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„A study on the correlation between gamification and motivation  
in a serious context with a cross-platform job-market application“

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# Abstract

This study aimed to extend scientific knowledge about the impact of gamification on intrinsic motivation. In particular, this impact was investigated by having subjects perform a task in a serious context with various degrees of gamification. As the serious context for this study, an innovative job-market concept was developed and integrated into a mobile cross-platform application. Furthermore, three versions of this application, each with different levels of integrated gamification, were implemented.

During the study, the intrinsic motivation of the participants was measured through questionnaires after performing a task with every version of the mobile application. Specifically, the task was to apply for a job by participating in a job-specific quiz. The Wilcoxon signed-rank test was used to evaluate this within-subject design study. The study was conducted in May 2023, involving 22 participants aged between 19 and 34. Due to contradictory answers in several control statements, one participant was excluded from the evaluation.

The findings of the study reveal scientifically valuable results regarding the correlation between gamification and intrinsic motivation when performing a task in a serious context. The Wilcoxon test demonstrated that gamification can indeed reinforce intrinsic motivation when comparing the minimally gamified version with the gamified or highly gamified version. No noteworthy difference in intrinsic motivation could be measured when comparing the gamified version with the highly gamified version. In summary, the results strongly indicate that the integration of a moderate to high degree of gamification in a serious context significantly improves intrinsic motivation when performing a task.



# Kurzfassung

Diese Arbeit untersucht den Einfluss von Gamifikation auf die intrinsische Motivation beim Ausführen einer Aufgabe in einem ernsthaften Kontext. Das Ziel dieser empirischen Forschung bestand darin, die Erkenntnisse vorangegangener Studien zu erweitern, die gezeigt haben, dass Gamifikation die Motivation von Individuen positiv beeinflussen kann. Zu diesem Zweck wurde in dieser Arbeit ein innovatives Job-Bewerbungskonzept entwickelt und in eine mobile Anwendung namens *JobQuiz* integriert.

Mithilfe von unterschiedlich stark gamifizierten Versionen dieser mobilen Anwendung, die als ernsthafter Kontext für die wissenschaftliche Untersuchung dienten, wurde die intrinsische Motivation der Probanden beim Ausführen einer Aufgabe mittels Fragebögen gemessen. In der Studie waren die Probanden in jeder Version von *JobQuiz* aufgefordert, sich für einen Job zu bewerben, indem sie an einem Quiz teilnahmen, das aus jobspezifischen Fragen bestand. Insgesamt nahmen 22 Teilnehmer an der Studie teil. Die erhobenen Daten eines Probanden wurden aufgrund widersprüchlicher Antworten von der Evaluation ausgeschlossen, die mittels des Wilcoxon Signed-Rank-Tests durchgeführt wurde.

Die Ergebnisse dieser Studie deuten stark darauf hin, dass Gamifikation die intrinsische Motivation zur Erfüllung einer Aufgabe in einem ernsthaften Kontext positiv beeinflusst. Dies wird besonders deutlich, wenn eine Version mit minimaler Gamifikation mit einer stärker gamifizierten Version verglichen wird. Im Vergleich zwischen der gamifizierten und stark gamifizierten Version zeigt sich kein signifikanter Unterschied in der intrinsischen Motivation. Zusammenfassend deuten die Studienergebnisse stark darauf hin, dass die mittlere oder starke Gamifikation eines ernsthaften Kontexts die intrinsische Motivation beim Erledigen einer Aufgabe erheblich verbessert.



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# 1. Introduction

Gamification has gained increasing attention from society in recent years [DDKN11, CG14], although the term “gamification” was initially introduced in 2002 [Pel09]. Nowadays, it can be argued that gamification has a significant impact as it has already changed activities, systems, and even entire organizations [CG14]. Gamification has achieved this by incorporating techniques and elements similar to those found in well-designed games [Ham17b].

Deterding et al. (2011) describe gamification as applying elements of games in contexts that are not game-related [DDKN11]. This concept entails deliberately incorporating game-like features, such as points, badges, leaderboards, and challenges, into contexts that traditionally do not have gaming characteristics. The objective of gamification is to encourage participation and intrinsic motivation by integrating gamified elements to make tasks more compelling and enjoyable [CHH20, PB14a]. This aims to transform serious or monotonous processes into more entertaining and intuitive ones [Zic, DDKN11]. Moreover, it is a promising avenue to enhance the engagement and intrinsic motivation of experienced and inexperienced participants [XH19, KTCK12].

In the academic field, most of the conducted empirical studies indicate that gamification positively influences intrinsic motivation along with other benefits [HKS14, Lay19, CHH20]. At the current state of research, there is still a lack of clear understanding of gamification, especially regarding intrinsic motivation [HKS14, XH19, Lay19].

Although gamification and its effects on the individual have not yet been fully researched, more and more businesses are integrating it into their operations to better adapt to digital transformation and reap the benefits of gamification [Zic]. According to a business expert in the field of gamification, Professor Dr. Roger Conaway, there are multiple advantages. The benefits even reach up to the point where “[...] profit margins may be positively affected by gamification through growth in customer loyalty, sales increases, and increased visits to websites” [CG14]. Given the growing trend of companies integrating gamification into their operations [Zic], it is important to conduct further research on the impact of gamification in a serious context rather than just applying it. Therefore, this thesis aims to delve deeper into the relationship between gamification and intrinsic motivation when accomplishing a task in a serious context by building upon the existing research.

For this reason, an innovative and gamified job-application concept is developed. The concept implies that each job offer includes a quiz created by the employer, which covers job-specific knowledge. The applicants perform the quiz instead of casually applying for a job offer. The concept offers multiple benefits and reduces potential barriers for both parties - employers and job seekers.

To access and evaluate the potential of the underlying gamification of this concept, an implementation onto a platform is required. Consequently, a mobile job-market

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application named *JobQuiz* is developed to serve as the platform for this concept. After the implementation phase, three versions of *JobQuiz* are created - each with a different level of utilized gamification. To answer the research question, these versions are used in a scientific study to collect data on intrinsic motivation.

### 1.1. Research Question

This research aims to examine what impact gamification has on intrinsic motivation. Additionally, insights shall be gained into the potential benefits of gamification in promoting and sustaining intrinsic motivation in a serious context - applying for a job. For this research, the mobile application called *JobQuiz* is employed to conduct an empirical study. The collected data from the study is evaluated to answer the following research question:

- Does utilizing gamification influence intrinsic motivation to perform a task in a serious context?

### 1.2. Hypotheses

To compare different levels of utilized gamification empirically, three versions of the mobile application are developed:

1. *Minimally gamified version*
2. *Gamified version*
3. *Highly gamified version*

These versions are used to scientifically investigate the research question. For this purpose, it is necessary to establish a null hypothesis referred to as  $H_0$ . Its objective is to represent the statement that no significant correlation between tested samples of data exists. In this research,  $H_0$  posits that no significant difference in intrinsic motivation can be statistically detected between the minimally and the (highly) gamified versions. Additionally, it is a basic assumption or default position tested against alternative hypotheses. To proceed with a scientific approach, the Wilcoxon signed-rank test is applied with the collected data for the evaluation of the study. The findings obtained from this test are then used to accept or reject each of the hypotheses based on the data gathered during the conduction of the study. If the findings reject  $H_0$ , it indicates a statistically significant relationship between tested versions under study [Wil06, CHH20, ZZ93]. To investigate the previously defined research question, three hypotheses are defined:

1.  $H_0$ : The level of gamification does not influence the intrinsic motivation to perform a task in a serious context.
2.  $H_1$ : Incorporating gamification elements in a serious context influences the intrinsic motivation to perform a task.

3.  **$H_2$** : The intrinsic motivation to perform a task in a serious context is significantly lower or higher in the *gamified version* compared to the *highly gamified version*.

To evaluate these hypotheses, the Wilcoxon signed-rank test is applied three times. First, the paired sample *minimally gamified version* and *gamified version* is evaluated. If  $H_0$  is rejected,  $H_1$  is accepted, which asserts that there is indeed a correlation between gamification and intrinsic motivation to perform a task in a serious context. Then, the *minimally gamified version* is evaluated against the *highly gamified version* for consistency and reconfirmation of the findings from the first Wilcoxon test.

Finally, the alternative  $H_2$  is addressed by comparing the two gamified versions. This last test aims to gain further insights into the performance of gamified applications regarding the intrinsic motivation to perform a task in a serious context. This comparison involves evaluating the *gamified version* against the *highly gamified version*. The conduction of these Wilcoxon signed-rank tests is elaborated and presented in Chapter 5.4 and Chapter 6.



## 2. Theoretical Fundamentals

This chapter provides an in-depth exploration of the theoretical concepts and principles underlying gamification. The first Section 2.1 begins with an introduction of gamification, followed by an examination of the different types of gamification in Section 2.2. Next, Section 2.3 covers the mechanics, and Section 2.4 the gamification elements with regard to their influence on engagement and motivation. In Section 2.5, the psychological effect of dopamine release in the brain and the physiological impact that gamified experiences can have on individuals are elaborated. The subsequent Section 2.6 provides primarily insights into intrinsic motivation but also covers extrinsic motivation from a psychological point of view through the *Self-Determination Theory* including its five mini-theories: *Basic Needs Theory*, *Organismic Integration Theory*, *Goals Contents Theory*, *Cognitive Evaluation Theory*, & *Causality Orientations Theory*. Section 2.7 presents another psychological theory called the *Flow Theory*. This theory focuses on the optimal balance between the skill and challenge level in an activity to strengthen motivation and engagement.

### 2.1. Introduction to Gamification

Gamification involves integrating elements and mechanics of games to foster individuals' motivation and engagement in activities and tasks that are not inherently related to games [Wer14, SL17]. Werbach (2014) explains gamification as a “process of making activities more game-like” [Wer14]. The idea behind gamification is to achieve the motivating and positive effects of games by integrating game-like features such as points, leaderboards, levels, and achievements in tasks or activities that are typical of a more serious matter [XH19, ZC11, Ham17a]. By incorporating these elements, gamification aims to leverage the intrinsic motivation of users to increase user engagement, participation, and enjoyment [XH19]. This is achieved using the motivating effect that game elements trigger, but with no game being played [DSN<sup>+</sup>11]. Therefore, gamification aims to make experiences usually unrelated to games more engaging and motivating by incorporating elements that appeal to the human desire for achievement, competition, and status [ZC11, SL17]. Thus, it encourages individuals to spend more time on an activity or to improve their performance by completing certain tasks [SF15, Maz21]. Concepts with underlying gamification should be understandable and intuitively usable. Specifically, the user should get the feeling of being immersed in the task [XH19]. Therefore, gamification design must also consider good usability and design to keep the user motivated during the task [ZC11, Ham17a, SL17, Maz21]. No unique definition of gamification can be found in literature as there is no consensus among scholars [Als18]. The following is a selection of well-formed definitions [PM22]:

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- “Gamification is a careful and considered application of game thinking to solving problems and encourage learning using all the elements of games that are appropriate.” [Kap12] (2012)
- “Game-based mechanics, aesthetics, and game thinking to engage people, motivate action, promote learning, and solve problems.” [Kir14] (2014)
- “Gamification is the use of technologies engaged in promoting intrinsic motivations by using diverse characteristics of games in other domains outside the entertainment industry, such as education, marketing, public administration, politics and health. It is an emerging trend derived from the huge popularity of games and their intrinsic ability for call to action to solve problems or enable learning in different fields and in people’s lives.” [BPLO18] (2018)
- “Gamification is the use of game design elements in non-game contexts to engage users and promote action.” [DDKN11] (2011)

Although these definitions come from different research fields of gamification, they overlap in some sense. These definitions emphasize the usage of elements and techniques from games to enhance motivation and engagement in non-game or more serious contexts. Additionally, these definitions highlight that the purpose of using gamification is to create a more entertaining and engaging experience.

### 2.2. Types of Gamification

Since the definition is not always uniform, gamification can be further divided into different types of areas. Kapp et al. (2013) distinguished gamification into two general types - content & structural gamification. The distinction between the two lies in where the gamification elements are applied [Kap13]. They argued that the fusion of structural gamification and content gamification represents the most efficacious method for bolstering motivation [Kap13]. Thus, applying gamification to both the content of the subject and the structure around are utilized in the scope of this thesis.

**Content gamification** refers to the content of the application, which gets altered to be more game-like to benefit from the positive effects of gamification. For content gamification, elements like feedback loops, storytelling, or challenges are integrated into the task or application [Des]. With this technique, user engagement shall be enhanced without turning the task or application into an actual game [Kap13]. A real-world example of content gamification can be observed in a workplace safety workshop. Instead of conventional presenting different learning objectives, a story that encompasses these objectives is presented. Subsequently, participants would be encouraged to actively engage with the subject matter by creating their own story incorporating the safety procedures taught during the workshop.

**Structural gamification** does not alter the content itself but the structure around it. Gamified elements like badges, points, and leaderboards modify a certain task

without changing the main content while supporting the motivation of the user [Kap13]. An instance of structural gamification can be observed in a scenario where students earn points for attending optional online lectures of a course. These points are then displayed on a public leaderboard, showcasing the participation of all students. This social comparison can enhance the engagement of individuals by the desire to be better than other competitors [ZC11].

## 2.3. Mechanics of Gamification

This chapter examines the fundamental operational principles of gamification. By exploring the mechanics, this thesis aims to provide a comprehensive understanding of the components that constitute gamification. According to Werbach et al. (2012), **gamification mechanics** encompass the structural guidelines that delineate the operational dynamics of the application [WH12]. In other words, gamification mechanics can be seen as a high-level framework or rulebook on how gamified applications shall be designed and used [TBTR21]. In the subsequent sections, the mechanics of gamification, namely feedback, reward, competition, and challenges, are presented, as these represent the most significant mechanics for the context of this academic thesis.

### Feedback

Feedback refers to the information regarding their performance or progress in a gamified environment. It serves as a mechanism to guide by offering guidance, evaluation, or constructive information. In general, feedback in gamification helps to inform, guide, and enhance engagement, motivation, progress, and performance [BW95, DKR99].

In literature, the term **feedback loop** is often used in the context of gamification. It refers to giving feedback on actions in a repetitive process [WH12]. A feedback loop is characterized by a continuous cycle of interaction between the actions of users and the corresponding feedback, where the feedback influences subsequent actions. This repeated feedback loop reinforces motivation and engagement by allowing users to autonomously adjust or adapt their behavior depending on the provided feedback [GDA05].

In gamification, different **types of feedback** can be differentiated. Each form differs in presentation and benefits, although they can be overlapping. Limiting one form of feedback is unnecessary because multimodal feedback can be beneficial [LS08]. Each of the different feedback types serves a unique role in guiding. Performance feedback assesses tasks or actions quality [KD96], correctness feedback focuses on precision [BW95], progress feedback tracks development [HT07], motivational feedback inspires [DKR99], and scaffolding feedback offers incremental support [WBR76, FM10]. These feedback types are explained in more detail below:

**Performance feedback** helps individuals identify their level of competence and skill.

Through performance feedback, individuals receive information about their actions for self-evaluation. Scores, leaderboards, and benchmarks are elements of performance feedback in the context of gamification [KD96].

## 2. Theoretical Fundamentals

**Correctness feedback** informs individuals about the correctness of their answers or actions. This type of feedback helps to understand responses by reinforcing correct behaviors [BW95].

**Progress feedback** gives information about the current advancement or progress in the form of levels, badges, or progress bars. This type of feedback gives a sense of accomplishment and motivates one to continue engaging with the task or action [HT07].

**Motivational feedback** aims to motivate users by providing rewards for their achievements or efforts. It can be realized by leaderboards, rewards, or badges. Motivational feedback aims to enhance engagement and intrinsic motivation [DKR99].

**Scaffolding feedback** provides hints or guidance at obstacles and therefore offers support to overcome such difficulties. Its purpose is to help individuals continue their progress when they have difficulties. This feedback is often provided incrementally, starting with more extensive assistance and gradually reducing as the individuals gain competence and confidence [WBR76, FM10]. In a study from 2010, researchers compared four feedback types, including scaffolded feedback, for error correction in short- and long-term retention intervals. While immediate test results showed similar memory performance between scaffolded feedback and standard feedback conditions, scaffolded feedback demonstrated superior memory retention for correct answers over a 30-minute and 1-day delay. These findings suggest that scaffolded feedback is more effective in promoting long-term memory of correct answers compared to other feedback methods tested in the study [FM10].

Depending on the time of delivery, feedback can be categorized into various categories [KK88]:

**Instant feedback** (or immediate feedback) is given directly after the action. It provides real-time information that gives immediate information, validation, or correction about actions. Instant feedback effectively amplifies engagement and reinforces desired behaviors [LDW22, KK88].

**Delayed feedback** is provided after a certain time lag between the action and the feedback. This intentional delay can help to encourage reflection or analysis of actions [Zeg15].

**Scheduled feedback** is given at predefined intervals within a gamified process. These feedback intervals maintain motivation and engagement because scheduled evaluation is performed, regardless of the actions performed [LDW22, KK88].

The **polarity of feedback** refers to the possible categorization of feedback into positive and negative. Both affect user behavior and intrinsic motivation. Positive feedback encompasses the recognition of actions or accomplishments and the provision of reinforcement. In gamification, positive feedback is realized with elements like points, badges, and rewards

[HT07, BW95]. Positive feedback increases the sense of accomplishment and encourages motivation and continued participation [VDK11]. On the contrary, negative feedback shows incorrect actions or behaviors as well as underlining possible improvements. It aims to guide better or more effective actions or behaviors. In gamification, negative feedback is provided by penalties, loss of points, or information about wrong actions. This type of feedback can foster a sense of challenge and encourages users to persist in their efforts [VDK11].

After executing multiple experiments, Dijk et al. (2004) demonstrated that “positive feedback is a greater motivator than negative feedback when individuals are promotion-focused, whereas negative feedback motivates more than positive feedback when people are prevention-focused” [VDK11, DK04]. Hence, striking a balance between these two types of feedback becomes imperative to sustain user interest and promote an enjoyable experience for all people.

The **transfer of feedback** refers to the process of conveying information, guidance, or reinforcement through various sensory channels, including visual, acoustic, and haptic [BW95, HT07, SRRea13, LS08]:

**Visual feedback** uses visual cues to provide individuals with immediate and intuitive information about their actions [CHH20]. This feedback can be utilized in two forms. One is the appearance or disappearance of elements, such as receiving or losing badges. Visual feedback can also be displayed as modification of elements that are already there, for example, when a button turns red after clicking or the animation of flames when answering correctly several times in a row.

**Acoustic feedback** employs auditory stimuli, such as sounds or spoken messages, to convey information about the actions [BRD18]. An example of acoustic feedback is playing sounds immediately after certain interactions, which can be intuitively interpreted as correct or incorrect. Another example would be modifying background music depending on factors, such as the scenario in which the remaining time to complete a task runs out.

**Haptic feedback** uses tactile sensations to provide physical feedback [CGL<sup>+</sup>21, SRRea13]. In gamification, this type of feedback is often utilized with vibrations. Certain kinds of vibration, which vary in sequence and duration, indicate whether the feedback is of a positive or negative nature.

## Competition

In gamification, competition is a widely used mechanic to enhance engagement and motivation [AKII21]. Competition refers to a dynamic environment where individuals can compete against each other [MHM19]. In this context, individuals are driven to outperform others and achieve a sense of accomplishment, resulting in higher performance and engagement [AKII21]. This mechanism of gamification can leverage intrinsic motivation by driving the desire for mastery, recognition, and social comparison [MHM19, Ree12, SRV13].

## 2. Theoretical Fundamentals

Within a competitive environment, individuals tend to demonstrate their competence by outperforming competitors and their own past performances [AKII21]. Resulting in a perceived sense of fulfillment and personal growth, which goes by the name of mastery and enhances the intrinsic motivation of individuals [Ree12, AKII21]. Competition brings individuals to compare their performances with others and brings the desire to be recognized by others. This seeking for reputation, validation, and social status enhances the motivation of individuals [MHM19]. Competitions are mostly connected and performed with measures of comparison. For example, leaderboards, levels, points, or badges can be found in this gamified environment. These rewards act as concrete symbols of accomplishment, providing a feeling of achievement and further enhancing motivation to participate in the gamified experience actively [MSH20, SRV13, AKII21]. However, it is important to mention that competition must not enhance intrinsic motivation. For example, interpersonal competition exerts a moderate level of control, leading to reduced task interest and intrinsic motivation, as demonstrated by Deci et al. (1981) [DBK<sup>+</sup>81], primarily by diminishing personal autonomy, as noted by Reeve and Deci (1996) [RD96].

### Rewards

In gamification, rewards play a crucial role, as they create a sense of accomplishment and satisfaction, which can be exploited to design effective motivation-enhancing strategies and designs. Rewards can help to encourage the active participation of individuals since they enhance goal-oriented strives. In general, rewards can give individuals something to strive for, which enhances motivation by providing a sense of purpose [Dah12]. Nevertheless, according to Deci et al. (1999), rewards can also significantly harm the intrinsic motivation of individuals [DKR99]. In several academic papers, Deci et al. (2000) show that there is evidence for both sides [RD00b, RD00a]. According to the authors, whether rewards enhance or undermine intrinsic motivation depends on the effect of the reward regarding the basic psychological needs [Ree12] as explained in Chapter 2.6. For example, rewards that lower the perceived level of autonomy and competence cause a significant decrease in intrinsic motivation, while other rewards cause the opposite [RD00b, RD00a]. In gamification, rewards can be categorized into various types [RD00b, MSH20, DKR99]. For the scope of this thesis, the following three are presented:

**Extrinsic rewards** are a kind of reward external to the activity or task itself and are very common in gamified tasks. Extrinsic rewards typically come in the form of badges, points, levels, or virtual currencies. By giving extrinsic rewards, positive behavior is recognized and reinforced because a sense of achievement is transmitted. Additionally, extrinsic rewards can be effective in capturing the attention of individuals and driving short-term motivation. Nevertheless, on the other hand, they can decrease lasting engagement if applied incorrectly [DDAA14, Als18].

**Intrinsic rewards** refer to the incentives provided for successfully completing tasks. Intrinsic rewards are primarily psychological and have a profound impact on the motivation and behavior of individuals. People who complete a task experience

a sense of accomplishment and personal growth, deriving satisfaction from their actions. Intrinsic rewards go beyond extrinsic motivators such as badges, points, or external recognition and have a long-term impact on engagement, motivation, and commitment [RD20].

**Social rewards** refer to the acknowledgment and interaction with fellow individuals. These rewards serve the purpose of relatedness by satisfying social needs for belongingness, connection, and social comparison (see Chapter 2.6). Social rewards are given in gamification as leaderboards or achievements, which can be shared with others [SRV13]. By increasing the social connection between individuals, competition and collaboration are leveraged, and therefore, individuals tend to strive for higher performance [Ree12].

## Challenges

Challenges are a fundamental mechanic of gamification. They refer to objectives that individuals shall overcome. Well-designed challenges include demanding tasks that push individuals to develop new strategies, skills, or knowledge [AKII21, LXH<sup>+</sup>20]. Since challenges create a sense of purpose and clear goals, they help individuals overcome obstacles and enhance a sense of accomplishment and personal growth. These intrinsic rewards reinforce the motivation of individuals since they recognize their competence and achievements [LXH<sup>+</sup>20, AKII21]. Additionally, intrinsic motivation is fostered if the level of difficulty and achievability of a challenge is in balance since a sense of autonomy is provided [Csi90, MMW10, AKII21]. On the contrary, challenges, where the level of difficulty and achievability are not in balance, can demotivate individuals since they are under or overwhelmed, and the sense of autonomy is not utilized [BPOL20, Ree12]. The optimal challenge is different for individuals with different skill levels. If the skill level and the challenge are balanced, the person is in the so-called flow area (see Chapter 2.7).

**Time challenges** are closely related to the gamification mechanic challenge, presented previously in Chapter 2.3. The main difference is that time challenges provide only a specified time frame to complete the task or objective. These challenges add a sense of urgency to the objective and force individuals to decide and work efficiently [MMW10]. Time challenges encourage motivation and engagement even more than challenges without time constraints due to the element of pressure, which increases the focus of the objective. Competitive instincts are triggered since individuals try to complete the task under the constraint of a limited time frame [AKII21]. In this gamified environment, the engagement of participants is enhanced because a sense of anticipation and excitement is created when the remaining time becomes smaller. The time component fosters individuals to stay immersed and gives them a sense of accomplishment when the challenge is completed successfully in time [LXH<sup>+</sup>20]. Similar to challenges without time constraints, the sense of accomplishment and intrinsic rewards reinforce the motivation of individuals [Ree12]. However, like challenges without time constraints, the motivation can also be weakened if the objective is too challenging or underwhelming. Thus, the complexity of the task and the available time must be appropriately set [BPOL20].

### 2.4. Elements of Gamification

In gamification, components that are originally from actual games play an immense role. These game elements, also known as the building blocks or components of gamification, form the foundation for creating gamified and rewarding experiences into applications that fulfill a different task [AKII21]. By incorporating game elements into non-game contexts, intrinsic motivators of individuals such as autonomy, social interaction, mastery, and achievement are encouraged [Ree12, DSN<sup>+</sup>11]. As a result, these psychological motivators triggered by gamification pursue to foster motivation, promote learning and enhance engagement, and drive desired outcomes [Als18, Juu03]. During their empirical exploration of motivational affordances in gamification, Hamari et al. (2014) discovered that the most frequently employed elements include leaderboards, badges, and points [HKS14]. Due to the fact that in literature many elements can be found, only the essential elements for this thesis are to be presented:

**Points** appear in various forms in almost every game and are usually an important basis of the game. Through points, the actions of individuals can be recorded and analyzed. Often, points are integrated into a gamification application, which shows the participant's progress in a certain task or action (i.e. experience points) [HT07]. In gamification, points can have two other purposes. Redeemable points, such as virtual currencies, are points that individuals can collect and spend. In some applications, redeemable points can be gathered through the user's actions and achievements and by spending real money [EK13]. In environments with social interactions, a user can award reputation or karma points. These points can also be received from other individuals to express appreciation [ZC11, SRV13].

**Leaderboards** are public ranking lists that visually represent ranked individuals in relation to other participants. They are an important part of the competition mechanic because they publicly showcase the performance of individuals in a certain task in decreasing order and therefore allow comparison of performance and success. The metrics for comparison are typically other gamification elements, such as points, badges, scores, and levels. Aroused ambition of individuals who are driven to strive for higher rankings can be a result of social comparison [SSS21]. Thus, leaderboards can enhance motivation and engagement since individuals aim to surpass their peers by the desire to be better than other competitors [ZC11, SSS21].

**Badges** are visually appealing objects awarded to users as rewards for achieving goals [ZC11, BNCP12]. Usually, badges are bound to a certain experience measured by a badge-levels. The more badges of the same kind are collected, the higher the level, and the more badges are needed to level up. Often, badges can be presented to friends or other users through the application platform [ZC11]. A badge has the versatility to represent various accomplishments or participations [BNCP12]. As an example, consider the "Top 10" badge, which signifies an individual's achievement of a position within the top ten performers in a specific task or challenge.

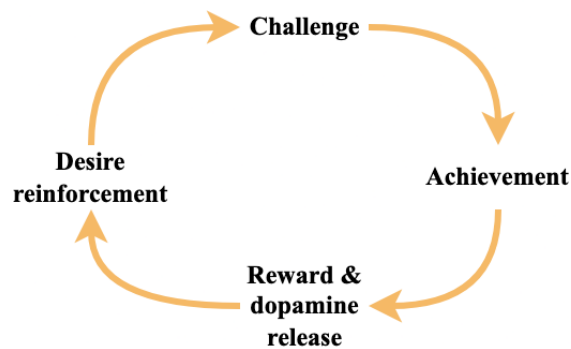
**Levels** are a frequently encountered element in games and gamification applications.

Users recognize their progress by reaching levels, which is an important tool for maintaining and increasing motivation. As users accumulate time and experience, the level of difficulty progressively escalates [Her14]. It is essential that they are neither over- nor under-challenged in order to achieve the so-called flow state [VCdS14]. The increase in difficulty and complexity of the levels should be logical, easy to understand, and comprehensible for the users. In addition, the level system must be flexible and easily expandable so that the game can grow and additional levels can be added later [ZC11].

**Audio** is another significant element of gamification. Music and sounds can be used to arouse emotions and provide valuable feedback. The importance of audio as an element of gamification is often underestimated. However, interesting effects can be achieved with background music and the targeted manipulation of sound through interactions [Ekm05].

## 2.5. The Biochemical Effect of Gamification

In the article *Gamification by Design* from 2011, Zichermann and Cunningham stated that “ [...] brain scientists all over the world agree that games’ challenge-achievement-reward loop promotes dopamine production in the brain, reinforcing our desire to play” [ZC11]. Moreover, “the real key to a successful gamification strategy is using dopamine loops (which could also be called reinforcement loops)” [KPW15, ZC11]. When a user earns a reward after accomplishing a challenge, dopamine is released [WH12]. This neurotransmitter, released in the brain, leads to enjoyment, and the user feels better [ZC11, DC99]. Since enjoyment and incentive motivation are strongly linked, the boost of dopamine release increases motivation and attention [DC99, AMTBCP21, IYT15]. Figure 2.1 shows the psychological mechanism behind the dopamine loop. As indicated



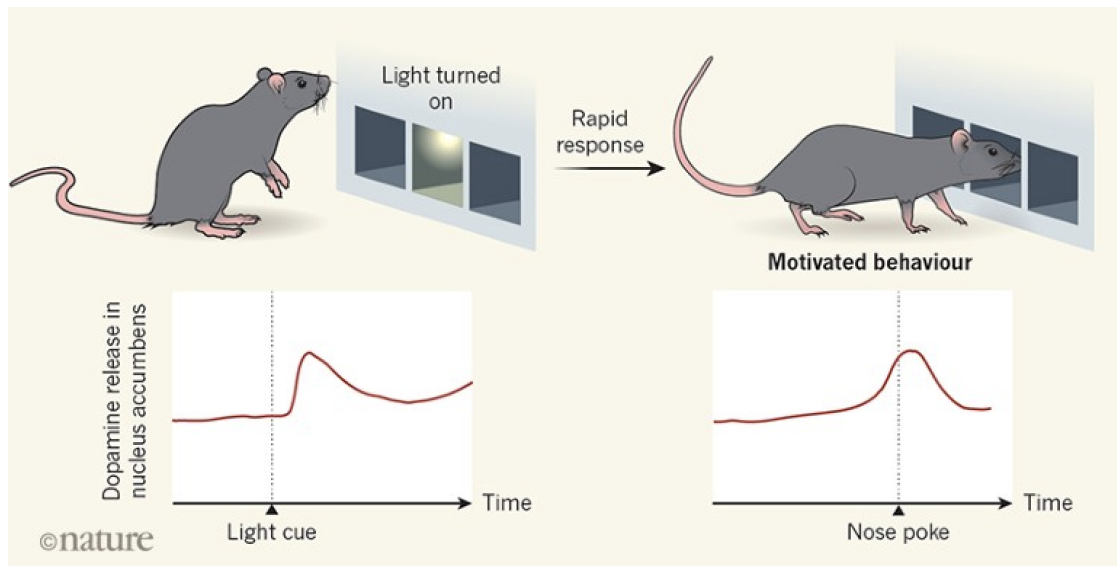
**Figure 2.1.:** Dopamine Loop [ZC11] (modified)

by the figure, the reinforcement desire drives the user to re-accomplish the loop and raise the level of enjoyment again. By constantly reiterating this loop, the motivation of the

## 2. Theoretical Fundamentals

user increases because the more or more often the user achieves something, the more dopamine is to be released in the user's brain. Several studies have proven the relation between motivation and dopamine [IYT15, ZC11, DC99, Wis06]. In a study from 1998, McFarland & Ettenberg showed that “dopamine clearly does have a role in the motivation of reward-seeking behaviors. [...] The incentive–motivational salience of these stimuli depends upon the prior dopamine-dependent reinforcement of their association with the reward” [ME98].

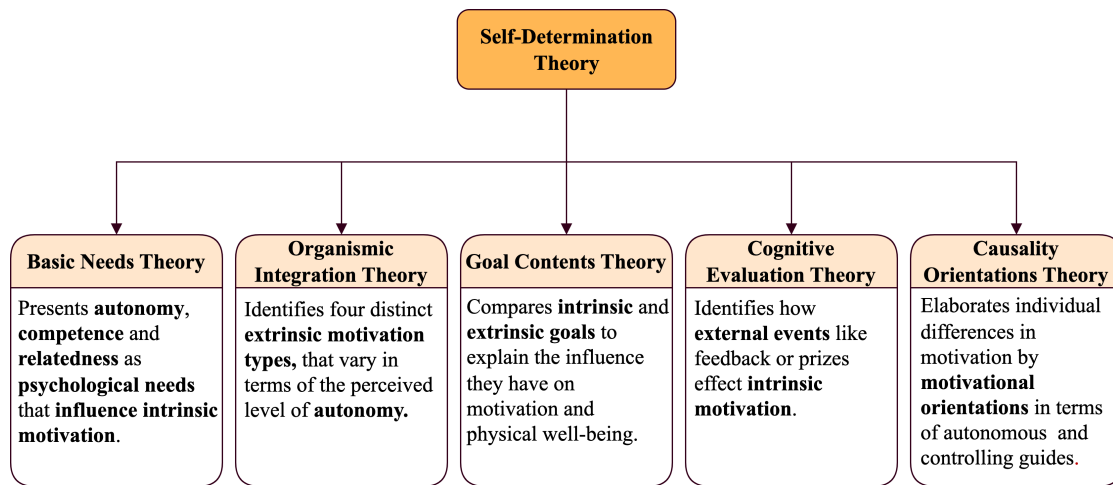
In 2019, a different study monitored freely moving rats while the amount of dopamine released in a certain area of the rats' brains was measured with a microdialysis technique. A light turned on if a rat poked its nose inside a central port. If the rat stayed inside the port until a sound was played, it received a food reward in a different port. This procedure was repeated in several rounds; each indicated to the animal with a light signal [Ric19]. In this study, an increase in dopamine release and neuronal activity was measured in the brains of the animals during the task. The dopamine release was boosted when the rat stayed inside the port when the light was on. It was observed that the rat started subsequent rounds quicker when the rate of rounds increased. This gradually increased extracellular dopamine levels as the rats approached the central or food-dispensing ports. This observation supports the previous proposition that the neurotransmitter dopamine is essential in driving motivation. Figure 2.2 shows the dopamine releases in the nucleus accumbens area in the brain of the rats during the experiment. This area of the brain is a crucial component, as it is responsible for regulating reward-seeking behaviors by controlling the release of dopamine [Ric19].



**Figure 2.2.:** Correlation Between Dopamine and Motivation [Ric19] (modified)

## 2.6. Self-Determination Theory

This chapter introduces the prominent Self-Determination Theory (SDT) developed by Edward Deci and Richard Ryan. The SDT gives essential insights into motivation and its impact on human behavior regardless of nationality, gender, age, cultural background, and other characteristics. This theory offers insights into motivation and engagement, particularly of human behavior. The theory took the authors several decades to develop because it was adjusted and extended over time. Now, the SDT consists of five smaller theories (i.e. mini-theories), each handling the phenomena motivation differently [Ree12]. In Figure 2.3, these mini-theories are briefly explained.



**Figure 2.3.:** *Self-Determination Theory* Including its Mini-Theories [Ree12] (modified)

### Basic Needs Theory

The essence of the *Basic Needs Theory* (BNT) is that the psychological need for autonomy, competence, and relatedness is deeply connected with motivation. According to this theory, these needs serve as a source to increase the intrinsic motivation to learn, practice, strengthen skills, investigate, and seek new challenges or new things [Ree12, NR09]. In 2021, a study analyzed the correlation between engagement and the psychological needs of the BNT through a gamified mobile application. The data from 276 participants revealed that the fulfillment of the mentioned psychological needs encouraged users' participation and led to improved ratings for the mobile application [BBC21]. The three basic psychological needs that influence intrinsic motivation according to the SDT are presented in detail below:

#### Autonomy

The inherent desire for autonomy on a psychological level pertains to feeling in control and having freedom of choice [Ree12]. Studies have shown that students who feel a sense of ownership in their studies are more likely to achieve their academic

## 2. Theoretical Fundamentals

goals because they experience autonomy and need satisfaction. [Ree12, NR09]. Another study has shown that participants with autonomy-supportive limitations are more intrinsically motivated than participants with tighter, more controlling limitations. Additionally, individuals with autonomy-supportive limitations are significantly more creative compared to the other group [KRBH84].

### Competence

The inherent human need to feel competent refers to being capable and effective in achieving goals, interactions with the environment, and pursuits [Ree12]. If students get challenging yet achievable exercises, they have enhanced competence, intrinsic motivation, and a higher confidence in their skills. Individuals who believe more in their skill set are more likely to search for challenges, be persistent, and master challenges [Ree12, NR09, Dec75].

### Relatedness

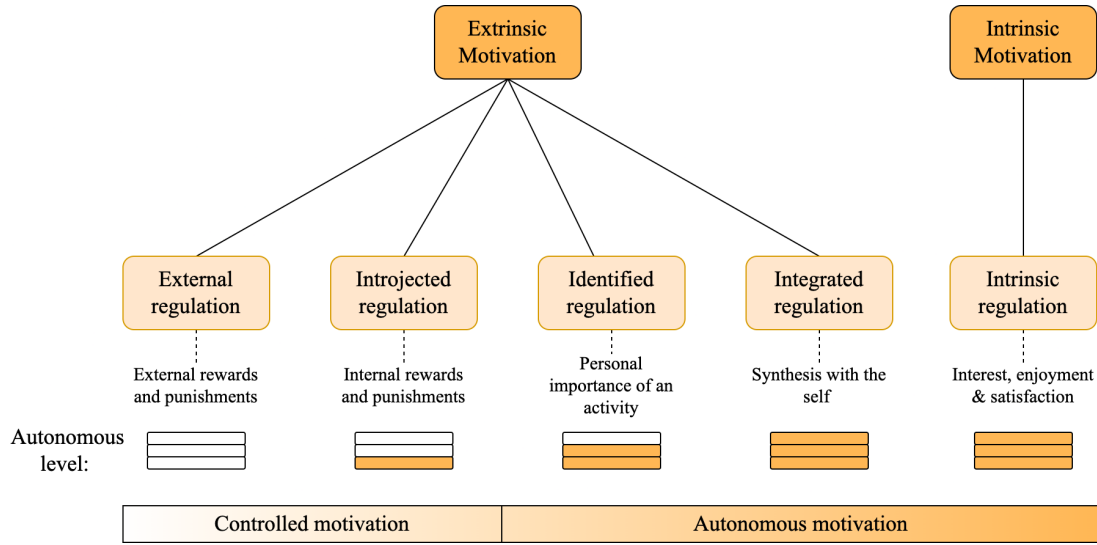
Relatedness is the psychological need for social connection, close emotional bonds, and a sense of belonging. It embodies a longing for emotional and interpersonal relationships characterized by warmth, care, and responsiveness [Ree12, DR91]. Students have enhanced intrinsic motivation when they feel socially connected to fellow students and teachers. This bond can arise from a collaborative learning environment. Students where the need for relatedness is fulfilled tend to have an increased engagement and a commitment to learn [Ree12, DR91, Rya93].

## Organismic Integration Theory

In contrast to the BNT, the *Organismic Integration Theory* (OIT) focuses on extrinsic motivation rather than intrinsic motivation. Richard M. Ryan and Edward L. Deci (2000) defined extrinsic motivation as “[...] a construct that pertains whenever an activity is done in order to attain some separable outcome. Extrinsic motivation thus contrasts with intrinsic motivation, which refers to doing an activity simply for the enjoyment of the activity itself rather than its instrumental value. However, unlike some perspectives that view extrinsically motivated behavior as invariantly nonautonomous, SDT proposes that extrinsic motivation can vary greatly in the degree to which it is autonomous” [RD00c].

The theory differentiates between multiple types of extrinsic motivation. These types vary in the level of autonomy in the sense of how much someone personally rates the importance of their actions. As a result, the theory defines four types of extrinsic motivation, each with a different degree of ownership and sense of psychological freedom [Ree12]. The extrinsic types of motivations from the OIT are presented in Figure 2.4.

The lowest autonomous motivation can be found in **external regulation**. If the behavior is categorized as externally regulated, the motivation is very little, and the task is only pursued to avoid punishment or win something [Ree12]. The autonomous motivation is low in **introjected regulation**. Tasks are fulfilled to serve two purposes only. One is to avoid a guilty feeling. The other is to meet external demands to confirm or maintain self-worth in the eyes of the social environment. Introjected regulation is associated with pressure either from the individual themselves or from others [Ree12].



**Figure 2.4.:** Types of Extrinsic Motivation According to the *Organismic Integration Theory* [RM19a] (modified)

In **identified regulation**, a sense of ownership of an action is perceived, and the goals or regulations are valued. These external regulations are interpreted as “useful” or “important” and are fulfilled with personal commitment [Ree12]. The last extrinsic motivation type **integrated regulation** refers to the highest level of autonomous motivation where no external motivators are involved. Regulations or goals are associated with personal needs and beliefs. Although this extrinsic motivation type has similarities with **intrinsic regulation**, it is still an extrinsic motivation. Other than intrinsic regulation, which refers to interest and enjoyment in the task itself, integrated regulation focuses on the importance of the task paired with self-awareness [Ree12].

As indicated in Figure 2.4, the level of autonomy is low if the motivation is categorized by the two external regulation extrinsic motivation types: external regulation & introjected regulation. Tasks are approached with a psychological sense of duty or obligation to achieve a goal. The expression for this is **controlled motivation** [RM19b]. In contrast, the types identified regulation & integrated regulation convey more the psychological sense of freedom and perceived choice. Furthermore, a behavior of self-determination is found. The scientific expression for this is **autonomous motivation** [RM19b, Ree12].

## Goal Contents Theory

The *Goal Contents Theory* (GCT) deals with the differentiation between the goals of intrinsic and extrinsic nature as well as the influence in motivation and physical well-being that comes along with these different goals [RSKD96, Ree12, VLD06a]. According to the theory, intrinsic goals - like personal growth and building deeper social connections - promote and maintain the psychological basic needs: autonomy, competence & relatedness [KR96]. Besides that, pursuing intrinsic goals encourages persistence, performance, deeper

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learning, and physical health [KR96, Ree12, VLD06b]. In particular, the GCT states that pursuing intrinsic goals fosters psychological well-being, compared to extrinsic goals and aspirations, because they seem fulfilling, challenging, and enjoyable [SRDK04, VLD06a, VSL<sup>+</sup>04].

Extrinsic goals such as improving social status and accumulating wealth, on the other hand, aggravate the three psychological basic needs [Ree12]. Consequently, extrinsic goals impair learning, performance, and persistence as well as foreshadow mental health issues like depression and anxiety, even though the goals might have been accomplished [VSL<sup>+</sup>04, KR96].

The GCT concludes that satisfying the basic needs - autonomy, competence & relatedness - and mental well-being mainly depends on whether a goal is of an intrinsic or extrinsic nature, and not so much if the goal is achieved. This statement is not accepted by all researchers because there are theories about psychological well-being that state the opposite [Ree12, VLD06a].

### Cognitive Evaluation Theory

This psychological theory explains the correlation between external consequences such as rewards and their effects on intrinsic motivation. More specifically, the *Cognitive Evaluation Theory* (CET) focuses on the aforementioned psychological basic needs. In particular, how extrinsic incentives influence these needs and therefore alter the intrinsic motivation [Ree12, DKR99]. CET argues that the first two basic psychological needs must be fulfilled for maintaining intrinsic motivation [DR91]. The third basic need relatedness can only influence intrinsic motivation if the task has social aspects [NTT20]. According to the SDT, tasks that provide an optimal challenge to promote competence paired with a highly preserved level of autonomy enhance intrinsic motivation and vice versa [Ree12, DR91]. Consequently, external factors can diminish the perceived competence or autonomy, undermining intrinsic motivation. This effect is also known as “motivational crowding out” [Dec75, NTT20].

The CET establishes three propositions that explain how internal motivation is affected by consequences [DR85, NTT20]. These propositions are presented independently in the below. The correlation between the propositions is visualized in Figure 2.5.

- **Proposition I** explains that external events can influence intrinsic motivation because external factors substitute internal factors as the motivation behind one’s actions. If an external reward is added to an optimally challenging activity, a trade factor causation behind one’s behavior or actions can be occupied. This changed the perceived locus of causality, which can decrease internal motivation [DR85, NTT20].
- **Proposition II** states that the sensation of self-determination and competence influences intrinsic competence. If these feelings are fully present and accompany each other, intrinsic motivation is positively affected [NTT20, DR85].
- **Proposition III** of the CET states that each instance of reward or feedback inherently carries informational and controlling elements, providing information regarding

an individual's competence and self-determination. The relative prominence of these elements determines the subsequent outcome. If the informational aspect predominates, it fosters an enhanced sense of competence and self-determination. Conversely, when the controlling factor outweighs the informative aspect, intrinsic motivation can be diminished [DR85, NTT20].

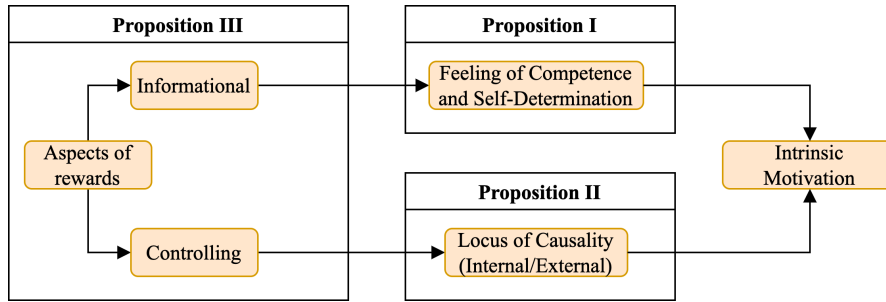


Figure 2.5.: Propositions of the *Cognitive Evaluation Theory* [NTT20] (modified)

## Causality Orientations Theory

The *Causality Orientations Theory* (COT) extends the SDT in terms of individual variances in people's motivational orientations [Rya23]. The theory explains how individuals possess different causality orientations, reflecting their preferences for external control and self-determined motivation. The authors of this theory present three causality orientations that represent motivational, relevant processes and classes of behavior [DR85]:

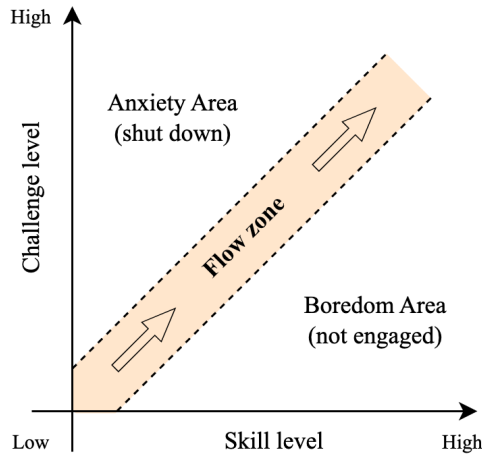
1. The **autonomy orientation** represents the self-regulation of behavior by choice. It is driven by the awareness of needs and goals. Individuals with high autonomy orientation seek out choices and experience a sense of autonomy in their decision-making processes [Rya23, DR85].
2. **Controlled orientation** refers to the degree to which behavior is regulated and controlled by environmental factors, such as behavioral rules or reward structures. Individuals with highly controlled orientation tend to prioritize external influences over their own volition and, at the same time, would describe their environment as controlling. These individuals often experience diminished intrinsic motivation and level of autonomy [DR85, Rya23].
3. The **impersonal orientation** relates to individuals who experience a very low level of initiative, autonomy, and sense of control. People with high impersonal orientation believe they cannot influence their behavior, as if they are helpless or unmotivated. They are often overwhelmed by emotions and external contingencies. Their intrinsic motivation is very low, as well as their sense of autonomy [Rya23, DR85].

## 2. Theoretical Fundamentals

The COT offers valuable insights into the underlying mechanisms of human motivation. The theory underlines the importance of the different causality orientations to understand the intrinsic motivation and behavior of individuals. By acknowledging the existence of control orientations, the COT provides valuable insights into how individuals promote or hinder their self-determination [Rya23, DR85].

### 2.7. Flow Theory

The *Flow Theory* is another important theory connected to gamification and motivation proposed by Mihaly Csikszentmihalyi [Csi90]. The theory explores the characteristics of an optimal state of consciousness, often referred to as being “in the flow zone”. In this zone, individuals experience deep engagement and enjoyment in their activities [VCdS14]. The *Flow Theory* often serves as an underlying principle of well-gamified activities. The essence of this theory is that when an optimal balance between skills and challenges is provided, individuals feel in control. That can result in being fully immersed in a task or activity [FE10], further motivating them to continue and master more complex tasks [ZC11, AKII21]. Figure 2.6 presents the flow zone in between the feelings of anxiety and boredom. As indicated in the visualization, individuals in the flow zone are willing to face more challenging tasks and expand their skill level.



**Figure 2.6.:** Visualization of the *Flow Theory* [ZC11] (modified)

## 3. The Innovative Job-Application Concept

This chapter presents an updated job-application concept. Section 3.1 explains how the idea of the concept is formed and which downsides and issues of the casual job-application process it addresses. In the following Section 3.2, the innovative concept is presented by introducing a more streamlined job-application process. Section 3.2.1 addresses the target groups, including the benefits this concept has to offer. To reduce potential misunderstanding, this chapter refers to the mobile application as an “app”, and the application for a job is called “application” or “job-application”.

### 3.1. Motivation

Nowadays, the procedure of how job-applications are handled can be optimized. It can be designed more efficiently by rethinking and automating parts of this process while solving multiple downsides for job seekers and employers. The main downsides and issues are briefly formulated in the subsequent two paragraphs. The following statements are not intended to be generic. Therefore, they do not apply to every job seeker or employer.

On the one hand, there is the applicant who invests effort and time into a job application. For example, they must update and submit documentation such as curriculum vitae, cover letter, motivation letter, and other application documents. Additionally, the applicant usually repeats this process to apply for multiple jobs to maximize the likelihood of getting hired. This repeated task in a serious context could have a demotivating effect. On the other hand, there is the hiring employer. In bigger companies, it is common that the hiring process is outsourced to colleges, mainly working in the human resources department. Since these people often are not familiar with the in-depth content of the job, they go over the applications mainly only searching for keywords and not properly reviewing the applications. Unfortunately, this leads to overlooking suitable candidates and not valuing the efforts of the applicants.

The lack of focus on critical values at certain times in the process is another major flaw of the common application process. In the first round of the application process, where all the applications are reviewed, the focus is set on appearance, reputation, education, experience, and recommendation. This is because these are the present values in the application documents. While sorting out the applicants based on those and similar values, more crucial ones like talent, not licensed or self-taught skills, and job-specific knowledge are not considered. Only in later rounds of the process applicants have direct contact with the hiring department. This can lead to sorting out very good candidates

### *3. The Innovative Job-Application Concept*

too early in the application process as they are not able to showcase their talent, skill, and knowledge anymore.

This issue of neglecting values does not only affect large companies. Also, small and medium-sized companies can inadvertently overlook potentially valuable candidates by initially filtering applicants on the wrong values. To illustrate this point, consider the following two fictitious examples in which the casual application process fails:

- The small shop “Natural Cosmetics” owned by A is looking for the first employee besides A. Due to a tight schedule, A cannot invest much time in this task. Thus, the owner decides only to consider applicants with a natural cosmetic license. This way, A thinks she shorts out all the applicants who do not have the necessary knowledge about natural cosmetics. Thereby, A sorts out candidate B, which is unfortunate because B has the most sufficient natural cosmetic knowledge and skill, even more than the candidates with the mentioned license. Due to the fact that B never acquired the license, the best-suited and most experienced candidate was not actually considered for the job.
- The larger company X plans to hire a junior software developer. Due to the large number of applications, the recruiting staff decides to consider only applicants with bachelor’s degrees or higher in computer science or related fields. Unfortunately, this decision resulted in the elimination of applicant Y from further consideration. Despite lacking formal academic qualifications, Candidate Y has exceptional programming talent acquired through self-teaching. Over several years, Y dedicated significant personal time to developing software, building up coding experience that surpassed that of all other applicants. Due to wrong filtering, company X hires a different person with academic qualifications but with fewer programming skills than candidate Y.

These examples show that filtering the applications by reputation, education, experience, or recommendation at first and only afterwards considering job-specific knowledge and skill can lead to not ideal decisions in the application process. If the procedure had been the other way around, so the job-specific knowledge is valued in the first place, these not-ideal decisions would probably not have been made. This change of orders would mean that the amount of time necessary to review all not sorted out applicants’ job-specific knowledge in person or manually would be immense.

To address this issue, the researcher developed an automated concept in which the initial job application filtering process only focuses on the applicant’s job-specific knowledge. This saves effort and time for both job seekers and employers. The ambition of this concept is to modernize the job-application process independent of the industry, social rank, or company size.

## **3.2. The Job-Application Concept**

This concept offers great potential for enhancing the recruitment and selection process in a more engaging and motivating manner. The core premise of this concept revolves

### 3.2. The Job-Application Concept

around utilizing a quiz-based application method, whereby individuals can apply for a job solely by participating in a quiz that assesses job-related knowledge. The hiring personnel create the quiz questions, ensuring that only the essential knowledge and skills required for the specific job are assessed. An algorithm designed explicitly for this purpose is employed to automatically rank applicants based on their job-specific knowledge. This innovative process enhances the application procedure by prioritizing and highlighting the significance of relevant knowledge in the initial interaction between applicants and potential employers. The presented approach significantly reduces the time and effort required for all parties by eliminating the need for traditional application documents such as a resume, cover letter, or letter of motivation at the beginning of the application process. Consequently, the streamlined process shall enhance applicants' motivation to apply for jobs. Moreover, it modernizes and simplifies the initial application round for applicants and employees.

To further reinforce the motivation of all participants, the innovative concept is realized with the support of gamification. Job-applications usually generate stress and anxiety for the applicants [CI07]. The use of gamification in the application process is intended to be more enjoyable, stimulating, informative, and varied. Through consistent gamification, applicants experience the process as a game in which they are in control, determine the course of events, have clear goals, and receive valuable feedback on their performance [VSL<sup>+</sup>04, RM19a].

To automate the application process, an algorithm takes over the work that would otherwise have to be evaluated manually. This algorithm orders the applications by scoring the application quiz, which is comparable to the job-specific knowledge of the applicant. The algorithm reduces the results to a single value based on various factors, such as correctness or time required. Furthermore, it supports the innovative application process by finding suitable applicants without prejudice. Thus, applicants are ranked and found based explicitly on their job-specific knowledge and, therefore, their suitability for a specific job. Factors such as education level, curriculum vitae, or appearance are irrelevant at the initial application round.

These factors are considered later in the application process when a mutual interest has been established between the job seeker and the prospective employer. At this stage, both parties have expressed a desire to examine the potential match further, thereby warranting the submission of supplementary documents to facilitate a more comprehensive understanding of the applicant's qualifications. Another advantage is that the concept is not bound to any industry. This implies that any job can be offered, which allows for offering different types of jobs. As a result, this concept encompasses a wide range of employment opportunities that target a variety of job seekers.

#### 3.2.1. Target Groups

The concept aims at two target groups: Job seekers actively looking for a job and employers looking for new employees. Job seekers are driven to use this concept due to its ability to simplify their application process. Unlike traditional applications, an application through the job quiz offers a streamlined and more entertaining experience

### *3. The Innovative Job-Application Concept*

that only takes a few minutes to complete. In addition, this platform enables applicants to be primarily selected based on their job-specific knowledge rather than solely relying on the contents of their resume. Consequently, job seekers can easily apply to relevant positions that are presented in an appealing and accessible manner.

The successful implementation of this concept relies on a secondary target group - the employers offering job positions. This target group enjoys many benefits from utilizing this innovative application concept. Once the employer has created a job offer, the applicants are automatically ranked according to their quiz results. This saves the employer significant time that would otherwise be spent manually evaluating each individual application. The efficiency remains consistent irrespective of the applicant volume, ensuring the employer's profitability. Additionally, this process facilitates an impartial and consistent evaluation of applicants and promotes fairness throughout the selection process.

The following points should be considered in a scenario where the concept is applied in the real world: A successful implementation of the concept requires the active engagement of both job seekers and employers. Generally, there is a mutually dependent relationship between these two parties, as the absence of one would undermine the motivation and utility of the other in utilizing the concept. Therefore, it is crucial to involve both job seekers and, notably, employers right from the start. Proactive measures should be taken to approach companies actively to facilitate the seamless introduction into a market of the concept. Companies need to be encouraged to create job offers on the platform where the concept is integrated, even before a substantial user base exists. By proactively engaging employers in this manner, the platform can establish a foundation of job offers, ensuring its attractiveness and usefulness to users, which makes the concept accessible to job seekers. After this initial promotion, both parties can fully utilize and benefit from the concept.

## 4. Job-Market Application Development

This chapter describes the development process of the mobile job-market application called *JobQuiz*. It begins with Section 4.1, which provides technical foundations that lay the groundwork for the development process. It includes discussions on the cross-platform framework, the employed programming language, as well as SDKs, IDEs, and data storage. Another important aspect covered in the section is the algorithm for quiz evaluation. It explores the different formulas used by the algorithm, providing insights into their calculations and significance. Section 4.2 delves into the design phase of the application development. It discusses the considerations regarding the user interface, user experience, and overall visual aesthetics. Following the design phase, Section 4.3 explores the development of the application prototype. This section presents the most important screens and functionalities of the *JobQuiz* application, focusing on the key features necessary for the study. In the last Section 4.4, the implemented mobile cross-platform application is presented. In this section, the three differently gamified versions of the application are presented.

### 4.1. Technical Foundations

To conduct an academic study about gamification, the innovative and gamified concept presented in the previous Chapter 3 needed to be integrated into a platform, which could then be scientifically tested. It has been decided that a mobile job market application is a suitable platform for the promising concept. It is essential to the author of this thesis that the application is developed and implemented to the full extent and not only the parts necessary for the study. Nevertheless, what is presented in the following sections might not be implemented exactly as this thesis presents, but at least approximately.

#### Cross-Platform Framework

The decision not only to develop a mobile application but a mobile cross-platform application extended the scope of this thesis. This future-oriented decision was made since cross-platform frameworks allow implementing applications for several operating systems simultaneously with a single source code, which saves much time in the long run. To limit the scope, only the mobile operations systems iOS and Android shall be covered within the project of this thesis. Due to the cross-platform framework, the developed mobile application could be converted into a website or a Linux, Windows, or MacOS application with few adjustments.

Nowadays, there are many different frameworks and programming languages to implement cross-platform applications. Considering that the application should run on several

#### 4. Job-Market Application Development

mobile operating systems, the selection was narrowed down to the frameworks Flutter, Xamarin, and React Native. After plenty of evaluation of these cross-platform frameworks, the decision was made to use the *Flutter* (Version 3.7.6) framework for developing the job-market application. This decision was made because *Flutter* appeared to be the most active and up-to-date support by the online developer community, probably because it is the latest cross-platform framework of a major company.

#### Programming Language and SDK

*Flutter* applications are commonly implemented in the programming language *Dart*. It is an object-oriented programming language and software development kit (SDK) optimized for user interface development but nevertheless applicable for back-end development. *Dart* provides a comprehensive ecosystem for constructing cross-platform applications by being both a language and an SDK. The used version of *Dart* for the development was 2.19.3.

#### IDEs and Devices

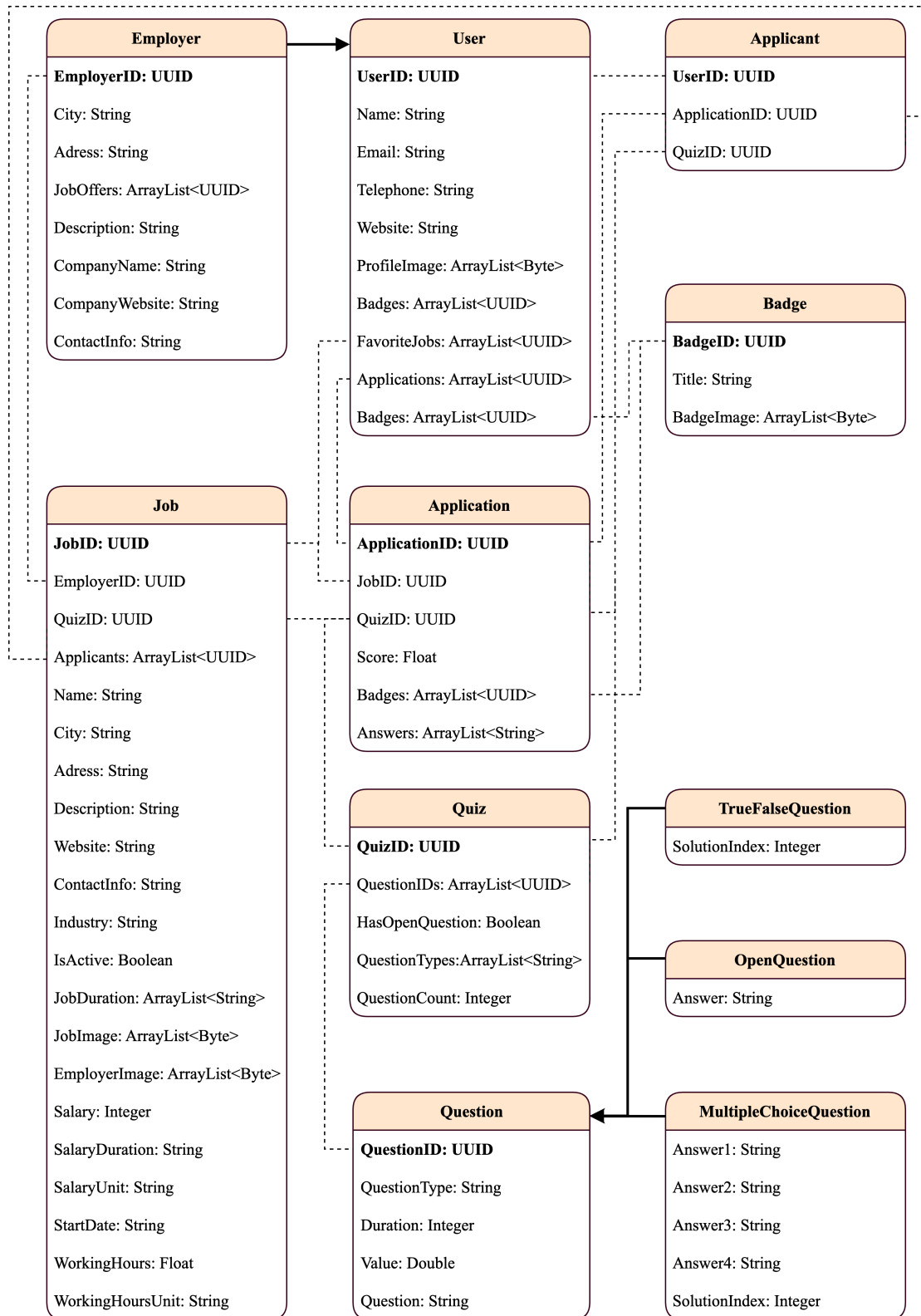
The *JobQuiz* application is implemented with the Android Studio Integrated Development Environment (IDE) version 2022.1, which was also created by Google, similar to *Flutter* and *Dart*. Since this IDE offers a feature-rich environment for building and testing applications, as well as optimal compatibility with other technical decisions, it has been used to develop the application.

Although the Xcode IDE is not used to develop the job-market application, it is necessary for the execution of the application on the mobile test device for the study. Xcode version 14.2, combined with macOS 13.2.1 on a MacBook Pro 2019, was used for building an executable version on the test device. For this, an Apple iPhone 11 Pro with iOS 16.2 was used to launch the *JobQuiz* application.

#### Cloud Data Storage

This thesis aims to build a fully functional mobile application, meaning that the application is completely implemented, not solely the parts necessary for the study. To reach the fully functional level, saving and exchanging data on demand is crucial. Therefore, data must be saved and transmitted to other users constantly while using the *JobQuiz* application. Thus, high consistency, meaning that changes in data are visible to all parties in real-time, shall be guaranteed. In addition, it should be possible to access the database from anywhere as long as there is a connection to the internet.

Given these requirements, only cloud-based data storages are eligible. After evaluating the available options, the choice for the cloud database solution fell on *Firebase* due to its compatibility with *Flutter* paired with the sufficient, free-of-charge access, which lasted for the development, test, and study conduction of the application. Integrated into *Firebase* is a NoSQL key-value database - called *Firestore* - for JSON documents as well as file-based storage for larger data.



**Figure 4.1.:** Visualization of the *Firebase* Cloud Database Structure Including Relations, Keys, and Inheritances

#### 4. Job-Market Application Development

Figure 4.1 illustrates the *Firestore* database structure, including relations, keys, and inheritances. Each box in the figure represents a database table with the name on top and underneath all the key-value pairs. In particular, each key-value pair is represented by its name on the left side and the data type on the right side of the colon. Every table has multiple items, each holding all or a subsection of the presented key-value pairs.

Looking at a table in the figure, the data type UUID is used for IDs to identify unique database items. The data type format UUID (Universally Unique Identifier) is a 32-digit combination of hexadecimal symbols. Mathematically, it can take  $2^{122}$  different combinations, which makes it statistically impossible to generate two UUIDs with the same combination of symbols. Thus, UUID was chosen for table entries' unique identification (ID), like "UserID", "JobID", and "QuizID". For example, a specific job can be easily looked up in the database through its primary key, which is the "JobID" in the UUID format. In general, keys are represented in the figure with bold key-value pairs. Dotted lines represent the connection between tables. If attention is paid to these links, it is clear that this relational database is fully interconnected through IDs, even though each table can be accessed independently, allowing for efficient data management.

The arrows in this figure show inheritances between tables, similar to the inheritance of classes. For example, the table "User" holds the data from all the users. If a user extends their profile by transforming into an employer, all the attributes of the "User" table are maintained, but additionally, the ones from the "Employer" are added. The same happens with the questions in the bottom-right of the figure, where each type of question (true or false, open & multiple choice) consists of all attributes from the "Question" table, on top of the attributes of the table of its specific type of question.

Data between the *JobQuiz* application and the *Firestore* cloud database is transmitted over HTTPS. This secure connection ensures that the confidentiality and integrity of the transmitted data are not violated. The data exchange between the two parties is performed as follows. When it comes to the need for data exchange, for example, when a job is created or other jobs should be loaded, the application sends an HTTP request containing all necessary data to the API of Firestore. Depending on the type of request, reads or writes are performed on the database. Afterwards, the API sends back a response to the application in JSON format containing either the requested data or a message about the status of the request.

#### Algorithm for Quiz Evaluation

As mentioned before, inside the *JobQuiz* application, each job offer contains a job quiz, which each user can play once to apply for this job. To evaluate the attempts of the quiz, which could theoretically be thousands of applications, an algorithm that automatically calculates the results of the quiz has been developed. This algorithm supports the innovative application process by finding applicants without prejudice, solely ranked based explicitly on their knowledge and suitability for the specific job. Thereby, the algorithm considers different factors and outputs a single value when the quiz is finished - the total score.

It is essential to consider that only multiple-choice and true-false questions are considered

by the algorithm. In the creation of a quiz, open questions serve the purpose of providing greater possibilities in asking questions, but they must be evaluated manually, which is also explained to the user. It is left to the person who creates the quiz what types of questions end up in the quiz. Adding a minimum of ten multiple-choice and true-false questions to a quiz is recommended for meaningful results and comparison between applicants. Optionally, one or more open questions can be included, and answers can only be considered by the applicants who achieve adequate scores.

Figure 4.2 shows a visualization of the sequence that is followed internally by the application during the conduction of a quiz. Thereby, this figure illustrates how the algorithm above calculates the `total_score` of the quiz automatically. The process begins when a user starts a job quiz. After the quiz is loaded from the *Firestore* database, the quiz starts with the value of zero for the `total_score`. Directly, a dynamically repeating process is entered, where the process starts to loop as long there are questions left in the quiz. This repeating process is indicated in the figure by the labeled box “Loop”. Processing a single quiz question is associated with one iteration of the loop. Since a user cannot pause or exit a quiz without finishing it, the loop of questions continues automatically until all questions of the quiz are answered, and the exit statement (“Quiz has next question?”) exits the loop. This repetitive process is a dynamic loop because it dynamically adapts regardless of the number of questions in the quiz.

There are four possible paths of this loop. Either the long process is executed, where the score of a correctly and in-time answered question is calculated, or the process is shortened. The three inner paths of the loop each show another shorter path because there is no need to calculate the `question_score` for the following reasons. If a question has the type `open`, if the answer is wrong, or if the countdown to answer the question has expired. For clarity, the visualization of parallelism has been omitted in this flowchart. At this point, it can be mentioned that all questions from the quiz, including their specified values, are already downloaded from the cloud database at the beginning of the entire process. Thus, no transaction is required to load this data during the execution of the quiz. Following the long process path, the score for the question is calculated at the outer process flow inside the “Loop” in clockwise order. Factors under consideration for evaluation include the response time and whether the quiz creator has assigned a specific value to this question. The specified value allows questions to play a varying degree of relevance in the evaluation. After the score of a question is calculated, it is added up to the `total_score` variable, which is initialized with zero at the beginning of the quiz. No matter which path is followed inside the “Loop”, a new question is loaded at the end of each iteration until no question is left in the quiz and the question loop is exited.

Afterwards, a sequential process begins, where the other applicants, which are the users who participated in the same quiz, are loaded for comparison. When the applicants are sorted by their `total_score`, and the algorithm calculates which badges are achieved, the results are displayed in the “Quiz result screen”. Which results are displayed on the screen depend on the application version as presented in Chapter 4.4. The algorithm terminates when all necessary data transmissions are fulfilled, and the quiz ends when the user exits the screen that displays the results of the quiz.

#### 4. Job-Market Application Development

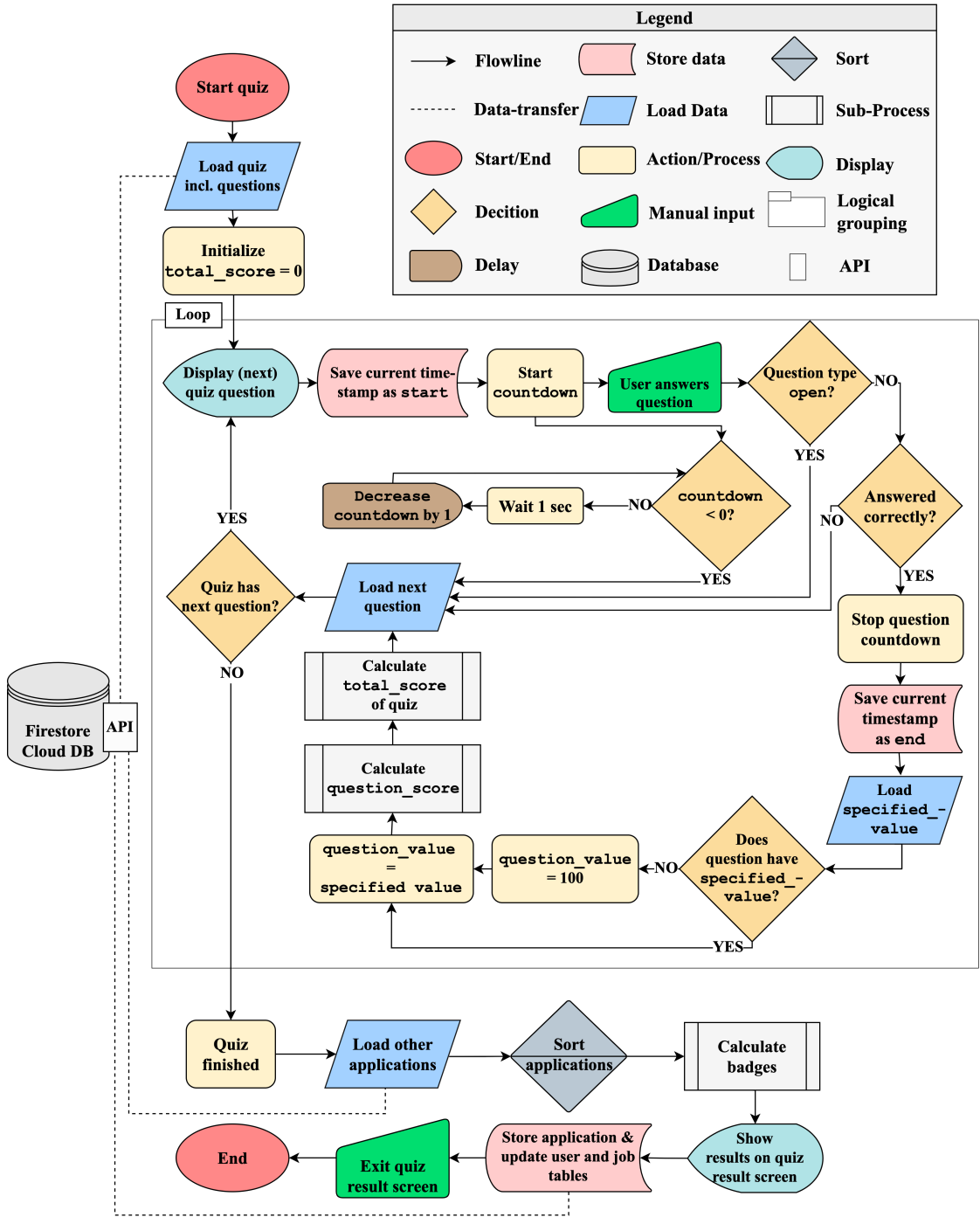


Figure 4.2.: Flowchart of the Algorithm: Processes Flows During the Conduction of a Quiz

### Formulas Integrated into the Algorithm

This paragraph covers the sub-process from Figure 4.2 “Calculate **question\_score**” in more detail. The formula used for the calculations by the algorithm to evaluate a correctly answered question is presented in Formula (4.1).

$$question\_score = (1 - \frac{end - start}{max\_question\_time}) \times value\_of\_question \quad (4.1)$$

The algorithm calculates a score for each correctly answered question based on several factors. These factors are, for example, the time taken to answer by calculating the difference between the two timestamps “start” and “end” in seconds, and the value of questions in a quiz. Due to the fact that only correctly answered questions reach that point of the algorithm, correctness is another considered factor. The faster a correct answer is given, the more points the algorithm calculates for this question.

In addition to the formula above, the sub-process from Figure 4.2 “Calculate **total\_score** of quiz” requires another formula. To compare job applicants only based on their job-specific knowledge, the **total\_score** is calculated by summing up all achieved question scores. By index=0 referencing the first **question\_score**, all questions of a quiz are covered by summing up to **question\_score** k-1. Consequently, the algorithm uses Formula (4.2) to calculate the final score of the quiz by summing up the results from Formula (4.1).

$$total\_score = \sum_{i=0}^{n=k-1} question\_score_i \quad (4.2)$$

After addressing two out of the three subprocesses depicted in Figure 4.2, the only remaining subprocess to be explained is “Calculate badges”. In the *JobQuiz* application, several badges can be achieved and collected by users. Badges, which are implemented into the application, are, for example, described as “Top 10% of applicants” when the **total\_score** of a quiz was ranked in the first tenth of all scores, or “Applied successfully” which refers to only completing a quiz.

In summary, the algorithm is a sequence of processes and loops executed during a quiz. The algorithm supports the innovative application process by sorting applicants without prejudice, solely ranked based explicitly on their knowledge and suitability for the specific job. Factors such as educational level, curriculum vitae, or appearance are irrelevant at the initial application round - the quiz.

## 4.2. Design

The application represents a serious context by being a job-market platform. Through minimalistic, intuitive, and visually appealing design, the application elevates seriousness by looking modern and reputable without seeming playful. Part of the design phase when developing the *JobQuiz* application was to achieve high usability using human-centered guidelines [TBTR21].

#### 4. Job-Market Application Development

Since the application runs on multiple mobile operating systems, dynamic scaling is important in the developing phase because the screen ratios vary throughout devices. This problem is solved using constraints for user interface elements, which allows them to scale dynamically up and down within given boundaries. As a result, the application is designed to have a visually similar and appealing user interface on various screen ratios and when other elements on the screen change in size. Figure 4.3 presents the colors in the color palette that is used to develop a visually appealing application.

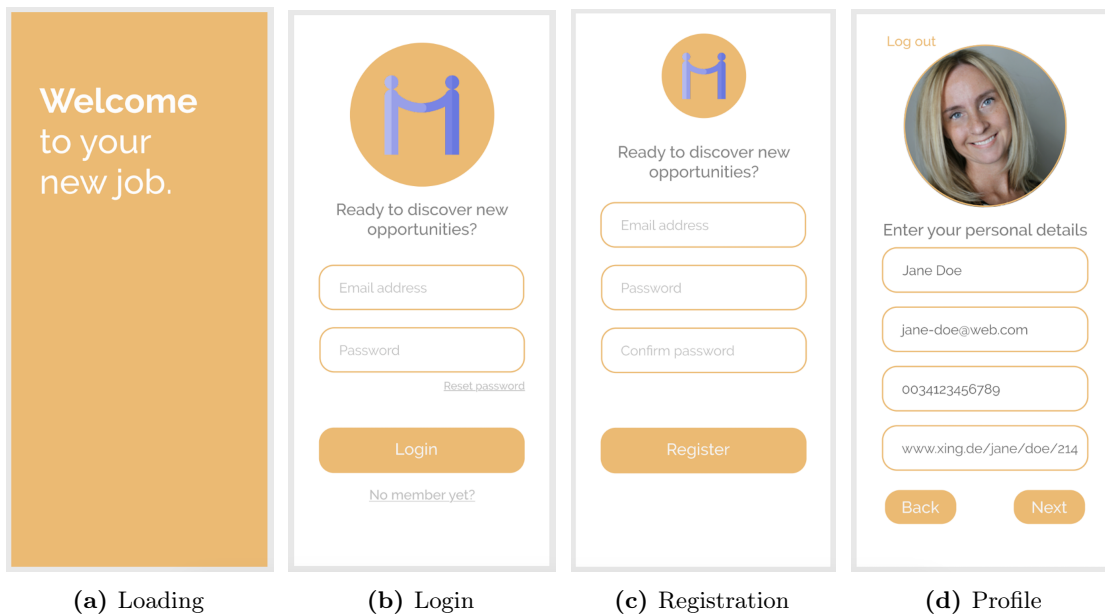


**Figure 4.3.:** Color Palette with RGB Values of *JobQuiz* Application

Orange is the primary application color to give the application a strong appearance and recognition value. However, to avoid an unprofessional or overstimulating appearance, a rather colorless scheme is used for further colors. Therefore, the second primary color is plain white. Additionally, three shades of gray are chosen as secondary colors. These are used for text and various other elements to provide a clean and minimalistic design. The color palette from Figure 4.3 does not include all the colors but the colors for most elements within the application.

### 4.3. Prototype

The development process of the application began with several mockups. With the guidance of the “Human Centered Gamification Process” and the corresponding “Gamification Codebook” [TBTR21], a prototype has been developed based on the mockups. The prototype, which consists of over 50 clickable screens, was built with the Adobe XD tool. In general, the screens of the application can be divided into three major parts. First is the general register and login part, where users can create an account, including a profile, or log into an existing one. Secondly, the employer part, where the employer can edit their representation, create job offers, and manage job applications. Lastly, the part for the general user, often referred to as the job seeker, where the profile is managed, job offers are presented, and applications through participation in quizzes are possible. Due to the fact that the prototype, as well as the actual application, consists of numerous screens, only the most relevant parts are presented. A complete navigable visualization of the prototype can be accessed via <https://xd.adobe.com/view/0007b3dd-65eb-4eb9-9c40-084375179473-5554/grid>.



**Figure 4.4.:** *JobQuiz* Prototype: Loading, Login, Registration and Profile Screens

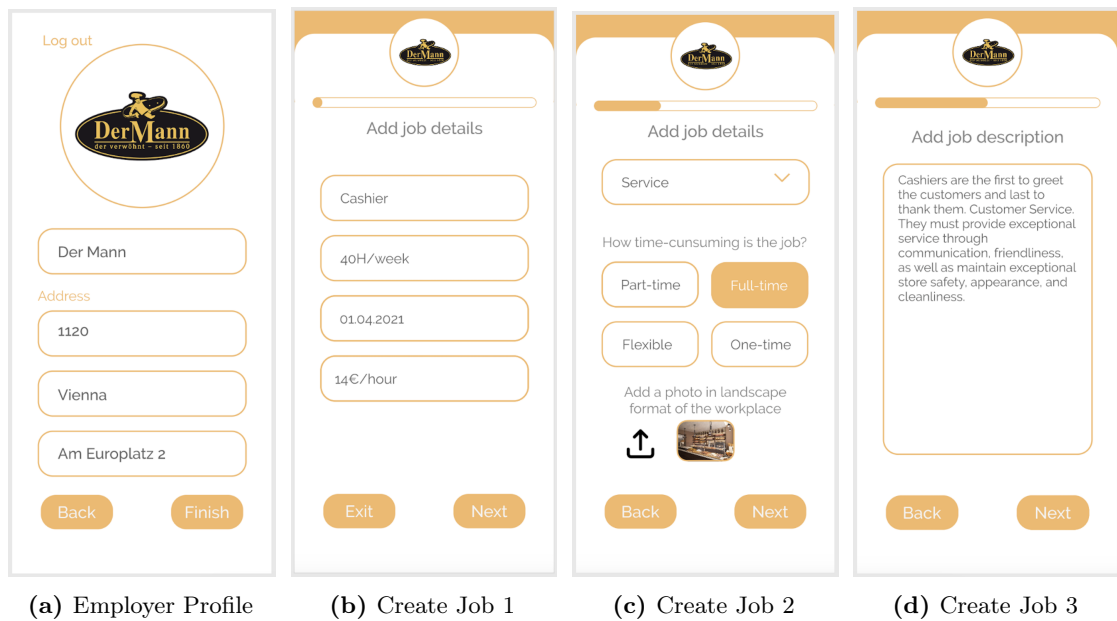
### Login, Registration, and Profile Creation

Presented in Figure 4.4 is the process the user goes through when using the application for the first time. Figure 4.4a shows the loading screen, which is presented when the application opens and loads. In Figure 4.4b, a screenshot is presented, where the user can log into the profile or navigate to the registration screen, which is displayed in Figure 4.4c. In this screen, the user can register to the *JobQuiz* application with an email address and a password. After registration, more information to the profile can optionally be added, as shown in Figure 4.4d. The profile of a user can also be modified after creation. In general, the application has a bright and friendly appearance. This should additionally be reinforced through personal and motivational phrases, as found in the sub-figures in Figure 4.4.

### Create a Job-Offer

In Figure 4.5, four prototype screens visualize the process an employer has to proceed when creating a new job offer. Figure 4.5a shows the “Create Employer Screen”, with which a user can additionally become an employer by providing further information, including uploading an image or logo of the employer. This screen only appears when a user wants to create their first job. The information of the employer is transmitted from the database and reused for further jobs. This way, this screen is skipped in further job creation processes. Nevertheless, if needed, this data of the profile of the employer can be edited after creation. Figure 4.5b, Figure 4.5c, and Figure 4.5d show the creation process of a job. On the top of the screens, the logo of the employer is visualized with a bar,

#### 4. Job-Market Application Development

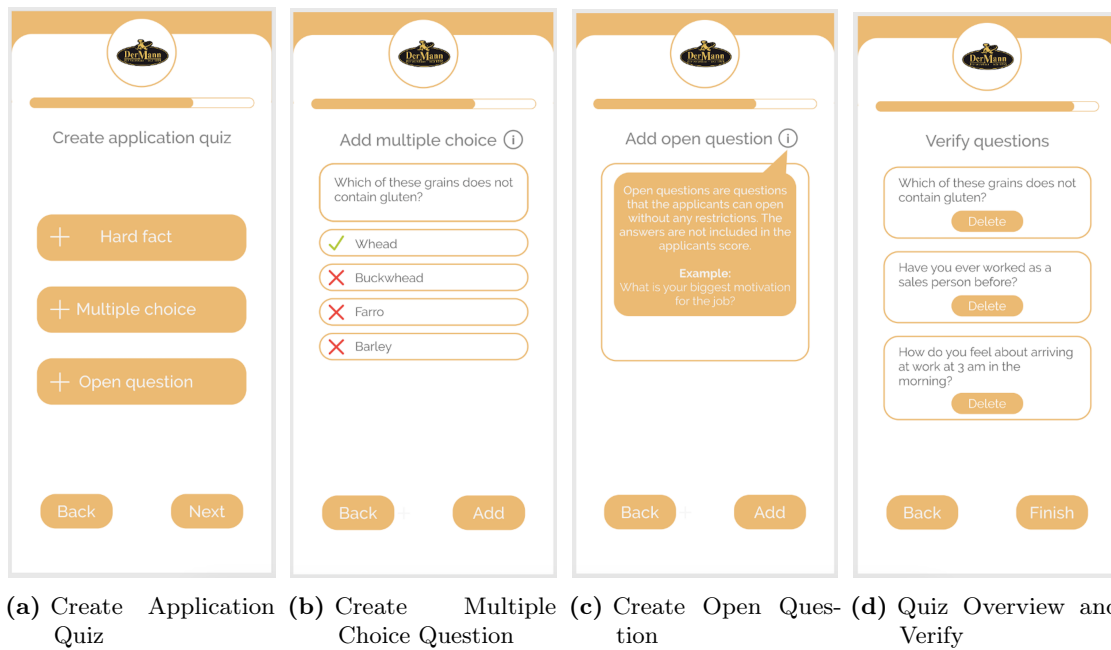


**Figure 4.5.:** *JobQuiz* Prototype: Create Employer and Job-Offer Screens

which indicates the progress of the job creation process underneath it. In these screens, the user enters a variety of information about the job, including name, duration of job, start date, salary, industry, description, and an image of the workplace. The progress bar indicates that the job creation process is not finished yet. The second part is covered in the subsequent paragraph.

#### Create a Job Quiz

As shown in Figure 4.6, the second part of the job creation process is dedicated to creating the job quiz. In the Sub-Figure 4.6a, the user must decide which type of question should be added to the quiz. The choices are open questions, multiple choice questions, and hard questions, whereas the wording of the last changed to true-false questions later in the development process. Each quiz shall contain questions about the knowledge required for the specific job it is designed for. Figure 4.6b displays the creation of a multiple-choice question. The user can write the question and possible answers in the provided text fields. Furthermore, the user can change the order of the answers and is able to toggle between correct and incorrect answers. Figure 4.6c is a screenshot of the creation of an open question. In this figure, the info button is active, which explains to the user what this question type is about using an example. The presented screen in Figure 4.6d shows an overview of all created questions of this quiz. This screen has the purpose of verification, which means that questions can still be modified and deleted. When the verification is complete, the user can click the finish button and upload the job offer. The utilized cloud database offers high consistency real-time data synchronization, which implies that uploaded jobs or other data are published to other users without any noticeable delay.



**Figure 4.6.:** *JobQuiz* Prototype: Create a Job Quiz Screens

## Visualization of Job Offers

Figure 4.7 presents two essential screens of the *JobQuiz* application. The screens in the figure have an increased height, which indicates the feature of scrolling vertically. In particular, in Figure 4.7a, an overview of job offers in an infinite scroll view is shown. Thus, the user can scroll down as long as there are job offers in the cloud database. The jobs are sorted by distance and relevance to the user to provide high-potential usefulness. The drop-down menu at the top of the screen allows the user to filter by industry, where the selection “All industries” is used as the default value. Each job is presented in a rounded window, showing the images of the workspace and logo of the employer, in addition to other information about the job. The user can add jobs as favorites at the top-right of each window. The data about the jobs loads automatically while scrolling down or can be manually updated automatically by scrolling up while at the top of the list. These common mobile motions create a smooth and intuitive experience when using the application. If the user clicks on the window, the screen transitions to the job-offer detailed view screen, which is displayed in Figure 4.7b. This screen presents a detailed view of a single job offer. The image of the workspace, as well as more information about the job, including current distance and description, can be found on this screen. On the bottom of this screen, a button labeled “Start application quiz” can be found. By clicking this button, a quiz with job-specific questions begins. To prevent cheating during a quiz, it cannot be paused and continued at a later point in time. Additionally, each quiz can only be participated once.

#### 4. Job-Market Application Development

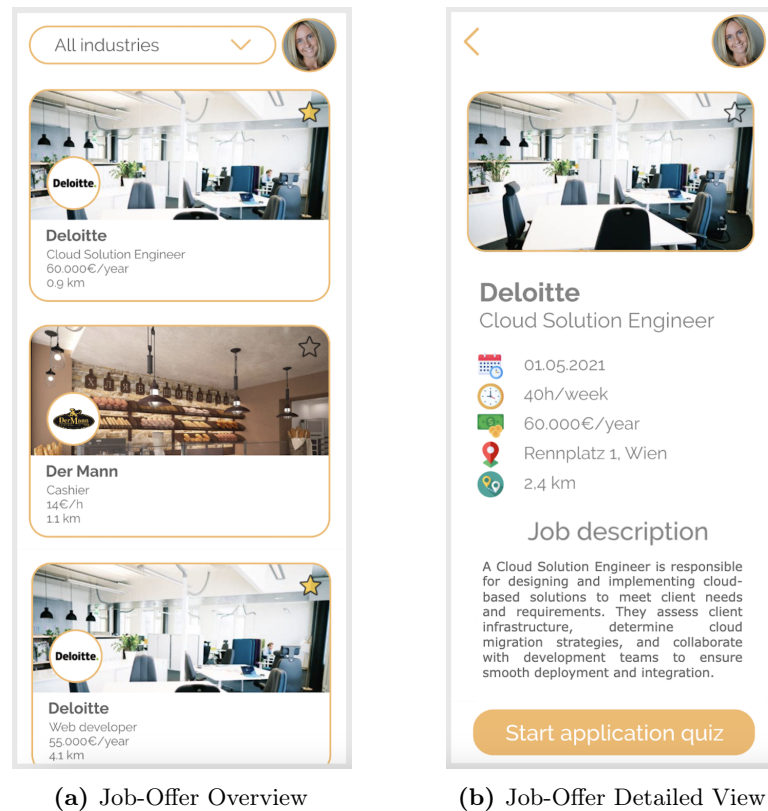
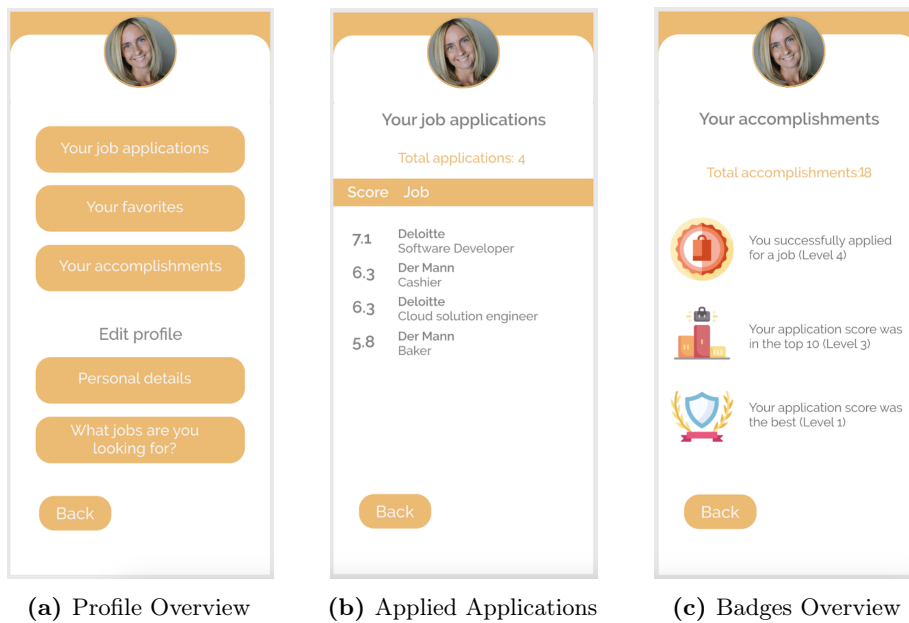


Figure 4.7.: *JobQuiz* Prototype: Job-Offers Overview and Detailed View Screens

#### User Profile

In most screens within the *JobQuiz* application, the user can reach their profile by clicking on their profile picture shown on the top right in Figure 4.7a or Figure 4.7b. By clicking that, the user opens the “Profile Overview” screen pictured in Figure 4.8a. There, the user is provided with a navigational overview, showing all possible sub-screens in the user profile. When the user, for example, clicks on the “Your job applications” button, the screen in Figure 4.8b opens. All the quiz results from jobs the user applied for are listed on this screen. Clicking on a job navigates to the detailed view of a job, shown in Figure 4.7b. Focusing on Figure 4.8c, a screen is visualized that presents gained and collected achievements, also called badges, which is an important element of gamification. On display are three different kinds of badges, each with a different experience level. The increase in experience levels can be compared to an exponentially growing function since the user needs to collect more and more badges of the same kind to reach higher levels of that badge. In other words, the more badges of the same kind are collected, the higher the level, and the more badges are needed to level up. Badges are used as a tool for social comparison on the application platform.



**Figure 4.8.:** *JobQuiz* Prototype: User Profile Screens

## 4.4. Application

After the prototype of the application was created, the implementation phase started. This was the most time-consuming phase, requiring more than ten thousand manually written lines of code to develop the application. Elaborate tasks included the infinite scroll view for job offers, general data handling (see Chapter 4.3), and the high-quality design with dynamic scaling (see Chapter 4.2). After several months, however, the developer implemented the application successfully but with minor modifications compared to the original plan and prototype.

To avoid repetition, only essential and not yet covered parts by the prototype are presented in this chapter. One crucial part of *JobQuiz* application is the job quiz, which is the critical functionality of the application according to the developed job concept. As mentioned in Chapter 3, the job quiz is a way to apply for a job in a straightforward and uncomplicated way. To increase intrinsic motivation within this process, gamification has been integrated especially into this part of the application.

### Job Quiz and Integrated Gamification

Table 4.1 presents the implemented elements and mechanics of gamification. As shown in the table, the three different versions of the *JobQuiz* application have integrated different levels of gamification. The names of the versions already indicate the gamified level. In the following three sections, the different versions of the application are presented, using the example of the job quiz, as it features gamification the most.

#### 4. Job-Market Application Development

|                                         | Minimally Gamified Version | Gamified Version | Highly Gamified Version |
|-----------------------------------------|----------------------------|------------------|-------------------------|
| Progress Indicator                      |                            |                  |                         |
| Attractive Design                       |                            |                  |                         |
| Challenge                               |                            |                  |                         |
| Time Challenge                          |                            |                  |                         |
| Score / Points                          |                            |                  |                         |
| Total Score                             |                            |                  |                         |
| Social Impact                           |                            |                  |                         |
| Leaderboard                             |                            |                  |                         |
| Visual Feedback for Correct Answers     |                            |                  |                         |
| Visual Feedback for Incorrect Answers   |                            |                  |                         |
| Acoustic Feedback for Correct Answers   |                            |                  |                         |
| Acoustic Feedback for Incorrect Answers |                            |                  |                         |
| Haptic Feedback for Incorrect Answers   |                            |                  |                         |
| Musical Accompaniment of the Quiz       |                            |                  |                         |
| Achievements / Badges                   |                            |                  |                         |

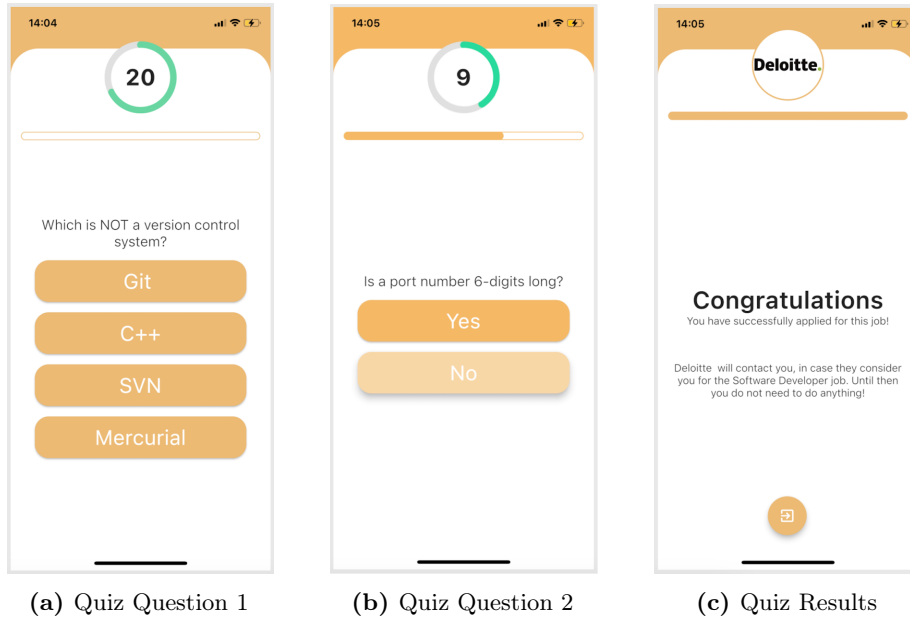
**Table 4.1.:** Integrated Gamification into *JobQuiz* Versions

#### Minimally Gamified Version

Visualized in Table 4.1, the *minimally gamified version* has just four components of gamification integrated. The progress indicator, presented as a progress bar, offers information on the progress of the user and contributes to a sense of accomplishment, thereby enhancing engagement within the job quiz [HT07]. *Attractive design* refers to the general design of the application. As explained in Chapter 4.2, the *JobQuiz* application aims to have a visually appealing design for the user. The concept of an attractive design encompasses the idea that captivates the attention of the user, drawing them into the application [KZ17]. In the *JobQuiz* application, a *challenge* is essentially a job quiz. Challenges in an application provide individuals with a sense of purpose and clear objectives, namely, applying for a job. This enables them to overcome obstacles and enhances a sense of accomplishment and personal growth. These intrinsic rewards serve as powerful motivators for individuals as they recognize and acknowledge their competence and achievements [LXH<sup>+</sup>20, Ree12]. In gamification, *time challenges* are closely related to challenges, but they add a sense of urgency to the task. By imposing time constraints for answering quiz questions, represented by a countdown timer, individuals are forced to be more efficient in deciding [MMW10]. Furthermore, it adds another variable to the algorithm, which calculates the quiz results, as shown in Chapter 4.1.

This paragraph delves into the significance of these gamification components in this version. The presented elements and mechanics of gamification are incorporated to ensure meaningful comparisons between the various versions. Without *(time) challenge*, this version would not have a competitive job quiz at all, undermining the meaningfulness of comparison. The *attractive design* is consistent throughout the versions because otherwise, the same fundamental conditions would not exist. The *progress indicator* exists in this version because its presence is already considered standard.

Figure 4.9 presents a variety of screens from the *minimally gamified version* of the application in the context of a job quiz participation procedure. Figure 4.9a presents a



**Figure 4.9.:** *Minimally Gamified Version of JobQuiz Application: Implemented Gamification Presented Through Job Quiz Screens*

possible multiple-choice question in a quiz for a software developer job offer. A countdown is located at the top-center of the screen to visualize that there is only limited time to answer the question. The countdown shows numbers, which decrease by one every second, surrounded by a continuously decreasing colored circle. When the countdown reaches zero, the animated circle has also completely decayed, and the time to answer this question runs out. As mentioned before, the faster the user answers correctly, the more points are received for a question that is known to the user. This shall additionally be enhanced through the utilization of the countdown.

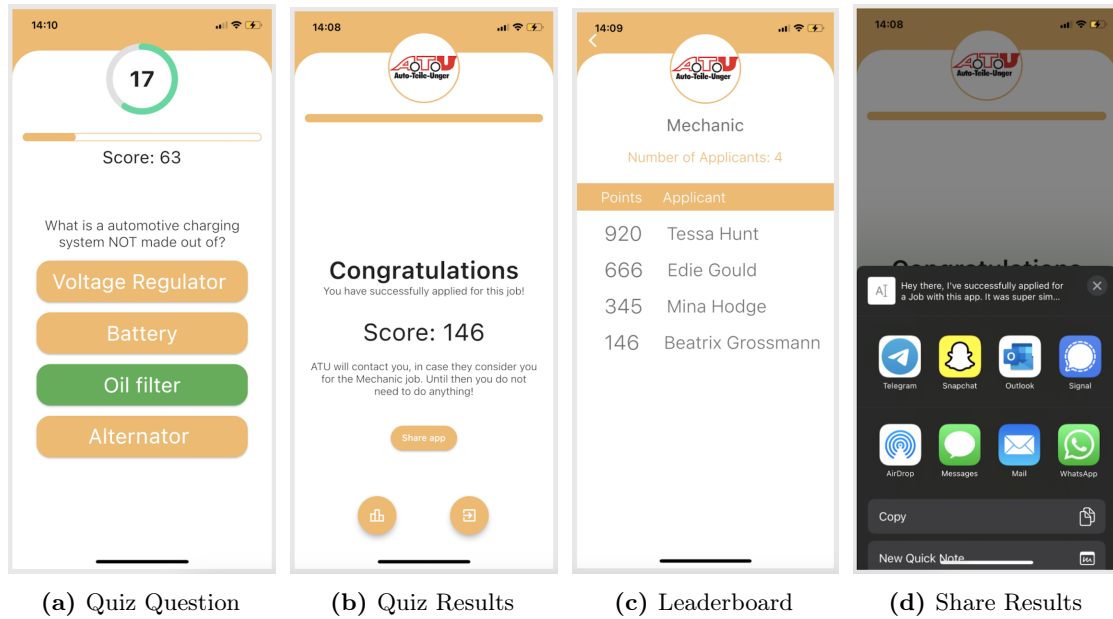
Figure 4.9b shows a true-false question later in the quiz, which is indicated by the progress bar. In this screen, the answer “No” is recently clicked. However, the clicking animation only indicates the selection. Thus, no feedback about the correctness of the answer is given to the user. In Figure 4.9c, the “Quiz Results” screen is displayed at the end of the quiz. This screen can provide information about the performance of the quiz to the user. However, the *minimally gamified version* lacks any user performance-related information.

## Gamified Version

Referring back to Table 4.1, it becomes clear that the *gamified version* of the *JobQuiz* application is an extension of the *minimally gamified version*, in terms of gamification. Additional elements and mechanics of gamification utilized in the *gamified version*, compared to the *minimally gamified version*, are presented in Table 4.1 and below:

#### 4. Job-Market Application Development

- *Visual feedback for correct answers*
- *Score/Points*
- *Total score*
- *Social connection*
- *Leaderboard*



**Figure 4.10.:** *Gamified Version of JobQuiz Application: Implemented Gamification Presented Through Job Quiz Screens*

The *gamified version* of *JobQuiz* application includes *visual feedback for correct answers* as presented by the green highlighted button in Figure 4.10a. In this screen, a *score* is displayed in the top region to give the user additional feedback about their performance. This value, also referred to as the *total\_score* of the quiz, is presented to the user at the “Quiz Results” screen, shown in Figure 4.10b. As explained in Chapter 4.1, the *total\_score* is the sum of scores from each question, where false questions have a value of zero. If the user clicks on the bottom-left button, the *leaderboard* appears. The centered button provides the functionality to share the results of the quiz. In Figure 4.10c, the *leaderboard* is presented. With the *leaderboard*, the user can compare their results with other users who also applied for the same job by participating in its quiz. As shown in this figure, the current user achieved 146 points, which is rather little in relation to the other applicants. From a theoretical point of view, utilizing leaderboards causes a heightened ambition in individuals who are driven to attain higher rankings, which can be attributed to *social connection*. The public showcase of user performance significantly contributes to boosting

motivation and engagement, as individuals aim to outperform their competitors [ZC11]. Since each quiz can only be participated in once, this refers to future quiz participation. Figure 4.10d presents the “Share Results” screen. Through this feature, users can share their quiz results with other individuals, even if those individuals are not users of the *JobQuiz* application themselves. This feature further reinforces the *social connection*, which is already provided by the *leaderboard*.

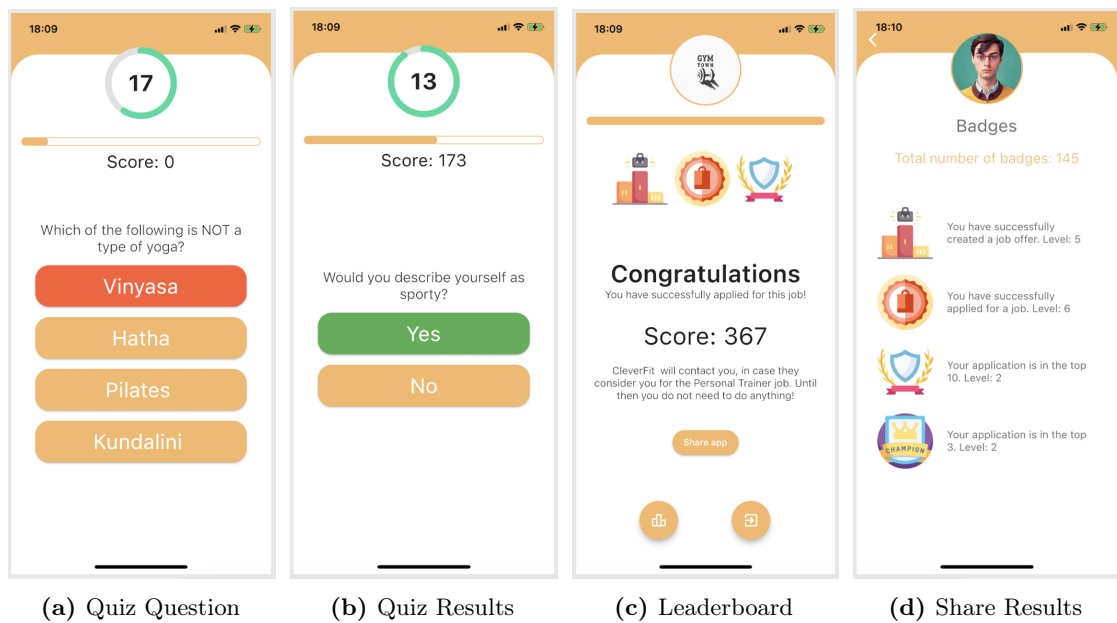
## Highly Gamified Version

Similar to the *gamified version*, the *highly gamified version* is an extension of the previously presented version in terms of gamification. As shown in Table 4.1, the additional components of gamification in the *highly gamified version* on top of the ones from the *gamified version* utilized are:

- *Musical accompaniment of the quiz*
- *Visual feedback for incorrect answers*
- *Acoustic feedback for incorrect answers*
- *Haptic feedback for incorrect answers*
- *Acoustic feedback for correct answers*
- *Achievements/Badges*

In Figure 4.11, the additional elements and mechanics of gamification are presented. In general, the *highly gamified version* is the only version that includes audio, specifically through music and acoustic feedback. Tense and exciting music is played during the conduction of the quiz in this version. This *musical accompaniment of the quiz* is integrated in a way that it plays quietly in the background, captivating the attention of the user. Nonetheless, the study later reveals that this musical accompaniment is disturbing to many participants. Figure 4.11a shows a multiple-choice question at the beginning of a quiz, which is part of the “Personal Trainer” job offer at a fitness company. As indicated by the red color of the button, the user selected the wrong answer, resulting in immediate and intuitive information about the incorrect actions, which refers to *visual feedback for incorrect answers*. Additionally, to the visual change, an acoustic sound associated with an error is played. That sound provides *acoustic feedback for incorrect answers* to the user. Furthermore, *haptic feedback for incorrect answers* is utilized through a short vibration performed on the device. In summary, the *highly gamified version* conveys negative feedback through visual, acoustic, and haptic channels. When attention is paid to Figure 4.11b, the focus shifts from negative to positive feedback due to the presented true-false question, which is answered correctly. Due to the implementation of *acoustic feedback for correct answers*, every correctly answered question is accompanied by a sound, which is a high-pitched tone associated with a valid action or answer. The engagement shall be amplified by providing instant correctness feedback to the user.

#### 4. Job-Market Application Development



**Figure 4.11.:** *Highly gamified version of JobQuiz Application: Implemented Gamification Presented Trough Job Quiz Screens*

The last elements of gamification added to this version of the *JobQuiz* application are *achievements/badges*, as shown in Figure 4.11c. In this “Quiz Result” screen, the user collected three badges for quiz participation, visualized on the screen. If the user clicks on one of the achieved badges, additional information about this achievement appears. Shown Figure 4.11d, each user can view their collected badges on a separate screen accessible through their profile. By collecting multiple instances of the same achievements, users can reach higher badge levels.

## 5. Study on Gamification and Motivation

In this chapter, the conduction of an empirical study is documented and evaluated. Section 5.1 defines the structure of the study by proposing the used forms. The most important one is the questionnaire, which comprehensively records participant motivation changes across the different versions of the *JobQuiz* application. In the subsequent Section 5.2, the conditions, settings, and environments for the study are specified. Section 5.3 covers the general conduction of the study, including first results, like demographic statistics of the participants. Additionally, the Wilcoxon signed-rank test is addressed in this section to sufficiently understand the utilized study procedure of the following Section 5.4. In this final section, the results of the study, including the utilization of the Wilcoxon signed-rank test procedures, are presented. The test is conducted three times to evaluate the pairs: *minimally gamified version* vs. *gamified version*, *minimally gamified version* vs. *highly gamified version*, and *gamified version* vs. *highly gamified version*.

This thesis employed a similar procedural approach to the empirical study conducted in a different academic paper titled “A Study on Gamification Effectiveness” [CHH20]. In that paper, Cvetkovic et al. (2020) conducted a study to measure the changes in intrinsic motivation through a mundane task between three different feedback types. Their results indicate that the intrinsic motivation when comparing the “No Feedback” type with visually stylized or plain text feedback is significantly different. In other words, a statistical difference between these feedback types is measured, which indicates a dependency between intrinsic motivation and feedback. In particular, the types, which include gamification through feedback, indicated enhanced motivation. Their results indicate that between visually stylized and plain text feedback, no significant difference in motivation is found. Since feedback is an indispensable part of gamification, this thesis conducts a study that involves a similar scientific approach to extend the scientific knowledge of the mentioned paper.

### 5.1. Structure of the Study

As mentioned, the presented *JobQuiz* application serves as a platform that represents the serious context for this study. The three implemented versions of this application are: *minimally gamified version*, *gamified version* & *highly gamified version*. The study is structured as a within-subject design study, meaning that each participant uses every version of the job-market application once. To minimize the influence of the order of the versions on the participants, the order of the versions was randomized for every participant. Before the empirical study began, the participants filled out two forms - *informed consent form* & *pre-questionnaire*.

## 5. Study on Gamification and Motivation

### Informed Consent Form

The *informed consent form* (see appendix A) explains the general details of the study to the participants. It is essential to uphold ethical principles, protect the rights of participants, establish trust, and maintain accurate records. In detail, it consists of multiple parts, which serve different purposes:

The first part informs the participant about the area of the study without revealing what the empirical research is about. Secondly, the form explicitly states that participation in the study is entirely voluntary. Every individual retains the right to withdraw from the study or decline to participate. Thirdly, the *informed consent form* explains what the data is used for, specifically in terms of data privacy. Participation in this study is kept confidential at all times. The data collected from the participants is handled anonymized and only used for this particular study. Only the researchers involved in this study have access to the collected information. Next, the general procedure of the study is explained in the following way:

1. Fill out a general *pre-questionnaire* about yourself.
2. Execute a short task on a randomly selected version of the mobile application.
3. Rate 12 statements about Task 2 in a *questionnaire*.
4. Repeat Task 2 & 3 three times with another randomly selected version of the same mobile application.

Tasks 2, 3, and 4 are later referred to as the main part or phase of the empirical study. The executions of one cycle, which include Task 2 & 3, are later referred to as one study run or round. Finally, participants are inquired about their reading and comprehension of the provided information. By signing the *informed consent form*, the participant agrees to participate in this empirical study, which begins with the *pre-questionnaire*.

### Pre-Questionnaire

The *pre-questionnaire* (see appendix B) serves the purpose of collecting demographic and personal information of the participants. To protect their privacy, the forms are anonymized by using IDs instead of names. It consists of the following questions:

1. How old are you?
2. What is your gender?
3. How much time do you spend on your phone on average a day?
4. How often do you play digital games?
5. What is your employment status?
6. Are you currently looking for a job or a different job?

### 5.1. Structure of the Study

The first two questions ask about the demographic features of the participants. The following two questions ask about the general digital affinity of the subjects by asking questions about the use of digital devices. Questions 5 and 6 focus on the current professional work situation. These questions help to better understand the participants in the three mentioned areas. The collected data is used to evaluate the results of the main study phase further.

## Questionnaire

As mentioned before, the participants “Execute a short task on a randomly selected version of a mobile application” and afterwards fill out a *questionnaire* (see appendix C). The execution is discussed in the following Chapter 5.3. The *questionnaire* consists of the 12 statements, which are presented in Table 5.1. The statements cover different aspects of intrinsic motivation, overall feeling, and engagement. They are used to measure how intrinsically motivated participants feel during the quiz and how satisfied they are with their performance. This way, the intrinsic motivation of subjects during and after the job quiz is measured in more general terms [CHH20].

|    |                                            |
|----|--------------------------------------------|
| 1  | Completing the process was entertaining    |
| 2  | I feel good after applying for the job     |
| 3  | I want to apply for other jobs             |
| 4  | Applying for a job this way was amusing    |
| 5  | I have never applied for a job so easily   |
| 6  | I was bored during the process             |
| 7  | My motivation to answer correctly was high |
| 8  | The quiz was exciting                      |
| 9  | I forgot I was applying for a job          |
| 10 | It felt wrong to apply for a job this way  |
| 11 | Next time I want to perform better         |
| 12 | Answering correctly felt good              |

**Table 5.1.:** Questionnaire

Participants can rate each statement of the survey using a Likert scale consisting of five levels, as shown in Figure 5.1. The Likert scale is a widely accepted and validated tool for measuring attitudes and opinions in academic research. Its structured format, multiple response options, and quantitative nature make it an effective method for capturing and analyzing subjective data. The participant must select exactly one of the provided options for each statement of the *questionnaire*. To easily evaluate the collected data, each of the five levels is given an integer value from -2 for “Strongly disagree” to +2 for “Strongly agree”.

## 5. Study on Gamification and Motivation

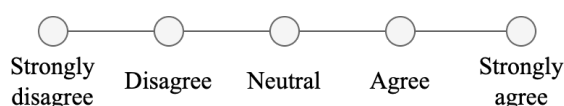


Figure 5.1.: Likert Scale

Depending on the formulation, the **polarity of statements** is either positive or negative. The results of two negatively formulated questions (Number 6 and 10) are inverted at evaluation. Thus, all statements have the same orientation to make an evaluation with the Wilcoxon signed-rank test possible. In particular, this means that the numerical value of negatively formulated statements is multiplied by -1.

Two **control statements** are integrated into the *questionnaire*. The function of control statements is to improve the data quality and identify possible biases or sources of error. They ensure that participants respond appropriately and honestly to the statements and do not respond randomly or arbitrarily. In this *questionnaire*, statement 1 (Completing the process was entertaining) and statement 6 (I was bored during the process) are control statements since both ask a similar question, but one is negated. Therefore, participants whose answers are inconsistent with these two control statements can be discarded from the empirical study evaluation.

## 5.2. General Study Settings

To allow similar conditions for every participant, conditions, settings, and environments are defined. This helps to ensure the reliability and validity of the study, including its findings. Additionally, it allows for a comprehensive understanding of behaviors, experiences, and interactions with mobile devices. For this study, the following is defined:

- **Physical settings** refer to the physical environment where the study is conducted. The location should be appropriate for the study and ensure comfort, concentration, and privacy. A suitable environment for the study would be indoors, where it is relatively quiet for concentration and without direct sunlight so that every participant can see the screen of the test device clearly.
- **Test devices** are technical devices that are used in the conduction of the study. Participants used an iPhone 11 Pro operating on iOS 16.2 as a mobile test device running the application. To change the running version of the application on the mobile test device, a MacBook Pro with the operating system macOS Ventura 13.2.1 was used.
- **Network connectivity** is crucial for conducting the study since the mobile test device involves data transmission. The execution of the application *JobQuiz* depends on a reliable Wi-Fi or cellular data connection since it constantly transmits data to and from the cloud database. Only with a properly working network connection real-time data transmission is achieved.

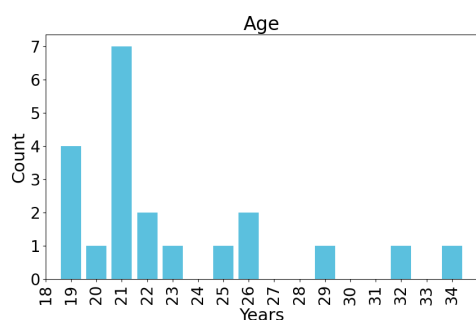
- **Time** is an important factor to consider in an academic study. The duration of a study can influence the quantity and quality of data obtained. More extended studies offer the advantage of gathering more data; however, they may suffer from reduced participant engagement and attention at some point, leading to lower data quality. Thus, the conduction of this study with one participant aims to take between 15 and 20 minutes.
- **Researcher presence** refers to the physical presence of the researcher during the study. It is required to perform the procedure of the academic study, demonstrate the application to the participant, and be available to answer questions or provide clarification. Since the presence of the researcher can affect the concentration and well-being of the subject, the researcher shall act reserved and calm.
- **Participant interaction** is about the interaction during the conduction of the study. Questions during the conduction about controls or operations of the application can be answered or shown by the supervisor as long as participants are conducting the tasks of the study by themselves. Additionally, interactions that are helpful for the conduction of the study, like briefly presenting the mobile application to the participant before handing the test device over, are allowed.
- **Documentation** is crucial to ensure the integrity and traceability of the data collected during the study. Since all forms are handed to the participants in printed form, these documents shall be collected systematically and later converted into digital form by the researcher.

## 5.3. Conduction of the Study

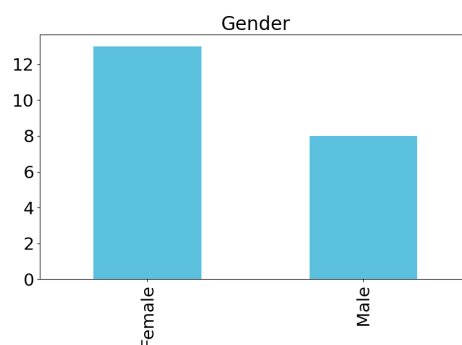
The study was performed in May 2023 in Vienna. The researcher asked people from the personal environment and the general public to participate in the study. The participation in the study was conducted one participant at a time. In total, 22 people participated in the empirical study. One participant was discarded due to their answers in the control statements. The answer to statement 1 (Completing the process was entertaining) and statement 6 (I was bored during the process) in the *questionnaire* were both “Totally agree”. Due to the inconsistency in their answers, the data generated by the subject cannot be included in further analysis. Thus, the number of relevant participants in the study decreases by one:  $n = 21$ .

The topic was introduced to the subject on an abstract level to prevent revealing the purpose of the study, which could have influenced the behavior of the participants. Every prospective participant was invited to choose whether they would voluntarily take part in a study concerning user interaction in the field of human-computer interaction. If someone agreed, the study began with the participant signing the *informed consent form*. Every individual who read the form signed it. Then, each participant received an ID to anonymize the subject with which they filled out the *pre-questionnaire* form.

## 5. Study on Gamification and Motivation



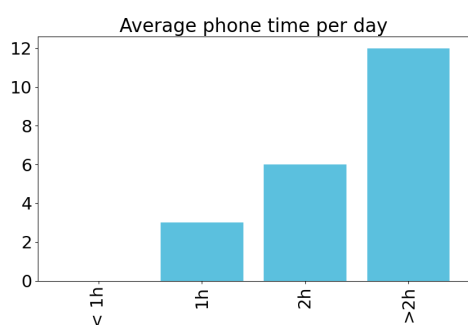
**Figure 5.2.:** Pre-Questionnaire Question 1: Age



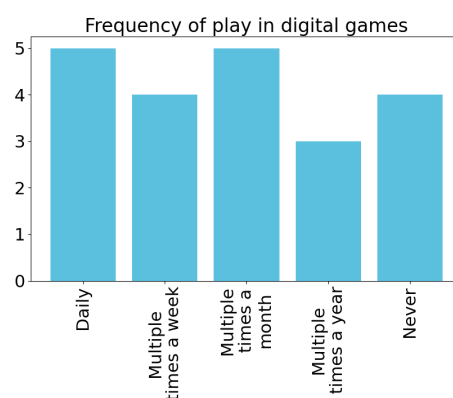
**Figure 5.3.:** Pre-Questionnaire Question 2: Gender

The first two questions ask about the demographic features of the participants. As shown in Figure 5.2, the participants are between 19 and 34 years old. The majority, with almost 62%, are between 19 and 21, with seven 21-year-olds. The median age of the respondents is 21; the average is 23. Visualized in Figure 5.3, more women than men participated in the study. From a total of 21 subjects, only eight (38%) selected the “Male” option, and 13 (62%) chose “Female”. No participant answered with “No comment”.

The *pre-questionnaire* continues with a question about the average amount of time spent on a phone a day, which is presented in Figure 5.4. Three participants answered “1h”, six answered “2h”, and with a majority of 57%, twelve selected “>2h”. No participant selected the “<1h” option. Question number 4, visualized in Figure 5.5, asked about the frequency of playing digital games. The results are relatively equally distributed between the different options. Five participants answered “Daily”, four picked “Multiple



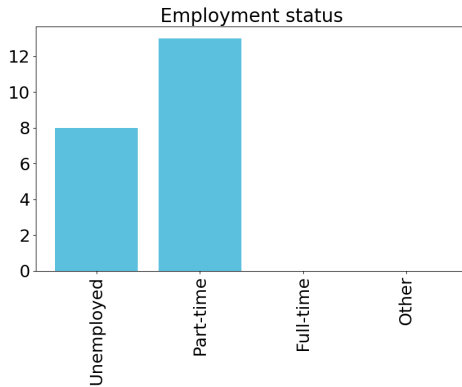
**Figure 5.4.:** Pre-Questionnaire Question 3: Average Phone Time Per Day



**Figure 5.5.:** Pre-Questionnaire Question 4: Digital Games Play Frequency

### 5.3. Conduction of the Study

times a week”, five chose “Multiple times a month”, only three selected “Multiple times a year”, and four answered that they “Never” play digital games. As a result, 81% of the participants participate in digital games, and only 19% are not.



**Figure 5.6.:** Pre-Questionnaire Question 5: Employment Status



**Figure 5.7.:** Pre-Questionnaire Question 6: Reception of Job Offers

The last two questions of the *pre-questionnaire* cover the area of professional work. Question 5 asked about the employment status of the respondents, as visualized in Figure 5.6. The majority of 62% answered that they work “Part-time”. The remaining eight participants (38%) chose the option “Unemployed”. At this point of the study, the question “Which option does being a full-time student belong to?” was raised several times. After clarification, those people selected the “Unemployed” option. In Figure 5.7, the results to the question “Are you currently looking for a job or a different job?” are presented. Five answers were given to “Yes”, which is roughly 24%, and around 42% of the participants chose the “Open for offers” option. 1/3 of respondents were not looking for a job or open for job offers when the study was conducted.

### Main research phase

Upon completion of the *pre-questionnaire* by each participant, the main phase of the study commenced. The researcher began by providing a concise introduction to the *JobQuiz* application, which included a demonstration of its navigation through various screens and a brief explanation of its underlying job market concept (see Chapter 3.2). This ensured that participants had a clear understanding of the fundamental aspects of the concept, namely that their participation in a job-specific quiz constituted an application for the corresponding job opportunity.

To ensure the smooth progression of the study, the application was configured with a user profile in advance. Additionally, the *JobQuiz* cloud database contained relevant data, creating an illusion of an actively utilized application with other users. For example, the database is filled with various job offers, like “Software Developer”, “Mechanic”, “Kindergartener” or “Fitness Coach” along with related data like job quizzes, badges,

## 5. Study on Gamification and Motivation

scores, or other applicants. The data presented to the user varies depending on the application version, which represents the level of utilized gamification.

The initial round of the main phase of the study always started by randomly selecting one of the three versions of the application. The smartphone was given to the test person with the main page of the application running - the job offers overview page. The participant was told to apply for any job by participating in the quiz of a job offer of their choice. Before the participant started, the researcher underlined that the application was only for fictive jobs.

Besides some translations of quiz questions and answers, all participants could finish the quiz independently. After the respondents finished the quiz connected with the chosen job, they filled out a *questionnaire*. While the form was filled out, the researcher used the time to prepare the next study round by randomly selecting another version of the application and loading it onto the test device. This process took around two minutes but was always faster than the time the participant needed for the *questionnaire*. Two benefits come along in this parallel execution of tasks. On the one hand, the conduction of the study is smothered and shortened due to no breaks during the study. On the other hand, the concentration of participants is less affected by the attendance of the researcher while filling out the *questionnaire* because the researcher is occupied.

When the initial study round finished, the second round started immediately. The participant received the test device again, which was prepared with another random gamified version of the *JobQuiz* application. In each round, the respondent should choose a different job to apply for. By not allowing participants to apply for the same job again, it is guaranteed that the questions of the quiz are not known, which could have influenced the behavior of the test person. Again, the *questionnaire* had to be filled out after the application task. This process is iterated once more, ensuring that each participant experiences all three application versions in a randomized order, as this study follows a within-subjects design.

The conduction of the entire study with all respondents lasted about two weeks. The duration for one participant in the study procedure varied between 11 and 32 minutes. The average duration was 16 minutes. It was noted that people who needed more than 20 minutes took their time to navigate through the *JobQuiz* application before starting with the actual task or were especially thoughtful when answering the questions of the quiz.

### The Wilcoxon Signed-Rank Test

The Wilcoxon signed-rank test statistically analyses if there is a significant difference in the two paired test samples [CHH20, PB14b]. For each test, an own  $H_0$  and an alternative  $H_1$  are defined. The rejection or acceptance of this hypothesis of each test subsequently determines the acceptance or rejection of the hypotheses of this thesis.

The Wilcoxon signed-rank test is applied with the predetermined significance level  $\alpha$  of 0.05. This value defines the threshold for rejecting  $H_0$ . Commonly used  $\alpha$  levels include 0.05 or 0.01, referencing a threshold of 5% or 1%. The asymptotic significance  $p$  is used as a statistical measure to quantify the acceptance or rejection of  $H_0$ . The bigger the asymptotic significance  $p$ , the more likely the data distribution arises by random chance.

This scenario supports  $H_0$  due to the lack of significant difference. Vice versa, strong evidence against  $H_0$  exists if the p-value is small. This means that the calculations of the Wilcoxon signed-rank test indicate that the analyzed data pairs support the alternative  $H_1$  [PB14b, Wil06].

To prove that a significant difference exists between the median values, the asymptotic significance p is compared with the chosen threshold:  $\alpha = 0.05$ . In the scenario,  $p \leq \alpha$ , the  $H_0$  is rejected because the data distribution is statistically unlikely to have occurred by chance. Conversely, the  $H_0$  is retained when the value of  $p > \alpha$ , indicating insufficient evidence to conclude a significant difference between the two median values [PB14b, ZZ93]. To calculate the results, the Wilcoxon signed-rank test was calculated with the IBM SPSS statistics tool and manually.

## 5.4. Results

This empirical study aimed to measure the changes in the intrinsic motivation of the same application but with a different level of gamification. As mentioned before, the two-tailed Wilcoxon signed-rank test is used for the statistical evaluation of the study. To utilize this non-parametric test, paired data samples are compared, representing the different versions of the application.

The hypotheses must be tested to prove that the level of gamification influences intrinsic motivation in a serious context. Therefore, three paired samples are built from every possible combination of the collected data. Initially, the Wilcoxon test analyzes the results of the *minimally gamified version* and the *gamified version*. Then, the results of *minimally gamified version* and the *highly gamified version*, and at last, the *gamified version* and the *highly gamified version* are compared as a paired sample.

Following each round of the study, data was gathered by letting each participant fill out a *questionnaire*, in which each statement is related to intrinsic motivation. The *questionnaire* consisted of 12 statements, each rated from “Totally disagree” to “Totally agree” by every participant. All answers are converted in numbers from -2 to 2. The results of the two negatively formulated statements are inverted to give each statement the same orientation. The sum of values for each statement further prepares the data for the Wilcoxon signed-rank test. Therefore, all the ratings from all respondents for each statement are reduced to a single value. Thus, there are 12 results for each gamified version, as shown in Table 5.2. This data is submitted for the Wilcoxon signed-rank tests. For clarification, the sum of sums references the sum of all statements, where each value is already the sum of all participants within the same tested gamified version.

When the evaluation is complete, each hypothesis is either rejected or accepted. One possible outcome of this study is the rejection of  $H_0$ , which would lead to the acceptance of  $H_1$ . In this case, this study would have empirically shown that gamification influences intrinsic motivation to perform a task in a serious context. These findings would be sufficient to answer the research question.  $H_2$ , which references the change of intrinsic motivation between two gamified versions, provides additional information to answer the research question in more detail.

## 5. Study on Gamification and Motivation

| Statement   | Minimally Gamified Version | Gamified Version | Highly Gamified Version |
|-------------|----------------------------|------------------|-------------------------|
| 1           | 8                          | 22               | 26                      |
| 2           | 3                          | 15               | 10                      |
| 3           | 7                          | 21               | 20                      |
| 4           | 0                          | 23               | 22                      |
| 5           | 24                         | 23               | 22                      |
| 6           | 16                         | 26               | 27                      |
| 7           | 9                          | 27               | 24                      |
| 8           | 7                          | 17               | 19                      |
| 9           | -4                         | -1               | 1                       |
| 10          | 5                          | 17               | 3                       |
| 11          | 7                          | 23               | 22                      |
| 12          | -1                         | 29               | 28                      |
| Sum of Sums | 81                         | 242              | 224                     |

**Table 5.2.:** Results of Questionnaires: Sum of Scores for Each Statement

### Minimally Gamified Version vs. Gamified Version

In this section, the Wilcoxon signed-rank test is applied to compare the collected data through the *questionnaire* between the *minimally gamified version* and the *gamified version*. The test determines whether a significant difference exists in the compared survey results. For this test, another null hypothesis and an alternative hypothesis are defined:

- $H_0$ : The level of gamification does not influence the intrinsic motivation to perform a task in a serious context.
- $H_1$ : Incorporating some gamification elements into a serious context influences the intrinsic motivation to accomplish a task.

Table 5.3 presents the descriptive statistics of the tested versions. Although the min and max values do not differ much, the average and the sum of sums values already indicate a difference in the results of the two versions. Still, the question remains if the difference is of a significant size. In Table 5.4, the calculated ranks of the data are presented. Only one out of twelve ranks was negative, meaning all other statement results from the *questionnaire* are favored to the *gamified version*. No ranks are tied.

The calculated test statistics are presented in the following Table 5.5. For this test, the p-value is 0.003, and the Z-value is 2.984. Since  $p \leq \alpha$ ,  $H_0$  is rejected and the alternative  $H_1$  is accepted. In other words, the test suggests a statistically significant relation between gamification and intrinsic motivation in a serious context. Conclusively,

| Statistics                 |    |       |        |     |     |          |      |             |
|----------------------------|----|-------|--------|-----|-----|----------|------|-------------|
|                            | N  | Mean  | Median | Min | Max | Variance | SDev | Sum of Sums |
| Minimally Gamified Version | 12 | 6.75  | 7      | -4  | 24  | 52.35    | 7.24 | 81          |
| Gamified Version           | 12 | 20.17 | 22.5   | -1  | 29  | 56.81    | 7.54 | 242         |

**Table 5.3.:** Descriptive Statistics: *Minimally Gamified Version* and *Gamified Version*

| Ranks         |                 |              |              |
|---------------|-----------------|--------------|--------------|
| Rank Polarity | N               | Average Rank | Sum of Ranks |
| Negative      | 1 <sup>a</sup>  | 1            | 1            |
| Positive      | 11 <sup>b</sup> | 7            | 77           |

a. *Minimally Gamified Version* > *Gamified Version*

b. *Minimally Gamified Version* < *Gamified Version*

**Table 5.4.:** Ranks of Wilcoxon Signed-Rank Test:  
*Minimally Gamified Version* vs. *Gamified Version*

the results indicate that the level of gamification influences the intrinsic motivation to accomplish a task in a serious context. Furthermore, the results indicate that gamification has an influence of a positive nature on intrinsic motivation.

**Wilcoxon Test Summary**

|                                |        |
|--------------------------------|--------|
| N                              | 12     |
| Test Statistic                 | 77     |
| Standard Error                 | 12.733 |
| Z: Standardized Test Statistic | 2.984  |
| p: Asymptotic Significance     | 0.003  |

**Table 5.5.:** Related-Samples Wilcoxon Signed Rank Test Summary:  
*Minimally Gamified Version* vs. *Gamified Version*

For a more exhaustive analysis, the effect size of the results is calculated with the formula:

$$r = \left| \frac{Z}{\sqrt{N}} \right|$$

The effect size  $r$  is calculated with two variables. The standardized test statistic  $Z$  determines the statistical significance of the observed differences, and  $N$  represents the number of samples used in the test. In this case, the  $Z$ -value is 2.984, and  $N$  is 24 since there are two times 12 samples tested. This results in an effect size of:

$$r = \left| \frac{2.984}{\sqrt{24}} \right| = 0.6091.$$

To determine the significance of this effect size, it is interpreted with Cohen's effect size table visualized in Table 5.6, showing that the effect size is large [Coh88]. Thus, utilizing some gamification elements in a serious context motivated the participants a lot more than the version with minimal gamification. To conclude the first round of the Wilcoxon signed-rank test, the hypothesis test summary from the used tool is presented in Table 5.7.

| Strength of association | Coefficient $r$ |
|-------------------------|-----------------|
| Small                   | 0.1 - 0.3       |
| Medium                  | 0.3 - 0.5       |
| Large                   | 0.5 - 1.0       |

**Table 5.6.:** Cohen's Effect Size Table [Coh88]

## 5. Study on Gamification and Motivation

**Hypothesis Test Summary**

| Null Hypothesis                                                                                                   | Test                                      | Asymptotic Significance <sup>a</sup> | Decision     |
|-------------------------------------------------------------------------------------------------------------------|-------------------------------------------|--------------------------------------|--------------|
| The median of differences between the <i>minimally gamified version</i> and the <i>gamified version</i> equals 0. | Related-Samples Wilcoxon Signed-Rank Test | 0.003                                | Reject $H_0$ |

a. Significance Level:  $\alpha = 0.05$

**Table 5.7.:** Hypothesis Test Summary: *Minimally Gamified Version* vs. *Gamified Version*

### Minimally Gamified Version vs. Highly Gamified Version

The previous section compared the *minimally gamified version* and the *gamified version*. Thereby, the results indicate that the gamified version positively influences the intrinsic motivation of the participant during the quiz conduction. Here, this thesis compares the *minimally gamified version* with the *highly gamified version* to gain more insights into the changes in motivation. Similar to the Wilcoxon test from the previous chapter,  $H_0$  and the alternative  $H_1$  are defined:

- **$H_0$ :** The level of gamification does not influence the intrinsic motivation to perform a task in a serious context.
- **$H_1$ :** Incorporating many gamification elements into a serious context influences the intrinsic motivation to accomplish a task.

Table 5.8 presents the descriptive statistics of the two tested versions. Not difficult to detect, the differences are large between the values of mean, median, and, most noticeably, the sum of sums between these two versions. This difference is an indication in favor of the *highly gamified version* and therefore also of  $H_1$ . The ranks of the *questionnaire* results from these versions are presented in Table 5.9. Most ranks are positive, and only 2 of 12 are negative, indicating that the *highly gamified version* performed better than the *minimally gamified version*. This imbalance in positive and negative ranks already indicates a tendency in favor of  $H_1$  – that high gamification influences intrinsic motivation. To empirically demonstrate the significance of the difference, the conduction of the Wilcoxon signed-rank test is pursued.

The test statistics of the Wilcoxon test are presented in Table 5.10. In accordance with the issued results  $p \leq \alpha \mapsto 0.005 \leq 0.05$ , the  $H_0$  is rejected. Thus,  $H_1$  is accepted, suggesting that a high level of gamification has an influence on intrinsic motivation to complete a task in a serious context.

| Statistics                 |    |       |        |     |     |          |      |             |
|----------------------------|----|-------|--------|-----|-----|----------|------|-------------|
|                            | N  | Mean  | Median | Min | Max | Variance | SDev | Sum of Sums |
| Minimally Gamified Version | 12 | 6.75  | 7      | -4  | 24  | 52.35    | 7.24 | 81          |
| Highly Gamified Version    | 12 | 18.66 | 22     | 1   | 28  | 75.56    | 8.69 | 224         |

**Table 5.8.:** Descriptive Statistics: *Minimally Gamified Version* and *Highly Gamified Version*

| Ranks         |                 |              |              |
|---------------|-----------------|--------------|--------------|
| Rank Polarity | N               | Average Rank | Sum of Ranks |
| Negative      | 2 <sup>a</sup>  | 1.5          | 3            |
| Positive      | 10 <sup>b</sup> | 7.5          | 75           |

a. *Minimally Gamified Version* > *Highly Gamified Version*

b. *Minimally Gamified Version* < *Highly Gamified Version*

**Table 5.9.:** Rank of Wilcoxon Signed-Rank Test:  
*Minimally Gamified Version* vs. *Highly Gamified Version*

| Wilcoxon Test Summary                 |        |
|---------------------------------------|--------|
| N                                     | 12     |
| Test Statistic                        | 75     |
| Standard Error                        | 12.738 |
| <b>Z:</b> Standardized Test Statistic | 2.826  |
| <b>p:</b> Asymptotic Significance     | 0.005  |

**Table 5.10.:** Related-Samples Wilcoxon Signed Rank Test Summary:  
*Minimally Gamified Version* vs. *Highly Gamified Version*

In this Wilcoxon signed-rank test, the calculated effect size is  $r = 0.5769$ , which is categorized as a large effect size since  $r > \alpha \mapsto 0.5769 > 0.5$ . Because the effect size  $r$  is less than the one from the first Wilcoxon test, the test between *gamified version* and *highly gamified version* may lead to a decrease in motivation. This is tested in the following section. The test procedure concludes with the presentation of the results in Table 5.11.

| Hypothesis Test Summary                                                                                                  |                                           |                                      |              |
|--------------------------------------------------------------------------------------------------------------------------|-------------------------------------------|--------------------------------------|--------------|
| Null Hypothesis                                                                                                          | Test                                      | Asymptotic Significance <sup>a</sup> | Decision     |
| The median of differences between the <i>minimally gamified version</i> and the <i>highly gamified version</i> equals 0. | Related-Samples Wilcoxon Signed-Rank Test | 0.005                                | Reject $H_0$ |

a. Significance Level:  $\alpha = 0.05$

**Table 5.11.:** Hypothesis Test Summary: *Minimally Gamified Version* vs. *Highly Gamified Version*

### Gamified Version vs. Highly Gamified Version

For the final Wilcoxon signed-rank test, the data of the two gamified versions is compared against each other to evaluate if the level of the perceived intrinsic motivation for these versions is different in a statistically significant manner. The null hypothesis and its alternative are defined for this test in the following way:

- **$H_0$ :** The motivation to perform a task in a serious context is similar in the *gamified version* and the *highly gamified version*.

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- **$H_1$** : The motivation to perform a task in a serious context is higher (or lower) in the *gamified version* compared to the *highly gamified version*.

In this test, the survey results of the two gamified versions are compared to gain valuable insights regarding changes in intrinsic motivation. As perceived in the previous chapters, the *gamified version* performs better than the *highly gamified version*. But the question remains if the measured difference is substantial enough to be deemed statistically significant, which would reject  $H_0$ .

| Statistics              |    |       |        |     |     |          |      |             |
|-------------------------|----|-------|--------|-----|-----|----------|------|-------------|
|                         | N  | Mean  | Median | Min | Max | Variance | SDev | Sum of Sums |
| Gamified Version        | 12 | 20.17 | 22.5   | -1  | 29  | 56.81    | 7.54 | 242         |
| Highly Gamified Version | 12 | 18.66 | 22     | 1   | 28  | 75.56    | 8.69 | 224         |

**Table 5.12.:** Descriptive Statistics: *Gamified Version* and *Highly Gamified Version*

The test continues by looking at the descriptive statistics of the two tested versions, shown in Table 5.12. The median, min, and max values are very similar. Noticeably, the variance and standard deviation values are bigger for the *highly gamified version*. That generally indicates a greater dispersion in the data, meaning that the data points are more spread out from the mean or central tendency. The values for the mean and sum of sums are larger at the *gamified version*, which vaguely indicates that the perceived intrinsic motivation is greater. To find evidence for this statement, the Wilcoxon signed-rank test is performed. Table 5.13 shows the intermediate results of the test. Four ranks favor the *highly gamified version*; the remaining eight are in favor of the *gamified version*. These findings are surprising because one might expect that incorporating more gamification elements and mechanics would further reinforce the intrinsic motivation of the participants. Contrary to expectations, the *gamified version* demonstrated superior performance. To further evaluate the results, the test proceeds by calculating the ranks, as shown below.

| Ranks         |                |              |              |
|---------------|----------------|--------------|--------------|
| Rank Polarity | N              | Average Rank | Sum of Ranks |
| Negative      | 4 <sup>a</sup> | 7.125        | 28.5         |
| Positive      | 8 <sup>b</sup> | 6.1875       | 49.5         |

a. *Gamified Version* > *Highly Gamified Version*

b. *Gamified Version* < *Highly Gamified Version*

**Table 5.13.:** Ranks of Wilcoxon Signed-Rank Test:  
*Gamified Version* vs. *Highly Gamified Version*

Not only the number of ranks favored for one polarity or another is important, but especially the number of the rank is decisive. For example, rank number 4, which represents the fourth lowest placement measuring the absolute difference of one survey statement between the two samples, has more influence on the outcome of the Wilcoxon test than rank 1, 2, or 1&2 combined. Therefore, the findings in Table 5.13 point out once more that the two tested samples (*gamified version* and *highly gamified version*) are different from each other in terms of intrinsic motivation. Whether the difference is significant is discussed after further statistical tests.

**Wilcoxon test summary**

|                                        |        |
|----------------------------------------|--------|
| N                                      | 12     |
| Test statistic                         | 28.5   |
| Standard Error                         | 12.570 |
| <b>Z</b> : Standardized Test Statistic | -0.835 |
| <b>p</b> : Asymptotic Significance     | 0.404  |

**Table 5.14.:** Related-Samples Wilcoxon Signed Rank Test Summary:  
*Gamified Version vs. Highly Gamified Version*

As shown in Table 5.14, the p-value is 0.404, and the value for Z is -0.835. In the test, the calculation results in  $p > \alpha \mapsto 0.404 > 0.05$ , which leads to the decision to retain  $H_0$  and reject the alternative  $H_1$ . In other words, the perceived difference in intrinsic motivation is too small to exceed a threshold, which leads to the statement that the differences in data samples are statistically non-significant. The effect size for this test is:

$$r = \left| \frac{-0.835}{\sqrt{24}} \right| = 0.170$$

The effect size  $r$  is notably small, further indicating a lack of substantial impact. It can be concluded that participants did not perceive a significant difference in their intrinsic motivation to perform a task in a serious context when it was presented with some or many gamification elements. Therefore, the perceived intrinsic motivation between the *gamified version* and the *highly gamified version* is similar. Table 5.15 displays the summary of the hypothesis test results generated by the used tool.

**Hypothesis Test Summary**

| Null Hypothesis                                                                                                | Test                                      | Asymptotic Significance <sup>a</sup> | Decision     |
|----------------------------------------------------------------------------------------------------------------|-------------------------------------------|--------------------------------------|--------------|
| The median of differences between the <i>gamified version</i> and the <i>highly gamified version</i> equals 0. | Related-Samples Wilcoxon Signed-Rank Test | 0.404                                | Retain $H_0$ |

a. Significance Level:  $\alpha = 0.05$

**Table 5.15.:** Hypothesis Test Summary: *Gamified Version vs. Highly Gamified Version*



## 6. Discussion and Conclusion

This chapter discusses and summarizes the thesis findings while offering insights into potential future work. Section 6.1 provides a comprehensive discussion of the results of the academic study. Thereby, each version of the *JobQuiz* application is covered independently. Subsequently, Section 6.2 discusses which further investigations and studies could be conducted based on this study. Furthermore, this section debates the limitations of this scientific study. Finally, Section 6.3 delves into the research question and provides a recap of the findings, thereby bringing this research to its conclusion.

### 6.1. General Discussion

The evaluation of Chapter 5.4 strongly indicates that the incorporation of gamification positively impacts the intrinsic motivation of the participants while performing a task in a serious context. As a result,  $H_0$  of this thesis, which suggests that there is no influence between gamification and intrinsic motivation, is rejected, based on the evaluation of the first two Wilcoxon signed-rank tests. Consequently, these statistical tests provide empirical evidence supporting  $H_1$  of this thesis, which states that gamification does indeed influence intrinsic motivation in a serious context.

The conduction of the second Wilcoxon signed-rank test, where the *minimally gamified version* and the *highly gamified version* are compared, is for reconfirmation of the findings and consistency purposes. The results obtained from the second Wilcoxon test exhibit similarities with those of the first test, reinforcing the decision to accept  $H_1$ . This consistency in the findings supports the conclusion that a correlation exists between gamification and intrinsic motivation in performing tasks within a serious context. The outcome of the last Wilcoxon signed rank test is intriguing to the author because the performance of the *highly gamified version* did not surpass the performance of the *gamified version*. Surprisingly, it even exhibited inferior performance, but in a non-significant manner, resulting in the rejection of alternative  $H_2$ . This hypothesis states that the *highly gamified version* performs better (or worse) than the *gamified version*. Consequently, the third Wilcoxon signed-rank test provides statistical evidence demonstrating a non-significant difference in intrinsic motivation between the moderate and high utilization of gamification in a serious context.

#### Minimally Gamified Version

The version of the *JobQuiz* application with minimal gamification surpassed the performance of both the *gamified version* and the *highly gamified version*, with significant

## 6. Discussion and Conclusion

effect sizes of 0.6091 & 0.5769. Since both exceeded 0.5, which indicates a large effect size on Cohen's effect size table, it is evident that participants exhibited considerably lower motivation when engaging with the *minimally gamified version*. This observation is further mirrored by the feedback of one participant, who expressed their experience as follows: "No feeling of happiness when answering => strange feeling, no desire for more". The absence of gamification clearly resulted in demotivation for this particular participant. A different participant expressed their confusion about the correctness of their actions, stating, "I did not know if I answered right or wrong". This confusion about performance arose because this version did not have any feedback regarding the correctness of quiz questions. Similarly, another participant made similar remarks by saying: "No feedback for answers". A different participant voiced their dissatisfaction with this version of the app, commenting, "Where are the scores and results?". As mentioned before, this version has minimal gamification; thus, no points, (total) scores, or leaderboards are displayed during or after the job quiz process. To summarize, the *minimally gamified version* elicited the least intrinsic motivation due to the absence of gamification mechanics and elements, such as feedback and points.

### Gamified Version

As previously mentioned, of all versions, the *gamified version* achieves the best results in terms of intrinsic motivation. However, it is noticed that many participants enjoy this version, although not all of them share this sentiment. The fact that this version has no integrated negative feedback results in a divided opinion among the subjects. Comments such as "No feedback for wrong answer and no audio or haptic feedback for correct answer" are written in the comments of the survey. These show that some respondents noticed the absence of negative feedback in this version. Additionally, this participant commented that this version does not provide haptic feedback for correct answers, although none of the versions have haptic feedback for correct answers integrated. As mentioned, the *highly gamified version* includes haptic feedback, but only for incorrect answers.

Another comment regarding the lack of negative feedback in the *gamified version* states, "The wrong answers weren't highlighted, so the right answer didn't feel as good (also no ding)". In this case, the test person used the *highly gamified version* in a previous round of the study and referred to that higher level of gamification. For this participant, the absence of visual negative feedback and acoustic positive feedback did not provide the same level of satisfaction.

A participant who followed the same sequence of application versions in the study procedure commented "No achievements" in the survey of the *gamified version*. Hence, this participant noticed that this version did not utilize badges as an element of structural gamification. The last comment regarding this version was "Accidentally answered the next question too fast". Here, the participant did not want to wait for the transition to the next question to finish. Therefore, after the participant selected an answer to a quiz question, clicking again to skip the animation was perceived. Unfortunately, the feature to skip animations was not implemented, which resulted in repeated clicking on the screen. When the animation finished and the next question screen appeared, this participant

unintentionally answered the next question immediately. This can be seen as a general remark to the application since the feature to skip animations is not included in any of the versions. In summary, the *gamified version* was generally enjoyed by a majority of participants but often compared with the *highly gamified version*.

### Highly Gamified Version

Analyzing the data from the study showed that *highly gamified version* performed well in terms of intrinsic motivation. It is ranked second closely behind the *gamified version*. But, according to the comments of the participant, the *highly gamified version* has one major issue, which revolved around the audio component. In the study, every participant received the test device with the same volume, which was noticeably loud but rather quiet. Many instinctively attempted to lower or mute the volume after the suspenseful quiz music started. Because in this version, the audio had multiple objectives, including providing negative and positive feedback with sounds, the researcher insisted on noticeably loud volume but allowed adjustments. Consequently, remarks such as “Background sound has disturbed” and “Music was annoying” followed. Judging by the opinion of the author, the main reason for the diminished performance of this version is caused by the fact that a significant number of participants preferred no audio at all.

An additional noteworthy comment was raised regarding haptic feedback. “Haptic feedback for correct answer was missing” was commented, which reveals that one participant complained about the absence of haptic feedback for correct answers. Upon further clarification, the individual argued that a brief single vibration signifies positive feedback, whereas long or multiple vibrations indicate negative feedback, representing errors or mistakes.

To summarize, the *highly gamified version* is generally enjoyed by the majority of participants. However, due to the issues above primarily related to audio, this version experienced a decline in performance, as indicated by the survey comments. Among other factors, including audiological issues, participants may have rated this version lower in the questionnaire due to these issues.

## 6.2. Future Work and Limitations

In this study, valuable insights into the correlation between intrinsic motivation and gamification are gained. However, according to the comments, none of the three gamified versions pleased all participants, which indicates room for improvement. Therefore, it is suggested that further studies utilize more combinations of gamification components that yield better results in terms of intrinsic motivation. These studies could include additional gamified versions, resulting in more comprehensive insights into the effects of different combinations of gamification elements on intrinsic motivation. By expanding the scope of the study with additional gamified variations, a deeper understanding of the underlying mechanisms and impacts of gamification on intrinsic motivation could be attained. A subsequent study could study the research question: “What combination of gamification

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mechanics and elements reinforces intrinsic motivation the most while performing a task in a serious context?”. This could be achieved through a similar subsequent study that compares only gamified versions with the Wilcoxon signed-rank test. In this case, it would be important to consider the comments and general insights gathered from this study when creating the subsequent research. As Dijk et al. (2004) demonstrated, “positive feedback is a greater motivator than negative feedback when individuals are promotion-focused, whereas negative feedback motivates more than positive feedback when people are prevention-focused” [VDK11, DK04], can be taken into account when designing following studies. The aim could be to study in a similar context but with finer degrees of gamification. Optimally, the results would bring more comprehensive insights into gamification elements, mechanics, and techniques regarding their effect on intrinsic motivation in a serious context.

The current study includes a total of 22 participants, with the results of 21 utilized. Since the sample size of 21 is relatively small, the results do not provide sufficient statistical power to generate generally applicable findings. A larger participant pool could have enhanced the power of the study. On top of that, the majority of participants were students within a similar age range, which further limited the generalizability of the results. Future studies should consider more and a broader diversity of participants to obtain more universally valid outcomes. Moreover, considering the results of the *pre-questionnaire*, further studies could be exclusively conducted with unemployed or job-seeking individuals. In this study, only 38% of the respondents were unemployed, and 66% were actively seeking employment or open to job offers. Additionally, expanding the number of gamified versions of the application would offer more comprehensive insights into specific gamification elements and mechanics concerning intrinsic motivation within a single study.

The concept presented in Chapter 3.2, represents a promising approach to modernize the current job offering process through gamification. It offers great potential to make the job recruitment and applicant selection process more engaging and motivating. Thus, additional studies should be conducted to gain a deeper understanding of the potential of this concept in terms of enhancing motivation. Nevertheless, broadening the serious context of future studies beyond the job-market application, such as tax or insurance applications, would additionally contribute to a more comprehensive understanding of the impact of gamification on intrinsic motivation, but in diverse, serious contexts. Such endeavors would help strengthen the validity and generalizability of the findings, leading to more robust conclusions about the relationship between gamification and intrinsic motivation in serious contexts.

### 6.3. Conclusions

The objective of this work was to explore the impact of gamification to perform a task in a serious context, focusing on intrinsic motivation. To achieve this goal, an innovative job-application concept presents a modernized approach to the conventional job application process. As extensively discussed in Chapter 3, this concept is designed to enhance

intrinsic motivation among applicants, as it lowers the barrier to apply for a job, among other benefits. However, this thesis uses the concept exclusively to conduct a study to answer the research question (“Does utilizing gamification influence intrinsic motivation to perform a task in a serious context?”). To answer this question, the aforementioned concept is integrated into the cross-platform mobile application. The outcomes of the academic study, in which different versions of the application are examined and evaluated in terms of intrinsic motivation, yielded the following scientific findings:

The findings of the study reveal that the implementation of gamification reinforces the intrinsic motivation to perform a task in a serious context, specifically in the context of job applications. Moreover, no difference in intrinsic motivation could be observed when comparing gamified versions. These findings are consistent with other studies, which indicate that gamification increases intrinsic motivation to complete tasks [SLH22, CHH20]. To finally answer the research question, this thesis asserts that the implementation of gamification does indeed have a substantial influence on intrinsic motivation within a serious context. Specifically, the absence of gamification in serious contexts significantly diminishes intrinsic motivation. Thus, these findings strongly indicate that utilizing a moderate to high level of gamification in a serious context substantially improves intrinsic motivation when performing a task.



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## A. Informed Consent



### Informed Consent Form

Institution: University of Vienna  
Principal Investigator: B. Sc. Niklas Grossmann  
Supervisor: Univ.-Prof. Dr. Helmut Hlavacs

In this study we will carry out research on user interaction in the area of human computer interaction.

The participation in this study is voluntary. You have the right to refuse to participate or to withdraw from the study at any point.

Your participation in this study will be kept confidential at all times. Only the researchers involved in this study will have access to your information. The data collected by your answers will be anonymized and only used for this particular study.

The procedure of the study will be:

1. Fill out a general questionnaire about yourself.
2. Execute a short task on a randomly selected version of a mobile application.
3. Rate 12 statements about Task 2 in a questionnaire.
4. Repeat Task 2 & 3 three times with another randomly selected version of the same mobile application.

By signing below, you acknowledge that you have read and understood the information provided above and agree to participate in this study. In particular you have understood that the collected data will be used in this study for anonymous evaluation.

Date:

Participant ID :

Participant Signature:



## B. Pre-Questionnaire



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### Prequestionnaire

Participant ID:

How old are you?

What is your gender?

- ☐ Male
- ☐ Female
- ☐ No comment

How much time do you spend on your phone on average a day?

- ☐ Less than 1 hour
- ☐ 1 hour
- ☐ 2 hours
- ☐ More than 2 hours

How often do you play digital games?

- ☐ Daily
- ☐ Multiple times a week
- ☐ Multiple times a month
- ☐ Multiple times a year
- ☐ Never

What is your employment status?

- ☐ Unemployed
- ☐ Part-time
- ☐ Fulltime
- ☐ Other: \_\_\_\_\_

Are you currently looking for a job or an other job?

- ☐ Yes
- ☐ Open for offers
- ☐ No



## C. Questionnaire



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### Questionnaire

Participant ID:

Application version:

Please choose one answer per line:

|                                            | Strongly disagree | Disagree | Neutral | Agree | Strongly agree |
|--------------------------------------------|-------------------|----------|---------|-------|----------------|
| Completing the process was entertaining    |                   |          |         |       |                |
| I feel good after applying for the job     |                   |          |         |       |                |
| I want to apply for other jobs             |                   |          |         |       |                |
| Applying for a job this way was amusing    |                   |          |         |       |                |
| I have never applied for a job so easily   |                   |          |         |       |                |
| I was bored during the process             |                   |          |         |       |                |
| My motivation to answer correctly was high |                   |          |         |       |                |
| The quiz was exiting                       |                   |          |         |       |                |
| I forgot I was applying for a job          |                   |          |         |       |                |
| It felt wrong to apply for a job this way  |                   |          |         |       |                |
| Next time I want to perform better         |                   |          |         |       |                |
| Answering correctly felt good              |                   |          |         |       |                |

Comments:



# D. Questionnaire Results

| Minimally Gamified Version |    |    |    |    |    |    |    |    |    |    |    |
|----------------------------|----|----|----|----|----|----|----|----|----|----|----|
| 1                          | 1  | 2  | -1 | -1 | 0  | 1  | 0  | 1  | 2  | 1  | 1  |
| 2                          | 2  | 1  | -1 | 0  | 0  | -1 | -1 | 2  | 1  | 2  | -1 |
| 3                          | 1  | 1  | -1 | -1 | -1 | 0  | 0  | 2  | 2  | 0  | 0  |
| 4                          | 1  | 1  | -1 | 0  | -2 | 1  | -1 | 0  | 2  | 1  | -1 |
| 5                          | 1  | 2  | 1  | -1 | -1 | 2  | 1  | 2  | 0  | -1 | 2  |
| 6                          | -2 | -1 | 0  | 1  | -1 | 1  | -1 | 2  | 0  | 2  | 1  |
| 7                          | 2  | 1  | 0  | -2 | 2  | 1  | -2 | -1 | 0  | -1 | -1 |
| 8                          | 1  | 1  | 0  | -1 | 0  | 1  | 1  | 0  | 0  | 2  | 1  |
| 9                          | -1 | 1  | -1 | 1  | -1 | 1  | 0  | 2  | 1  | -2 | 0  |
| 10                         | -1 | -1 | 2  | 2  | -1 | 1  | 0  | -2 | 0  | 0  | 1  |
| 11                         | -1 | 2  | 0  | -1 | 0  | -1 | 2  | 1  | 0  | 1  | 1  |
| 12                         | 2  | 2  | 0  | -2 | 1  | -2 | 0  | 2  | 0  | 1  | -2 |
| Gamified Version           |    |    |    |    |    |    |    |    |    |    |    |
| 1                          | 1  | 2  | 1  | 1  | 0  | 1  | 1  | 2  | 1  | 1  | 1  |
| 2                          | 1  | 1  | 0  | -2 | 0  | 1  | 1  | 2  | 0  | 2  | 0  |
| 3                          | 1  | 1  | 0  | 2  | 1  | 1  | 1  | 2  | 1  | 1  | 1  |
| 4                          | 1  | 2  | 1  | 2  | -1 | 2  | 1  | 2  | 1  | 0  | 2  |
| 5                          | 1  | 1  | 1  | 1  | -1 | 2  | 2  | 2  | 1  | 2  | 1  |
| 6                          | -2 | -2 | -1 | -2 | 0  | -2 | -1 | -2 | -1 | 0  | -1 |
| 7                          | 2  | 2  | 0  | 2  | 1  | 1  | 1  | 2  | 1  | 1  | 2  |
| 8                          | 1  | 1  | 1  | 2  | -1 | 1  | 1  | 2  | 0  | 1  | 0  |
| 9                          | -2 | 1  | 0  | 2  | 0  | -1 | -1 | 2  | 1  | -1 | 0  |
| 10                         | -2 | -2 | -1 | 0  | -2 | 1  | 0  | -1 | 0  | -1 | 0  |
| 11                         | 2  | 1  | 2  | 1  | 1  | 2  | 1  | 2  | 0  | 1  | 2  |
| 12                         | 2  | 1  | 1  | 2  | -1 | 1  | 2  | 2  | 1  | 0  | 2  |
| Highly Gamified Version    |    |    |    |    |    |    |    |    |    |    |    |
| 1                          | 1  | 2  | 1  | 1  | 1  | 1  | 2  | 2  | 1  | 1  | 2  |
| 2                          | 0  | 0  | -1 | 0  | 1  | 2  | 1  | 1  | 0  | 1  | 0  |
| 3                          | 1  | 1  | 0  | 2  | 1  | 2  | 1  | 2  | 1  | 1  | 1  |
| 4                          | 1  | 1  | -1 | 0  | 2  | 2  | 2  | 2  | 1  | 2  | 2  |
| 5                          | 1  | 2  | 0  | -1 | -1 | 3  | 2  | 1  | 0  | 1  | 0  |
| 6                          | -2 | -2 | -1 | 1  | -2 | -2 | -2 | -2 | -1 | -1 | 0  |
| 7                          | 2  | 1  | -2 | 0  | 2  | 2  | 2  | 2  | 1  | 1  | 2  |
| 8                          | 1  | 1  | -1 | 1  | 1  | 0  | 2  | 0  | 1  | 2  | 1  |
| 9                          | -2 | 2  | -1 | 1  | 0  | -1 | 1  | 2  | 2  | 1  | 0  |
| 10                         | -2 | -2 | 2  | 2  | -1 | 0  | -1 | 0  | -1 | 0  | 2  |
| 11                         | 2  | 1  | 2  | 1  | 1  | 2  | 1  | 2  | 1  | 2  | 0  |
| 12                         | 2  | 1  | 1  | 2  | -1 | 1  | 2  | 2  | 2  | 2  | 1  |



## E. Study Results from SPSS Tool

### Nonparametric Tests

| Notes                          |                |                                                                                                                                                                                   |
|--------------------------------|----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Output Created                 |                | 17-JUL-2023 23:11:01                                                                                                                                                              |
| Comments                       |                |                                                                                                                                                                                   |
| Input                          | Data           | /Users/niklasgrossmann/Documents/Studium/MasterThesis/SPSS/StudyData.sav                                                                                                          |
|                                | Active Dataset | DataSet1                                                                                                                                                                          |
|                                | Filter         | <none>                                                                                                                                                                            |
|                                | Weight         | <none>                                                                                                                                                                            |
|                                | Split File     | <none>                                                                                                                                                                            |
| N of Rows in Working Data File |                | 12                                                                                                                                                                                |
| Syntax                         |                | NPTESTS<br>/RELATED TEST<br>(Minimal_gamified_version Gamified_version) SIGN<br>WILCOXON<br>/MISSING<br>SCOPE=ANALYSIS<br>USERMISSING=EXCLUDE<br>/CRITERIA ALPHA=0.05 CILEVEL=95. |
| Resources                      | Processor Time | 00:00:00.87                                                                                                                                                                       |
|                                | Elapsed Time   | 00:00:01.00                                                                                                                                                                       |

[DataSet1] /Users/niklasgrossmann/Documents/Studium/MasterThesis/SPSS/StudyData.sav

### Hypothesis Test Summary

|   | Null Hypothesis                                                                           | Test                                      | Sig. <sup>a,b</sup> |
|---|-------------------------------------------------------------------------------------------|-------------------------------------------|---------------------|
| 1 | The median of differences between Minimal_gamified_version and Gamified_version equals 0. | Related-Samples Sign Test                 | .006 <sup>c</sup>   |
| 2 | The median of differences between Minimal_gamified_version and Gamified_version equals 0. | Related-Samples Wilcoxon Signed Rank Test | .003                |

### Hypothesis Test Summary

|   | Decision                    |
|---|-----------------------------|
| 1 | Reject the null hypothesis. |
| 2 | Reject the null hypothesis. |

a. The significance level is .050.

b. Asymptotic significance is displayed.

c. Exact significance is displayed for this test.

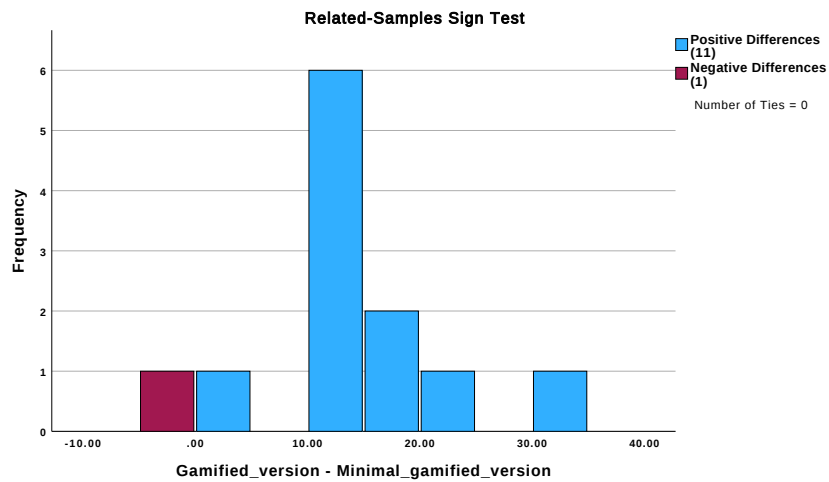
### Related-Samples Sign Test

Minimal\_gamified\_version, Gamified\_version

#### Related-Samples Sign Test Summary

|                               |                     |
|-------------------------------|---------------------|
| Total N                       | 12                  |
| Test Statistic                | 11.000 <sup>a</sup> |
| Standard Error                | 1.732               |
| Standardized Test Statistic   | 2.598               |
| Asymptotic Sig.(2-sided test) | .009                |
| Exact Sig.(2-sided test)      | .006                |

a. The exact p-value is computed based on the binomial distribution because there are 25 or fewer cases.



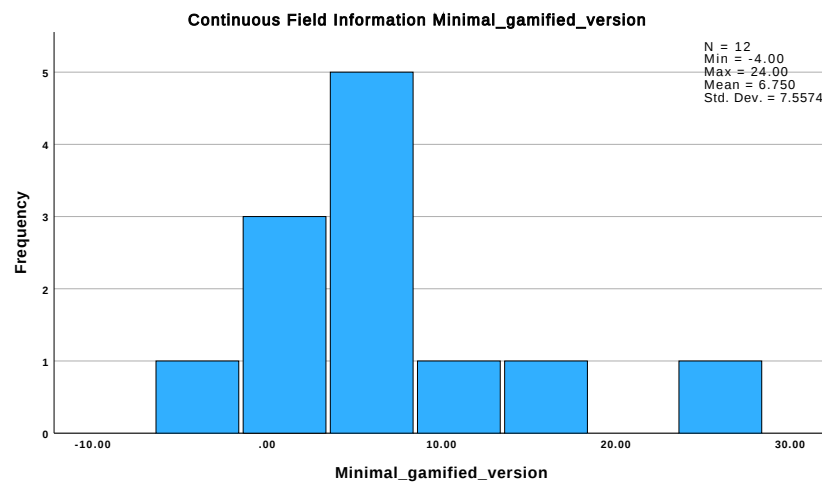
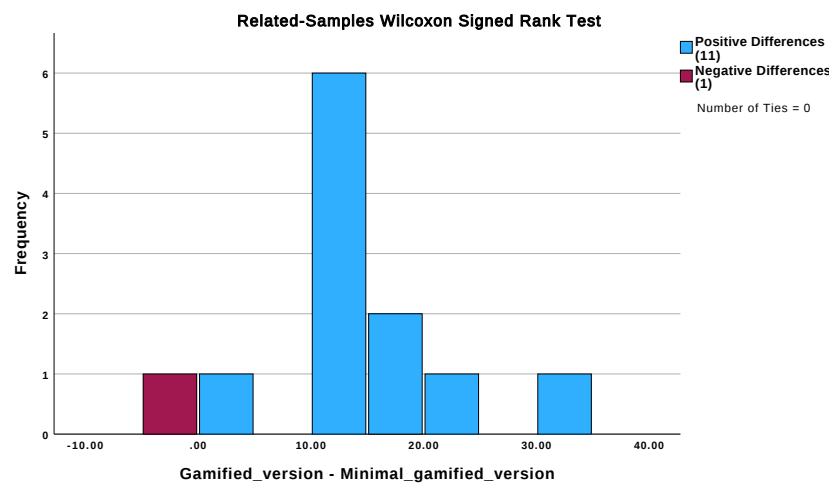
### Related-Samples Wilcoxon Signed Rank Test

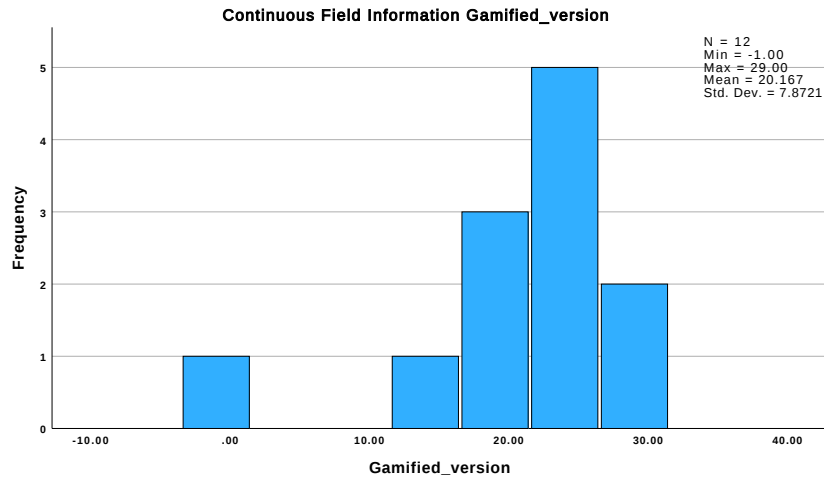
Minimal\_gamified\_version, Gamified\_version

## E. Study Results from SPSS Tool

**Related-Samples Wilcoxon Signed Rank Test Summary**

|                               |        |
|-------------------------------|--------|
| Total N                       | 12     |
| Test Statistic                | 77.000 |
| Standard Error                | 12.733 |
| Standardized Test Statistic   | 2.984  |
| Asymptotic Sig.(2-sided test) | .003   |





#### Nonparametric Tests

##### Notes

|                |                                |                                                                                                                                                                                                 |
|----------------|--------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Output Created |                                | 17-JUL-2023 23:12:34                                                                                                                                                                            |
| Comments       |                                |                                                                                                                                                                                                 |
| Input          | Data                           | /Users/niklasgrossmann/Documents/Studium/MasterThesis/SPSS/StudyData/ata.sav                                                                                                                    |
|                | Active Dataset                 | DataSet1                                                                                                                                                                                        |
|                | Filter                         | <none>                                                                                                                                                                                          |
|                | Weight                         | <none>                                                                                                                                                                                          |
|                | Split File                     | <none>                                                                                                                                                                                          |
|                | N of Rows in Working Data File | 12                                                                                                                                                                                              |
| Syntax         |                                | NPTESTS<br>/RELATED TEST<br>(Minimal_gamified_version<br>n High_gamified_version)<br>SIGN WILCOXON<br>/MISSING<br>SCOPE=ANALYSIS<br>USERMISSING=EXCLUDE<br>/CRITERIA ALPHA=0.<br>05 CILEVEL=95. |
| Resources      | Processor Time                 | 00:00:00.82                                                                                                                                                                                     |
|                | Elapsed Time                   | 00:00:01.00                                                                                                                                                                                     |

## E. Study Results from SPSS Tool

**Hypothesis Test Summary**

|   | Null Hypothesis                                                                                | Test                                      | Sig. <sup>a,b</sup> |
|---|------------------------------------------------------------------------------------------------|-------------------------------------------|---------------------|
| 1 | The median of differences between Minimal_gamified_version and High_gamified_version equals 0. | Related-Samples Sign Test                 | .039 <sup>c</sup>   |
| 2 | The median of differences between Minimal_gamified_version and High_gamified_version equals 0. | Related-Samples Wilcoxon Signed Rank Test | .005                |

**Hypothesis Test Summary**

|   | Decision                    |
|---|-----------------------------|
| 1 | Reject the null hypothesis. |
| 2 | Reject the null hypothesis. |

a. The significance level is .050.

b. Asymptotic significance is displayed.

c. Exact significance is displayed for this test.

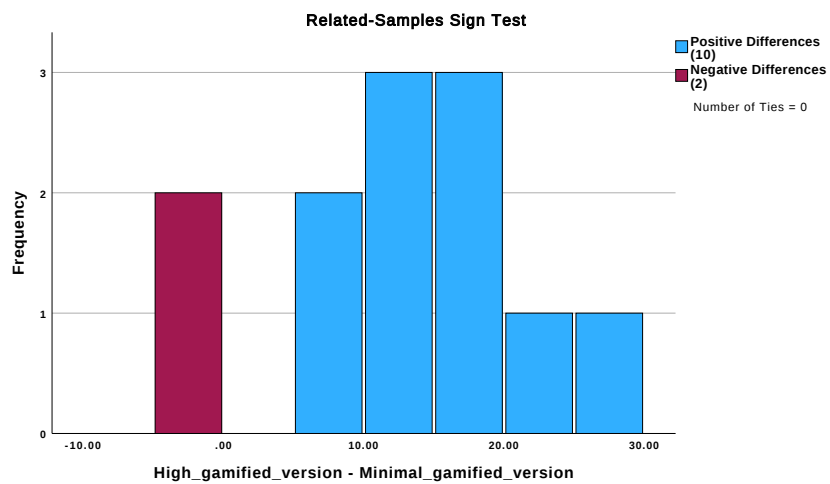
### Related-Samples Sign Test

Minimal\_gamified\_version, High\_gamified\_version

**Related-Samples Sign Test Summary**

|                               |                     |
|-------------------------------|---------------------|
| Total N                       | 12                  |
| Test Statistic                | 10.000 <sup>a</sup> |
| Standard Error                | 1.732               |
| Standardized Test Statistic   | 2.021               |
| Asymptotic Sig.(2-sided test) | .043                |
| Exact Sig.(2-sided test)      | .039                |

a. The exact p-value is computed based on the binomial distribution because there are 25 or fewer cases.



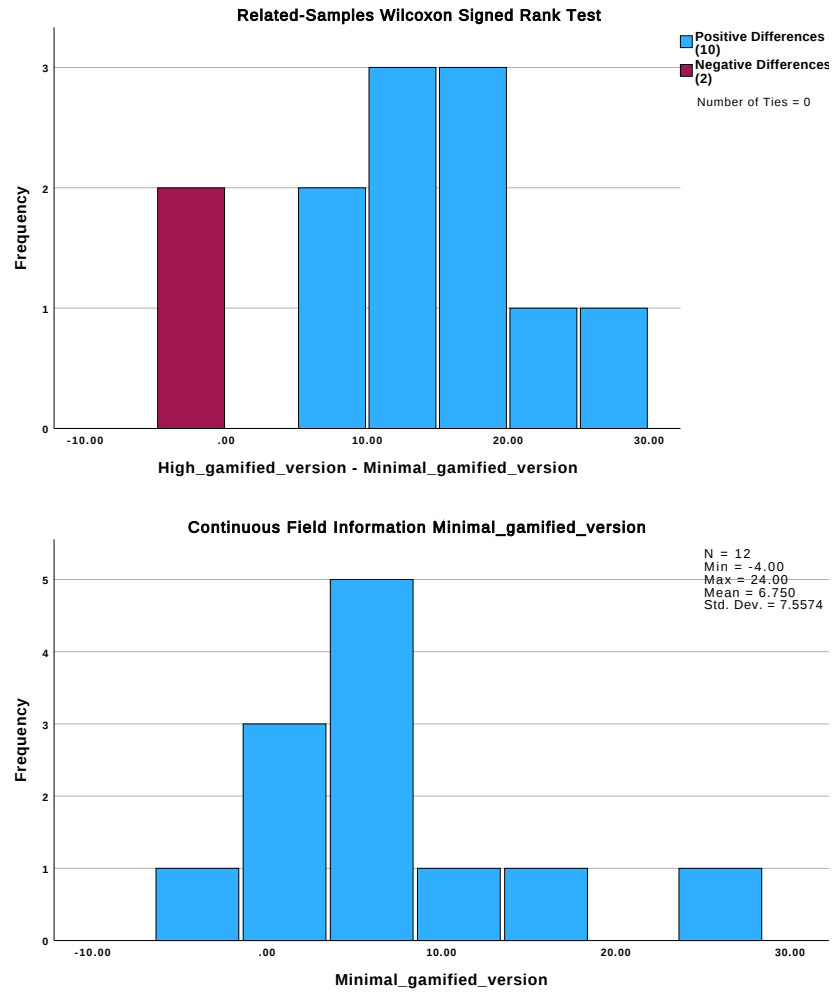
#### Related-Samples Wilcoxon Signed Rank Test

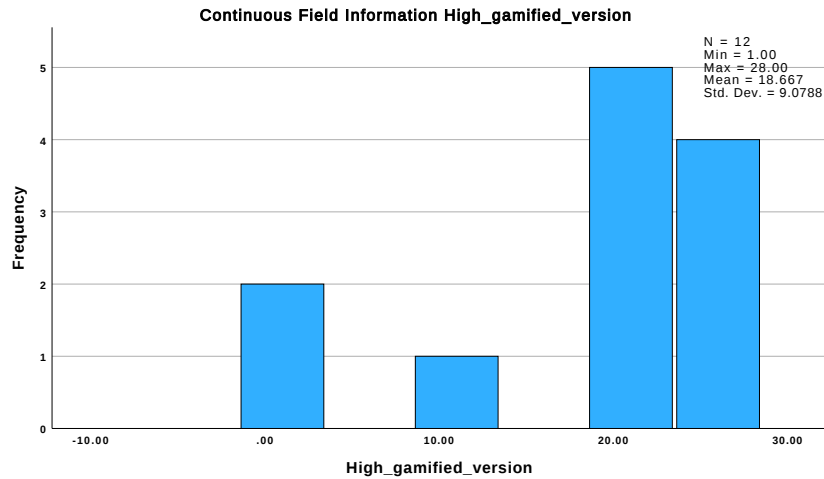
Minimal\_gamified\_version, High\_gamified\_version

##### Related-Samples Wilcoxon Signed Rank Test Summary

|                               |        |
|-------------------------------|--------|
| Total N                       | 12     |
| Test Statistic                | 75.000 |
| Standard Error                | 12.738 |
| Standardized Test Statistic   | 2.826  |
| Asymptotic Sig.(2-sided test) | .005   |

*E. Study Results from SPSS Tool*





#### Nonparametric Tests

##### Notes

|                |                                |                                                                                                                                                                                   |
|----------------|--------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Output Created |                                | 17-JUL-2023 23:12:53                                                                                                                                                              |
| Comments       |                                |                                                                                                                                                                                   |
| Input          | Data                           | /Users/niklasgrossmann/Documents/Studium/MasterThesis/SPSS/StudyData/ata.sav                                                                                                      |
|                | Active Dataset                 | DataSet1                                                                                                                                                                          |
|                | Filter                         | <none>                                                                                                                                                                            |
|                | Weight                         | <none>                                                                                                                                                                            |
|                | Split File                     | <none>                                                                                                                                                                            |
|                | N of Rows in Working Data File | 12                                                                                                                                                                                |
| Syntax         |                                | NPTESTS<br>/RELATED TEST<br>(Gamified_version<br>High_gamified_version)<br>SIGN WILCOXON<br>/MISSING<br>SCOPE=ANALYSIS<br>USERMISSING=EXCLUDE<br>/CRITERIA ALPHA=0.05 CILEVEL=95. |
| Resources      | Processor Time                 | 00:00:01.19                                                                                                                                                                       |
|                | Elapsed Time                   | 00:00:01.00                                                                                                                                                                       |

## E. Study Results from SPSS Tool

**Hypothesis Test Summary**

|   | Null Hypothesis                                                                        | Test                                      | Sig. <sup>a,b</sup> |
|---|----------------------------------------------------------------------------------------|-------------------------------------------|---------------------|
| 1 | The median of differences between Gamified_version and High_gamified_version equals 0. | Related-Samples Sign Test                 | .388 <sup>c</sup>   |
| 2 | The median of differences between Gamified_version and High_gamified_version equals 0. | Related-Samples Wilcoxon Signed Rank Test | .404                |

**Hypothesis Test Summary**

|   | Decision                    |
|---|-----------------------------|
| 1 | Retain the null hypothesis. |
| 2 | Retain the null hypothesis. |

a. The significance level is .050.

b. Asymptotic significance is displayed.

c. Exact significance is displayed for this test.

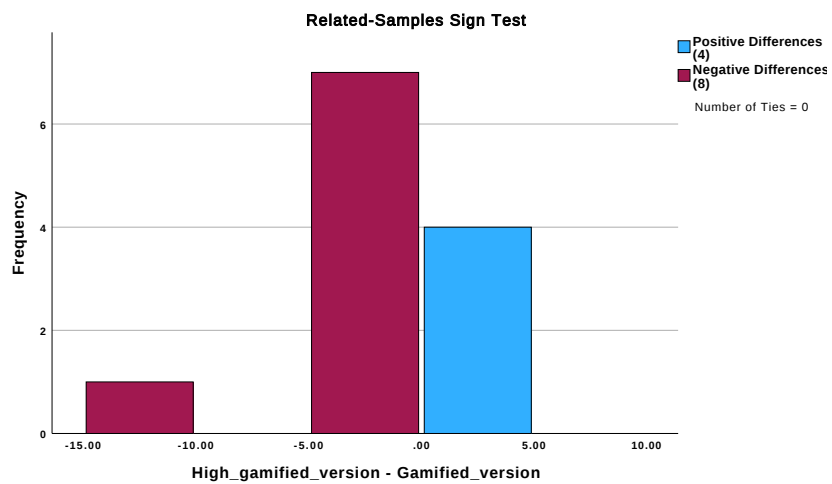
### Related-Samples Sign Test

Gamified\_version, High\_gamified\_version

**Related-Samples Sign Test Summary**

|                               |                    |
|-------------------------------|--------------------|
| Total N                       | 12                 |
| Test Statistic                | 4.000 <sup>a</sup> |
| Standard Error                | 1.732              |
| Standardized Test Statistic   | -.866              |
| Asymptotic Sig.(2-sided test) | .386               |
| Exact Sig.(2-sided test)      | .388               |

a. The exact p-value is computed based on the binomial distribution because there are 25 or fewer cases.



#### Related-Samples Wilcoxon Signed Rank Test

Gamified\_version, High\_gamified\_version

##### Related-Samples Wilcoxon Signed Rank Test Summary

|                               |        |
|-------------------------------|--------|
| Total N                       | 12     |
| Test Statistic                | 28.500 |
| Standard Error                | 12.570 |
| Standardized Test Statistic   | -.835  |
| Asymptotic Sig.(2-sided test) | .404   |

### E. Study Results from SPSS Tool

