Negative	
	Levels	**Points**	**Challenges**	**Badges**	**Rewards**
Engaging	6/8	5/8	4/8	3/8	4/8
Motivating	8/8	4/8	7/8	6/8	7/8
Fun	4/8	7/8	5/8	4/8	5/8

Significant results are those where a clear majority of participants thought that an element did or did not affect their behavior. In the case of this test, which was held as a user test with eight participants, when six or more participants agreed, it counts as a clearly positive response to an element. Contrarily, three or less counts as a clearly negative response where the element failed to have a positive impact on the users' behavior. The test results also include participant comments which are introduced in the results of each element. Because the test was a user test, many of the comments dealt with the same issues or positives so as each test passed, there would be less new findings in the next. This means that most common issues and positives of elements could be found reliably even with the small number of participants because the interview format allowed for a more thorough inspection.

Seeing the results, it appears that the participants did not think the overall gamification of the application clearly increases engagement. Instead, most of the elements are seen as engaging by only around half of the participants, and the worst received aspect of the application was about the engagement caused by the badges (see Table 3). The only element used that was seen as clearly engaging by most participants was levels, which included the block style

visual programming aspect. The participants found the levels engaging, because “the blocks helped write code without having to think about syntax so you could focus on the solution,” and the blocks functioned as suggestions that helped students find the solution.

Motivation was instead the category with the most positive response in the gamified elements. Four out of five elements of gamification were clearly motivating to the participants, which suggests that the gamification used in the application is clearly motivational in studying. Only the points element had an unclear effect on student motivation, and the levels element was seen as motivational by all the participants (see Table 3). The participants thought that the short form levels do not feel too formidable and help motivate them by giving fast feedback.

The experience of fun seemed to be quite subjective as many participants found some elements fun while others did not. Some participants also had completely opposed opinions on which elements are fun, such as with the reward block, where some participants thought it was a fun addition for playing around in the learning environment, while other participants thought it was too unnecessary for learning and that it should be more related to the exercises to be fun. Points also accumulated differing opinions on fun, because to some participants collecting a lot of points was the ideal form of fun in gamification, while others did not find the star shaped points fun, and thought that they should be numerical instead. The points element was clearly the most fun element for the participants in this application (see Table 3).

When asked what the participants’ favorite reward was between points that are awarded from the exercises, badges from challenges or other rewards from challenges, the most popular elements were in order, the reward block, points and badges as the least favorite reward. The reward block was a clear favorite among the participants when asked. However, contrary to the results, the points were considered fun more often than the reward block was (see Table 3). Therefore, it is hard to conclude which was the more popular reward, but both rewards were generally received well. The reward block received many positive comments saying that it was the most memorable and fun reward. The badges instead were not received as positively and were often considered too hard to notice for them to be engaging. This could be an issue with the implementation of the badges on the prototype platform, but they also did not have a greater impact on the experience, because the challenges were more prominent than the badges.

6.1.1 Levels

Levels were overall the most popular element among the participants. Looking at the results, it had a clear effect on the engagement and motivation felt by the students (see Table 3). The levels included the visual programming with human language aspect of the application, so it was one of the main elements used. While the students found it engaging and motivating, it was not as clearly seen as fun with many of the older students claiming that programming using human language felt annoying, or that the blocks teach bad programming habits and that they hide too much of the syntax.

The first-year students especially found the levels fun. Many of the students also felt that programming with blocks is the most engaging and motivating for new students who are learning programming for the first time. One of the first-year students felt that this style of teaching is no longer useful in adult education, because they had already used similar learning tools in middle school.

Most of the positive comments on feedback were about the fast nature of the levels where feedback can be given quickly and the blocks save on time and concentration spent on writing code. The short levels also helped motivate students by not being too overwhelming. One of the positive comments said that “The first exercise was just easy enough, because the language was new to me, and the difficulty increased appropriately, so I was interested in finding out what comes next.”

6.1.2 Points

Unlike with the rest of the elements, the participants were quite neutral about the motivational effect of points, and the fun aspect had a clearly positive response. The engagement value did not have a clearly positive response, but five out of the eight participants did consider points engaging. The points were an outlier element in the test, because unlike other elements, the points were not clearly motivating to all participants, but they were clearly considered fun by the participants (see Table 3). None of the other elements were considered clearly fun by the participants.

Points did make some of the participants more engaged in the tasks, by allowing them to see their progress from earlier levels or by making them think more of how to complete exercises with full points. One of the participants even suggested that a teacher could make it

mandatory to get a minimum number of points in a week to pass a course to make it more engaging and motivating. Other participants instead thought that the points were not necessary for engagement and that doing exercises and succeeding in them was enough.

The opinions on the motivational effect of the points were divided where some participants found points extremely motivating and that they did not want to leave any exercises without full points. Points also functioned as feedback to the students, which motivated some of them. Other participants instead thought that numerical points would be better than the star points that were used in this application and that there should be a lot more points to gather for them to motivate users. This was not possible on the prototype platform, but in real use it could be done easily.

The fun aspect of the points was received clearly more positively by the first-year students than by the older students. The participants thought that collecting points was fun because they gave you a feeling that you are successful. Other comments give the impression that what makes points fun is similar to what makes them feel engaging and motivating. The collecting aspect of the points was fun according to the participants.

6.1.3 Challenges

Challenges also had a mostly neutral response with a clearly positive response towards motivation. The response for engagement and fun was not clearly positive instead (see Table 3). Interestingly, the older students rated the engagement, motivation and fun values for challenges more highly than the first-year students. Three out of the four older students thought challenges were engaging and fun, and all four of them thought challenges were motivating so most of the older students found challenges engaging, motivating and fun.

The overall response to the challenges was that it adds to the motivation when there are extra tasks to do in the exercises. One of the participants said that “Challenges are something you always want to solve when there is one.” and another said that “It always adds to the fun when there is more to do.” Some of the participants thought that it was fun to try solving the exercises in different ways and others thought they were not noticeable enough. One participant thought that if the challenge is not relevant to the exercise task, then it feels too separate to be engaging.

6.1.4 Badges

Badges were the element that was received worst by the participants. It was the only element with less than half of the participants thinking it was engaging, and it had only a neutral response in the fun aspect. Most of the fun and engagement for it came from the collection aspect but it was not designed well enough to take this into consideration. Therefore, the badge element in this implementation was somewhat overshadowed by the other elements. One of the participants commented that the badges would have been more engaging if they had a place where all of them could be collected but that was not on the test platform. Overall, the badges were too hard to spot for participants, and they were at best considered a secondary reward compared to stars.

Some participants thought that the collection of badges was fun because they directly corresponded to the challenges from where you get the badges. Other participants thought that the badges were fun to collect because you can consider them unlockable skills that help you later in studies and in real life. Another participant said that the badges would be especially motivating if you could compare your collection to your friends' collections in a real class setting. This is a social aspect of gamification that was purposefully omitted from this test, but it seems that the badge element could do better with the social aspects of gamification in place.

6.1.5 Other rewards

Not studying related other rewards are the last element of gamification in the test. The response for this element was similar to most of the other elements where engagement and fun did not have a clearly positive response, but motivation got a clearly positive response with seven out of the eight participants thinking it increases motivation (see Table 3). There were no major differences between first-year and older students either.

Some of the participants thought that the rewards were still engaging even if they were not related to studying, but others thought that they should be directly related to the exercise solutions to be more engaging. One of the participants thought that "It was motivating but I started wondering how it could be used in the exercise." This suggests that the rewards might have been more engaging if they were related to the exercise solutions but that might also have unfair effects on the learning content, where an unlockable block trivializes other exercises. Another participant though that it was more engaging because "You can play

around with the block when you can't concentrate." This is related to the fun aspect of the reward and suggests that some students might find the rewards engaging because they are fun.

The effect on motivation was clearly positive instead. The participants thought that it is always motivating when there is a reward for doing something related to studies. One of the participants agreed that it was more motivating but also thought that there might be a correlation with age where younger students might be more motivated by rewards unrelated to studying and older students would be more interested in rewards that directly affect their studies. Another participant though that "If the student is not really interested in studying, the separate block might not be motivating. Only the students who are already excited would be motivated by something like this." From the viewpoint of students, better rewards might be more motivating, and playful rewards might seem unnecessary, but as discussed earlier, offering serious rewards such as real-world rewards for studying does not lead to more motivation and instead puts the focus on maximizing rewards (see Section 3.2.1).

Some participants did not find the reward block to be engaging, because they thought it was not clear enough. This means that the reward block in the test could have been better positioned and made more clear to the participants to be more engaging. Many of the participants did not use the block, because they were focused on attempting to clear the exercise. One of the participants thought that the rewards that are unrelated to studying do not fit and that clearer, study related rewards like points are more fun.

6.2 General response to the platform

The general response to the test platform is based on the other questions in the interview questions (see Appendix C). The participants unanimously thought that the amount of gamification in the platform was just right without it being too much. This result was expected because the gamification elements used were carefully selected from the most popular ones (see Section 2.6). The participants thought that the gamification did not feel forced. Five elements appear to be a good number of elements that do not shift the focus to gamification. One of the participants mentioned that "There are too few game elements if it is a game. Otherwise, it is about enough." This suggests that all the participants might not have had a full grasp on the definition of gamification, as gamification is specifically not a game (see Section 2.1.1), but it also verifies that the amount of gamification was enough in this test.

When asked what the most memorable good or bad thing about the platform was, the participants answered things like liking the puzzle-like blocks, connecting the blocks and how easy it was switching between exercises. One participant said they especially liked seeing all the collected points at the same time. The critical feedback had to do with the code that was largely hidden by the blocks. Most of the critical feedback was given by the older students who had gotten the most used to regular programming. Things like the code not showing immediately bothered participants who thought it was too complicated having to translate human language to code in their head, so it was hard to keep up sometimes. One participant commented that the console should be better integrated to the platform because it was bothersome to have to open the browser console each time there was output from the blocks. Another participant also mentioned that the blocks teach programming syntax wrong, which has to do with how the blocks had to be connected for the solutions to be valid. This was a problem with what kind of solutions Blockly allowed for.

Overall, the participants were not too bothered by the usability of the platform, but they recognized that there were some bugs, which were expected from the prototype platform. Usability aspects that bothered the participants included things like having to press multiple buttons for the code to appear and the poor view of the platform which hid interactable buttons sometimes. The view of the platform adjusts to the screen size, so these problems were generally device specific and hard to avoid in the mockup platform. Finally, the participants were asked how they would rate their overall experience with the platform. The rating used was a number between one to five where one meant disliking a lot, two meant disliking, three was neutral, four meant liking and five meant liking a lot. The average number ended up being three and a half so most of the participants did find it at least a slightly positive experience, but it was a mostly neutral experience for the participants.

6.3 Conclusions and comparing to hypotheses

In conclusion, the results suggest that the general use of gamification did not clearly increase the engagement of students while learning JavaScript. The hypothesis was that gamification would increase the engagement, motivation and fun felt by the students. The results showed that it cannot be assumed that there is a clear connection between gamification and engagement or fun felt by students in the case of this test platform. However, the results of this user test should not be generalized to conclude that gamification does not affect engagement in any application. The results can only be taken as decisive evidence that in this

iteration of a gamified learning environment, the gamification does not clearly increase engagement or fun, and that some elements may have a higher potential in increasing engagement or fun than others. Especially when the gamified platform is a finalized version unlike the prototype platform used in the test.

For individual elements, I predicted that the levels and challenges would be the most well received elements of gamification that affect engagement. This hypothesis was partially true according to the test results, where levels were received clearly more positively by participants in terms of engagement than the other elements. The levels were clearly engaging to six out of the eight participants, which I consider to be at the mark of significance for this test where 75 percent of the participants agreed that the element was engaging. The levels were also clearly motivating to the participants with all the participants agreeing that they were motivating for them in a learning environment. While the engagement and motivation values of levels were considered clearly positive, the element was not clearly fun for the participants. The only element that was considered clearly fun by the participants was points.

The challenges were the second element I expected to do well in a learning setting, but it did not do as well as the levels element. The challenges were not considered clearly engaging or fun by the participants. However, the challenges were considered clearly motivating by the participants, with seven out of the eight participants seeing them as motivating. This is a positive result, but most of the other elements used were also considered motivating by the participants so these are not significant results for a single element.

As mentioned before, the positive motivational value of the elements was the clearest relation among all the results. While not as clearly engaging or fun, all the elements of gamification aside from points were clearly motivating according to the participants. This suggests a clear relation with gamification and motivation in studying CS in an online learning environment. This could even be considered a test result that can be generalized, where gamification generally has a positive effect on the motivation felt by the students at least when learning programming at university level. Of course, these results should be first compared to the results of other studies where gamification is used in learning to affect motivation before making a generalization.

Lastly, there were few differences between the opinions of the first-year and older students. The most notable differences were about the fun felt by the first-year students and about how the older students rated the challenges more positively. The older students generally found

challenges more engaging and motivating than first-year students and the first-year students found both the levels and points more fun. Judging by the comments, the older students did not think the block-style programming levels were for them and that they found them partially frustrating.

6.4 Answering the research questions

The first research question is "*Does gamification help students feel more engaged or entertained with a learning platform intended for teaching programming?*" (see Section 1.1). In the light of the test platform and test results, the answer to the first research question is that in a learning environment for programming, gamification does not make a clear difference in students feeling engaged or entertained.

The results cannot be taken as proof that gamification does not affect student engagement or the fun felt by them whatsoever, because the results are obtained from the test platform with a limited number of participants, so the implementation of the platform and the test likely had an impact on some of the results. The results also do not suggest a negative relationship between student engagement and gamification, because most of the results for individual elements were either neutral or on the positive side. In conclusion, the answer cannot find a clear connection between gamification and engagement, or fun, and this research question would benefit from further research.

The second research question is "*Which ones of the common elements of gamification help students stay motivated?"* (see Section 1.1). In the light of the test platform and the test results, the answer to the second research question is that out of the common gamification elements that were selected for the test, all elements aside from points make students feel more motivated in their studies in an environment for learning programming.

The results for motivation felt by the students were clearly more positive than with the other aspects researched, which suggests a clear relationship between gamification and motivation felt by students. Levels, challenges, badges and rewards were all considered clearly motivating by the participants, and only the points element was not seen as clearly motivating. Out of these results, gamification increasing student motivation is the most generalizable result that could be replicated. The individual elements might yield different results in another implementation of the test platform, so the effects of individual elements are not completely

generalizable results. In conclusion, different elements of gamification do appear to motivate students, and this could be further proven with larger scale research.

7 Discussion

As discussed in the previous chapter, the results of the test did not entirely meet expectations and correspond to the hypotheses. The hypotheses were based on previous research and the literature surrounding gamification, so the results were expected to show a clear connection with at least engagement and gamification. The experience of fun instead differs strongly from person to person so it was expected that there might be conflicting opinions on what elements the participants found fun. The test platform being only a prototype also might have influenced the participants' opinions because the experience was not fully polished or a finalized platform for learning.

The results of the test likely do not represent greater change in how gamification should be designed going forward but they do add to the knowledge of how gamification affects students' behavior in learning. In practice, the results could be used to better understand how to design gamified systems that make students feel motivated. The gamification design in the thesis could be taken as directions on how to approach designing more engaging gamification. Even though the results could not be taken as evidence that gamification affects engagement in a positive or a negative way, the thesis still functions as a good example on how to start designing gamification that truly affects student behavior and the results do deepen the knowledge of what kind of changes in behavior different elements of gamification cause when learning programming.

There have also been earlier studies where gamification was not found to be effective by itself, but instead, individual elements have been found to have different effects on the psychological needs of users (Sailer et al. 2017). In this way, the results of this thesis seem to align with previous research. Other recent research on gamification in learning has also found evidence that gamification increases feelings of working towards a goal and motivation (van den Broek et al. 2026). The same research also found evidence that gamification did not affect learning outcomes in retrieval practice despite higher motivation. The results of my study seem to align with other studies in that gamification does increase motivation, but this study focuses more on the effects of individual elements. While this study did not find clear evidence for gamification increasing engagement, previous studies have also found conflicting results where other studies claim gamification increases student engagement and others have found opposing effects (Oliveira & Bittencourt 2019). Because of this, further

research on gamification's effects on student engagement are necessary to find more decisive evidence.

7.1 Engagement in the test

The levels element was clearly the most engaging element in the test. This might be because it was able to establish a sense of mediated presence in the users by using game attributes like immersion, the environment and even action language to a small extent. It also used the rule and control attributes, so it also functioned as an environment where the user could satisfy their psychological needs, and it gave the user goals to pursue in the environment (see sections 3.2 and 3.4).

The sense of presence in the platform is merely a sense of physical presence made with the help of visuals and audio (see Section 3.3.1). This type of presence that is not fully immersive seems to be enough to engage students in a learning environment without becoming too distractive. The feeling of presence on the platform was mostly thanks to the level element, which provided the users with an opportunity to express themselves and interact with the learning environment to feel their presence in it. Other forms of presence like social and self could also be implemented in an environment like this but they might not be necessary depending on whether the platform uses social elements (see Section 3.3.1).

Inferring from the test results of the level element, it could be theorized that game elements which help the user satisfy various psychological needs using multiple types of game attributes could be more engaging in a gamified learning environment. Especially immersive elements that also help satisfy user needs could be seen as being the most engaging. Manipulating objects on the screen makes the user feel their presence is much larger and the experience becomes much more personal to them as they can control how and where elements are placed (see Section 3.3). The participants appreciated the level element for allowing immersion in the platform and making it easier to focus simply on the solution instead of on writing the code (see Section 6.1). This could be especially meaningful in making a learning environment feel engaging because otherwise many of the elements tend to focus only on performance instead of immersion in the experience. In the case that immersion is desired, elements such as stories, avatars and in-game rewards become even more important to students engaging in the experience. Unfortunately, many of these immersive elements were not used in the test platform, which could be one of the causes for engagement being lower than expected.

Although a stronger feeling of engagement is expected to benefit students in learning, the test showed that not all students feel elements such as the block-based stages were appropriate in their studies or even intuitive to use. Especially older students felt that block-based programming like the one in the test platform should be reserved for early studies in the subject or even just to earlier levels of education such as primary and middle school (see Section 6.1.1). This means that there might be a discrepancy between a stronger feeling of immersion through gamification and learning motivation in adult education that would benefit from more research in the future.

Creating an especially immersive and engaging gamified environment for learning programming that is not boring can be challenging as programming is already done using a computer, but getting too far away from the subject and making the environment too focused on unrelated stimuli will cause the environment to be seen as unserious. In terms of action language, just a mouse and a keyboard seem sufficient in learning programming as these are the primary tools of the trade.

While social needs were not a part of this thesis, it is possible that including all three self-determination needs would have resulted in more engaging gamification. For example, the badges could have been better received if the social aspects of gamification were included in the test platform and the users could compare their badges and points to other users'.

7.2 Motivation in the test

The test results showed that basically all the gamification elements were motivating in a learning environment to the participants. This suggests that gamification elements in general could be good for helping students meet their self-determination needs like competence and autonomy among other motivational needs (see Section 3.2). Social needs were not a part of this study, because of limitations on the scope of the thesis so the results do not say anything about meeting social needs. Autonomy needs were instead met with elements such as the levels and challenges. These elements let the users pick courses of actions that let them exercise their freedom and pick goals that fit them. The points also gave the users feedback so that they could choose to go back to a previous exercise if they wanted to improve their score. The competence needs were instead met with elements such as points, badges and other rewards that gave granular and cumulative feedback to the user upon succeeding in a task. Some participants thought that these elements "make you feel like you know what you are doing" or even make you feel like you are unlocking skills that you can use in real life.

While majority of the elements were not clearly fun or engaging to the participants, the participants did consider them clearly motivating despite the self-determination theory suggesting that the use of gamification would lead to more engagement and only then to more motivated students through that (see Section 3.2). To keep the students' intrinsic motivation high, the test platform attempted to use elements that provide feedback, autonomy and avoid punishing the students. Rewards are considered to lead to extrinsic motivation, which is not desired in gamified learning (see Section 3.2), but the platform did make use of some reward and reward-like elements despite it and succeeded in making the students feel motivated.

The rewards were internal rewards that did not affect learning grades to avoid appealing too much to the extrinsic motivation of the students. Majority of the participants said that the other reward element was their favorite element that they could get as a reward for clearing a level or a challenge, and it was also considered clearly motivating by the participants (see Section 6.1). The participants often mentioned that it is always motivating to them when there is an opportunity to get something as a reward, even if it is an unrelated in-system reward that does not affect learning (see Section 6.1.5). This suggests that playful rewards that do not affect grades and are only relevant in the learning system seem to be motivating to students despite students not always finding them fun or necessary (see Section 6.1.5). Though the students found the rewards motivating, there is still a possibility that they do not lead to improvement in learning outcomes as the self-determination theory suggests (see Section 3.2.1). Then again, the purpose of gamification is to lead to improvement in learning behavior instead of improvement in learning outcomes directly as the theory of gamified learning asserts (see Chapter 3).

Another aspect of the platform that helped increase motivation were elements that cause goal-setting behavior such as challenges and the levels that gave the user a goal for completing the exercise. By themselves, these elements do not make for high level goals that require much effort to accomplish them, but they give the user tangible challenges and help avoid vague and abstract goals (see Section 3.4). The aim of these elements is to provide a clear direction for a goal in the exercises and make it easy to persist in them. Effort could not be replicated well in the test platform, because the tests did not take place in a real learning environment and the tests could not take too much of the participants' time.

These elements tried to create SMART goals by encouraging students to learn different solutions for the exercises (see Section 3.4.1). For example, points would give less stars for

solutions that did not have thought put into them and challenges required the student to use blocks in their solution that were not necessary in the regular solution. While the points failed at clearly increasing participants' motivation (see Section 6.1), the challenges were thought to be clearly motivating by the participants and were especially well received by the older students. The challenges seem to be a good element for causing goal-driven behavior as the participants thought that they like to always attempt challenges whenever they are available (see Section 6.1.3). The biggest shortcoming in this iteration of challenges was likely that the element was not always visible enough to the participants (see Section 6.1.3). As suggested by the GST, the existence of a reward for achieving a goal was well received by the participants and the participants thought that it is always more motivating and fun to do challenges when there is any kind of reward in for it. Overall, the elements that helped motivate students seemed to tap into the psychological needs of the students or help them set goals in the platform. Also, the levels element being immersive likely helped make that element more motivating to the students.

7.3 Fun in the test

In the end, the participants did not find the gamification in the test platform clearly fun. This could be because gamification is an individual experience where all elements do not appeal to each user the same way (Oliveira & Bittencourt 2019). Inferring from the test results, it seems to be true as many of the participants had differing preferences in which elements were fun to them. Despite immersion being found from the level element, it might not have been enough to create an experience of flow in the participants in combination with the exercises not being optimally challenging to the students. It was difficult to create an optimally challenging experience for test purposes where the exact level of participant skills was not known, and the test had to be easy enough to be accessible, so the learning contents were challenging to some while others also found the controls to be challenging in an unpleasant way. The lack of flow in the experience may have caused the participants to not find the experience as fun or engaging as it could be with optimal flow, which could explain why the participants did not find all the elements engaging or fun (see Section 3.5).

The testing effect was instead not utilized in the test platform, because there was not enough learning content for the participants to be tested on and the learning content was not the focus of the test. A better utilization of the testing effect might have resulted in better learning

outcomes, but this would have been hard to conclude in a convincible way using only the results of the short test sessions.

7.4 Design choices retrospective, best practices and limitations

The research focused on performance related and immersive game elements and did not use any social game elements. This resulted in gamification research that differed from many others, which often make full use of social elements in their platforms. Because social aspects were not present in the test platform, some mechanics that were used did not reach their full engagement potential, but the research was able to focus better on individual gamification mechanics as UI elements.

The test was designed with JavaScript programming basics in mind, but the participants were not required to be new students (see Section 4.1.1). This ended up creating an interesting comparison between new and older students, which revealed differences in how these students react to gamification. In this way, the participants fit the test design well. While it was not possible to find decisive evidence of how gamification in general affects student behavior, the interview and test session format of testing was effective in finding the effects and problems in the elements used by the test platform.

Having more participants would not have likely affected the test findings in a major way, and the test being held online did not pose any major issues, so I consider the test to have succeeded in determining the effectiveness of the gamification in the test platform. The elements used in the platform were also familiar enough to the participants so onboarding the testers did not pose any issues. However, as this research is a graduate thesis and the participants were recruited from the author's university, there is a possibility that some of the participants responded positively to the interview questions out of courtesy or because they were already interested in the subject.

As for best practices when designing a gamified platform, the frameworks used worked well for the purpose of creating gamification with a purpose. The 6D model helps establish what the gamification is meant for and what kind of activities should be added to make the experience fun and engaging. While this is an important place to start with gamification design, this model is likely even more essential in larger, already existing systems than in the prototype platform used in this thesis because the platform did not have a clear purpose for existing aside from being used as a test platform. The MDE framework is also notable as it

does help put attention into what the mechanics are used for instead of applying mechanics at will in the design phase. Unfortunately, it was still challenging to imagine the dynamics that the mechanics would provide while being new to designing gamification, so using the framework does not make the process completely straightforward. While the MDE framework was used to focus more on each element of gamification, it is possible that the platform could have been more engaging if the Fogg behavioral model were used instead as it focuses more on designing immersive engagement loops with flow. The test results favoring the levels element seem to imply that this type of design could have been more engaging.

When looking at the participants' comments, it seems that the platform succeeded in creating a gamified experience with the right amount of gamification (see Section 6.2). The elements received some critical feedback as well, such as challenges feeling too separate, reward block not feeling appropriate, blocks hiding too much of the syntax and so on. These issues should be considered if redesigning the platform, and the platform could have a better integrated console than the browser console. For example, reward blocks could be made even more optional so they would not have to be a part of the experience if the student does not want them. The platform itself had some issues that bothered the participants, which was expected from the prototype platform, but overall, the platform was received more positively than negatively.

While the levels that used Blockly were generally well received as an idea, the implementation had some issues, and future development of the platform using Blockly would continue to be difficult, because Blockly is not natively compatible with the React framework, and the customization of blocks proved harder than expected. In this light, creating a new visual programming tool for the platform would be preferrable so the levels could have more varied programming concepts and so that the solutions would be easier to evaluate. Another step in improving the platform would be to create a backend where data is stored so user profiles could be created and information such as points and badges that have been acquired could be stored.

7.5 Future research

Based on the findings of this thesis, future research on the topic of gamification in education and engagement could focus on finding more decisive evidence that gamification helps students engage in learning. Future research should include the social mechanics and dynamics of gamification to inspect the gamification on a larger scale than merely on the

scale of individual elements of the gamified UI. The dynamics and emotions that are caused by the mechanics should be a greater focus in future studies to inspect the behavior of students and to inspect if they create better learning outcomes. This type of research should take place over a long period of time as the effects of gamification have been mainly studied in individual courses. While the MDE framework did work in designing gamification, it could be replaced with Fogg behavioral model to see if it could help design even more engaging gamification.

Many of the older participants did not seem to appreciate the most immersive and engaging element as much as the first-year participants so it could be beneficial to further research into what age groups gamification should be targeted at. For example, if students in high school enjoy gamified learning more than university students do. It could also be the case that the effects are similar across age groups, but gamification could take on a different form depending on the target age group.

This thesis answered the question of how different elements of gamification affect student behavior and showed evidence that gamification does make students feel more motivated. New research questions could continue to focus on how to make engaging elements of gamification in learning, but they could also include research questions such as: *Does gamification in learning make for better learning outcomes?* or *Do students from different levels of education benefit from gamification the same?*

8 Conclusion

This thesis researched the relationship between gamification and engagement in computer science learning at university level. The research also focused on the motivational potential and fun of gamification. These relationships were researched with a user test of a gamified environment for learning basics of JavaScript programming where the testers were both first-year and older students from the University of Turku.

The gamified elements were inspected through the lens of theory of gamified learning. The psychological theories that were relevant to the gamification in this thesis were theories that deal with motivation, immersion or enjoyment, so self-determination theory, presence theory, goal-setting theory and flow theory were chosen. To design and develop the test environment, frameworks for designing gamification and elements of gamification were presented as well.

The frameworks used were the 6D model and MDE framework. These frameworks were chosen to help design purposeful gamification with engaging activity loops and to better inspect the dynamics of the elements that would lead to behavioral changes. The elements that were in the research were: levels, points, challenges, badges and rewards. These elements were chosen to create dynamics such as collecting, strategizing and discovery.

The results of the research suggested that some elements may have a higher potential in increasing feelings of engagement than others. The levels were clearly the most engaging element to the participants. The only element that was considered clearly fun by the participants was points. The implementation of the test platform had a few small issues that made some elements less noticeable than others, which may have impacted test results.

Differences in the students' level of studies did not make a great difference in the results. The most notable differences were that first-year students found the levels and points more fun, while the older students found the challenges more engaging and motivating. There was also a notable difference between the older and first-year students in how they reacted to the programming with blocks, where younger students were generally more in favor of it.

In conclusion, the results suggest that the use of gamification does not clearly increase the engagement felt by students while using the platform for learning JavaScript. The test could not find a decisive connection between gamification and engagement, but the results could apply only to the test platform as the implementation of the platform could have had an impact on the results. The results did not find a clear negative relationship between

engagement and gamification either. However, while all the elements were not clearly fun or engaging to the participants, the test found evidence that gamification does help increase user motivation as all elements aside from points were clearly motivating to the participants. This suggests a clear relation with gamification and motivation when studying programming in an online learning environment, but these results should only be generalized with larger research.

References

Adams, D. M., Mayer, R. E., MacNamara, A., Koenig, A., & Wainess, R. (2012). Narrative Games for Learning: Testing the Discovery and Narrative Hypotheses. *Journal of Educational Psychology*, *104*(1), 235–249. https://doi.org/10.1037/a0025595

Ai-Lim Lee, E., Wong, K. W., & Fung, C. C. (2010). How does desktop virtual reality enhance learning outcomes? A structural equation modeling approach. *Computers and Education*, *55*(4), 1424–1442. https://doi.org/10.1016/j.compedu.2010.06.006

Annetta, L. A. (2010). The "I's" Have It: A Framework for Serious Educational Game Design. *Review of General Psychology*, *14*(2), 105–112. https://doi.org/10.1037/a0018985

Bedwell, W. L., Pavlas, D., Heyne, K., Lazzara, E. H., & Salas, E. (2012). Toward a Taxonomy Linking Game Attributes to Learning: An Empirical Study. *Simulation & Gaming*, *43*(6), 729–760. https://doi.org/10.1177/1046878112439444

Bell, K. (2018). *Game on! : gamification, gameful design, and the rise of the gamer educator*. Johns Hopkins University Press.

Berkling, K., & Thomas, C. (2013, September). Gamification of a Software Engineering course and a detailed analysis of the factors that lead to it's failure. In *2013 international conference on interactive collaborative learning (ICL)* (pp. 525-530). IEEE.

Biocca, F. (1999). Chapter 6 The Cyborg's dilemma. In *Human Factors in Information Technology* (Vol. 13, pp. 113–144). https://doi.org/10.1016/S0923-8433(99)80011-2

Boulet, G. (2012). Gamification: The Latest Buzzword and the Next Fad. *ELearn Magazine*, *2012*(12). https://doi.org/10.1145/2407138.2421596

van den Broek, G. S. E., Scholten, S., van Thuil, B., van Rijn, H., van Gog, T., & van der Velde, M. (2026). Gamified feedback in adaptive retrieval practice: Points and progress-bars enhance motivation but not learning. *Computers in Human Behavior*, *177*, Article 108862. https://doi.org/10.1016/j.chb.2025.108862

Carini, R. M., Kuh, G. D., & Klein, S. P. (2006). Student Engagement and Student Learning: Testing the Linkages. *Research in Higher Education*, *47*(1), 1–32. https://doi.org/10.1007/s11162-005-8150-9

Christopoulos, A., & Mystakidis, S. (2023). Gamification in Education. *Encyclopedia*, *3*(4), 1223-1243. https://doi.org/10.3390/encyclopedia3040089

Colquitt, J. A., LePine, J. A., & Noe, R. A. (2000). Toward an Integrative Theory of Training Motivation: A Meta-Analytic Path Analysis of 20 Years of Research. *Journal of Applied Psychology*, *85*(5), 678–707. https://doi.org/10.1037/0021-9010.85.5.678

Costa, J. P., Wehbe, R. R., Robb, J., & Nacke, L. E. (2013). Time's up: studying leaderboards for engaging punctual behaviour. *Gamification 2013 : Proceedings of the First International Conference on Gameful Design, Research, and Applications : October 2-4, 2013, Stratford, Ontario, Canada*, 26–33. https://doi.org/10.1145/2583008.2583012

Csikszentmihalyi, M. (1990). *Flow: The psychology of optimal experience*. New York: Harper- Perennial.

Csikszentmihalyi, M. (1997). Finding flow: *The psychology of engagement with everyday life. The masterminds series*. New York: Basic Books.

Csikszentmihalyi, M. (2014). Student Engagement in High School Classrooms from the Perspective of Flow Theory. In *Applications of Flow in Human Development and Education* (pp. 475–494). Springer Netherlands. https://doi.org/10.1007/978-94-017-9094-9_24

Cunningham, L. J., & Gall, M. D. (1990). The effects of expository and narrative prose on student achievement and attitudes toward textbooks. *The Journal of Experimental Education*, *58*(3), 165–175. https://doi.org/10.1080/00220973.1990.10806532

Deci, E, L. (1975). *Intrinsic motivation*. New York: Plenum Press.

Deci, E. L., Schwartz, A. J., Sheinman, L., & Ryan, R. M. (1981). An instrument to assess adults' orientations toward control versus autonomy with children: Reflections on intrinsic motivation and perceived competence. *Journal of Educational Psychology*, *73*(5), 642–650. https://doi.org/10.1037/0022-0663.73.5.642

Deterding, S., Dixon, D., Khaled, R., & Nacke, L. (2011). From game design elements to gamefulness: defining "gamification." *Proceedings of the 15th International Academic MindTrek Conference : Envisioning Future Media Environments*, 9–15. https://doi.org/10.1145/2181037.2181040

Dominguez, A., Saenz-de-Navarrete, J., de-Marcos, L., Fernandez-Sanz, L., Pages, C., & Martinez-Herraiz, J.-J. (2013). Gamifying learning experiences: Practical implications and outcomes. *Computers and Education*, *63*, 380–392. https://doi.org/10.1016/j.compedu.2012.12.020

Eickhoff, C., Harris, C. G., de Vries, A. P., & Srinivasan, P. (2012, August). Quality through flow and immersion: gamifying crowdsourced relevance assessments. In *Proceedings*

of the 35th international ACM SIGIR conference on Research and development in information retrieval (pp. 871-880).

Eisingerich, A. B., Marchand, A., Fritze, M. P., & Dong, L. (2019). Hook vs. hope: How to enhance customer engagement through gamification. *International Journal of Research in Marketing*, *36*(2), 200–215. https://doi.org/10.1016/j.ijresmar.2019.02.003

Economou, D., Doumanis, I., Pedersen, F., Kathrani, P., Mentzelopoulos, M., & Bouki, V. (2015). Evaluation of a dynamic role-playing platform for simulations based on Octalysis gamification framework. In *Workshop Proceedings of the 11th International Conference on Intelligent Environments* (pp. 388-395). IOS Press.

Fogg, B. (2009). A behavior model for persuasive design. *Proceedings of the 4th International Conference on Persuasive Technology*, *350*, Article 40. https://doi.org/10.1145/1541948.1541999

Garris, R., Ahlers, R., & Driskell, J. E. (2002). Games, Motivation, and Learning: A Research and Practice Model. *Simulation & Gaming*, *33*(4), 441–467. https://doi.org/10.1177/1046878102238607

Gee, J. P. (2003). *What video games have to teach us about learning and literacy*. Palgrave Macmillan.

Gerling, K. M., Klauser, M., & Niesenhaus, J. (2011). Measuring the impact of game controllers on player experience in FPS games. *Proceedings of the 15th International Academic MindTrek Conference : Envisioning Future Media Environments*, 83–86. https://doi.org/10.1145/2181037.2181052

Graesser, A. C., Hauft-Smith, K., Cohen, A. D., & Pyles, L. D. (1980). Advanced Outlines, Familiarity, and Text Genre on Retention of Prose. *The Journal of Experimental Education*, *48*(4), 281–290. https://doi.org/10.1080/00220973.1980.11011745

Guay, F., & Vallerand, R. J. (1996). Social context, student's motivation, and academic achievement: Toward a process model. *Social psychology of education*, *1*(3), 211-233.

Gustafsson, A., & Bång, M. (2008). Evaluation of a pervasive game for domestic energy engagement among teenagers. *Proceedings of the 2008 International Conference on Advances in Computer Entertainment Technology*, 232–239. https://doi.org/10.1145/1501750.1501804

Hamari, J., Koivisto, J., & Sarsa, H. (2014). Does Gamification Work? -- A Literature Review of Empirical Studies on Gamification. In R. Sprague (Ed.), *2014 47TH HAWAII INTERNATIONAL CONFERENCE ON SYSTEM SCIENCES (HICSS)* (No. 6758978). IEEE. https://doi.org/10.1109/HICSS.2014.377

Hamari, J. (2017). Do badges increase user activity? A field experiment on the effects of gamification. *Computers in Human Behavior*, *71*, 469–478. https://doi.org/10.1016/j.chb.2015.03.036

Hamari, J., & Koivisto, J. (2015). "Working out for likes": An empirical study on social influence in exercise gamification. *Computers in Human Behavior*, *50*, 333–347. https://doi.org/10.1016/j.chb.2015.04.018

Hamari, J., Shernoff, D. J., Rowe, E., Coller, B., Asbell-Clarke, J., & Edwards, T. (2016). Challenging games help students learn: An empirical study on engagement, flow and immersion in game-based learning. *Computers in Human Behavior*, *54*, 170–179. https://doi.org/10.1016/j.chb.2015.07.045

Hanus, M. D., & Fox, J. (2015). Assessing the effects of gamification in the classroom: A longitudinal study on intrinsic motivation, social comparison, satisfaction, effort, and academic performance. *Computers and Education*, *80*, 152–161. https://doi.org/10.1016/j.compedu.2014.08.019

Huang, H.-C., Pham, T. T. L., Wong, M.-K., Chiu, H.-Y., Yang, Y.-H., & Teng, C.-I. (2018). How to create flow experience in exergames? Perspective of flow theory. *Telematics and Informatics*, *35*(5), 1288–1296. https://doi.org/10.1016/j.tele.2018.03.001

Hunicke, R., LeBlanc, M., & Zubek, R. (2004, July). MDA: A formal approach to game design and game research. In *Proceedings of the AAAI Workshop on Challenges in Game AI* (Vol. 4, No. 1, p. 1722).

Huotari, K., & Hamari, J. (2017). A definition for gamification: anchoring gamification in the service marketing literature. *Electronic Markets*, *27*(1), 21–31. https://doi.org/10.1007/s12525-015-0212-z

Jones, B. A., Madden, G. J., & Wengreen, H. J. (2014). The FIT Game: preliminary evaluation of a gamification approach to increasing fruit and vegetable consumption in school. *Preventive Medicine*, *68*, 76–79. https://doi.org/10.1016/j.ypmed.2014.04.015

Kapp, K. M. (2012). *The gamification of learning and instruction : game-based methods and strategies for training and education*. Pfeiffer.

Kaya, O. S., & Ercag, E. (2023). The impact of applying challenge-based gamification program on students' learning outcomes: Academic achievement, motivation and flow. *Education and Information Technologies*, *28*(8), 10053–10078. https://doi.org/10.1007/s10639-023-11585-z

Keller, J. M. (2009). The Arcs model of motivational design. In *Motivational design for learning and performance: The ARCS model approach* (pp. 43-74). Boston, MA: Springer US.

Koivisto, J.-M., Multisilta, J., Niemi, H., Katajisto, J., & Eriksson, E. (2016). Learning by playing: A cross-sectional descriptive study of nursing students' experiences of learning clinical reasoning. *Nurse Education Today*, *45*, 22–28. https://doi.org/10.1016/j.nedt.2016.06.009

Koivisto, J., & Hamari, J. (2019). The rise of motivational information systems: A review of gamification research. *International Journal of Information Management*, *45*, 191–210. https://doi.org/10.1016/j.ijinfomgt.2018.10.013

Lamrani, R., & Abdelwahed, E. H. (2020). Game-based learning and gamification to improve skills in early years education. *Computer Science and Information Systems*, *17*(1), 339-356.

Landers, R. N., & Landers, A. K. (2014). An Empirical Test of the Theory of Gamified Learning: The Effect of Leaderboards on Time-on-Task and Academic Performance. *Simulation & Gaming*, *45*(6), 769–785. https://doi.org/10.1177/1046878114563662

Landers, R. N. (2015). Developing a Theory of Gamified Learning: Linking Serious Games and Gamification of Learning: Linking Serious Games and Gamification of Learning. *Simulation & Gaming*, *45*(6), 752-768. https://doi.org/10.1177/1046878114563660 (Original work published 2014)

Landers, R. N., Armstrong, M. B., & Collmus, A. B. (2017). How to Use Game Elements to Enhance Learning: Applications of the Theory of Gamified Learning. In M. Ma & A. Oikonomou (Eds.), *Serious Games and Edutainment Applications* (pp. 457–483). Springer International Publishing. https://doi.org/10.1007/978-3-319-51645-5_21

Latham, G. P., & Brown, T. C. (2006). The Effect of Learning vs. Outcome Goals on Self-Efficacy, Satisfaction and Performance in an MBA Program. *Applied Psychology*, *55*(4), 606–623. https://doi.org/10.1111/j.1464-0597.2006.00246.x

Lee, K. M. (2004). Presence, Explicated. *Communication Theory*, *14*(1), 27–50. https://doi.org/10.1111/j.1468-2885.2004.tb00302.x

Legaki, N.-Z., Xi, N., Hamari, J., Karpouzis, K., & Assimakopoulos, V. (2020). The effect of challenge-based gamification on learning: An experiment in the context of statistics education. *International Journal of Human-Computer Studies*, *144*, Article 102496. https://doi.org/10.1016/j.ijhcs.2020.102496

Liu, D, Santhanam, R., & Webster, J. (2017). Toward Meaningful Engagement: A Framework for Design and Research of Gamified Information Systems. *MIS Quarterly*, *41*(4), 1011–1034. https://doi.org/10.25300/MISQ/2017/41.4.01

Liu, Y., Alexandrova, T., & Nakajima, T. (2011). Gamifying intelligent environments. Proceedings of the 2011 International ACM Workshop on Ubiquitous Meta User Interfaces, 7–12. https://doi.org/10.1145/2072652.2072655

Locke, E. A., & Latham, G. P. (2013). New Developments in Goal Setting and Task Performance (G. P. Latham & E. A. Locke, Eds.; 1st ed.). Routledge. https://doi.org/10.4324/9780203082744

Luarn, P., Chen, C.-C., & Chiu, Y.-P. (2023). Enhancing intrinsic learning motivation through gamification: a self-determination theory perspective. *Campus-Wide Information Systems*, *40*(5), 413–424. https://doi.org/10.1108/IJILT-07-2022-0145

McDaniel, R., & Fanfarelli, J. (2016). Building Better Digital Badges: Pairing Completion Logic With Psychological Factors. *Simulation & Gaming*, *47*(1), 73–102. https://doi.org/10.1177/1046878115627138

Minsky, M. (1980, June). Telepresence. Omni, 2, 45–51.

Mora, A., Riera, D., González, C., & Arnedo-Moreno, J. (2017). Gamification: a systematic review of design frameworks. *Journal of Computing in Higher Education*, *29*(3), 516–548. https://doi.org/10.1007/s12528-017-9150-4

Nielsen, J., & Landauer, T. K. (1993). A mathematical model of the finding of usability problems. *INTERCHI '93 : Conference Proceedings : Bridges between Worlds*, 206–213. https://doi.org/10.1145/169059.169166

Oliveira, W., & Bittencourt, I. I. (2019). *Tailored Gamification to Educational Technologies* (1st ed. 2019.). Springer Nature Singapore. https://doi.org/10.1007/978-981-32-9812-5

Oliveira, W., Pastushenko, O., Rodrigues, L., Toda, A. M., Palomino, P. T., Hamari, J., & Isotani, S. (2021). *Does gamification affect flow experience? A systematic literature review*. https://doi.org/10.48550/arxiv.2106.09942

Oliveira, W., Hamari, J., Shi, L., Toda, A. M., Rodrigues, L., Palomino, P. T., & Isotani, S. (2023). Tailored gamification in education: A literature review and future agenda. *Education and Information Technologies*, *28*(1), 373–406. https://doi.org/10.1007/s10639-022-11122-4

Pedroso, T., Cardoso, E., Rações, F., Baptista, A., & Barateiro, J. (2019). Learning Scorecard Gamification: Application of the MDA Framework. In T. Oliveira, R. Quaresma, P.

Silva, & I. Ramos (Eds.), *Information Systems for Industry 4. 0* (Vol. 31, pp. 29–46). Springer International Publishing AG. https://doi.org/10.1007/978-3-030-14850-8_3

Raymer, R. (2011). Gamification: Using Game Mechanics to Enhance eLearning. *ELearn Magazine*, *2011*(9). https://doi.org/10.1145/2025356.2031772

Robson, K., Plangger, K., Kietzmann, J. H., McCarthy, I., & Pitt, L. (2015). Is it all a game? Understanding the principles of gamification. *Business Horizons*, *58*(4), 411–420. https://doi.org/10.1016/j.bushor.2015.03.006

Roediger, H. L., & Butler, A. C. (2011). The critical role of retrieval practice in long-term retention. *Trends in Cognitive Sciences*, *15*(1), 20–27. https://doi.org/10.1016/j.tics.2010.09.003

Rowland, C. A. (2014). The Effect of Testing Versus Restudy on Retention: A Meta-Analytic Review of the Testing Effect. *Psychological Bulletin*, *140*(6), 1432–1463. https://doi.org/10.1037/a0037559

Ryan, R. M., & Deci, E. L. (2017). *Self-determination theory : basic psychological needs in motivation, development, and wellness*. The Guilford Press.

Ryan, R. M., & Deci, E. L. (2020). Intrinsic and extrinsic motivation from a self-determination theory perspective: Definitions, theory, practices, and future directions. *Contemporary Educational Psychology*, *61*, Article 101860. https://doi.org/10.1016/j.cedpsych.2020.101860

Sailer, M., Hense, J. U., Mayr, S. K., & Mandl, H. (2017). How gamification motivates: An experimental study of the effects of specific game design elements on psychological need satisfaction. *Computers in Human Behavior*, *69*, 371–380. https://doi.org/10.1016/j.chb.2016.12.033

Saputro, R. E., Salam, S., Zakaria, Mohd. H., & Anwar, T. (2019). A gamification framework to enhance students' intrinsic motivation on MOOC. *Telkomnika*, *17*(1), 170–178. https://doi.org/10.12928/telkomnika.v17i1.10090

Seijts, G. H., & Latham, G. P. (2005). Learning versus performance goals: When should each be used? *The Academy of Management Executive (1993)*, *19*(1), 124–131. https://doi.org/10.5465/ame.2005.15841964

Sheridan, T. B. (1992). Musings on telepresence and virtual presence. Presence: Teleoperators and Virtual Environments, 1, 120–126.

Shernoff, D. J., & SpringerLink. (2013). *Optimal Learning Environments to Promote Student Engagement*. Springer New York. https://doi.org/10.1007/978-1-4614-7089-2

Subhash, S., & Cudney, E. A. (2018). Gamified learning in higher education: A systematic review of the literature. *Computers in Human Behavior*, *87*, 192–206. https://doi.org/10.1016/j.chb.2018.05.028

Toda, A. M., Valle, P. H. D., & Isotani, S. (2018). The Dark Side of Gamification: An Overview of Negative Effects of Gamification in Education. In F. Lima, I. I. Bittencourt, & A. I. Cristea (Eds.), *Higher Education for All: From Challenges to Novel Technology-enhanced Solutions* (Vol. 832, pp. 143–156). Springer International Publishing AG. https://doi.org/10.1007/978-3-319-97934-2_9

Tsay, C. H., Kofinas, A. K., Trivedi, S. K., & Yang, Y. (2020). Overcoming the novelty effect in online gamified learning systems: An empirical evaluation of student engagement and performance. *Journal of Computer Assisted Learning*, *36*(2), 128–146. https://doi.org/10.1111/jcal.12385

Vrcelj, A., Hoic-Božic, N., & Dlab, M. H. (2023). Use of Gamification in Primary and Secondary Education: A Systematic Literature Review. *International Journal of Educational Methodology*, *9*(1), 13.

Warmelink, H., Koivisto, J., Mayer, I., Vesa, M., & Hamari, J. (2020). Gamification of production and logistics operations: Status quo and future directions. *Journal of Business Research*, *106*, 331–340. https://doi.org/10.1016/j.jbusres.2018.09.011

Werbach, K., & Hunter, D. (2012). *For the win : how game thinking can revolutionize your business* (1st ed.). Wharton Digital Press. https://ebookcentral.proquest.com/lib/kutu/detail.action?docID=5482556.

Werbach, K. (2014). (Re)Defining Gamification: A Process Approach. In L. Gamberini, A. Spagnolli, & L. Chittaro (Eds.), *Persuasive Technology* (Vol. 8462, pp. 266–272). Springer International Publishing. https://doi.org/10.1007/978-3-319-07127-5_23

Winters, D., & Latham, G. P. (1996). The Effect of Learning versus Outcome Goals on a Simple versus a Complex Task. *Group & Organization Management*, *21*(2), 236–250. https://doi.org/10.1177/1059601196212007

Witmer, B. G., & Singer, M. J. (1998). Measuring presence in virtual environments: A presence questionnaire. *Presence*, *7*(3), 225-240

Zichermann, G., & Cunningham, C. (2011). *Gamification by design : implementing game mechanics in web and mobile apps*. O`Reilly Media, Inc.

Appendices

Appendix A: Research introduction

Demographic questions:

- Name?
- Main subject of study and what year are you studying?

Introduction:

Welcome! In this test, you get to try out a gamified prototype platform for learning JavaScript. The platform uses a visual programming workspace where you can generate JavaScript code by combining blocks and execute the code snippets generated from them by pressing a button. The main objective of the test is to measure, in the context of learning computer science, how game elements affect student behavior, such as engagement and motivation. So, pay close attention to the user interface and its elements. The elements that appear in the test include points, levels, challenges, badges, and rewards. To clarify how engagement is defined in this test, it refers to a state in which attention, interest, and fun are higher than usual when solving study assignments.

You will face four exercises with different gamification elements. Each exercise has its own instructions, and they can be solved in a few different ways. However, the platform is only a prototype, so not all correct solutions have necessarily been considered. In these cases, I will advise how the problem is expected to be solved. The focus of the test is not on the learning content of the exercises, so they are not difficult.

You are free to explore the platform during the test, but I will also give you instructions during the test. You can think aloud during the exercises, explaining what you are doing and why. After the test, I will ask a few questions about the different elements. You are also free to comment on the experience at the end. Each exercise has instructions on how to complete the task, and you can read more detailed instructions for using the platform by pressing the question mark icon in the upper right corner.

In short, you can connect blocks and run the code generated from them by pressing the blue generate code button. When you think you have reached the right solution, you can evaluate the task by pressing the green button. For technical reasons, it is a good idea to start with the

indices from the ones and avoid leaving unnecessary pieces on the table. You may start the first exercise.

Appendix B: Test scenario

1. As a new JavaScript with Blockly user, you need to get an idea of how the platform functions. Read the instructions for the platform and try to complete the first exercise using the two blocks provided.
2. Congratulations on completing the first exercise! Try to check your progress in the platform and see the stars you got as a reward. If you are feeling unsatisfied with the points you got, go back to the first exercise and try it again and pay attention to capital letters and the exclamation mark.
3. Now you can start the second exercise. In addition to points, this exercise rewards you with a badge for completing the exercise while following the challenge rules. Try to clear this exercise using any possible solution but remember you can achieve the badge only by following the challenge rules.
4. Congratulations! You can go back to the second exercise and see how the badge looks now. If you did not get it the first try, you can try again.
5. Next you can start the third exercise. This exercise also has a challenge but seems to reward you with something else. This exercise is a little more complicated than the first two exercises so try to complete it with or without the reward.
6. Now you can start the fourth and last exercise. In this exercise you can use the reward block that you get from the challenge in the third exercise. It seems like the reward is connected to a bonus badge. If you did not unlock it the first time, you can go back to the third exercise to unlock the bonus block.
7. You can freely play around with your reward, and it will not affect your exercise. You can complete the last exercise.
8. Congratulations on completing all the Blockly exercises! Now is a good time to check if you have left any stars, badges or rewards uncollected.

Appendix C: Interview questions

Levels and block-based code editor:

- Was the block-based editor in exercises more immersive and engaging than normal text-based assignments?
- Did the separation of exercises into shorter levels make completing exercises more engaging or motivating?
- Do you think exercises that use Blockly or a similar tool would be an enjoyable way to learn at school?

Points/Stars:

- Did the collectable stars make you feel more concentrated, interested or entertained?
    - Did you find collecting stars motivating in a learning context?
- Was it fun collecting stars and looking back on your progress?

Optional challenges:

- Did the optional challenges make you feel more concentrated, interested or entertained?
    - Did you find the challenges motivating in a learning context?
- Is it more fun having optional challenges than being without them in school exercises?
- Which of the rewards did you prefer, stars, badges or the reward block?

Badges:

- Did collecting badges make you feel more concentrated, interested or entertained?
    - Did you find the badges motivating in learning?
- Was collecting badges fun?

Reward block:

- Do you think miscellaneous rewards such as the note block make the experience more engaging even if they are not relevant to learning?
    - Did you find them motivating even if they were not relevant to learning?

Other questions:

- Was the amount of gamification elements in the platform about right, too much or too little?
- Was there anything that bothered you on the learning platform or something that you liked?
- Was the usability of the platform good enough?
- How much did you enjoy the experience on a scale of 1–5?
- Any other comments?