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Bachelor Thesis

Gamification of Software Engineering Education: An Exploration

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Abstract

Gamification has established a change of paradigm in various domains, such as: human-computer interaction, health, and education. Yet, the concept itself is still underdeveloped, and nonetheless missing in standardization for its practical use. Despite widespread usage, little effort has been done to constitute a normalized state for its components. Moreover, the application of gamification has yet to find its rightful place in fields it is being used, since the lack of guideline makes it difficult for practitioners to find ground during the execution of the concept. In this bachelor thesis, we outline well-established approaches of gamification, and attempt to design a concept by synthesizing. We validate our design through an experiment involving a gamified system and the appropriate group of participants. Further, the feedbacks shall present the merits and shortcomings of gamification in practice. We end by suggesting possible gaps to examine. Gaps we discovered while composing this thesis.

Kurzfassung

Gamification hat in verschiedenen Bereichen wie Mensch-Computer-Interaktion, Gesundheit und Bildung einen Paradigmenwechsel eingeleitet. Das Konzept selbst ist jedoch noch unterentwickelt, und es fehlt noch an einer Standardisierung für seine praktische Anwendung. Trotz der weit verbreiteten Verwendung wurden nur wenige Anstrengungen unternommen, um einen standardisierten Zustand für seine Komponenten zu schaffen. Darüber hinaus hat die Anwendung von Gamification noch nicht den ihr gebührenden Platz in den Anwendungsbereichen gefunden, da das Fehlen eines Leitfadens es den Praktikern erschwert, sich bei der Umsetzung des Konzepts zurechtzufinden. In dieser Bachelorarbeit skizzieren wir etablierte Ansätze der Gamification und versuchen, durch Synthese ein Konzept zu entwerfen. Wir validieren unseren Entwurf durch ein Experiment mit einem gamifizierten System und der entsprechenden Teilnehmergruppe. Außerdem werden in den Rückmeldungen die Vorzüge und Mängel von Gamification in der Praxis dargestellt. Abschließend schlagen wir mögliche Lücken vor, die es zu untersuchen gilt. Lücken, die wir beim Verfassen dieser Arbeit entdeckt haben.

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1 Introduction

In a generation surrounded with a digitalized world, the process of learning cannot be stagnated in what it is decades ago [Lev10]. Today's youth requires a different learning approach to process information. A possible solution to this problem can be acquired by rethinking the old ways. Rethinking also means redesigning, which leads to recreating. Gamification offers such solution in both low- and high-fidelity execution [Pre05].

The basic hunch of gamification is introducing gaming elements in non-gaming context [DDKN11]. The application of the method can be found in a wide spectrum of domains, such as health, sports, business, and in our case education [HKS14]. This bachelor thesis shall present the method of gamification as an alternative to the traditional way of learning process. Employing elements like points, badges, leaderboard to engage the students into participating more and fostering a better behavior towards task completion and community within the university [WH12].

We specifically set our focus on the software engineering field. A domain that presents high connection to technology and modern ways of thinking, as well as a deep learning curve for novices [KL15]. Not to mention, the hurdles it gathers for students studying at an academic level. The present work shall explore the moving parts of gamification, and examine the potential effectivity of the method when applied in higher education. Our work contains possible solution, on rethinking the classic learning process, and showcase an experiment conducted on the appropriate audience to prove its validity.

1.1 Research Questions

To tackle our topic, we aim to answer three main Research Questions

- Research Question 1: Which gamification elements have been used in existing works on software engineering gamification?
- Research Question 2: How can gamification elements be applied when teaching an introductory software engineering course at the Bachelor of Science Level?
- Research Question 3: Which gamification elements are more effective when teaching an introductory software engineering course at the Bachelor of Science level?

While setting a concrete definition to our research questions, we found that granulating them would help us get a better and detailed answer.

In Table 1.1, we formulate new questions to answer the main research questions properly. We propose the sub-questions RQ1.1 and RQ1.2, that would provide background information to resolve RQ1. RQ1.1 and RQ1.2 give us the introduction to our main topic, which is gamification. Further, we suggest the sub-questions RQ2.1 and RQ2.2 to provide process relevant content, that would optimize our answer to RQ2.

ID	Research Question
RQ1	Which gamification elements have been used in existing works on software engineering gamification?
RQ1.1	What are gamification elements?
RQ1.2	How do we apply gamification elements?
RQ2	How can gamification elements be applied when teaching an introductory software engineering course at the Bachelor of Science Level?
RQ2.1	What should we consider when applying gamification elements?
RQ2.2	How to decide which gamification elements are the right ones to use?
RQ3	Which gamification elements are more effective when teaching an introductory software engineering course at the Bachelor of Science level?

Table 1.1: Extended Research Questions

1.2 Outline

This small section shall help the reader understand the flow of this bachelor thesis. After the Introduction, we start with the Fundamentals to get a vital knowledge about the components that surround gamification. Then we get to understand the context of our work in a more specific manner with the Background. Next, we will examine existing papers that are relevant to the present work in the Related Work Chapter. The next chapters will include the main parts of the thesis. Beginning with the Conceptual Design, which will present a detailed look into the design we created with the support of the knowledge we obtain from the previous chapters. After the abstraction comes the concretization, Experimental Design, in the form of the execution of our design, here we present the solid result of the lecture we redesign with gamification. Next, Results, we examine the results from a small experiment we conducted, and investigate what effects we can see through the views of the participants. Additionally, we noted limitations and challenges to consider, when reading this thesis. Finally, we summarize our work and present other gaps we have observed throughout the process of composing this thesis in our Conclusion and Outlook.

2 Fundamentals

This chapter provides the foundations of this Bachelor Thesis. First, we provide an introduction to Gamification. It is then followed by the two core components of Gamification, which are Gamification Elements and Gamification Frameworks. Our goal is to obtain valuable knowledge about the topic. This part will also bring answers to research questions:RQ1.1 and RQ1.2.

2.1 Gamification

From here on forward, we will learn about gamification step-by-step. We start from the generic to the specific. This section contains general aspects of gamification.

The definition of gamification varies in some way or the other. As a whole, the discipline of gamification revolves around implementing gaming elements into non-game contexts [DDKN11]. The first instance of gamification is not clear, since the term itself is first coined by *Nick Pelling* in 2002[Kim15], and yet the presence of this method can already be observed as early as 1896¹, in the form of rewards provided by merchants to their loyal customers. In gamification, this kind of action is called: “Awards” [Cho19], and is a gamification element that acts as an extrinsic incentive to users.

The Goal of gamification is to change or improve user behaviors. The application of this method has a wide spectrum [HKS14], and can be notice in domains such as Business(Payback²), Health(Nike Run Club³)[TL18], and of course our topic of interest: Software Engineering Education (Hackerrank⁴)[KSF16].

Before we go even further, we have to determine what we mean when we use the term gamification. It is in fact vital to differentiate between games and gamified systems. While games, we know on a daily basis, aim to entertain us, the practice of gamifying varies its focus depending on the application [DDKN11]. The main distinction of games and toys to gamification, is the goal they have. Each one motivates a different human aspect [Cho19]. In Figure 2.1, we can see where the practice of gamification belongs to, compared to its counterparts. On the top-right, Parts and Gaming. This means gamification, while it uses gaming elements, is not ought to be a game itself.

¹<https://www.gamify.com/gamification-blog/the-history-of-gamification>

²<https://www.payback.de/>

³<https://www.nike.com/nrc-app>

⁴<https://www.hackerrank.com/>

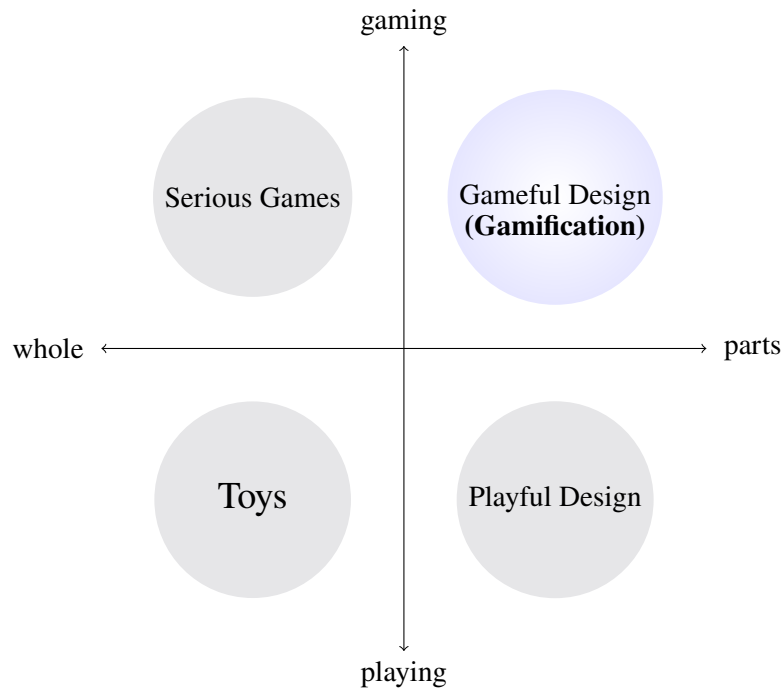


Figure 2.1: Gamification compared to other gaming terms [DDKN11]

2.2 Gamification Elements

Gamification Elements are the core components of the Gamification process [WH12]. With the help of Gamification Frameworks, practitioners can apply gamification elements efficiently, and have a better overview of which elements they need for the field of application. The number of existing Gamification Frameworks has grown in the last couple of years, and so the number of Gamification elements [TCS+19]. This growth has affected the attempt of normalization of gamification elements, since most gamification frameworks have different understandings and application of the elements. We can also observe that although numbers of gamification elements have risen, the amount of synonyms being acknowledged as *new elements* has also grown [DD17]. This is a side effect of the lack of the existence of a naming convention in the field of gamification. Toda et al. has classified existing gamification elements, in an attempt to give various existing elements with the same meaning a unified term [SF15]. In this work, we take the taxonomy introduced by Toda et al. as the basis to fall back on when we talk about gamification elements [TKO+19].

The following is a summary of Gamification Elements as defined by Toda et al. ([TKO+19]) In their work, 21 elements have been classified into 5 *dimensions*. Each of the 21 elements have been reviewed by at least five experts⁵ to be then put into one of the five following dimensions.

⁵Gamification Practitioners and Teachers

Performance: this dimension corresponds to elements that provide the users environmental response. Lack of these elements in the system leads to disorientation, as their actions demand certain feedbacks. Elements that belong to this dimension are: *Level, Progression, Point, Stats, and Acknowledgement*.

Ecological: this dimension contains elements, that exhibit the gamified environment to the user in the sense of interaction through the system itself. Elements that belong to this dimension are: *Chance, Imposed choice, Economy, Rarity, and Time Pressure*. The lack of this dimension may cause boredom.

Social: this dimension represents elements that are responsible for interactions between users within the environment. *Competition, Cooperation, Reputation, and Social Pressure* are the elements in this dimension. Without these social components, users may end up being isolated from others, due to lack of interactions.

Personal: *Objectives, Puzzle, Renovation, Sensation, and Novelty* are the elements that belong to the Personal dimension. These factors provide users a sense of meaning, and the lack of them can lead to demotivation.

Fictional: this dimension is a mix between environmental oriented and user oriented components. This gives context to the system as whole. *Narrative and Storytelling* are the main parts of this dimension.

After reviewing the 5 proposed categories of elements, we will look in the detailed descriptions of each element we mentioned above. For an overview, we provide the following table:

	Elements	Description
Performance	Progression	Provides an extrinsic guidance to the users of the achievements in the environment, allowing them to track themselves.
	Level	Also referred to as skill level, character level, and so on. This is related to an extrinsic hierarchical layer that provides the user with new advantages as they advance in the environment, for example, students gain a level when they complete a certain number of tasks, and as they advance their level, they have access to more difficult tasks.
	Point	Point is the most basic concept found in almost all gamified applications [DD17]. It comes in all kinds of variety like scores, skills points, experience points. It is a simple way to give extrinsic feedback.
	Stats	Visual representation of the player's current data. This can come as a dashboard of properties, or in many games as a Head Up Display(HUD).
	Acknowledgement	Badges, Medals, Trophies. Extrinsic Feedback that praises the players' specific set of actions, like completing a certain number of problems, may lead them to earn a "solver" badge. Acknowledgement is one of the most used elements in gamification[KOGP18]

Ecological	Rarity	It is related to extrinsically limited resources within the environment that can motivate learners to achieve a specific goal. It is also known as exclusive items, collection or limited items.
	Economy	This concept is extrinsically related to any transaction within the environment. This may, for example be, trading points for advantages. It can occur in a form of marketplace or transactions between users.
	Imposed Choice	This extrinsic concept occurs when the player is presented with an explicit choice that they must make in order to progress in the environment. One example of this concept is to present the user with two different paths and force them to choose one or the other, preventing them from progressing if a choice is not made. It is also known as choice, judgement and paths.
	Chance	Also known as chance, fortune, or probability. This intrinsic concept is related to the random property of a specific event or outcome, e.g., the student may receive a random number of points after completing a task; spinning a roulette that may give the user a bonus; the user has a chance of receiving a special item based on its luck [Dig11].
	Time Pressure	also known as countdown timers or clocks during a process or while doing a task. This element puts pressure on the users. It occurs in a learning environment as deadlines. Time Pressure is considered as one of the irrelevant elements since it can potentially harm the learning process [TVI17].
Social	Social Pressure	More commonly known as peer pressure, or in some cases guild mission. Like Time Pressure in the Ecological dimension. This Element exerts pressure on the player, and is also considered as an irrelevant element.
	Competition	It is an intrinsic concept, that comes as conflict, leader boards, Player vs Player(PvP), etc. It is tied to a challenge where the user faces another user to achieve a common goal.
	Cooperation	This element is considered to be the absolute opposite of Competition. This intrinsic concept is rather than competitive, takes advantage of collaborative effort of a community. It is also known as Co-op or Teamwork. An example is players helping players [SCHD14].
	Reputation	This intrinsic Element takes advantage of social status of players within the environment or community. Unlike levels, reputation can be gained when players complete tasks outstandingly. It can also form another type of hierarchy within the system.
Personal	Novelty	This concept introduces updates, surprises, and changes in the system. This kind of strategy offers users more dynamic perception of the environment, which is good, since studies have shown, that static approaches are vulnerable to players being demotivated [HF15].
	Renovation	Also known as boosts, extra life or renewal. This concept allows players to re-do a failed task, in a form of second chance. It is one of the properties that makes games fun[LH11].

	Puzzle	This intrinsic concept is associated with the activities that are implemented within the environment; they can be linked or considered as learning activities because the focus is to provide a cognitive challenge to the learner. This concept is also present implicitly in all educational settings, such as quizzes or challenges.
	Objective	This concept is related to goals, it gives the user an end, or purpose to perform the required tasks. Objectives can come in all forms, from broad, such as course approval, or specific, such as completing critical tasks [TVI17].
	Sensation	This element is perceived via Visual or Sound stimulation. It is an intrinsic approach to improve the user's learning experience. This can come as a dynamic or gameful interface, and also as complex as AR/VR representation (Augmented-/Virtual-Reality).
Fictional	Narrative	This Element is also known as Karma System or implicit decisions. This experience is influenced by implicit choices that the users have done. As an example, is giving token of appreciation for player to player interactions[PTO+19].
	Storytelling	This can be seen as audio queues or text stories throughout the environment. It is highly used as a tool to support the narrative within an environment[PTO+19].

Table 2.1: Taxonomy of Gamification Elements by Toda et al. [TKO+19]

2.3 Gamification Frameworks

After getting to know the elements in gamification. We will have a detailed look into existing Gamification Frameworks. The goal of this part is to present how the elements interact with each other in the process of gamification, and how they work with the use of a Framework. In this bachelor thesis, we have only considered well established concepts.

2.3.1 Octalysis Framework by Yu-kai Chou

The Octalysis Framework, developed by Yu-Kai Chou, a gamification Pioneer, and amongst others, a gaming enthusiast. The whole Section 2.3.1 is dedicated and based on the works of Yu-Kai Chou [Cho19]. The framework is suitable for both design and analysis, which means we can use it to create a game-based system or gamify an existing instance, as well as analyze existing games, platforms, programs, etc. Analyzing with Octalysis brings out which factors speak to the user, and specifically which core drives we target with each element we use. Like analyzing, designing with the Octalysis Framework utilizes core drives, by which we base our decision-making process on the needs of potential users. But what are core drives? Defined by Yu-Kai Chou, these are Factors, that motivate a user to complete a task efficiently.

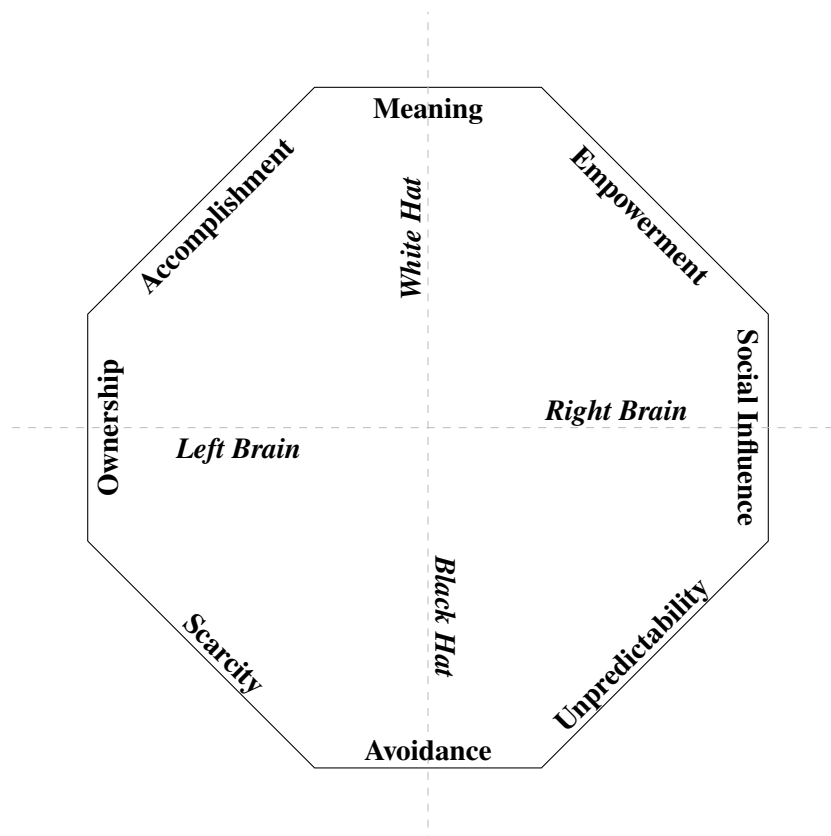


Figure 2.2: A visual representation of the Octalysis Framework [Cho19]

Meaning, Accomplishment, Empowerment, Ownership, Social Influence, Scarcity, Unpredictability, and Avoidance build together the 8 Core Drives of the Octalysis Framework. As already mentioned in Section 2.2, existing gamification frameworks tend to have a different interpretation of gamification elements. To better understand this framework, we look into a detailed description of each Core Drives and observe how they go with gaming elements.

Descriptions	Examples
Core Drive 1: Epic Meaning and Calling	
This Core Drive addresses the user's "good side". When they take action with reasoning of doing something for a good cause, or something that is greater than oneself. An example would be, users creating contents for the community without expecting something in return. This drive is not solely limited to altruistic behaviors.	Narrative, Elitism, Hero, Beginners Luck
Core Drive 2: Development and Accomplishment	
This Core Drive is intact when users feel to have achieved something when successfully carrying out a task. An important aspect is the perception of progress through overcoming hurdles, which are then rewarded in a noticeable way.	Points, Badges, Leaderboards
Core Drive 3: Empowerment of Creativity and Feedback	
This Core Drive is in play when the players engage the activity to express creativity and obtain visible results. Lego and Minecraft are the best examples. The best outcome is when the design does not need to actively intercept the process, because the users are entertaining themselves through their own creativeness.	Milestone Unlocks, Boosters, Dynamic Feedback
Core Drive 4: Ownership and Possession	
This Core Drive plays, when users feel connection to what they get from the system. This drive speaks to the motivation of getting more from the system and collecting some kind of compensation. It is also observable that when users spend more time on it, the more it can deepen the bond between them. This drive makes collecting, hoarding, and also creating something unique fun.	Avatar, Collection Set, Virtual Goods
Core Drive 5: Social Influence & Relatedness	
This drive integrates all the social elements that move people. Motivations like competition, collaboration, companionship, and envy. This Core Drive focuses on connection to people and material possession, such as relating to something from their past, or getting driven by the skill set of others within the system.	Friending, Mentorship, Group Quests

Core Drive 6: Scarcity & Impatience	
This is the drive of wanting something because you can not have it right away. Many games have Appointment Dynamics, where players are ought to wait for rewards before getting it. People get driven by annoyance. This is also mostly exploited by games to get players to spend money on premium purchases.	Timers, Prizes, Appointment Dynamics
Core Drive 7: Unpredictability & Curiosity	
In general, this is a harmless drive of wanting to find out what will happen next. Not knowing what is going to happen next can engage the user to wonder about it. Good applications can be surprise task or cliffhangers. Sometimes it can be used to exploit users through lottery and mystery boxes.	hidden Quests, cliffhangers, mystery boxes, lottery
Core Drive 8: Loss & Avoidance	
This core drive is based upon the rejection of something negative happening. For example, preventing to go back to a previous starting point. It can also move users to act with the reasoning of avoiding losing the opportunity to fulfil something, if nothing is done.	Progress Loss, Penalty tasks

Table 2.2: Octalysis Core Drives: Definitions and Examples [Cho19]

As seen in Figure 2.2, the Octalysis Framework acts with 8 core drives, which are categorized into 4 intersecting groups. Notice the Octagon representation of the core drives, this is not just for aesthetics, but goes intuitively with how the categories of the core drives are form.

Left Brain & Right Brain Motivators: On the left and right side of the octagon, we have the drives that responds to, respectively, *the left and the right brain*. Core drives Accomplishment, Ownership, and Scarcity on the left are extrinsic motivators, which cause users to act, given they gain something in return. Behaviors supplemented by these motivators tend to diminish as the gain disappear or lessen. The right side, on the other hand, relies on the user’s intrinsic motivation. These incentives employ creativity, self-expression and social-dynamics, rather than the need of reward in return. Core Drives that belong to this category are Empowerment, Social Influence, Unpredictability.

White Hat & Black Hat Motivators: Techniques that utilize the Top and Bottom portions of the octagon structure are, respectively, *“White Hat Gamification”* and *“Black Hat Gamification”*. White Hat Core Drives are Accomplishment, Epic Meaning, and Empowerment. These drives keep the users engaged into the activity, through expression of creativity and achievements. For example: visible improvements of skills can give the user a higher sense of meaning, which empowers them and give a pleasant feeling about themselves. Unlike White Hat Motivators, Black Hat Motivators exploit the addictive nature within the users. The fear of losing, or being motivated by greed are typical behaviors the users tend to show when being driven by Black Hat Motivators. Scarcity, Avoidance, and Unpredictability are the Core Drives that belong to this motivator.

2.3.2 6D Framework by Werbach and Hunter

Unlike the Octalysis Framework by Yu-kai Chou [Cho19] that helps us to design and analyze, the 6D Framework functions as an assistance in planning a gamification system. As seen on the right Figure 2.3, the 6D Framework follows a 6-step procedure to gamify a process. This section is based on the works of Kevin Werbach and Dan Hunter[WH15].

Step 1: **Define business objectives**

State the reasons why we decide to use gamification, along with expectations, such as: positive changes or results, specific goals, and what benefits we want to obtain through a gamified system.

Step 2: **Delineate target behaviors**

Express the desired behaviors we want to see from the users. Implement metrics to measure how much the users show during the process.

Step 3: **Describe your players**

Identify the users we have in focus for the process we want to gamify. The use of demographics, psychographics, or user typologies is hereby proposed.

Step 4: **Devise your activity loops**

Design the process in such a way that it will enhance the user's motivation, and would help them stay engaged through the whole process. A system that would give them feedbacks about their progress is necessary to keep users on track of themselves.

Step 5: **Don't forget the fun**

Include "fun" elements in the gamified process. This should act as an intrinsic motivator for the users and would improve their connection to the system.

Step 6: **Deploy the appropriate tools**

The last step combines all decisions made in the previous steps. Here we create the layout of the system as a whole, and describe how it will look from the structure within to the overlay the user would then use once deployed. Here we also decide which are the appropriate tools to use, from low to high fidelity (pen & paper, digital, mobile-based, etc.), abstract to concrete (elements, frameworks, gamification tools, etc).

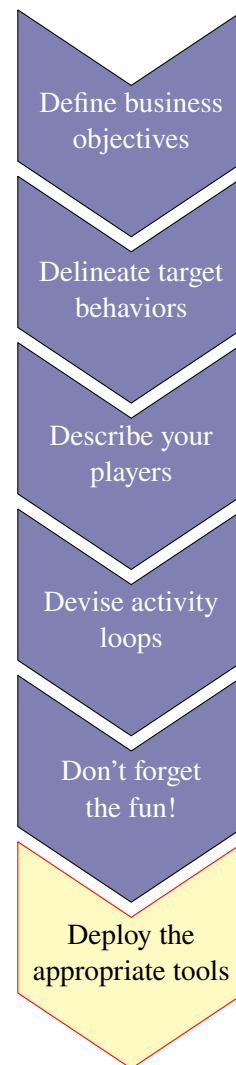


Figure 2.3: 6 Steps of the 6D Framework [WH12]

Like other gamification frameworks, Werbach and Hunter also have their own interpretation of gamification elements. Different to the previous Octalysis Framework by Yu-kai Chou, the elements in this framework takes the form of a pyramid, which is separated in 3 parts.

From the top: Dynamics represents the concepts and implicit structure of the gamified system, such as the narrative of the system and what constraints are on the users. Mechanics, these are actions that move along the user while progressing through the system (rewards, feedback, turns, etc.). Finally, Components, these are the gaming elements we use in the system (levels, badges, quests, avatars, etc.).

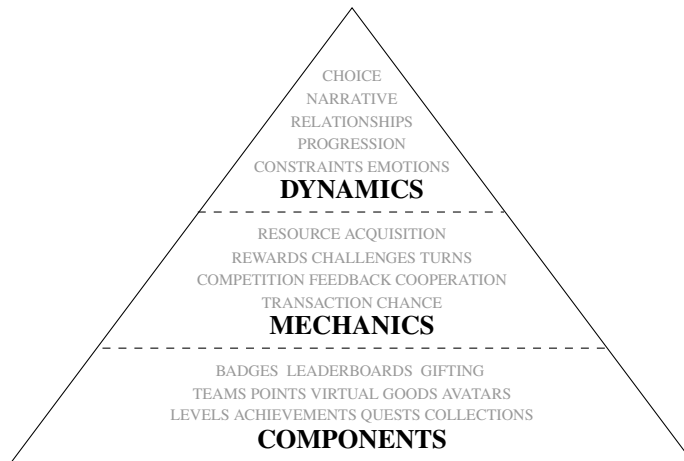


Figure 2.4: Pyramid of Game Elements by Werbach and Hunter[WH15]

2.4 Summary of Gamification Components

We will end this chapter by giving an overview of the components we examined in the previous sections. Together with elaborate answers to Research Questions RQ 1.1, RQ 1.2, RQ 2.1, RQ 2.2.

With the efforts of unifying gaming elements and giving them conventional terms[TKO+19], the work of Toda et al. assists us when dealing with multiple gamification frameworks while designing. As seen in the previous sections: 6D Framework and The Octalysis Framework, gaming elements can have different interpretations when used in different frameworks.

Different Frameworks can also mean different application focuses. While the Octalysis Framework can act as both design and analysis pattern, the 6D Framework provides a detailed form of process in planning and creating a gamified system. Both these frameworks have their strengths and weaknesses, which can be compensated when applied together[SDRI14].

This chapter also offers answers to the research questions we defined in the Introduction. RQ 1.1: “What are gamification elements?” is answered in the Gamification Elements Section. RQ 1.2: “How do we apply gamification elements?” is answered in the Frameworks Section. Likewise, RQ 2.1: “What should we consider when applying gamification elements?” and RQ 2.2: “How to decide which gamification elements are the right ones to use?” are answered in the Frameworks section, through two different approaches suggested in Yu-Kai Chou’s [Cho19] and Werbach’s [WH15] works.

3 Background

This chapter will sustain the preamble to our main work with relevant information about our focus. We explore different branches of the main topic, which is *Gamification in Software Engineering Education*. Here, we divided it in two subjects: Gamification in Software Engineering Workplace and Gamification in Software Engineering Education. While the latter, speaks directly to our main topic, it is important for us to see a comparison between two variables of the same field. The goal of this chapter is to provide data about the use of Gamification in Education and Workplace in the context of Software Engineering, and at the end, summarize differences and similarities of the two.

3.1 Gamification in Software Engineering Workplace

This section reviews the landscape of Gamification in the Software Engineering Workplace. Here, we use the studies of Pedreira et al. [PGBP15] as an assistance to crawl through this topic. This part also aims to answer Research Question 1.

Software Engineering, as it is, has always been a human-intensive process. Every Software in existence has humans behind it[Wei71]. Gamification, consequently, has a promising place in this process. There are already commercial tools which support Software Engineering Processes, that are incorporating basic gamification elements. Some examples are: ScrumKnowsy¹, Hackerrank² and Leetcode³.

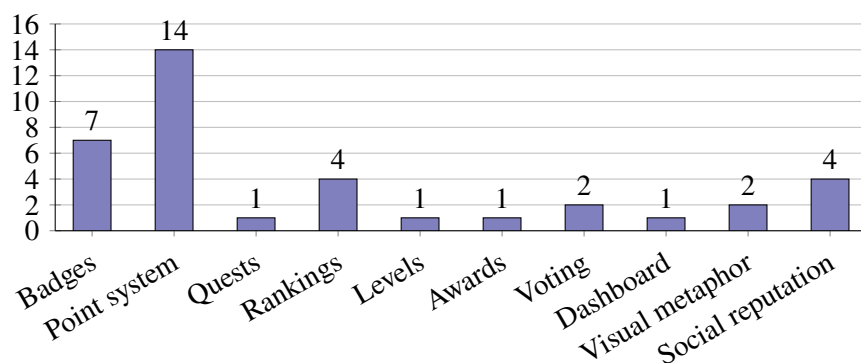


Figure 3.1: Distribution of gamification elements used in primary studies [PGBP15]

¹ScrumKnowsy: <https://www.scrumknowsy.com/>

²Hackerrank: <https://www.hackerrank.com/>

³Leetcode: <https://leetcode.com/>

We notice in Figure 3.1, most studies only apply “simple” gaming elements, such as Points and Badges, which are elements to enhance extrinsic motivation. This type of application can also cause draw-backs when the time comes, because relying solely on these elements can also demotivate users when not applied correctly [Cho19]. Tools that have been cited by earlier papers are often discontinued due to lack of impact, or even negative feedback from users. The lack of creativity can be an obstacle for the application of gamification [MRGA15]. Especially, with software engineering not being just like any other job, the difficulty to design a successful gamified application rises.

3.2 Gamification in Software Engineering Education

Recent studies show that gamification in software engineering education has proven to have positive impact in the most instances it was implemented [AM18]. Unlike gamification in software engineering workplace, the application in the educational field has more promising results. The reason to this can be due to the fact that gamification appeals more when applied in learning process, to which the users are to overcome a rather high learning curve [KL15]. Other studies, have already found the positivity of the application of gamification in software engineering education [NZT+14]. We can also notice the presence of gamification in software engineering education in academic reports stems majorly from application in higher education [CEO14]. Thus, the high potential of gamification in the educational field shall be the main motivation of this work [JBC+16].

3.3 Education vs Workplace

When surveying existing literature on gamification in education as well as workplace, we found that the method of application of elements can be easily distinguished. while in education, the application varies and tend to be more creative, in a work environment, gaming elements are kept simple. The application of gamification requires dedication and creativity [MRGA15]. Thus, a halfhearted usage could turn negative during the execution or even earlier.

4 Related Work

In the last two chapters, we examined vital components of gamification. This chapter presents existing scientific papers, that we found relevant to our main topic, and would assist us in answering our research questions. In this bachelor thesis, we aim to explore gamification concepts and their applicability in the context of teaching software engineering at an academic level.

The application of gamification is widely used in various domains, such as health, marketing, and education [HKS14]. This work targets education, specifically higher education at the university level. This chapter shall showcase the presence of our main focus in scientific literature. For instance, Bartel et al. [BH14] came up with a mobile based concept of gamifying a university course. They built a 3-part Structure(Supervising Client \Leftrightarrow Mobile Server \Leftrightarrow Mobile Client), using a Java Client to supervise the students, and provide instant feedbacks. They employed elements such as, Leaderboards to compare and compete with other participants, and personal profiles to inform students about the recent achievements and knowledge state. Our work also considers this approach and comes up with a comparable idea.

Another example of a gamified approach in Software Engineering Education, is Call et al. [CFS21] on motivating students to start and finish assignments earlier. Their study proposes to solve the problem of first year students during their early semesters, and help them acquire good standards along the way. To achieve their goals, they applied gamification suggestions from [HIHK14] and [SFSR13]. From which they took the ideas such as leaderboard and a point system. They used a course of Data Structure in Computer Science with 50 Students to test their gamified environment. The system builds as follows: Assignments can be push via Git and goes through an automated testing system, which gives instant feed back to students. Feedbacks are then recorded in a moodle¹ leaderboard plugin. Students also obtain points from answering questions from their peers. These elements are, respectively, competition and collaboration, which are both extrinsic elements in gamification(Table 2.1). The study obtained a positive outcome, since students of the course responded well, by finishing tasks earlier. They can also observe a higher amount of Q&A feedbacks, which allows a better Student-to-Student communication. The Study also presents a negative side of gamification in education, which is the complexity of designing a gamified system to get a better result and response.

Another instance in efforts of motivating first year students to acquire and retain good software engineering habits can be observed in a case study by Matsubara et al. [MD17]. They apply the concept of gamification in the form of a group project. The game design was created with the help of the 6D Framework of Werbach et al. [WH15], which we analyzed in an earlier section (6D Framework by Werbach and Hunter). They have also thoroughly examined the needs on both the side of students and the side of teachers in software engineering education[Fra14]. They employed gamification elements such as Experience Points(EXP) as a progression index, and the

¹<https://moodle.org/>

option of trading obtained points for real points that affects their grades. They also discussed the negative impacts of gamification they observed throughout the case study, for example: completion time of the given tasks can collide with other tasks that have a higher priority. This caused a lower engagement level, since the project consists of volunteer students. Although, negative aspects were present, students show appreciation towards the presence of game elements in the whole process.

Our main contribution to science is to offer a gamified approach to redesign the learning process of software engineering education at an academic level. Further, we direct our focus on students with low preexisting knowledge on software engineering, and ease the learning curve it presents to novices.

5 Conceptual Design

After acquiring a generous understanding of our topic and all elements that surround it, we decided it is best to answer RQ2 and RQ3 through an experiment. With the guidance of the previous chapters, we designed a prototype of a gamified learning process in the form of a digital lecture and tested it on students of the University of Stuttgart. This chapter provides all steps taken to design a gamified Software Engineering course, which includes a planning phase, defining phase, and a designing phase. Every phase we mentioned derived from the previous approaches we presented. The 6D Framework of Werbach and Hunter [WH15] inspired the concept of the planning phase, while the Octalysis Framework of Yu-Kai Chou [Cho19] and the definitions provided by Toda et al. [TKO+19] assisted us in both defining the elements and designing the prototype. The defining and designing phase posed a challenge due to their creative nature, and the different interpretations of each approach, as already mentioned in the Gamification Elements section. In most of our decision, we let the success of existing studies influence the element of choice. We made it our task to redesign an introductory course of software engineering as it is taught in the university of Stuttgart.

Redesigning a learning process means to extract the set of activities that produce learning as a result. Further, we rethink its activities to achieve a better result from the objectives of the process. This implies that the outcome should generate a more efficient and effective result than the previous method. Therefore, the following experiment shall offer an answer, if gamification provides such solution in our case.

5.1 Planning Phase

This section consists of the steps we take before going to the definition phase. We use the 6D Framework as a guide in constructing the scaffold that we will use to base our design later.

Define business objectives:

We aim to answer RQ2 and RQ3. These Research Questions focus mainly on how gamification can affect Software Engineering in higher education, specifically on the introductory level. This step requires us to describe what changes we want to perceive from the system we create. We made a list of these goals to have an overview:

- enhance Student Engagement in lectures
- boost Student-to-Student communication
- promote task completion

Delineate target behaviors:

In this step, we specify the behaviors we want to promote with each of the goals listed in the previous step, and how we can measure them in our system. We want to witness an increase in student engaging in lectures through a progress tracking metric. Student-to-student communication should be measurable and rewarded. Task completion within and outside the lecture should be encouraged with a point system.

Describe your players:

Here, we describe the demographics of our target population. As already specified in step 1, our goal is to employ changes in behaviors of relatively new students with none to little pre-existing knowledge about Software Engineering. To get better details on the target users, we read through the Module Handbook of the Software Engineering Curriculum of the University of Stuttgart¹. We extract the courses relevant to our focus and the semesters they are recommended.

Software Engineering B.Sc., University of Stuttgart	
Courses	Recommended Semester
Programming and Software Development	1 st Semester
Program Development I	1 st Semester
Data structures & Algorithms	2 nd Semester
Introduction to Software Engineering	2 nd Semester
Practical Training in Software Development	3 rd Semester
Program Development II	3 rd Semester
Course Project	4 th Semester
Programming Paradigms	4 th Semester
Software Engineering	5 th Semester

Table 5.1: Summary of Software Engineering Courses in the University of Stuttgart for B.Sc. Software Engineering Students

Table 5.1 shows us a brief listing of the courses we found relevant, which means these are all mandatory to Software Engineering Students, and all optional courses are excluded from the extraction. We can see that the first practical experience of a student starts at the 3rd Semester, after the introductory courses in the 1st and 2nd Semesters. This made us decide to define the target group as students below the 3rd Semester, which we assume to have low preexisting knowledge about Software Engineering.

¹<https://www.uni-stuttgart.de/studium/bachelor/softwaretechnik-b.sc./img/studienverlaufplan-bsc-softwaretechnik.pdf>

Devise activity loops:

In this step, we define two activity loops. Engagement and Progression Loops will both enhance the user's motivation to use the gamified system in the long run [WH12]. While Progression Loops operate at a macro level, which is perceivable in the gamified environment, and guides the user through the whole process, Engagement Loops are rather recurring and constantly pursuing the user to act. In our case, we want the user to feel the gamified environment in a form of global progression or narrative, as well as engage them throughout the process with an activity or task they need to complete within a given time. The vital part of this step is to give a clear progression pattern that the users would go through in order to master the gamified course by the end of the semester. This step gives the designer a challenge, since it is uncertain to know which elements would fit best to the requirements we define.

Don't forget the fun:

This step is a challenge for designers as well. Including a fun factor is not necessarily the use of game-like structures. It is to apply gamification elements so that they engage the user's intrinsic motivation and provide a strong commitment to the system. We save further details of this step, and expand it in the designing phase.

Deploy the appropriate tools:

The final step of the 6D Framework brings all 5 previous steps together. After evaluating the requirements we defined, we start the assessment of existing tools, or create the system of our own. In our case, the last step is the bridge to the next phase of our process, which is the defining & designing phase.

5.2 Defining and Designing Phase

The defining and designing phase exhibits a challenge for every practitioner. It is important to apply knowledge we obtain from previous studies to determine our elements, since it is our first and only attempt to design the process within the time permitted for this bachelor thesis. This phase utilized the Core Drives introduced by the Octalysis Framework[Cho19] in manifesting the ideas we define in the previous phase. Table 5.2 shows the elements we decided to use, as well as the core drives we wanted to address. We used the generalized Elements suggested by Toda et al. [TKO+19], and later refined them to be visualized in the form of mock-ups.

Core Drive 1 – Epic Meaning & Calling:

We want users to feel a certain meaning to each action they fulfill, and go further than to act to satisfy themselves. A narrative that advance each time the user takes step

Core Drive 2 – Development & Accomplishment:

We want users to experience progress, when completing tasks. The system should provide feedback after every given assignment. This should allow the users to track their improvement, while using a gamified system.

Core Drive 5 – Social Influence & Relatedness:

Users should be motivated to communicate with others, and foster a sound community. Every instance of communication should be able to be recognized.

Core Drive 7 – Unpredictability & Curiosity:

The system should showcase unpredictable tasks to motivate users in completing them out of curiosity. We want users to act on their own, and solve the problem with their interest in getting the answer.

Elements	Core Drives
Progression	2
Narrative	1,2
Cooperation	1,2,5
Acknowledgement	2,7

Table 5.2: Elements and Core Drives used for designing the gamified lecture

We then took inspiration from existing papers to refine the elements we listed above (Table 5.2). The following elements emerged from the choices we made:

For **Progression**, we decided to apply EXP (Experience Points) and levels [MD17]. These elements will help students track their progress, while taking the gamified course. The element of a **Narrative**, shall be embodied by quests and challenges. We aim to bring meaning to every action taken by the students in the form of completing significant tasks [BH14]. **Cooperation** will be fostered by recognition of solidarity within the community of students [CFS21], which means events driven by community points shall incentivize good behavior among students, and promote helpfulness between peers. **Acknowledgement** shall represent progression in a bigger picture. Student should feel recognition from both peers and the gamified system. Such recognition should also be unpredictable[HKS14], and address the students' curiosity.

5.3 Prototype

This chapter reaches its ending with this section. Here we present the results of designing a gamified software engineering course. A quick summary of the steps taken to conceptualize our design shall provide an overview of the relatively lengthy process. We first planned our process with the direction of the 6D Framework. After that, we defined and designated gaming elements we found befitting to the needs of our target group. All processes come together in this section, where we introduce the prototype for the first time.

As already defined in our research questions RQ2 and RQ3, we want to provide an insight to how can gamification be executed in an introductory course, and on top of that, which element stands out on top the others. The course of choice was rather convenient, as we can see in Table 5.1, "Introduction to Software Engineering" gives a promising title. While analysing the course'

program, we found that, it is, in fact, the best fit to our criteria. Due to current circumstances (SARS-CoV-2-COVID19 Pandemic ²), the course was last offered in a digital format. The course is structured in a modular manner, which provides pre-recorded videos that are divided in categories accordingly. The organizers have a recommended sequence to watch the videos, but the students are free to pick what to watch first. The videos also offer an interactive element in which students can answer questions from the lecturer in the chat asynchronously. There are no prerequisites for this course, and students from any other computer science related majors can attend. Participating students are required to form a group of 5 with other participants, and have to regularly submit assigned tasks on a weekly basis. Adequate task completion is mandatory, as it is a requirement to be allowed to partake in the final exam.

Finally, we present the ideas we visualized, and later executed. This part provides low-fidelity mock-ups to display the structure more distinctly.

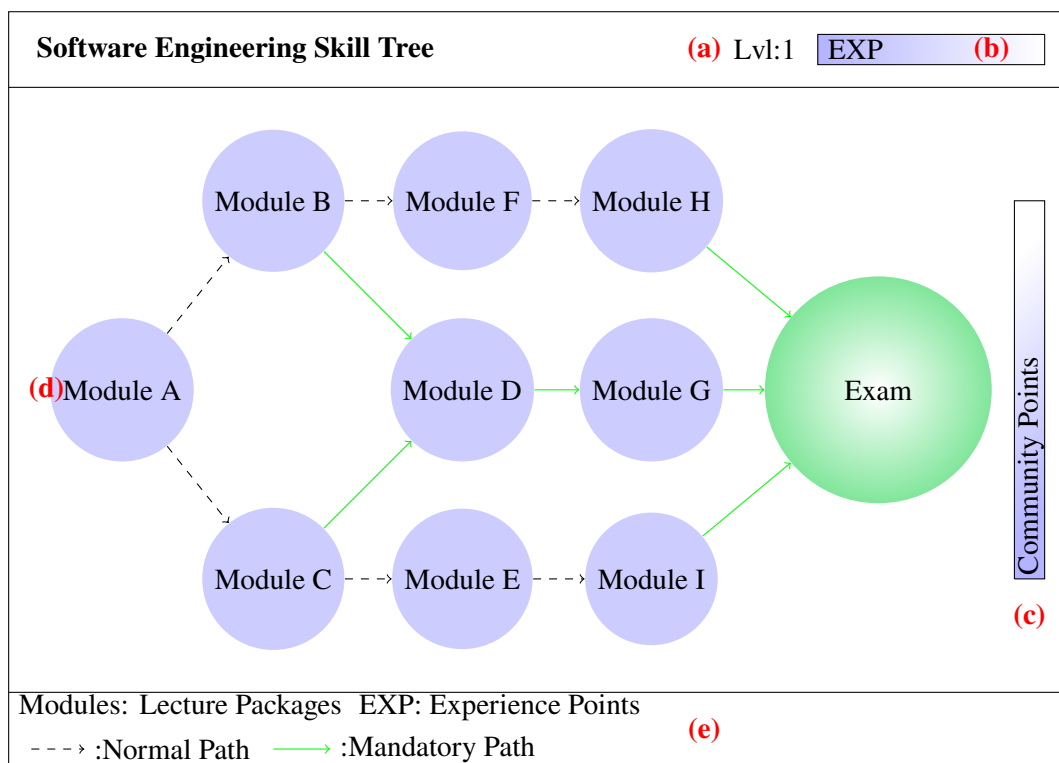


Figure 5.1: The Software Engineering Skill Tree. (a) Student Level, (b) Current EXP Progress, (c) Community Points Progress, (d) Module Unit(s), (e) Legend

As seen in Figure 5.1, we wanted to execute our idea in a form of a skill tree system. The modular structure of the course suits the skill tree design. This pattern allows the implementation of many elements in one system. The skill tree, we visualized, offers a granulated version of the course, which means every Module (d) stands for lecture packages. A lecture package contains

²<https://www.rki.de/EN/Content/infections/epidemiology/outbreaks/COVID-19/COVID19.html>

videos and slides about the topic it represents, i.e., the lecture package “Test” contains materials on “Unit-Test-Patterns” and “Integration Tests, Acceptance Tests, System Tests”. The sequence of modules shall give a certain narrative to the students as they continue to complete their tasks.

We also employed progression elements such as Levels, Progress bars, and EXP (experience points) (a), (b), (c). These elements shall help users track their progress, as well as obtain feedback when completing tasks. The community progress bar shall provide the current status of collaborative efforts within students. We wanted to address both of the users’ intrinsic and extrinsic motivation. Levels and EXP will ideally give the students a drive to participate more in activities to gain points. The community points will help improve communication within the students, to boost team spirit.

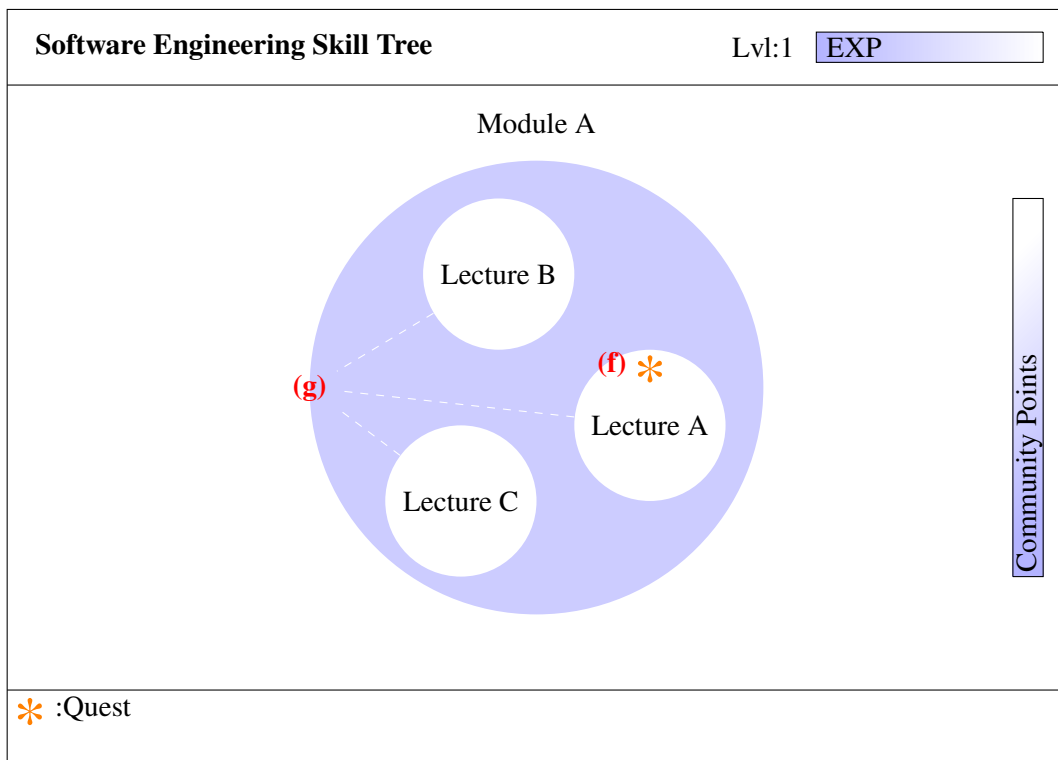


Figure 5.2: Inside a module: (f) side quest,(g) lectures of a module

Figure 5.2 shows a single module when focused on. We designed the modules to contain lecture materials (g) for the topics they correspond to. Additionally, we want each module to incorporate a side quests(f), which are optional for the students, but still provide feedback in a form of EXP.

Side Quests shall present a variety of tasks that aim to engage and teach students. We thought of coding challenges, to improve practical understanding, and also small team projects to improve comradery among peers.

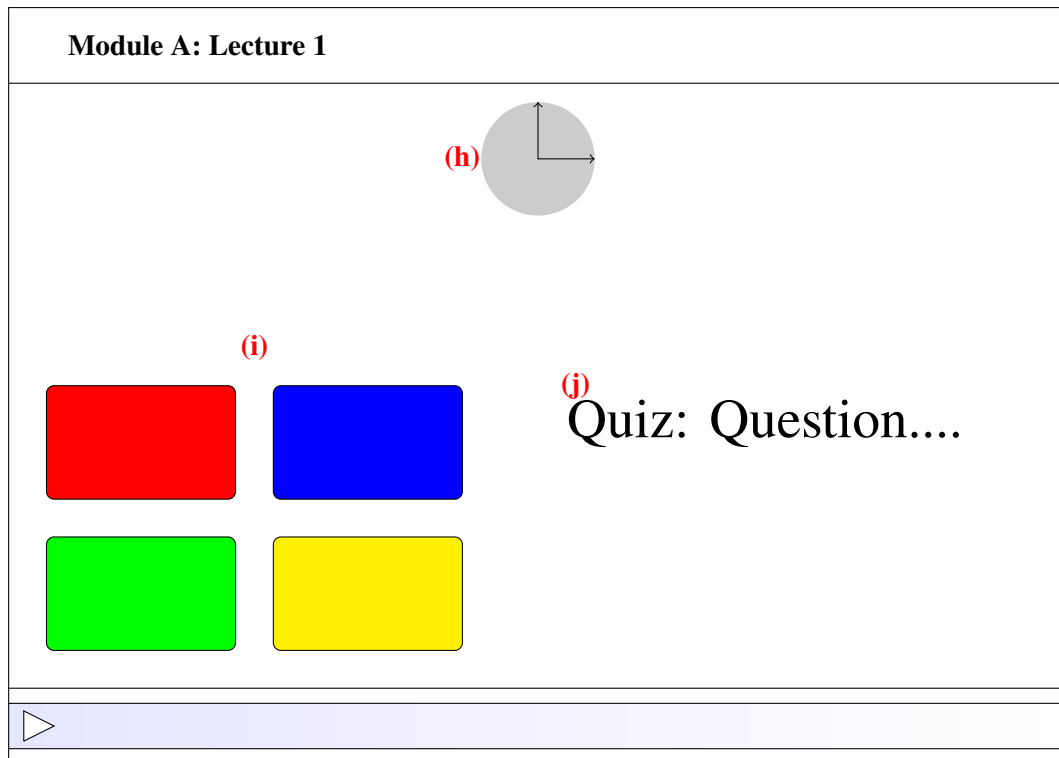


Figure 5.3: Quizzes within the lecture video. (h) Quiz timer, (i) Choices, (j) Question

We also wanted to include quizzes in the learning process, to engage students while watching lecture videos. To our convenience, the videos from the lecturers of the course already implemented such approach, so that we have less editing to do. Figure 5.3 shows how we want a quiz to look like, when being applied in a lecture video. A quiz showcases a variety of gaming elements, (h) indicates the duration of the time period to answer the question. With (i) as the set of possible answers to choose from, and (j) for the question currently being asked. With this, we devise activity loops [WH12], as suggested in Planning Phase. The presence of pop quizzes also addresses Core Drive 7: Unpredictability & Curiosity of the Octalysis Framework [Cho19].

We conclude this chapter with a summary of the ideal scenario we aim to present with our prototype. This includes the subjects of our interest, and the mechanics of the gamified course, i.e., show how this course should work in the view of both the organizer and participating students.

Our goal is to demonstrate the potential of gamification in software engineering education. We designed a line of processes to convert a software engineering course into a gamified lecture with the help of existing frameworks in gamification. Our prototype shows the elements we gamified, while explain the reasoning behind it. Further, we implemented mechanics together with the elements to function as a whole system.

The mechanics we want to function behind the elements are the following: The skill tree structure shall function as the backbone of the gamified lecture. A skill tree can be found in various gaming scenarios, but it is also adopted in gamified applications like duolingo³. The skill tree

³<https://www.duolingo.com/>

consists of modules, which in turn consists of lecture materials. The students shall perceive the process of learning in granulated parts, together with a sort of narrative or sequence, to be able to track their place in the gamified lecture. Each module shall contain a side quest, i.e., surprise task, to engage the students to the topic even further, with the help of their own curiosity. The system itself is surrounded by extrinsic motivators to give the students both feedback and the impression of progress. This means every adequate action within our system shall be rewarded in the form of EXP (experience points). Actions that provide rewards, shall be the behaviors we want to foster with the gamified lecture, i.e, completing a lecture or finishing a side quest for promoting task completion, answering quizzes for participation in lectures, or answering questions in the course forum to boost communication among students. All these actions shall acquire rewards appropriately.

6 Experimental Design

After a detailed look at the design process for the gamified lecture, this chapter will constitute the experiment our prototype undertook to provide answers to the remaining research questions. It is our goal to determine the quality of gamification in software engineering education, and to evaluate which elements have significant impact on students when fulfilling gamified tasks. This chapter shall present the tools we used to implement the concept we designed in the previous chapter, the scenario we induced to the participants, the structure of the experiment we conducted, and finally, the execution of the experiment itself

6.1 Tools

The software engineering course of our choice is already available in digital format. This made the process to apply the concepts we design easier. We used the video and image editing tools, such as Adobe Photoshop¹ and Adobe Premiere², to edit lecture videos, and include the gamified overlay in the scenes. For the quizzes, we used the cross-platform application kahoot!³ to generate the interaction with the student. Designing the overlay takes creativity, but it worked well. The problem we could not solve with any tool is the delay during the sessions, which are caused from human and technical side.

6.2 Experiment Structure

We aimed to produce the following scenario to provide a better context to the participants. We instructed the students to imagine that they are currently starting a new course of software engineering, and we provide them with video material. We then proceed to explain the context of the experiment, and the procedure that is about to happen. Each session followed the same structure Figure 6.1.

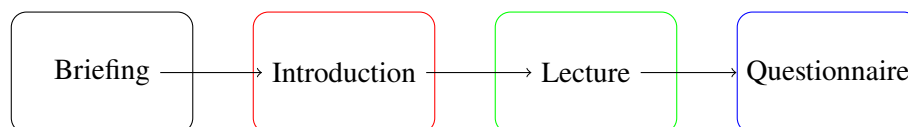


Figure 6.1: Structure of the sessions

¹<https://www.adobe.com/products/photoshop.html>

²<https://www.adobe.com/products/premiere.html>

³<https://kahoot.it/>

In order to evaluate our prototype, we built the questions upon our research goals and gamification objectives we defined in the Planning Phase. Since the number of participants is rather small, we decided to perform a semi-structured interview on every student, to get a detailed response from each session.

6.3 Execution

The sessions lasted between 30 and 45 minutes each time. For the experiment, we needed two laptops to synchronize the timing of each quiz, since it was activated manually by the operator. The participant will then have to join a kahoot! session with a mobile phone to answer the interactive questions.

The participants were allowed to ask questions during the sessions, if anything was not clear or a difficulty occurred. We conducted the interviews after watching the videos, with just a small break. The interviews start with questions relevant to the status of the student, such as semester number, course of study, etc. Then followed by open structured questions about the topic, that would help us evaluate the prototype. After gathering the data from all the participants, we summarize the results in the next chapter to answer our research questions.

7 Results and Discussion

7.1 Limitations and Challenges

Before getting to the results and discussion portion of this thesis, we would like to discuss limitations we encountered, while designing, as well as conducting the experiment. Further, we would like to identify challenges we discovered, during the process of composing this bachelor thesis. This chapter shall provide factors to be considered, while interpreting the outcomes we produced, not to mention, when reproducing the experiment with the same method.

7.1.1 Limitations

When reading through our results, these following factors shall be considered. These factors might have affected the outcome of our results vaguely. Through the low number of participants, we could not obtain a high level of validity and saturate our questions with unique responses. It is also important to state that the duration of the experiment is rather short for this kind of topic. The lack of standards in designing with gamification frameworks for education also poses as a threat to our results. Additionally, the design and execution was produced by an amateur, without the supervision of a gamification expert. We also have to note that our prototype, was expressed in a lower quality than an end-product, which might affect the perception of our participants.

7.1.2 Challenges

The main challenge during the production of this work was the Corona Pandemic. With the rules changing every month, the uncertainty of the situation was always a factor we had to put our eyes on. Such, that it can cancel sessions, and thus delay the experiment ending.

7.2 Results

The following shall present the results we obtain from the interviews we conducted. Starting with the demography of the participants. We successfully completed 10 sessions with each 1 Student.

7.2.1 Demography

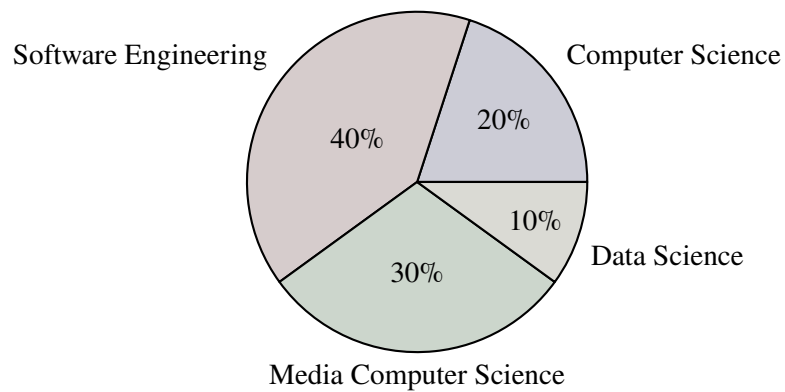


Figure 7.1: Course of study

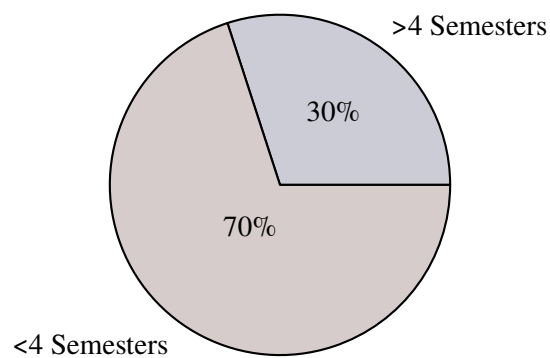


Figure 7.2: Semester Completed

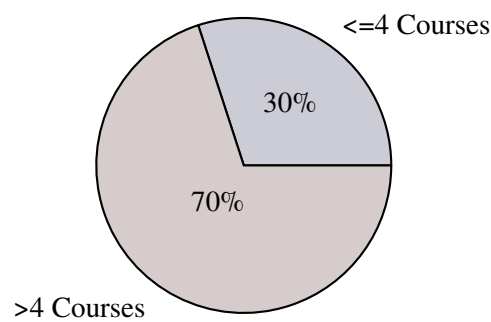


Figure 7.3: SE courses completed

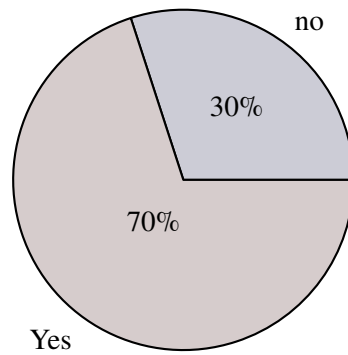


Figure 7.4: attended EST/GSE

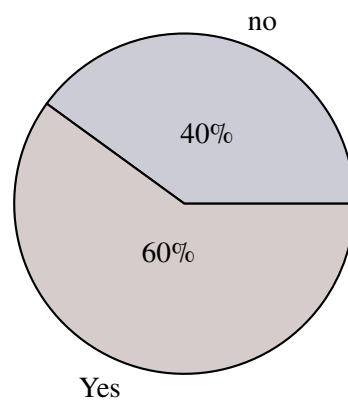


Figure 7.5: preexisting knowledge about gamification

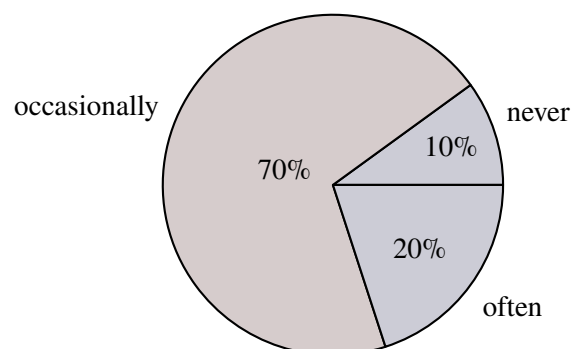


Figure 7.6: gaming behavior

7.2.2 Results of the interviews

This part contains the response we obtained from the interviews we performed. We go through all questions we asked, as listed in Questionnaires.

Q1: Did the system motivate you to participate in the lecture?

This question addresses the presence of a quiz system in the lecture. The participants all partake on the quizzes, and they all found it intriguing. Most of the students were not sure if the feeling is motivation, but nevertheless all agreed that the interactive element moved them to act while during the lecture.

Q2: Would you participate more in group works, if there is a reward?

This question addresses the behavior of strong community we want to foster. The most common question is “yes”. And some commented that it is already like this in the university, because of mandatory group assignments. When asked if a gamified system would help them be more motivated to do so, the most answered with “maybe”.

Q3: Would you complete side quests for extra points?

This question aims to evaluate the gaming element of quest, which was not clearly executed in the system, due to lack of time. We improvised by asking if the students would do tasks in Hackerrank in order to advance in the system. All participants answered with “yes”. With the comments about learning with a good implemented system is a great method.

Q4: What do you think of the skill tree structure?

This question aims to evaluate the skill tree structure we implemented. Students, who have seen such structure before, found it a good idea. A few found it an interesting execution and would like to see it in a university course.

Q5: Do the progress bars help you track your current development?

This question aims to evaluate the progress bars we implemented. The most common answer is “not really”, due to the fact the system was not fully executed to its ideal length, which would be a whole semester. The students are rather interested if that could motivate them when implemented in a course.

Q6: Would you do more for the community, if it was rewarded?

Students referenced their answers from Question 2, since it was almost the same question. We expanded the question into the idea of community events through team work. The most common response is “yes, events would be great”, followed by only if within the event occurs within the lecture time, and not during their free time.

Q7: Do you think a gamified lecture like this should be implemented in the university?

Students answered this question with “yes”, with the most common comment was about the quality of the system. Since we introduced a prototype, students perceived the gamified lecture as low quality, but yet interesting.

Q8: Were the tasks beyond your skill set?

All students answered this question with “yes”. Even though, some of them have lower preexisting understanding of the topic than the other.

Q9: Do you have any notes/suggestions/critique for this prototype?

(optional)

This question was optional, and aims to get the students to talk about the prototype we presented. Most of them commented on the length of the experiment. While they found it good that the session was shorter than expected, they noted that such an experiment is meant to be executed in bigger groups and in more than one session. To which we agreed. There are also critique about the quality of the videos and delays that occurred during the sessions.

7.3 Discussion

We will end this chapter with the discussion of obtained results from the experiment we conducted. Our goal is to present implications for practice and implications for theory, as well as answer the remaining research question, RQ3.

7.3.1 Implications for practice

It is important for us to discuss the outcome of our experiment, and how it may help practitioners understand this topic. The present setting was not ideal, as already listed at the beginning of this chapter, we encountered certain limitations during our execution phase. Nevertheless, the low participant number of our focus group brought us a variety of students that are rather outside our scope. The results we obtain, yet still invaluable, for future studies. The responses from participants within our ideal group and from those outside, both indistinguishable from one another. This implies that there might be other factors that play an important role to see different results from different groups of participants.

7.3.2 Implications for theory

This bachelor thesis showcases synthesized application of gamification framework that is rarely seen in academic literatures. After obtaining rather positive feedback, this might imply that some solution can be found in blending different approaches together to acquire an ideal result.

7.3.3 Which gamification elements are more effective when teaching an introductory software engineering course at the Bachelor of Science level?

It is difficult to pinpoint the answer to our question, due to the fact that the participants recognized both positive and negative sides of each element. We could only state, by observing the answers, that the quizzes had the most positive impact on the students, while the progress bars the least. Although, through interpretation, we could say that it is only due to the short duration of the experiment, since the quizzes had a huge presence during the videos, and the progress bars were only visible for a few times.

8 Conclusion and Outlook

8.1 Conclusion

This bachelor thesis presented an insight to the field of gamification. We obtained valuable knowledge from existing literature and found answers to questions we inquired early on.

We explored gamification and examined each moving part of it. Our Fundamentals and Background sections answered research questions RQ1, RQ1.1, RQ1.2. Elements in existing works can be clearly seen in Figure 3.1. We can take away the definition of gamification elements and its application from the Gamification Elements and Gamification Frameworks section, which we explored in detail. Research questions RQ2, RQ2.1 and RQ2.2, were answered in Conceptual Design part of our thesis. There we can see an elaborate utilization of gamification elements and what factors play an import role when doing so. Finally, we conducted an experiment in an attempt to give RQ3 an adequate answer.

To obtain these answers, we examined existing literature about gamification in the context of software engineering, and specifically in software engineering education. We found out that the application and success is different between the gamification of software engineering workplace and software engineering education. We have seen, that there is lack of standardization in this field, even though we can observe that the growth of existing framework is still growing.

In an attempt to gamify an online lecture, we obtained insight in the hands on process of gamification, and encountered difficulties while designing and rethinking a learning process. We were rewarded by a majorly positive feedback from the participants and proved that it is possible for a non-experts to gamify something with the guidance of existing frameworks and literature.

8.2 Outlook

This section presents suggestions that might be interesting for future work. While surveying the literature, we found that gamification has an enormous presence in gray literature. A gray literature review would bring light to a different, yet valuable perspective in gamification. As already remarked in the previous chapters, the lack of design pattern that specifically assist practitioners of the educational field, made the designing portion of our experiment rather difficult. We find it vital for gamification in the domain of education to advance, to put effort in creating a standard guideline to gamify learning processes. To conclude this bachelor thesis, we recommend future steps to improve the experiment outcome. The gamified course has proven, that it has indeed affected the students to a certain extent, which is why we expect a much better outcome, if the high-fidelity prototype would advance in a fully functional system. A larger number of subject would also bring a better insight to the topic and saturate the discussion around RQ3.

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A Appendix

A.1 Questionnaires

Gamification In Software Engineering Education

DISCLAIMER: We want to assure you that your responses are completely anonymous. Responses to anonymous surveys cannot be traced back to the respondent. No personally identifiable information is captured. Additionally, your responses are combined with those of others and summarized in a report. All the questions in this survey are intended to properly address the research.

About the participant

1. **Which course of study are you pursuing?**
 - Computer Science
 - Software Engineering
 - Media Computer Science
 - Data Science
2. **How many semesters have you completed so far?**
 - 3 Semesters or less
 - more than 4 Semesters
3. **How many Software Engineering courses have you completed so far?**
 - 4 courses or less
 - more than 4 courses
4. **Have you completed the Software Engineering course: EST/GSE already?**
 - Yes
 - No
 - Yes(but digital)

5. Have you heard of gamification before?

- Yes
- No

6. How often do you play games in your free time?

- Never
- Occasionally
- Often

Questions about the gamified lecture

7. Did the system motivate you to participate in the lecture? Please elaborate, if possible.

8. Would you participate more in group works, if there is a reward? Please elaborate, if possible.

9. Would you complete side quests for extra points? Please elaborate, if possible.

10. What do you think of the skill tree structure? Please elaborate, if possible.

11. Do the progress bars help you track your current development? Please elaborate, if possible.

12. Would you do more for the community, if it was rewarded? Please elaborate, if possible.

- 13. Do you think a gamified lecture like this should be implemented in the university?
Please elaborate, if possible.**

- 14. Did you feel motivated during the session? Please elaborate, if possible.**

- 15. Were the tasks beyond your skill set? Please elaborate, if possible.**

- 16. Do you have any notes/suggestions/critique for this prototype? (optional)**

Declaration of Consent

By marking “I agree.” I confirm, that the enquirer clearly stated the purpose of this survey and explained the usage of the answers I provided throughout the session.

- I agree.**

Declaration

I hereby declare that the work presented in this thesis is entirely my own and that I did not use any other sources and references than the listed ones. I have marked all direct or indirect statements from other sources contained therein as quotations. Neither this work nor significant parts of it were part of another examination procedure. I have not published this work in whole or in part before. The electronic copy is consistent with all submitted copies.

place, date, signature