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Comparing the Enjoyment of Video Game Mechanics

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Abstract

The video game industry has grown faster than ever and there is no sign that this trend will slow down in the near future. Creating an enjoyable game mechanic is crucial for the success of a game – but to what extent, and is a unique and innovative game mechanic a success factor? This survey paper describes the basics of gameplay and game mechanics, gives some renowned examples of innovative game mechanics and then investigates related work that shows how to measure player enjoyment as well as player perception on different aspects of a game. Through a comparative study of traditional and innovative game mechanics within a fixed video game scenario, our findings, reveal no general preference between the two. Despite innovative mechanics often being more complex and scoring lower on usability, they offer greater creative freedom, which appears to be a significant factor in overall player satisfaction. However, our results suggest that player experience influences the preference for game mechanics, with more experienced players favoring innovative game mechanics, and less experienced players leaning towards traditional ones.

Kurzfassung

Die Videospielindustrie wächst schneller denn je, und es gibt keine Anzeichen dafür, dass dieser Trend in naher Zukunft abschwächen wird. Unterhaltsame Spielmechaniken sind entscheidend für den Erfolg eines Spiels - aber in welchem Ausmaß, und ist eine einzigartige und innovative Spielmechanik ein Erfolgsfaktor? Diese Arbeit beschreibt die Grundlagen von Gameplay und Spielmechaniken, nennt einige bekannte Beispiele für innovative Spielmechaniken und untersucht verwandte Arbeiten, die zeigen, wie man den Spielspaß misst. Durch eine vergleichende Studie traditioneller und innovativer Spielmechaniken bei einem Videospielszenario zeigen unsere Ergebnisse keine allgemeine Präferenz zwischen den beiden. Obwohl innovative Mechaniken oft komplexer und weniger benutzerfreundlich sind, bieten sie einen größeren kreativen Spielraum, was ein wichtiger Faktor für die Gesamtzufriedenheit der Spieler zu sein scheint. Jedoch deuten unsere Ergebnisse darauf hin, dass die Spielerfahrung die Präferenz für Spielmechaniken beeinflusst, wobei erfahrenere Spieler innovative Mechaniken bevorzugen, während weniger erfahrene Spieler eher traditionelle Spielmechaniken bevorzugen.

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1. Introduction

In the world of video game design, the significance of game mechanics cannot be overstated. They are determinants of player enjoyment, engagement as well as the overall experience. As digital interactive mediums, video games rely on a solid rule set not only to enable player interaction, but also to provide challenges, rewards and control over gameplay. After providing a good overview about game mechanics and the measuring of game enjoyment, this work describes the implementation of a video game which allows the player to compare and rate different kinds of game mechanics. It then highlights findings as well as the evaluation of the results.

1.1. Motivation

Although creating a video game is a very complex, costly and time consuming process, more and more games get developed and released each year. The global video game industry is at an all time high with an estimated market size of 217.1 billion US dollars for 2022 and will likely have a compound annual growth rate of 13.4% from 2023 to 2030 [Res23]. Since many video games are not a one-time purchase anymore, developers and publishers rely upon elements that keep their players engaged and willing to spend more time or even pay for further content.

One option to keep consumers of media engaged for a long time has always been to establish an interesting story with good characters. But due to the fact that video games nowadays get recorded and broadcasted online by many streamers worldwide and can be watched for free by any interested people, this selling point definitely decreased. "Lootboxes" and other disputed ways to keep players engaged have already been well researched. To keep risks of a "flop" as low as possible, developers tend to implement proven common mechanics, but even those are no guaranteed success factors. And although game mechanics are not a new concept in games research, comparisons between more traditional and innovative mechanics are missing in this domain. As games continue to push the boundaries of creativity and technology, understanding the dynamics between established and time-tested game mechanics and their innovative counterparts becomes more and more relevant. In the fast changing domain of video game design, the interplay between traditional and innovative game mechanics is a fascinating aspect that significantly shapes the player's experience. Good game mechanics can be talked about, described and praised – but to experience them, one has to play the game themselves.

By creating a video game with a fixed test setting, as well as developing 4 different game mechanics, we aim to analyze how each mechanic contributes to player engagement,

satisfaction, and the overall gaming experience. This investigation not only promises valuable insights into the complexity of game design but also seeks to inform future game designers in creating immersive and captivating gaming experiences.

1.2. Research Question and Hypotheses

Understanding player preferences is key to creating engaging and satisfying gaming experiences. This study aims to understand the complexities of how players experience different types of game mechanics. Specifically, it seeks to answer the question: Do innovative game mechanics provide more enjoyment, and how do different levels of player experience influence preferences for traditional versus innovative game mechanics? Because we want to measure the differences of traditional versus more innovative game mechanics, the following hypothesis focus on the specific innovative weapons used in the game compared to a traditional one:

- **H1**: Innovative Game Mechanics provide higher video game satisfaction than traditional game mechanics.

This study aims to assess a diverse range of participants with different video game experiences, hence the following hypothesis will also get examined:

- **H2**: Players with varying levels of experience exhibit different preferences between traditional and innovative game mechanics.

To get a more nuanced evaluation for the statistical analysis (see Section 7.3) we will then split the hypotheses further into smaller, more detailed sub-hypotheses.

1.3. Document Outline

The general idea of this work is to measure and compare the enjoyment of different video game mechanics in a specific test scenario.

- Chapter 1, Introduction: Demonstrates the main motivation and idea behind comparing game mechanics as well as highlighting the hypotheses of the paper.
- Chapter 2, Related Work: Goes over some related work in gaming research, where researchers tried to measure and compare gaming experiences.
- Chapter 3, Background: To get a better understanding of the topic a brief description about game mechanics and gameplay as well as definitions and types gives a good foundation. This chapter also gives some innovative examples in the industry that were very well received.
- Chapter 4, Measuring Game Enjoyment: This chapter displays the different types of measures used to determine enjoyment. It also shows some common tools and practices used in the games research as well as in the video game industry.

- Chapter 5, The Game: A detailed description of the design and implementation process of the video game used to carry out the experiment.
- Chapter 6, Experiment: Introduces the methods used in the experiment as well as showcasing the process, the questionnaires used and additional data that gets collected.
- Chapter 7, Results and Evaluation: Includes a presentation of the results gathered during the experiment, as well as an evaluation and interpretation.
- Chapter 8, Conclusion: Conclusion of this work by reiterating the core results as well as discussing limitations and possible future work in this field.

2. Related Work

Just like the number of global video gamers increased over the last few years [Cle23], popularity in gaming research also has increased a lot [GB14]. This chapter looks at some related work that focus on comparing video game mechanics as well as trying to measure video game enjoyment.

A popular area in gaming research is the field of "serious games". These are games whose primary goal has a "serious" background, such as education or research, rather than just entertainment [MC06]. Since serious games are mostly validated as a whole, insights about specific mechanic elements of the games are missing. This is why Kniestedt et al. [KGML+21] wanted to compare different versions of the same game.

One of the hypotheses of their work was that participants that played a version with additional game mechanics would rate their experience higher. To test this, the authors took a 2D game called "Pocket Odyssey" and made four different versions of it. The first version called **Base** was the most basic version, which only included the core mechanics where players had to go for treasure hunting with a submarine. The second version called **Cust** added a renovation mechanic where the players could use their collected coins to modify their ship. **Narlin** included the story to the game and allowed their players to experience the narratative in a linear fashion. The last version called **Narcho** gave the players choices that impact how the story unfolds. Out of the 344 participants, 204 provided results. The results show, that the different versions had no impact on the overall experience of the players. However, the authors state that the versions with additional game mechanics might be beneficial in long-term playing sessions, which was not tested, but participants comments suggest that.

While the authors' paper compared different versions of a video game that had **additional** game mechanics on top, this study wants to compare the same versions except with different game mechanics **instead**. Our experiment also has a different approach: While Kniestedt et al. [KGML+21] randomly assigned the participants into different groups which each got a different version of the game, the experiment in this study let's the players play all different game mechanics, but in random order (see Section 6.2).

When describing a media experience people often use words like "fun" or "meaningful". Oliver and Hartmann [OH10] state that participants who should report "meaningful" films often name movies that deal with life's purpose or human vurtue. On the other hand "pleasurable" or "fun" movies are used as a mean to escape from life's worries and are generally associated with greater laughter [OHW12]. Rogers et al. [RWS+17] wanted to investigate video games experiences with a similar approach. The authors examined multiple user's descriptions of their gaming experiences. By recruiting participants via

online platforms, they were either asked to name their "most fun" or "most meaningful" gaming experience. Results show, that games like World of Warcraft and the Final Fantasy Franchise were named for most meaningful. Super Mario and Angry Birds were named when asked about the most fun one. After identifying their most fun or meaningful game, they were asked to justify their decision. It turned out, that participants who described their most fun game tended to focus more on gameplay and mechanics, while participants who shared their most meaningful game provide moral choices, noteworthy characters or story [RWS+17].

Klimmt and Vorderer [KV00] suggested that a video game situation is a competition that features possibilities, as well as the necessity to act, alongside the player's attempt to resolve the situation followed by a rewarding result (if the player succeeds). Vorderer et al. [VHK03] further investigated this topic by a field experiment. The authors hypothesized that game situations become more enjoyable when they offer a variety of possibilities to act and include competitive elements. To test these assumptions, a verbally depicted situation of the video game "Tomb Raider" was described to participants with additional information in 4 different versions. In the first version, Lara Croft (the protagonist of the game) had a various amount of weapons and tools, in the second she only had very few options. In the third version the participants were told that monsters suddenly start to attack her, in the fourth version no monsters were mentioned.

The participants (394 in total) then had to rate the enjoyment they would feel given the situation. The results show that the version with many possibilities to act and a necessity to act were rated the highest, and the version with few possibilities and no necessity to act was rated the lowest. Even though the field experiment of Vorderer et al. [VHK03] demonstrated the importance of the competitive element with verbally depicted situations, a **real** video game needs to get used to further investigate the enjoyment – just as this current study is executing (see Section 5).

When comparing video game mechanics, it's important to recognize that different individuals have different preferences for various types of games. To examine this interplay between personality factors and video game engagement, researchers have highlighted differences in how various traits influence gaming behaviors. Abbasi et al. [ASR+21] conducted a study among young adults in Malaysia using the HEXACO model [LA13], that found that conscientiousness and extraversion significantly predict consumer video game engagement, underscoring the role of personality in how players interact with games. This insight is further expanded by findings from Abbasi et al. [ATH+22] which investigates the personality differences between video game consumers and non-consumers. Results show, that gamers typically exhibit higher levels of agreeableness, extraversion, conscientiousness, and openness to experience, indicating a distinct personality profile compared to non-gamers. Additionally, engagement in violent video games was scrutinized, revealing that affective and behavioral engagements are positively correlated with aggressive behaviors, while cognitive engagement showed no significant impact [ARH+22]. These studies collectively enhance our understanding of the interplay between personality traits and gaming behaviors, suggesting that both the type of engagement and inherent

personality traits can influence the psychological outcomes associated with gaming.

Moll et al. [MFRL20] explored the relationship between game mechanics and player interaction within the context of the popular game Fortnite. The work focused on extracting and analyzing data from video streams of gameplay. The authors developed a toolchain that allowed them to study player behavior based on publicly available videos. The researchers conducted a user study with 12 Fortnite beginners to compare their gameplay behavior against experienced players using stream data. They hypothesized that factors like game duration, success in the game (measured by survival time and number of kills), and player interactions at specific locations on the game map (like landing spots) significantly affect players' enjoyment and satisfaction. Key findings include that beginners' enjoyment correlates with their in-game success and that the choice of landing spot influences their game experience. They also identified "hot spots" and "boring spots" on the map, areas with high and low player activity, respectively, which influenced the dynamics of player engagement and satisfaction. Overall the analysis revealed patterns that could help game developers optimize game mechanics to enhance player experience [MFRL20].

3. Background

Just like with every other interactive medium, video games require the user to interact with it in a certain way, to which the game responds. This chapter focuses on the two concepts that often get referred to interchangeably, which describe how this interaction takes place: gameplay and game mechanics.

3.1. Gameplay

When asked about a game, players generally tend to answer by talking about the gameplay. It focuses on a player-centric perspective, since it is the dynamic experience that emerges from the players' interactions. Fabricatore [Fab07] describes gameplay as what the player can do, and how the game responds to that. Using this definition we could say that e.g., in the game "Super Mario Bros" [Nin83] "jumping" can be described as a game mechanic, whereas "maneuvering through the level" or "collecting coins" can be described as the gameplay. After examining multiple handbooks, Guardiola [Gua19] suggested a definition from a game design perspective:

> "The Gameplay consists of the actions performed by the player when involved in a challenge. It emerges from the emotionally-charged interaction between the player and the game components." [Gua19]

This definition is similar to Fabricatores', but adds elements of "challenge" and "emotionally-charged". In the following section readers will see, that the line between gameplay and game mechanics is not always easy to draw, especially with more complex games.

3.2. Game Mechanics

In contrast to gameplay, game mechanics refer to the rules, systems, and interactions that define how a game operates. Video games always have a fixed underlying "rule set" of how to interact with them. They are the "back bone" of every game and define what the player can and cannot do. They are fundamental for shaping gameplay and creating the overall experience. By providing challenges or goals, well-designed game mechanics can enhance the player engagement.

Mechanics are also independent of the input device. The specific buttons or keys used to initiate the action may differ, but the underlying mechanic – e.g., moving the character from one point to another – is consistent. This means, that a player using his mouse and keyboard walking around with his character by pressing the corresponding buttons,

uses the same game mechanic as a player who is playing the same game with a gamepad instead, controlling by tilting the analogue stick. Game mechanics describe how the player interacts with the virtual world.

In games research, the definition or meaning of game mechanics varies a lot. Sicart [Sic08] defines game mechanics using concepts of object-oriented programming as "methods invoked by agents for interacting with the game world" (where methods can be performable actions and an agent e.g., the player). Some game mechanics cannot be described within the framework of object-oriented programming because they are not a method per se. When looking at "driving" as an example, it consists of multiple smaller mechanics (accelerating, steering, etc.) that are in fact the methods. Sicart describes mechanics that consists of multiple smaller mechanics as compound game mechanics. Fabricatore [Fab07] describes game mechanics from a player-centered perspective as "tools for gameplay" that take an input from the player and produce an output. This output can either get forwarded to another mechanic or just change a state in the virtual world.

Even though it is not always easy – let alone possible – to categorize every game mechanic of every game (especially more complex ones) consistently, it is important to know about the concepts of core game mechanics. Core game mechanics are responsible for the majority of the gameplay. They usually consist of walking, jumping, shooting etc. They are easy to learn and eventually assessed without thinking much about them by the player as he progresses. Sicart [Sic08] notes that just because players use a game mechanic often, does not mean it is a core game mechanic. He states that a core game mechanic has to fulfill the requirement of being used to reach the "systemically rewarded end-game state". Sicart also deepens the concepts of core mechanics by dividing them into primary and secondary mechanics. Primary core mechanics are necessary to reach the goals or overcome the challenges of the game, while secondary core mechanics can "ease the player's interaction with the game towards reaching the end state". He describes the concepts with missions in the game "Grand Theft Auto IV" [Roc08]. Players have to shoot to fulfill the missions (primary core mechanic), but if the player uses the cover-mechanic or not is up to him since it is not necessary but might be helpful to reach the goal more easily (secondary core mechanic) [Sic08]. Satellite game mechanics is another concept described by Fabricatore [Fab07]. He states that satellite mechanics are enhancements or add-ons for already existing mechanics without increasing its complexity. Such enhancements can contribute to challenge and motivate the player to keep playing by adapting to new features and scenarios. Popular examples are telescope or silencer add-ons for a rifle.

However, just creating a variety of game mechanics does not mean it produces a good game. In a guideline developed by Fabricatore [Fab07] he states that it is important to make sure that the time spent learning a game mechanic is proportional to the "player's perceived complexity and relevance of the feature". But the challenge and reward does not come from learning alone. He notes that "using the mechanic as a tool for gameplay in ordinary situations" as well as in extraordinary situations should happen as soon as possible [Fab07].

Hofmann [Hof18] created a distinct definition of game mechanics that builds on top of the previous authors' definitions. Hofmann adds the concept of "game experience" which is created by game mechanics via gameplay. In this definition the gameplay is merely the interface between the mechanic and the experience. The author states that game mechanics and gameplay are both objective, but the mechanics are game-focused rules while the gameplay consists of player-focused actions. The game experience is subjective and player-focused [Hof18].

3.2.1. Types of Game Mechanics

Although Fabricatore [Fab07] and Sicart [Sic08] already categorized game mechanics by their importance with the concepts of core mechanics (as well as primary and secondary mechanics), a classification of their **types** is missing. The sheer amount of different game mechanics and their distinct implementations make a complete and mutually exclusive classification impossible. Many game mechanics can fall into multiple types depending on their characteristics. Game designers often balance and combine different types of mechanics to create an enjoyable experience. A proposed categorization of types looks as follows:

- Spatial Mechanics: Mechanics related to navigating and interacting within a game's space, whether 2D or 3D. This includes moving characters, objects, or cameras, essential for direct gameplay interaction.
- Temporal Mechanics: Mechanics involving the use and manipulation of time in gameplay, such as time limits, speed requirements, or critical timing for actions, enhancing strategic depth and challenge.
- Weapon Mechanics: Mechanics related to handling and using weapons in a game, including shooting, aiming, reloading, and melee combat.
- Economic Mechanics: Mechanics governing the economic systems within a game, involving resource collection, item acquisition, or unlocking new areas.
- Social Mechanics: Mechanics that facilitate player interactions within the game, such as forming teams, guilds, or clans, trading, or cooperative missions.
- Narrative Mechanics: Tools and methods used to convey stories in games, including dialogue, cutscenes, and environmental storytelling.
- Physics-based Mechanics: Mechanics based on physical laws to create realistic or stylized interactions and challenges, such as gravity, fluid dynamics, and destructible environments.
- Progression Mechanics: Mechanics that govern how players advance through the game, including character development, skill unlocking, and item collection.

Later on we will look at some examples for each type. The game created for the experiment of this paper tests Weapon-, Spatial- as well as Physics-based Mechanics.

3.2.2. Evolution

Beyond the visible advancements in graphics over the past three decades, an equally significant evolution has occurred in the field of game mechanics. While improved and much more realistic graphics are often the initial observations of players when comparing games from 30 years ago to contemporary titles, the progress in game mechanics is equally noteworthy. Video games have undergone a transformation in terms of innovations in game mechanics and gameplay. These developments contribute not only to enhanced player experiences but also to the overall depth and complexity of interactive storytelling within the gaming medium.

Taking "Super Mario Bros." [Nin83] as an example, released over 30 years ago, we see that it contained only a few core game mechanics like "jumping" and "walking". When comparing it to an open world game like the current game in the "Grand Theft Auto" franchise, we observe that just the intro sequence of the game contains multiple complex mechanics like "shooting", "driving" or "switching characters". Receiving high praise in its launch year 2013, this game had multiple re-releases for newer consoles and remains popular as it is still played regularly even today. Of course "Super Mario Bros." [Nin83] is a milestone in video game history and is considered one of the most influential games ever. But even though it is a well crafted game, in terms of game mechanics it's very basic. It is the variety and combination of well crafted game mechanics of open world games like "Grand Theft Auto V" [Roc13] that allow players to dive into the virtual world and experience stories that they can interact with or even create.

3.2.3. Examples of Traditional Mechanics

Traditional game mechanics refer to the established and commonly used elements used in video games and have become familiar to players over time. Of course, in the early era of video games, nearly everything was "innovative" in terms of game mechanics. From moving the in-game paddle in "Pong" [Ata72] to "jumping" with Mario in "Super Mario Bros." [Nin83] is arguably a big step. But after some time, a couple of mechanics have repeatedly been used to make games. Using traditional mechanics is almost unavoidable since nearly every game has to support basic functionality to interact with the game world. But beyond that, games still use primarily traditional mechanics. This does not mean that every game is the same, since it also depends on how the mechanic is implemented, in what order they appear in gameplay, and how they interact with the other elements of the game.

Spatial Mechanics Whether in a 2D or 3D game, the most important interactions are probably done via spatial mechanics. They range from positioning the paddle in "Pong" [Ata72] to clicking in a "Point and Click" adventure, to jumping and running in a "First-Person-Shooter" (FPS), as well as to moving the camera in a "Real-Time Strategy' (RTS) game.

Temporal Mechanics Time plays a big roal in racing games, where players try to get to the finish line as fast as possible. Time can also get used to generate pressure in a mission, e.g., time limit to escape from a time bomb. A slightly different example for temporal mechanics are timing mechanics, where players have to act in a certain time frame, e.g., when a boss exposes his weak spot for a short period of time and players have to deal damage to that spot.

Weapon Mechanics Weapons are one of the most popular tools to allow interactions for attacking. Mechanics range from shooting, aiming, reloading to swinging or blocking with a sword, to doing melee attacks. Because of their characteristics, weapons are a good fit for implementing an additional upgrading mechanic, e.g., adding scopes, or altering bullet types. Because weapons in the virtual world can be used to launch virtually anything, they form the basis of many innovative game mechanics (see Section 3.2.4) that extend beyond mere weapon functionality.

Economic Mechanics Just as time plays an essential role in racing games, economic mechanics are essential in "Jump'n'Runs". During a section players usually can collect coins or other in-game currency which is necessary to either unlock other areas of the game, or to buy items. In "Survival Games" an essential part of the game is to gather resources and build a shelter or weapons.

Social Mechanics In the early days of video games when the narrative aspects were not as pronounced as today, playing them together was a major selling point. When online multiplayer became more popular, local multiplayer support decreased. Many games allow players to form guilds or clans, encouraging players to work together, complete missions or team up against other groups. In some MMOGs (Massively Multiplayer Online Games), trading with other players is practically essential for player progression hence it is a primary mechanic.

Narrative Mechanics Video games have always been used to tell interesting and engaging stories. This usually gets done via pre-rendered or in-game cutscenes as well as with dialogue. Dialogue choices let the player interact with the story and create more complex outcomes. A simple yet effective method to enhance the overall experience is to create the virtual world in a way, that the world itself reveals insights into the story. This is called environmental storytelling. Elements of this can be notes, audio logs or subtle modifications in the map, that hint to an event in the past.

Physics-based Mechanics Physics-based mechanics involve the use of realistic or stylized physics to create challenges or gameplay experiences. Physics in general are important for a believable experience and to keep the immersion intact. If objects wouldn't behave in a way the player expects it, the immersion could break. The most common mechanic in this category is gravity, where objects simply fall or move according to gravitational forces. Floating objects on water, as well as water physics in general can be used for

puzzles. Paired with weapon mechanics, games often also integrate explosions with an area effect or destructible environments, such as crates, walls or windows.

Progression Mechanics Progression mechanics govern the players' advancement throughout the game from start to finish. They are either necessary to beat the game (easier), or just "filler" content to provide extras. In many older games, progress simply meant to beat level after level, but in more modern games, or especially open world games, certain areas can be shielded by enemies that are too strong, abilities which the player did not learn yet, or key items that have yet to be found. Collecting in-game money to buy equipment, or leveling up to make the character stronger are popular mechanics. Often, games let the user decide which attributes of the character they want to level up with "skill trees". In-game collectibles are a tool to keep the player engaged and spend more time. An example of this are the feathers in "Assassin's Creed II" [Ubi09]. They are scathered throughout the whole game, and when everyone has been collected, the player gets a special cape for his character.

The examples shown in Table 3.1 can be found in many games and generally build the basis of them. It makes sense to not only sort them into the types mentioned in Section 3.2.1, but also to categorize them into primary and secondary mechanics mentioned by Sicart [Sic08]. However, as already stated, some examples might fit into more than one type as well as category, but they were sorted based upon how they usually get used in games (e.g., "time limits in missions" are often requirements to succeed – hence it is considered a primary core mechanic, whereas day-night cycles are mostly irrelevant for the progression – hence a secondary mechanic).

Type	Primary	Secondary
Spatial Mechanics	walking, jumping, driving	sneaking, fast travelling
Temporal Mechanics	time limits in missions	day-night cycle
Weapon Mechanics	shooting, aiming, reloading	upgrading weapon
Economic Mechanics	point system	resource gathering
Social Mechanics	trading with other players	multiplayer mode
Narrative Mechanics	cutscenes	dialogue choices
Physics-based Mechanics	explosions	destructible environments
Progression Mechanics	experience points, leveling up	collectibles, skill trees

Table 3.1.: Examples of Traditional Game Mechanics

While traditional mechanics provide a sense of familiarity and comfort, more innovative mechanics try to push the boundaries of what game experiences can provide forward and contribute to the overall evolution of the medium.

3.2.4. Examples of Innovative Mechanics

Over the years, games generally have gotten more complex in terms of gameplay, but most of them share the same core game mechanics. This is not a bad thing per se, since users are able to learn the controls more quickly and can focus on the narrative aspects of the game. However, there are a variety of games which stand out because of their unique mechanics and were very well received. These mechanics often seek to provide unique and novel experiences for players, challenging established norms and introducing fresh ways to engage with a game. There are arguably more innovative game mechanics that fall into the primary category. This is because when a developer decides to implement a more complex mechanic, it usually is a big and necessary part to complete the game.

Spatial Mechanics "Portal" [Val07] introduced a creative weapon that can shoot "portals" which are then used to solve puzzles. The weapon has two modes: shooting a blue portal and shooting an orange portal. The two different colored portals combined act as a wormhole or gateway. Simply put: when going through a blue portal you come out of the orange portal and vice versa. In combination with the fact that the player retains his speed when exiting a portal from the point at entrance, this tool kit allows for very engaging puzzles. This mechanic can be categorized as both – a spatial as well as a weapon mechanic. The development of the Teleporter (see Section 5.2.3) for the experiment was highly influenced by the "Portal" gun. Another example for a spatial mechanic is the "Dimension Shifting" or "Wall Merging" mechanic of "The Legend of Zelda: A Link Between Worlds" [Nin13]. With this mechanic, the player can transform the character "Link" into the 2-dimensional space and merge him onto the wall. With this ability he can avoid enemies' attacks and reach otherwise unreachable areas.

Temporal Mechanics A popular kind of design choice is to allow the player to manipulate time in a certain way. In the First-person shooter "Super Hot" [SUP16] the time only progresses at normal speed when the player either moves or shoots a projectile, allowing for a more strategic approach to clear each level. In "Prince of Persia: The Sands of Time" [Ubi03] the players character gathers a dagger with magical powers. With this dagger, the character has the ability to manipulate time. The most popular type is rewinding the time for up to 10 seconds. This allows the player to revert a mistake in combat or platforming. In recent years many time loop games like "Outer Wilds" [Mob19], "Life Is Strange" [Don15] or "The Forgotten City" [Mod21] got released. This often gets used in a narrative way, having parallels to films [Lah18].

Weapon Mechanics The video game "Elden Ring" [Fro22] introduced a feature called "Ashes of War", collectable items that can be used to reinforce/upgrade your weapon with unique abilities or attacks, fundamentally altering how the weapon is used in combat.

Economic Mechanics In "Grand Theft Auto V" [Roc13] the player has access to an in-game stock market that gets affected by the players' actions. There are two different

markets, one for the offline game, and one for the online community. For the offline version, the player can buy stocks of an in-game company, whose virtual competitor he will eventually attack in a mission. Games like “Dark Souls” [Fro11] or “Hollow Knight” [Tea17] also have in-game currencies. When defeating enemies or finding treasure chests the player gets usually rewarded with “souls” respectively “geos”. When dying, the player loses everything and drops it at the point he died. Then he has one chance to progress back to the spot and recollect his lost items. If however, he dies on his way before he manages to gather his lost goods again, the in-game money can no longer be regained. Because of this penalty, situations like this can create much frustration but on the opposite, the constant fear can also create a lot of enjoyment for certain people.

Social Mechanics The “Souls”-Franchise consists of a list of very renowned games of the Japanese Role-Playing Game (JRPG) genre. In most of the games players can – if they are connected to the internet – consume an in-game item, that enables them to “invade” another real players’ world. Invading often triggers many emotions and can lead to very intense experiences envoking feelings of anger, grief or joy. In the “Souls”- games it is also possible to leave messages in the game world for other players to see. These messages can get created using predefined text blocks and are intended to warn other players from dangerous enemies, but also gets used for fun. In “Team ICO”’s game “ICO” [Tea01], the social component not only takes a big role narratively, but also in gameplay. The main character controlled by the player has to escort a princess by regularly taking her by the hand. This mechanic, demands the player to continously hold a button while holding his companion, adding weight to this act and the characters’ responsibility. But there are also games where the whole experience is designed to enjoy together: “A Way Out” [Haz18] and “It Takes Two” [Haz21] can only be played together with another person.

Narrative Mechanics Today, video games focus more and more on narrative aspects of a game. Cutscenes in modern titles have the look and feel of good written movies. By giving the player a choice to interact in the storyline, either by dialogue choices that impact the outcome, or by taking into account the players’ actions and act and adapt accordingly. “Baldur’s Gate 3” [Lar23] is a well-known example for this concept. There are also narrative meta-mechanics, which describe mechanics that make use of information outside the game world. The famous boss fight against “Psycho Mantis” in “Metal Gear Solid” [Kon98] is considered to be one of the most iconic and memorable encounters in video game history. It is known for its unique and innovative approach to breaking the fourth wall and engaging with the player on a meta-level. It featured dialogues where the antagonist mentioned other games which were stored on the memory card. Defeating the enemy the usual way was not possible since the boss could "read" the players inputs. In order to succeed one had to switch the controller port. The fight is designed to create a psychological tension, challenging the player’s understanding of the game and their interactions with it. It is often cited as an example for using unique mechanics to engage with players on a deeper level. “Inscryption” [Dan21] is a game full of meta mechanics. One example is a boss fight where the player gets assigned to find a file on his computer

with such a large size that it inflicts heavy damage. Even though meta mechanics certainly would deserve a whole category, they usually are implemented in a narrative manor, hence they belong to the narrative type.

Physics-based Mechanics A famous example of physics manipulation in games is the "gravity gun" in "Half Life 2" [Val04]. The gravity gun looks like a futuristic firearm which players can use to pick up, launch, and interact with various items in the game world. "Gravity Rush" [Tea12] is about a girl named Kat who has the power to shift the direction of gravity at will. This means she can fall in any direction, walk on walls, and soar through the air in defiance of traditional gravitational forces.

Progression Mechanics Progression Mechanics are usually very tight connected to Economic Mechanics, where players use their collected in-game currency – whether these are points, items or materials – to upgrade the character via a skill tree for example. In the game "A Plague Tale: Requiem" [Aso22], the skills evolve dynamically corresponding to the play style the player engages with. This means that the player unlocks "aggressive" skills when he kills enemies and uses the weapons a lot. However, if he sneaks past enemies and uses distractions to avoid conflict, he will gain "Prudence" skills. Time loop games often have something very special in common: from the very start of the game, the player has everything to beat the game immediately, except the knowledge on how to do this. This separates them from most games, where players first have to acquire certain items or defeat multiple bosses. Such a mechanic can be described as "knowledge-based progression".

Table 3.2 summarizes some innovative game mechanics and groups them into the corresponding type and category. As already mentioned above: some examples might fit into more than one type as well as category, but they were sorted based upon how they usually get used in games.

Type	Primary	Secondary
Spatial Mechanics	teleporting	dimension shifting
Temporal Mechanics	time manipulation	time loops
Weapon Mechanics	shooting portals	modifiable special attacks
Economic Mechanics	death & retrieval	dynamic market system
Social Mechanics	mandatory coop	invasions, messages
Narrative Mechanics	impacting outcome of story	procedural storytelling
Physics-based Mechanics	manipulating gravity	momentum conservation
Progression Mechanics	knowledge-based progression	dynamic skill trees

Table 3.2.: Examples of Innovative Game Mechanics

4. Measuring Game Enjoyment

Measuring game enjoyment is crucial in academic research as well as in the video game industry. Understanding the player experience helps designing an even more immersive or satisfying experience. When finding positive or negative aspects of a game, designers can modify the game in a way that benefits the overall game greatly. Data gathered in measurements of video game experiences provide good information about psychological, emotional and cognitive aspects of a game, contributing knowledge in the fields of psychology, human computer interaction or game studies. Although there is not enough literature to support this, measurements about video game enjoyment probably can get used to predict success and marketability.

The measurement of video game enjoyment is fundamental for optimizing game design, informing research, and ultimately enhancing the overall quality of the player experience. It is an integral component of both academic inquiry and industry practices in the dynamic and evolving field of video game development.

4.1. Measurement Types

In gaming research, objective and subjective measures are two distinct approaches to assessing video game enjoyment, each offering unique insights into the player experience. Measuring video game enjoyment often involves a combination of subjective and objective measures.

Objective Measures Objective measures provide quantifiable data such as time to complete a level, collected coins or other scores, or defeated enemies and other in-game achievements. Another objective measure can also be the tracking of player movement or click logs that evaluate the "style" of how the player assesses a gameplay situation. Biometric data like heart rate or eye-movement may also get collected and evaluated.

Subjective Measures Subjective measures focus on the player's perceived experience and personal opinions. This includes self-reported feelings, emotions, and thoughts about the game which usually are reported during open questions, questionnaires or interviews.

4.2. Measurement Tools

The choice of measurement tools depends on the specific research question, the goals of the study, and the preferences of the researcher. Sometimes researchers combine multiple measures to gain a more holistic understanding. Although adapting tools is sometimes

necessary to fit specific needs, the originally intended evaluation method might not be fitting anymore. Researchers may also develop their own questionnaires based on the specific aspects they want to investigate. As the field of video game research continues to evolve, new measurement tools may emerge, and existing ones may be adapted or refined. While there isn't a single universally accepted tool or questionnaire, there are some commonly used approaches.

4.2.1. Player Experience of Need Satisfaction (PENS)

Based on the Self Determination Theory [DR85, DR00], Ryan et al. [RRP06] introduced a tool/questionnaire called Player Experience of Need Satisfaction (PENS) that assesses the satisfaction of psychological needs (autonomy, competence, and relatedness) in the gaming context. The questionnaire contains so-called PENS-variables:

- In-Game Competence. e.g., "I felt very capable and effective"
- In-Game Autonomy. e.g., "I did things in the game because they interested me"
- Presence. e.g., "When moving through the game world I feel as if I am actually there"
- Intuitive Controls (IC). e.g., "When I wanted to do something in the game it was easy to remember the corresponding control."

Overall the PENS is designed to assess motivational aspects of gaming by understanding how well these psychological needs are met during gameplay. It is particularly useful for studies investigating the motivational aspects and well-being of players [RRP06].

4.2.2. Game Experience Questionnaire (GEQ)

The GEQ was introduced in 2008 by IJsselsteijn et al. [IHK+08] in the course of a EU-funded project. It is designed to assess the overall gaming experience and includes the following subscales:

- Sensory and Imaginative Immersion (e.g., "I felt imaginative")
- Competence (e.g., "I was good at it")
- Flow (e.g., "I lost track of time")
- Tension/Anxiety (e.g., "I felt annoyed")
- Negative Affect (e.g., "I was distracted")
- Positive Affect (e.g., "I enjoyed it")
- Challenge (e.g., "I thought it was hard")

Although the Game Experience Questionnaire is one of the most popular measuring tool it has also received a lot of criticism [LBM18, Nor13].

4.2.3. Game User Experience Satisfaction Scale (GUESS)

Phan et al. [PKC16] introduced the Game User Experience Satisfaction Scale (GUESS) in 2016. It was developed by generating a new set of items from already existing scales and heuristics. After multiple iterations of refinements, expert reviews and pilot testing, the final product was validated by over 600 participants. The questionnaire was psychometrically validated and consists of 55 items in total and has 9 subscales:

- Usability/Playability (e.g., "I think it is easy to learn how to play the game.")
- Narratives (e.g., "I enjoy the fantasy or story provided by the game.")
- Play Engrossment (e.g., "Sometimes I lose track of time while playing the game.")
- Enjoyment (e.g., "I think the game is fun.")
- Creative Freedom (e.g., "I feel creative while playing the game.")
- Audio Aesthetics (e.g., "I enjoy the music in the game.")
- Personal Gratification (e.g., "I feel successful when I overcome the obstacles in the game.")
- Social Connectivity (e.g., "I like to play this game with other players.")
- Visual Aesthetics (e.g., "I enjoy the game's graphics.")

It is also possible to remove the Narrative and Social Subscales from the questionnaire if the tested game does not include those aspects [PKC16]. Although the authors state that it only takes approximately 5 to 10 minutes to complete the whole questionnaire, 55 items can feel quite overwhelming, particularly if one wants to test different versions of a game successively. For that reason, Keebler et al. [KSS+20] introduced a more compact version, the GUESS 18 which only features 18 items.

4.2.4. Player Experience Inventory (PXI)

The Player Experience Inventory (PXI) [ASN+20] was developed on the basis of the Means-End Theory [Gut82] as well as with the help of over 60 domain experts. It contains 10 different constructs with 3 items each. Five of the constructs measure player experience at the functional level, these are:

- Ease of control (e.g., "The actions to control the game were clear to me.")
- Progress feedback (e.g., "I could easily assess how I was performing in the game.")
- Audiovisual appeal (e.g., "I liked the look and feel of the game.")
- Goals and rules (e.g., "The goals of the game were clear to me.")

- Challenge (e.g., "The challenges in the game were at the right level of difficulty for me.")

The other five constructs measure the player experience at a psychological level:

- Mastery (e.g., "I felt capable while playing the game.")
- Curiosity (e.g., "I felt eager to discover how the game continued.")
- Immersion (e.g., "I was no longer aware of my surroundings while I was playing.")
- Autonomy (e.g., "I felt a sense of freedom about how I wanted to play this game.")
- Meaning (e.g., "Playing the game was meaningful to me.")

The 30 item- questionnaire has been validated with over 500 participants and is a popular tool in the game research community. Just like the GUESS (see Section 4.2.3) has a smaller 18-items version, there is also a compact version of the PXI, namely the miniPXI containing only 11 items [HHJ+22].

4.2.5. NASA Task Load Index (NASA-TLX)

While not specific to gaming, the NASA-TLX [HS88] is a widely used tool to assess perceived workload. The NASA-TLX focuses on dimensions such as mental demand, physical demand, temporal demand, performance, effort, and frustration, which are more aligned with the assessment of cognitive and physical load. In the context of video games, it can be used to measure the cognitive load and overall mental effort involved in gameplay (e.g., [McF16, Ram21]).

4.2.6. Game Engagement Questionnaire (GEQ)

Not to be confused with the Game Experience Questionnaire (see Section 4.2.2) Brockmyer et al. [BFC+09] created the Game **Engagement** Questionnaire (GEQ). The authors had a different motivation in creating this questionnaire. While others focus on the positive aspects of a game, they focus on negative effects like video game violence. The questionnaire aims on assessing the impact of playing violent video games. This can also be seen in some of their items chosen in their 19 items long questionnaire: "I feel scared", "I feel different", "I get wound up". While having proven reliability and validity the use case seem to focus more on the negative effects of a video game.

4.2.7. Consumer Videogame Engagement Scale

This scale was designed by Abbasi et al. [ATH17a, ATH16]. It breaks down engagement into three primary categories: cognitive, affective, and behavioral. Each category includes specific scales with corresponding items, structured to capture the various dimensions of player engagement.

Cognitive Engagement

- Conscious Attention: Measures the level of attention and concentration. (e.g., "I like to know more about this video-game.")
- Absorption: Assesses how deeply a player is immersed in the gameplay. (e.g., "Time flies when I am playing this video-game.")

Affective Engagement

- Dedication: Reflects the player's commitment and motivation towards the game. (e.g., "I am proud of playing this video-game.")
- Enthusiasm: Captures the emotional involvement and excitement experienced during gameplay. (e.g., "I am passionate about playing this video-game.")

Behavioral Engagement

- Social Connection: Measures the extent of social interactions and connections formed through gaming. (e.g., "I enjoy playing this video-game more when I am with others.")
- Interaction: Evaluates the frequency and quality of interactions with other players during gaming sessions. (e.g., "I am someone who enjoys playing this video-game with others like-minded video-game players.")

The development of this scale involved procedures like exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) to ensure it accurately captures the multidimensional nature of video game engagement. The instrument is validated to be a reflective-formative model, considering both psychological and behavioral dimensions of engagement, which makes it a robust tool for measuring engagement in videogame contexts [ATH17a, ATH16].

4.2.8. Playful-Consumption Experience Scale

The Playful-Consumption Experience Scale was developed by Abbasi et al. [ATH17b, ATH$^+$18] to capture the player's experiences during digital game playing, focusing on imaginal, emotional, and sensory dimensions.

Imaginal Experience

- Escapism: Assesses the player's ability to use the game as an escape from reality. (e.g., "Playing a video-game gets me away from the reality.")
- Fantasy: Measures the extent to which the game stimulates the player's creativity and imagination. (e.g., "Playing a video-game helps me create daydreams.")

- Role-Projection: Evaluates the player's ability to project themselves into a character or role within the game. (e.g., "Playing a video-game enables me to project myself into a particular role.")

Emotional Experience

- Enjoyment: Captures the fun and pleasure derived from the gameplay. (e.g., "Playing a video-game provides me with a lot of enjoyment.")
- Emotional Involvement: Measures the depth of emotional engagement with the game. (e.g., "When I am playing a video-game, I get into this video-game playing experience.")
- Arousal: Reflects the intensity of emotional arousal during gameplay. (e.g., "Playing a video-game makes me inspired.")

Sensory Experience

- This dimension addresses how the game appeals to and influences the player's senses. (e.g., "Playing a video-game influences my physical movement.")

This scale involved careful item selection and validation through exploratory factor analysis (EFA) and reliability tests. This ensures that each dimension and sub-dimension accurately captures the intended aspects of playful-consumption experiences in digital gaming [ATH17b, ATH+18].

4.2.9. GameFlow

The GameFlow model developed by Sweetser et al. [SW05] provides a framework for evaluating player enjoyment in video games. This model integrates core aspects of player interaction into an assessment tool. The model is based on Csikszentmihalyi's general concept of flow [Csi90]. The eight core elements of the GameFlow model include:

- Concentration: Games should require concentration and the player should be able to concentrate on the game.
- Challenge: Games should be sufficiently challenging and match the player's skill level.
- Player Skills: Games must support player skill development and mastery.
- Control: Players should feel a sense of control over their actions in the game.
- Clear Goals: Games should provide the player with clear goals at appropriate times.
- Feedback: Players must receive appropriate feedback at appropriate times.
- Immersion: Players should experience deep but effortless involvement in the game.

- Social Interaction: Games should support and create opportunities for social interaction.

The authors evaluated this model with two Real-Time-Strategy (RTS) games using the GameFlow model highlighted the importance of concentration for player enjoyment and demonstrated that categories like control and immersion are more applicable to other genres. The findings confirm the utility of the GameFlow model in diagnosing game design issues and enhancing player engagement, making it a valuable tool for both research and game development [SW05].

5. The Game

To ensure the integrity of the empirical results, a game that has a fixed scenario but with varying game mechanics had to be created. An important factor during the implementation process was to design every puzzle, task, obstacle in such a way that it can be solved with each game mechanic. Building on this, another key element was to provide freedom of choice. It can be very frustrating if you are stuck at a puzzle because you don't come up with the solution. In contrast, it can be exceptionally rewarding if you solve a puzzle with a unique idea that was not the "intended" solution but worked.

5.1. Gameplay Overview

The players' journey begins with a home screen. After pressing start, the player gets prompted to fill out the first form. This general form is necessary to gather basic information such as age, gender, experiences with video games etc. After submitting the form, descriptions of the controls are shown.

The game starts and the player finds himself in the "Start Area". This area only consists of a hovering weapon and some stairs which lead outside. The head up display (HUD) shows the current objective: "Pick up your weapon". The player then approaches the weapon and picks it up. The HUD tells the player to go outside and up the stairs. On the way out, the player notices a brief description on how to use the gun. After arriving upstairs, the "Main Area" is visible. This area consists of patrolling roboter like enemies, platforms surrounded by toxic fluid and a treasure chest in the center. The player gets prompted to collect 10 energy cores to open the chest, gather the key inside and flee. The energy cores are scattered around the arena. If the player gets seen (gets inside its search radius) by one of the enemies, its "Attack mode" is activated that inflicts damage on contact. The player can either try to esccape (get outside of its search radius), or destroy it by using his weapon. The player character can lose health by enemies attacks or touching the green toxic fluid. To gain some health back he can collect one of the two medi packs placed on either side of the treasure chest.

After collecting the 10 energy cores, a way to the treasure has to be found. It is behind thick glass, which can either be destroyed, or the player has to find a way around it – depending on which weapon he is currently using. If the player manages to get to the treasure, the treasure chest opens the key can get collected. Using this key, he can now complete the game by fleeing through the door at the end of the arena.

This triggers the main questionnaire, which asks the player about enjoyment and engagement. By submitting the form, the player wakes up again at the start of the scene (in

the "Start Area") but this time with a different random weapon. The player goes over this scene 4 times, each time evaluating his enjoyment. After the last round, the game is finished and the "Thank You For Playing!" screen gets shown.

5.2. Weapons

Game mechanics are implemented in many different ways in video games. Sometimes they are represented as part of the character movement, in other games they are represented by weapons. In order to only change one part of the game for each round we thought it would make sense to represent the different game mechanics by specific weapons. They are well known assets in video games to let the player interact with the virtual world, and their functionality is generally very easy to understand. Even though most people never held a firearm in their life, it is an object we can relate to more easily than something which does not exist, regardless of the fact that the game mechanic it provides is unrealistic. It was very important to make sure, that each weapon/mechanic provides the player a tool to get rid of the enemies as well as to solve the puzzle as to how get to the key at the center of the map. This way, the mechanic instantly gets used as a tool for two separate gameplay scenarios: "destroying enemies" and "getting to the key".

5.2.1. Assault Rifle

The Assault Rifle (see Figure 5.1) represents a very basic form of "Shooting". It is one of the most – if not the most – prominent game mechanic (after walking and jumping) in video games. The player presses the shoot button and the impact (the damage) is instantly visible. The controls are held very simple: Aiming with the mouse and shooting

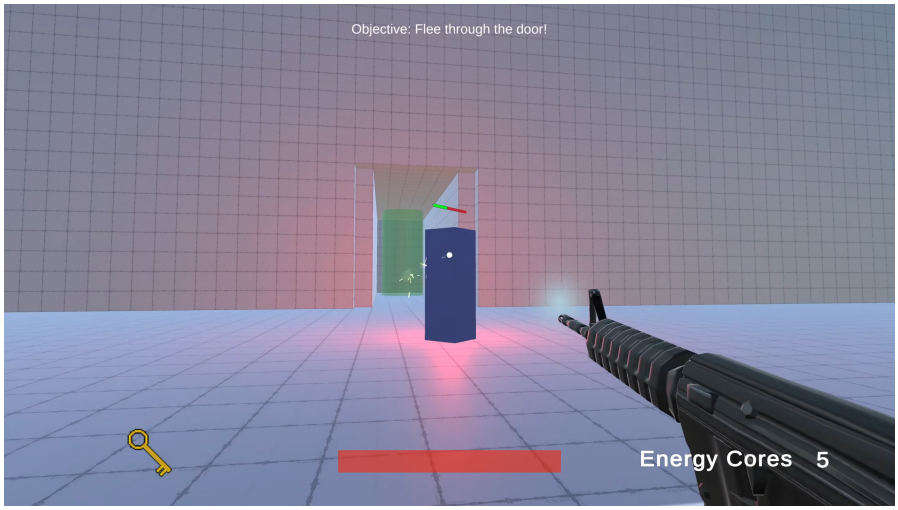

Figure 5.1.: The Assault Rifle in Action. The Bullets Continuously Reduce the Enemies' Health on Impact.

with the left mouse button. Every bullet hit on an enemy reduces its health by 10 points. To get to the treasure, the player just has to destroy the glass by shooting it and jump onto the platform. This weapon/game mechanic was also implemented to act as a base rate to compare the other more extraordinary weapons to.

5.2.2. Wind Blaster

A popular game mechanic in video games has always been a "boost" that lets the player reach higher areas or platforms. Whether this is implemented as a double jump, a trampoline like platform or a jetpack. To comply with the requirement to only change

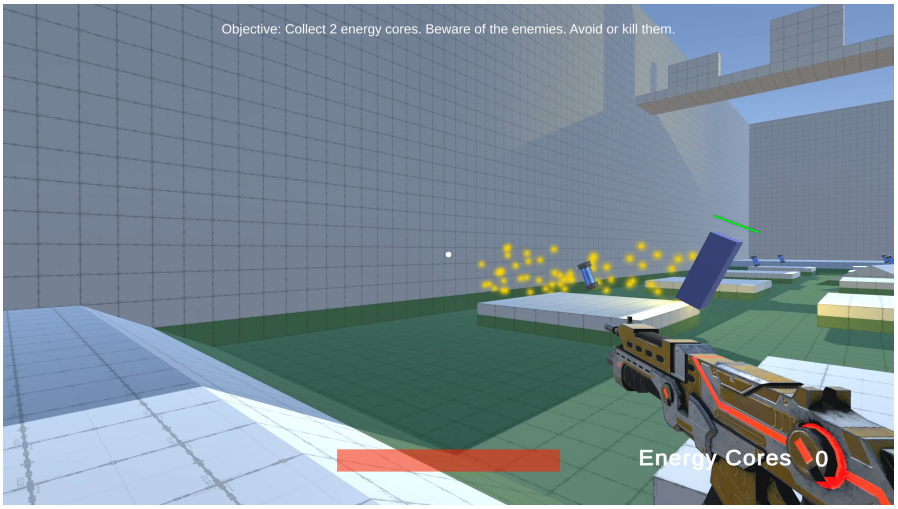

Figure 5.2.: The Wind Blaster in Action. The Wind Area is Pushing an Enemy into the Toxic Fluid.

the weapon each round we decided to implement a gun called "Wind Blaster" that lets the user create a cylinder shaped wind area (see Figure 5.2). The cylinder is always positioned perpendicular to the hit surface. The wind direction complies to this rule and is also visualized by particle effects. Upon entering this cylinder, the player gets boosted in the wind direction and enables him to reach places he usually wouldn't be able to. The Wind Blaster not only can be used to boost yourself to certain places but also to push away or into the toxic fluid.

5.2.3. Teleporter

The third game mechanic which was implemented is the Teleporter (see Figure 5.3). It lets the player transport himself from one place to another instantly. In contrast to the other weapons it is controlled by two inputs, the left and the right mouse button. After aiming for a surface area, the user can trigger the placement of two distinct linked portals: The left mouse button creates a portal for position A and the right mouse button creates a portal for position B. Stepping through either portal instantly transports the player

to the opposite location. As with the Wind Blaster (see Section 5.2.2), the effects of

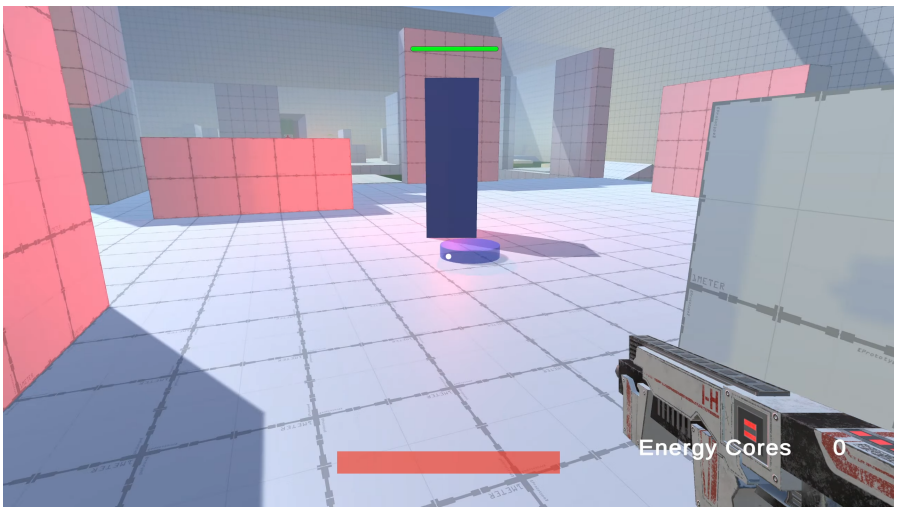

Figure 5.3.: The Teleporter in Action. Luring the Enemy into the Blue Portal. The Red Portal is Positioned over the Toxic Fluid.

the Teleporter also work on enemies – so by strategically positioning portals, the player can teleport enemies into the toxic fluid and destroy them. The weapons functionality is basically the same as the functionality of the "Portal Gun" in the video game "Portal" [Val07] described in Section 3.2.4.

5.2.4. Force Gun

The fourth and last game mechanic is the Force Gun (see Figure 5.4). It bursts a short shock wave in the aimed direction, which slings enemies away. In some way the shock wave acts like the wind area of the WindBlaster but the direction is related to the aiming direction and you cannot boost your character with it. It's important to note that, unlike the Assault Rifle, the shock wave itself does not inflict damage upon enemies. Instead, players must strategically utilize the Force Gun to sling the enemies into the toxic fluid, thereby ensuring their destruction. If the enemy does not land in the toxic fluid, they will eventually stand up again and chase the player again. This distinctive mechanic adds a layer of strategic depth to the gameplay, requiring players to consider the environment and use the Force Gun in a clever way to get over the challenges and neutralize threats effectively. One unique characteristic of the Force Gun is that it allows the player to clear any dangerous situation without having to aim precisely. This is because the weapon has a much wider spread than the Assault Rifle. In order to get to the key, the player has to destroy the glass barrier with it and simply jump to the center platform.

Figure 5.4.: The Force Gun in Action. Pushing an Enemy Away to Avoid Getting Damaged.

5.3. Enemies

Besides the main goal of the game – to get the key and flee – the enemies are implemented in such a way that the player feels a little tension or stress and is compelled to use the weapon to manage the situation. By creating a stressful situation it is possible to force the player into making a quick decision on how to use the specific game mechanic. The enemies are non-humanoid robots, shaped like rectangular pillars. They have two modes:

- Patrol Mode: Patrolling between 2 or more points while searching for the player.
- Attack Mode: Pursuing the player and attack when near enough.

Each mode is visualized by area lights positioned at the bottom of the enemies – green for the Patrol Mode (see Figure 5.5), red for the Attack Mode (see Figure 5.6). Furthermore, the robots make different sounds when patrolling, attacking or dying. The enemies have invisible search radii that define the area in which the player triggers the Attack Mode. This radius increases by 1.5 when the Attack Mode is enabled. It also increases when the robot gets shot at, so that the player has not too much advantage when attacking from far away. If the player manages to escape the radius again, he gets back to patrolling where he left off. A simple health bar positioned on top of the enemy indicates its current health status. Enemies have 100 health points, which when dropping to zero makes them explode. If a robot falls into the toxic fluid, it won't be able to escape and also explodes shortly after.

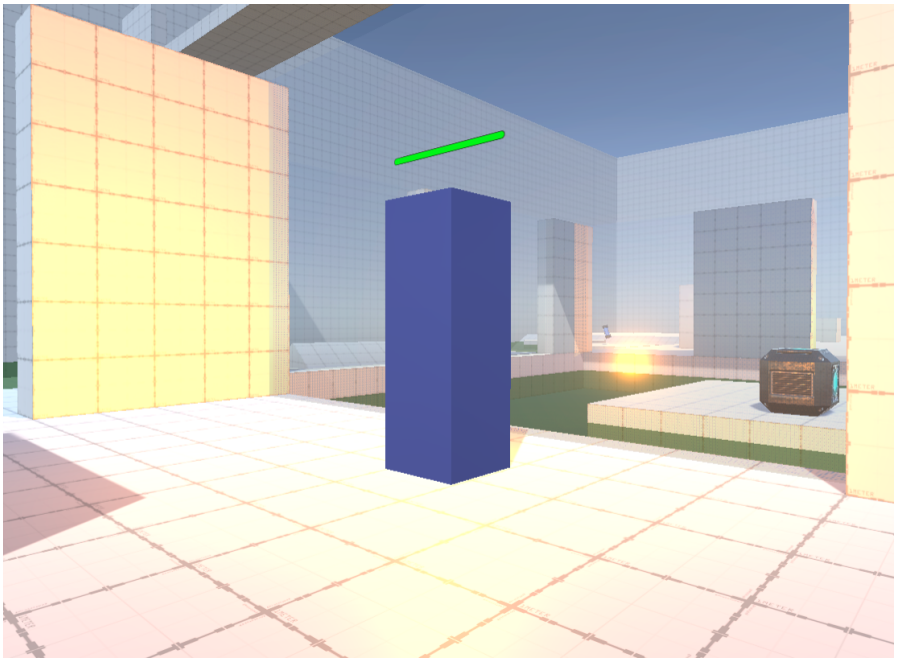

Figure 5.5.: Enemy in Patrol Mode

5.4. Map

The initial idea was to create an arena like scenario that challenges the player to complete simple tasks in different ways. But since the player deals with completely new game mechanics it was important to give a small start area that allows the player to play around with the weapon and get a little bit used to it before going outside. The map (see Figure 5.7) also had to facilitate all the components that enable different approaches to win the game. The map basically consists of 2 areas:

1. Start area: This zone acts as the entry point of the game. It gives the player enough space to try out and get used to the character controls. The area not only holds one of the weapons described in Section 5.2 but also presents the player a description on how to use it. The player cannot leave the initial room until he picks up the weapon. After the blocking wall is gone the user can then walk outside where he finds instructions on how to use the weapon. After experimenting with the weapon the way leads up some stairs to the next area.

2. Main area: This central space is the primary place that confronts the player with multiple tasks which can be completed by using the unique game mechanics of the weapons. Patrolling enemies challenge the player while he has to jump on platforms floating in a toxic fluid. Positioned at the center of the arena lies a treasure chest that holds the key. It is surrounded by thick glass. Multiple blocks positioned around the map act as strategical barriers between the player and the enemies.

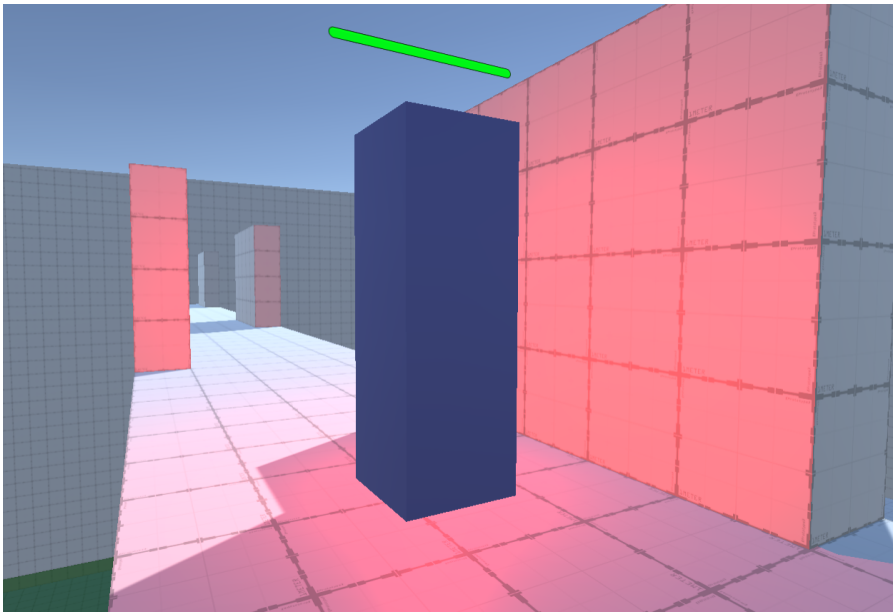

Figure 5.6.: Enemy in Attack Mode

There is also a completely optional area which lies way above the ground. It can only be reached with the Teleporter (see Section5.2.3) or skilled use of the Wind Blaster (see Section 5.2.2). After gathering the key, the player can escape through the door at the end of the arena.

With the layout of the map clearly divided into two functional areas, the game design effectively balances introductory learning with slightly more advanced gameplay challenges. This structure ensures a smooth transition from basic handling like walking and jumping to using the actual weapon by introducing the players to the game's full potential.

5.5. HUD

A Head-up-Display (HUD) is a common tool to show the player essential information during gameplay. Since this game has no complicated stats the player has to keep track of, it is held very simple. To make sure to not overwhelm new players the HUD (see Figure 5.8) starts with very little information and gradually shows more and more as the player progresses by fulfilling tasks. When spawning in the Start area the HUD only consists of an area at the top which shows the current "quest" or objective. After each completed objective, the next one gets shown with a little sound and animation so that the player does not miss it. By completing the first objective – picking up the gun – more elements of the HUD get visible: the health bar at the bottom center and the counter of the collected energy cores at the bottom right. The health bar's red filling dynamically changes corresponding to the players' health, and the energy core counter just increments

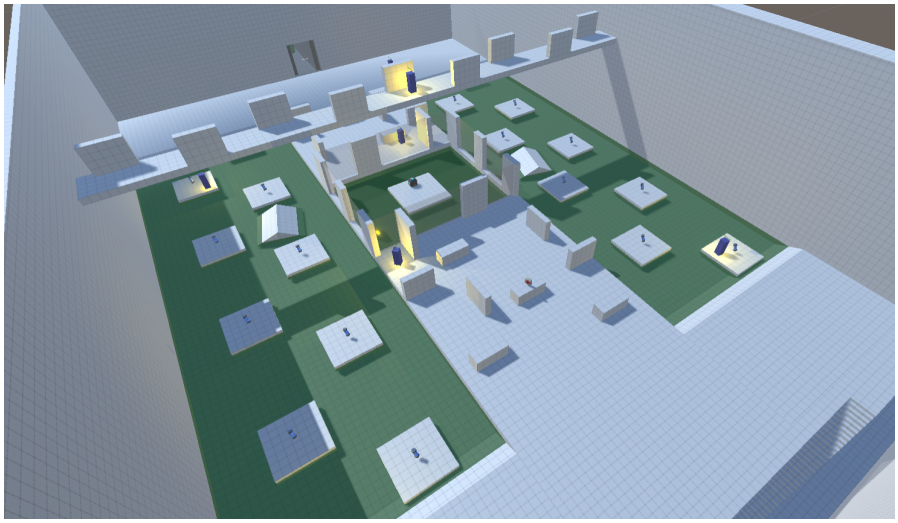

Figure 5.7.: The Map from Above

when picking up a core. After gathering the key, a key-icon gets shown at the bottom left.

5.6. Sound Design

Sounds in video games are not only important to give feedback to the user's input, but also to make the virtual world feel much more vivid. All sounds are either self made or were downloaded from freesound.org, a collaborative database where users share their work. In total the game uses 68 sounds, which are all dedicated to the public domain and have no copyright. The home screen as well as the ending screen have "mesmerizing" background music that has elements of a descending Shepard tone and establishes a science fiction atmosphere. Hovering any buttons triggers a short "beeping" sound to give feedback for selecting the desired action. Forms and questionnaires do not have any sounds to not distract the subject.

From the moment on the player starts walking around he hears varying footstep sounds. Jumping as well as Landing also trigger suitable sounds. If the character gets hurt – either by an enemy or by the toxic fluid – he groans. Picking up and equipping a weapon makes a sound that reminds one of a gun loading sound. The Assault Rifle has a generic shooting sound. Depending on which surface a bullet hits, it makes a different sound. Hits on enemies e.g., set off a tone sounding like clinging steel, while hitting the glass is more "dull" (until it breaks). Shooting the Wind Blaster or the Teleporter triggers a short futuristic tone which sounds like an old television being turned on. The Force Gun sounds very similar but has a much sharper feel to it. Stepping through a placed portal or flying through the air with the help of a wind area also trigger fitting sounds. Because the enemies are the only other characters in the game it was important to give them some kind of personality. The idea was to make them dangerous and evil, but in

Figure 5.8.: Head-Up-Display

a comical way. During Patrol Mode, enemies "mumble", and during Attack Mode they scream in a robot-styled fashion. Shortly before their health points go to zero and they explode, they desperately shout "Help me!" to the player.

Another important part of good sound design is to give the player feedback if he changes something significant in the environment or motivate him if he makes progress. Collecting energy cores, completing objectives or collecting the key gets signalized with motivating sounds. Taking damage from the toxic fluid creates an unpleasant corrosion sound.

5.7. Used Technologies

Most of the assets are self-made. Either by creating them using builtin tools which unity provides, or with blender. Some of the assets, like the weapons, the treasure chest and the energy core are free assets downloaded from the Unity asset store. In the development of the video game, several key technologies were employed to construct and design the game. These technologies were chosen for their robustness, flexibility, and wide usage in the video game development community with proven results.

Unity Engine 3D The primary technology used in the development of the game was Unity Engine [Uni23], a powerful and versatile game development platform. Unity's integrated development environment (IDE) operates on multiple platforms such as Windows, MacOS or Linux. It provided a stable and efficient workspace for coding, asset management, and playtesting. Because Unity supports a wide range of media assets, and has a user-friendly interface, it was an ideal choice for this project. The engine's advanced rendering capabilities, physics engine, and support for various scripting languages, primarily C, allowed for a high degree of customization and control over the game mechanics.

Unity Asset Store Most of the in-game assets were created using the built-in tools of Unity. Objects like simple platforms, walls, stairs, water effects, explosions, light, etc. are very easy to implement using the available instruments. For more complex objects (e.g., the breakable windows), as well as to enhance the visual and functional aspects of the game, free assets from the Unity Asset Store were utilized. The Unity Asset Store is a rich repository of resources, offering a wide array of assets, including textures, models, animations, and scripts. These assets were selectively incorporated to complement the custom content created for the game. The use of these assets not only saved a lot of time in the development process but also introduced a variety of artistic styles and elements that enriched the overall gaming experience.

Blender If neither, the built-in unity tools or free assets were sufficient or fitting, models were created using Blender [Ble23]. This open-source 3D creation software enables the design of custom assets with precise details, which were then imported into the Unity environment. For this game it was used for the medi pack, the key as well as the enemies.

Freesound For the sound design, which was already described in detail (see Section 5.6), the collaborative database "freesound" [Fre23] was used. Freesound.org is a collaborative database where users download, and share sound samples and audio snippets under Creative Commons licenses. The platform was originally started in 2005 by a group of the Universitat Pompeu Fabra in Barcelona. It holds a very large and well organized collection of all kinds of sounds, sound effects, music from artists and enthusiasts. The database is very popular among creators of video games and other media projects.

The combination of these technologies provided a comprehensive toolkit for the creation of this game. Unity Engine's robust framework, coupled with the artistic capabilities of Blender and the diverse resources from the Unity Asset Store, allowed for a deep exploration and implementation of various game mechanics. This technological amalgamation was instrumental in achieving the objectives of the comparative study and in realizing the vision for the video game.

5.8. Implementation Details

Scenes Unity engine has a concept called "Scenes". A "Scene" is a self-contained chapter of a game. In order to only load the essential assets that are needed in a level, and have good performance it is considered best practice to dedicate at least one scene per level. Although small games like ours may not experience any performance issues having everything in one scene, it makes sense from a clean-code perspective to at least split up the title screen, as well as the forms from the main game. In total, the game consists of 6 scenes in the following order:

- Main Menu: A title screen consisting 2 Buttons, "Start" and "Quit".

- General Form: A general form that asks the user about age, gender, and experience with video games (see Section 6.3.1).
- Controls: A brief description on how to control the character.
- Testroom: The "actual" game itself, consisting of the areas described in Section 5.4.
- Weapon Form: The questionnaire asking about the just finished round. The questionnaire is further described in detail in Section 6.3.2.
- End Screen: A simple screen showing a text stating "Thank you for playing!".

Animations Unity provides an animation tool that facilitates the creation of dynamic animations using pre-existing models. This feature was used to develop realistic gun recoil animations for the weapons featured in the game. The tool allows to perform transformations on models over specified timeframes, giving control over the animation details and timing. For the recoil animation this was a small transformation on the weapons' z-axis within a 0.2 seconds timeframe. This specific transformation, combined with a synchronized muzzle flash effect, delivered good visual feedback to the player each time a shot is fired, contributing to a more immersive and responsive gaming experience.

Application Manager To share information across all scenes it was necessary to have a manager that fills variables with data and grants read and write access to those from any scene. Information that needed to be available in multiple scenes was e.g., the current weapon used, the time played, round nr., collected energy cores or defeated enemies. The Application Manager is also responsible for randomly selecting a weapon which was not used yet for the next round. The script also creates a separate folder for each user on startup, writes a text file with the filled out form/questionnaires and stores it with the corresponding weapon name.

Game Manager Everything that is necessary to manage the actual game is implemented inside the Game Manager script. The Game Manager script runs in the Testroom scene and is responsible for functionalities such as:

- displaying the correct weapon to pick up
- updating the dynamic HUD
- counting energy cores/defeated enemies
- keeping track of the player's location on the map
- managing the player's health
- reloading the game if the player dies
- loading the next scene if the player completes all objectives

Weapons Most of the weapons' functionalities are handled in the Weapon script's "Shoot" method (see Listing 5.8). For a regular gun, like the Assault Rifle, the process is as follows: If the player presses the shoot button, the gun sound, as well as the recoil and flash animations get triggered.

```
void Shoot()
{
    handleEffects();
    handleAnimation();
    handleSound();

    RaycastHit hit;

    if (Physics.Raycast(camera.transform.position, camera.transform.
    forward, out hit, range))
    {
        if (activeWeaponType == WeaponType.WindBlaster)
        {
            if (!hitEnemy(hit) && !hitToxicFluid(hit))
            {
                if (windBlastObject != null)
                    Destroy(windBlastObject);
                windBlastObject = Instantiate(windBlast, hit.point,
    Quaternion.FromToRotation(Vector3.up, hit.normal));
            }
        } else if (activeWeaponType == WeaponType.Teleporter)
        {
            if (!hitEnemy(hit) && !hitToxicFluid(hit) && !hitWindow(hit))
            {
                ShootTeleporter(hit, Input.GetButtonDown("Fire1"));
            }

        } else if (activeWeaponType == WeaponType.ForceGun)
        {
            forceGunEffect.SetActive(true);
            forceGunLastTimeStamp = Time.time;
        } else
        {
            if (hitEnemy(hit))
            {
                enemyController.TakeDamage(damage);
            } else if (hitWindow(hit))
            {
                hit.transform.GetComponent<BreakableWindow>().
    adjustHealthBy(-damage);
            }
            handleHitEffect(hit);
        }
    }
}
```

Listing 5.1: The "Shoot" Method of the Weapon Script

Then a ray gets casted from the gun's muzzle into the direction the player is aiming at. If

the ray hits something, the code checks whether the hit object reacts to that. In case of an enemy for example, the enemy loses health points. For the other weapons with unique game mechanics, a lot more functionality had to be implemented on top of the regular process described above to make it work. The Wind Blaster for example listens for a raycast hit on a wall or floor. If that happens, the cylinder shaped wind area described in Section 5.2.2 gets spawned perpendicular to the surface. A separate Wind Blaster script listens for a collision with the wind area and boosts the colliding character up by applying a force into the wind direction. The Force Gun works quite similar, but instead of placing the wind area on the hit surface, it gets created at the end of the barrel and only affects enemies as well as windows.

Placing portals with the Teleporter works like placing the wind areas with the Wind Blaster. A separate Teleporter script handles the teleporting. After a collision with either portal A or portal B, the character gets sent to the opposite one by changing the position of the character to the other portal's position. To prevent a never ending loop of constantly teleporting from A to B if one would position the portals too close, one can only teleport after the subject has left the collision area where he just got teleported to.

Enemies To make the game more challenging, enemies patrol around the map. Every enemy has a couple of patrol points which he successively has to reach, and then start over again. Unity has a feature called "NavMesh" which creates a navigation mesh out of a given map. This mesh allows the "NavMeshAgent" to calculate the shortest path to any given point and lead the way for the enemies. When setting up the NavMesh one can select which objects should be part of the mesh and which not (e.g., toxic fluid) as well as choosing the max height an agent can handle, e.g., enemies should have no problem getting over stairs, but they should not be able to jump on barricades. The platforms positioned in the toxic fluid also are part of the NavMesh. However, they are too far away to be reachable by default. To let the enemies jump over the platforms a NavMesh Link is necessary, which allows a transition between two mesh areas.

```
1  void Update()
2  {
3      if (toxicFluidHasOverWhelmed())
4          Die();
5
6      if (movementAllowed && !isOverWhelmed)
7      {
8          float distanceToPlayer = Vector3.Distance(target.position,
       transform.position);
9          if (distanceToPlayer <= currentLookRadius)
10         {
11             if (isSearching)
12                 Following();
13             agent.SetDestination(target.position);
14
15             if (distanceToPlayer <= agent.stoppingDistance)
16             {
17                 FaceTarget();
```

```
18                  ConflictDamage(damagePoints);
19              }
20          }
21          else if (!agent.pathPending)
22          {
23              if (agent.remainingDistance <= agent.stoppingDistance)
24              {
25                  Searching();
26                  IteratePatrolPointIndex();
27                  UpdateDestination();
28              }
29          }
30      }
31  }
```

Listing 5.2: The "Update" Method of the Enemy Script

The "Update" method of the Enemy script (see Listing 5.8) handles the main functionality if the he is in Patrol or Attack Mode. Each enemy starts out in the Patrol Mode and its' current path is always to one of his patrol points If the distance to the player is smaller than the specified "lookRadius" it switches to Attack mode and sets the player as his next destination. If the distance between the enemy and the player is smaller than the specified "stoppingDistance" it also conflicts damage.

5.9. Challenges

One of the challenges was to create a map that works with all the different weapons and approaches their game mechanics enable. It had to be possible to defeat or avoid the enemies as well as to find a way to get to the key in the center of the map. On top of that was the necessity to design the innovative mechanics in such a way, that they are easy to learn and don't take up too much time, like Fabricatore mentioned in his guidelines [Fab07]. Additionally, integrating the game mechanics into the game presented its own set of challenges. Each mechanic had to be distinct enough to provide a fresh challenge on each of the four runs, but also cohesive enough that the overall design remained functional and engaging. Completing a form after each round is also not something that helps to maintain the flow and keeps the player engaged. On one hand, the forms needed to be very detailed to gather comprehensive information, but on the other hand, the bigger the questionnaire became, the more it risked disrupting the player's immersion. During playtesting a couple of bugs were noticed. They ranged from small ones like incorrect data collection when dying and restarting or invisible mouses when entering the form scene to more critical ones like clipping through the floor or enemies that got stuck. Finding and fixing those problems was very time consuming.

When working with external assets from the Unity Asset Store 5.7 incompabilities with the renderer or shader are not uncommon and fixing those can be also time consuming and tedious. Another challenge was to export the game and make it compatible for other users. Other operating systems, lower hardware capabilities and other screen resolutions

are just a few problems that occurred during this process. Finally we decided to carry out the experiment exclusively on the development machine because the time it would have taken to solve all those problems was too much.

6. Experiment

6.1. Participants

The participants of the experiment were acquaintances. It is important to note that this aspect of the participant selection is not expected to influence the outcomes of the research, as the study focused on comparative values within the experimental framework rather than on absolute results. The design of the experiment ensured that the relationships among participants would not affect the integrity of the comparative analysis conducted. In total, 15 people participated in the experiment. Their age ranged from 26 to 35, were mostly male and their education level ranged from Bachelor's to Master's degree.

6.2. Procedure

All experiment sessions were exclusively carried out at the author's personal computer, where the game also was developed. Reasons for this decision are varied. One of them is that when observing the participants reaction first hand gives a really good insight and it is a good addition to the other measurements taken (see Section 6.3). Occasionally it was also necessary to guide certain participants when they got stuck, which would not have been possible if they were playing on their own computer. Another reason is that participants usually don't like to download and install a program in the course of a short experiment – let alone that exporting the project and making it compatible with many machines would have been a very time-consuming process (see Section 5.9). The participants were told beforehand that this experiment was part of a master thesis, which is about video games. After preparing the peripherals such as keyboard, mouse and speakers, the program was started and as soon as the title screen was visible the participants were asked to take a seat on the desk. After filling out the general questionnaire they started with the first round and could control their character (see Figure 6.1). Experienced players immediately picked up their weapon, walked upstairs and started using it. Inexperienced players were a lot more cautious and tried out the basic controls such as walking, jumping and looking around. Walking and moving the camera at the same time – a process which is normal to most players – was one of the first challenges for more inexperienced players. When participants got frustrated because they didn't know how to proceed they were told to take another look at the instruction videos with tips positioned at the start of the game. Even though these videos are one of the first thing the player sees when starting each round, they ignored it or didn't pay attention. After finishing the experiment with all the questionnaires, participants usually expressed additional thoughts on what they liked the most, what surprised them, what was frustrating etc.

Figure 6.1.: A Participant Engaged in the Experiment – Currently Using the Assault Rifle

6.3. Measurements

In this study, the measurement of player interactions and their responses play a crucial role in evaluating the impact of the different game mechanics. The methodology is designed to capture a comprehensive picture of the player experience, using both objective-, as well as subjective measures (see Section 4.1). The objective measures in this experiment are represented by two questionnaires, and the subjective measures are represented by click logs. Additionally verbal comments from the participants were also collected and documented that provided a more nuanced understanding of participants' perspectives and experiences.

6.3.1. Demographics

After the title screen, the first element the participants interact with is a general questionnaire (see Figure 6.2). It contains demographic information about the user including

Figure 6.2.: The General Questionnaire

age, gender, and the level of prior experience with video games. This preliminary data collection serves two primary purposes. First, it allows for the segmentation of data analysis to understand if and how different demographic groups experience the game mechanics differently. Second, it provides contextual background that may help explain variations in gameplay performance and preferences, offering a nuanced understanding of the game's accessibility and appeal across a diverse player base.

6.3.2. Modified GUESS Questionnaire

The basis for our "main" questionnaire after each round is the GUESS 18 [KSS+20]. It is a short version of the GUESS questionnaire [PKC16], already described in detail in Section 4.2.3. Because the GUESS 18 is fairly popular and suited for repeated assessments it was the foundation of our questionnaire. The GUESS consists of 9 subscales: Usability/Playability, Narratives, Play Engrossment, Enjoyment, Creative Freedom, Audio Aesthetics, Personal Gratification, Social Connectivity and Visual Aesthetics.

Unfortunately, some subscales don't fit our purpose because they are either not represented in the game (e.g., Social Connectivity, Narratives) or they don't change for each game mechanic (e.g., Visual Aesthetics). It was important to only use items which can be perceived different each round, and leave out items that would confuse participants or create noise in the evaluation. This is why we modified the questionnaire. The modified version will further be referenced as mGUESS. The final item list for the main questionnaire covers Usability, Enjoyment, Creative Freedom, Audio Asthetics and

Personal Gratification (see Table 6.1). Participants fill out the form in-game using a

Subscale	Item
Usability	I find the controls of the game to be straightforward.
Enjoyment	I think the game is fun.
Enjoyment	I feel bored while playing the game.
Creative Freedom	I feel the game allows me to be imaginative.
Creative Freedom	I feel creative while playing the game.
Audio Aesthetics	I enjoy the sound effects in the game.
Personal Gratification	I am very focused on my own performance while playing the game.
Personal Gratification	I want to do as well as possible during the game.

Table 6.1.: Items of the mGUESS Questionnaire

slider that indicates the level of agreement on a 7 point likert scale. In order to make use of the evaluation tool provided by the authors, we used the original scale from the GUESS 18. The scale ranges from "Strongly Disagree" to "Strongly Agree". The in-game questionnaire can be seen at Figure 6.3.

Figure 6.3.: The In-Game Main Questionnaire mGUESS (Modified GUESS). It Gets Displayed After Each Round.

6.3.3. Clicklogs

Each round the filled out questionnaire gets stored on the file system. To better understand the participants' decisions we thought it would make sense to also collect some objective data during each round. These "clicklogs" include sequence of used weapons, deaths, collected energy cores, number of enemies defeated and the duration of time taken to complete each round. This gathered data can give insights on efficiency and difficulty during a session. If e.g., a participant rated a round to be particularly difficult but the clicklog shows no deaths it could indicate that the participant had problems with the puzzle instead of the enemies.

6.3.4. Observations and Comments

During the procedure of the experiment sessions the participants always commented on something verbally. These comments were collected and sometimes helpful to better understand reasons for their questionnaire results. We deliberately abstained from a "remarks" input field because the amount of questionnaires was already at the limit and an additional item with free text would have been too much for each round.

7. Results and Evaluation

This chapter contains a detailed evaluation of the results gathered during the experiment. The primary goal of this evaluation is to assess the impact of the four different game mechanics described in Section 5.2. Through the measurements described in Section 6.3, the portion of this work seeks to understand how each mechanic influences enjoyment, creativity or usability and to see whether the hypotheses (see Section 1.2) can be confirmed. Additional observations and findings also will get covered. A complete table of the raw data is available in the appendix (see Tables A.1 and A.2)

7.1. Data Presentation

All data gathered from the in-game questionnaires clicklogs were extracted from the game environment and saved into distinct files for organized handling. These files were then extracted from their initial format into Microsoft Excel. This step was crucial as it facilitated the merging of disparate data streams into a unified dataset, enabling a more organized analysis. The study involved a total of 15 participants, each interacting with the game playing with the four different weapons. As a result, each participant generated four unique datasets corresponding to each game mechanic they engaged with. Consequently, the experiment accumulated a total of 60 datasets.

7.1.1. Demographic Analysis

The participant pool consisted of a small range of ages but a diverse range of gaming experiences. The participants average age was 29.7 years. All of the participants had at least some experiences with video games. 46% rated themselves as very high experienced, 27% as high, 7% as medium, 13% as low and 7% as very low experienced (see Figure 7.2). The participants were predominantly male, with 13% female and 87% male (see Figure 7.1) and all of them had a Bachelor's degree or higher.

7.1.2. Clicklogs

The clicklogs show that the experiment on average took 13 minutes to complete. Rounds with the Teleporter game mechanic took the longest to complete with 4.47 minutes. After that comes the WincBlaster with 4.22 minutes, followed by the Assault Rifle with 2.29 minutes, and the ForceGun with 1.85 minutes. One reason that participants with the ForceGun were so fast is, that it let's the player get rid of nearby enemies fairly easy because it's effect has a wide spread and there is no need for precise aiming. Rounds

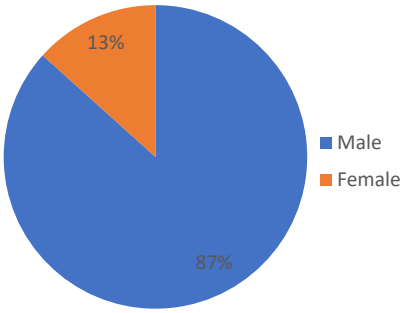

Figure 7.1.: The Gender Distribution

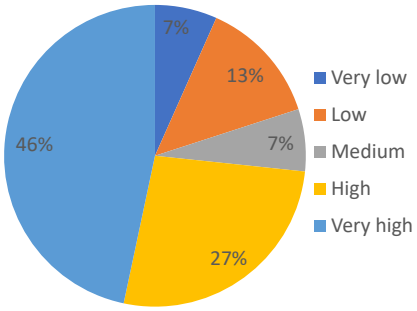

Figure 7.2.: The Video Game Experience Distribution

with the Teleporter were the ones with the most deaths. On average participants died 3.1 times, and they killed 5 enemies per round.

As expected, participants who had more video game experiences generally completed the experiment much faster than participants who had less: Players with "Very high" experience took lees than a third and players with "High" experience took less than half the time than players with "Very low" experience (see Figure 7.3). Interestingly, participants who rated themselves "Medium" experienced took longer than participants with "Low" experience. This could indicate that some players classified themselves higher or lower than what their actual skills are, but a higher sample size would probably have evened that error out.
The time it took to complete each round of course also correlates with the deaths by the used Game Mechanic because when the player dies, he loses the collected energy cores, enemies respawn and he has to start the round all over again (see Figures 7.4 and 7.5). The higher death count for the WindBlaster and the Teleporter will get further analysed in detail in Section 7.2.

7.1.3. Modified GUESS Questionnaire

Results of the Main Questionnaire show that the Teleporter received the highest mGUESS Score with 28.33, after that the WindBlaster with 27.87, than the ForceGun with 27.73 and the Assault Rifle with the lowest score of 27.33 (see Figure 7.6). We can gain more insight if we compare the sub scales of the Assault Rifle and the Teleporter: Even though Usability scored lower on the Teleporter, the much higher Creative Freedom as well as the Enjoyment raise the overall score above the Assault Rifle's score.
The rated difficulty (see Figure 7.7) seems to correlate with the mGUESS score, since the game mechanics' difficulty ranks are the same as from the mGUESS score. The high difficulty score for the Teleporter is probably a result of control issues (indicated by the low usability score) which also led to the highest death score of all rounds. Since we have

Figure 7.3.: Time to Complete the Experiment by Experience

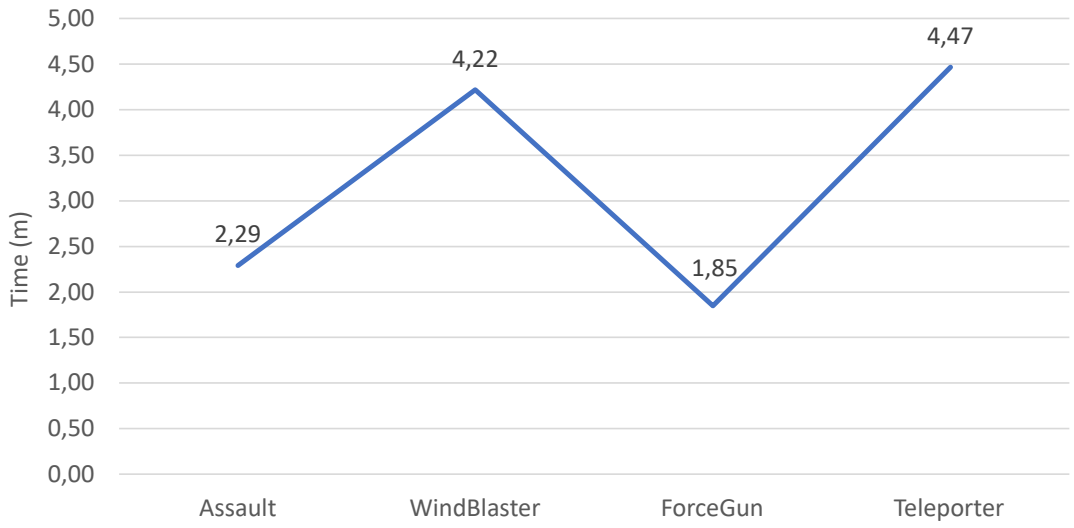

Figure 7.4.: Time to Complete each Round by Weapon

a wide range of different gaming experiences it makes sense to take a closer look at which game mechanic types the individual groups preferred.

Overall we can see that participants on the higher end of the experience spectrum were more critical and gave less score on average, while participants with less experience gave higher scores. The results also show that participants with “Very low“ to “Medium”

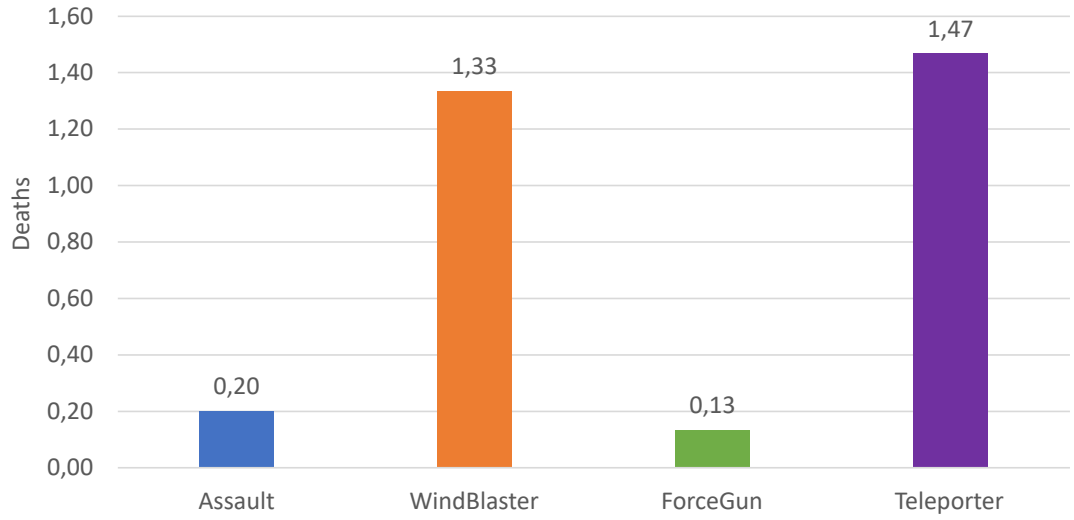

Figure 7.5.: Average Deaths by Each Weapon

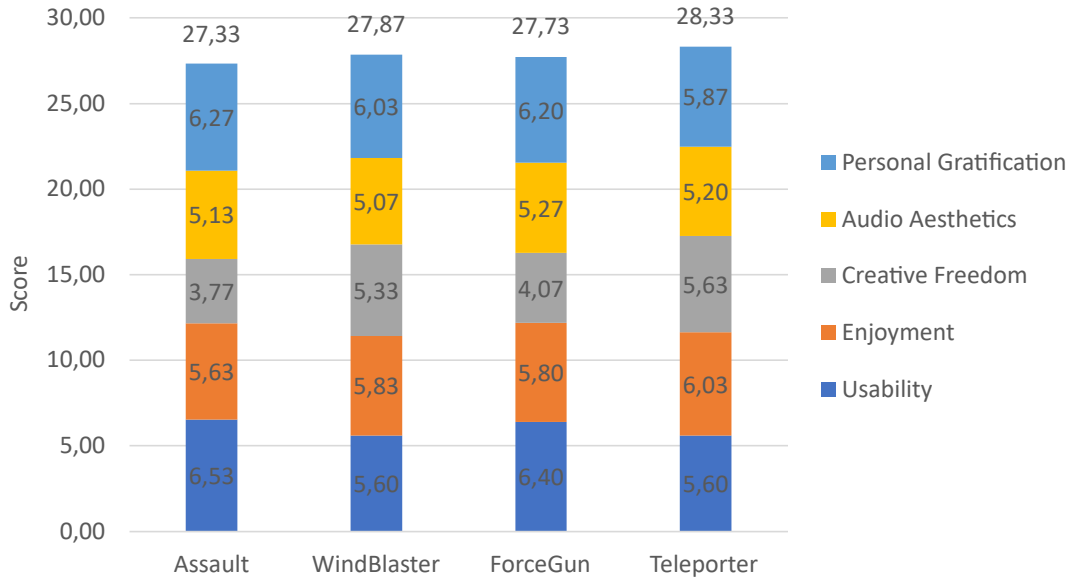

Figure 7.6.: The mGUESS Score by Weapon

experience preferred the traditional mechanic - the Assault Rifle. On the other hand, participants with "High" to "Very high" experience rated the innovative game mechanics (WindBlaster, Teleporter, ForceGun) higher than the traditional (see Figure 7.8).

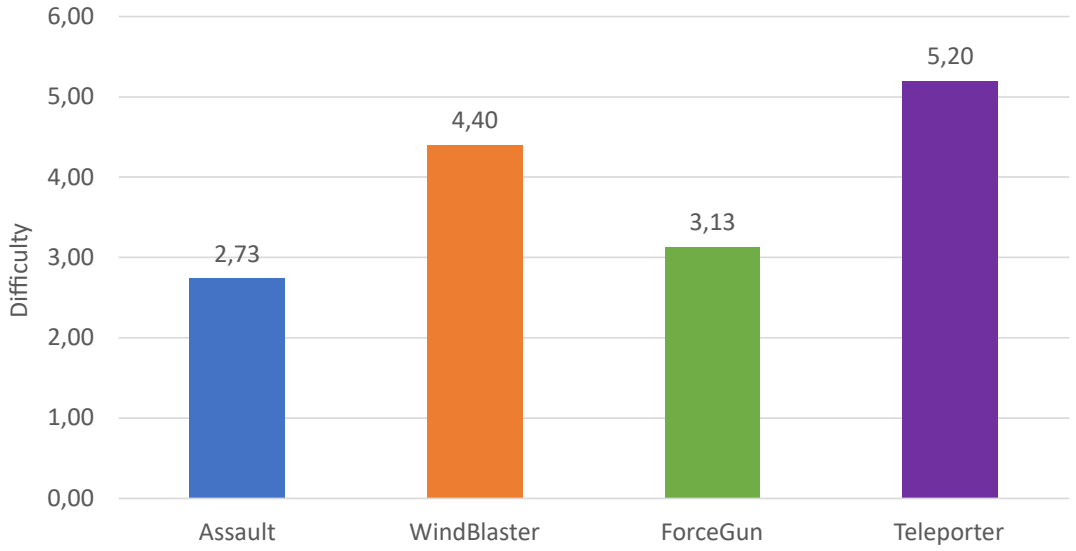

Figure 7.7.: The Rated Difficulty by Weapon

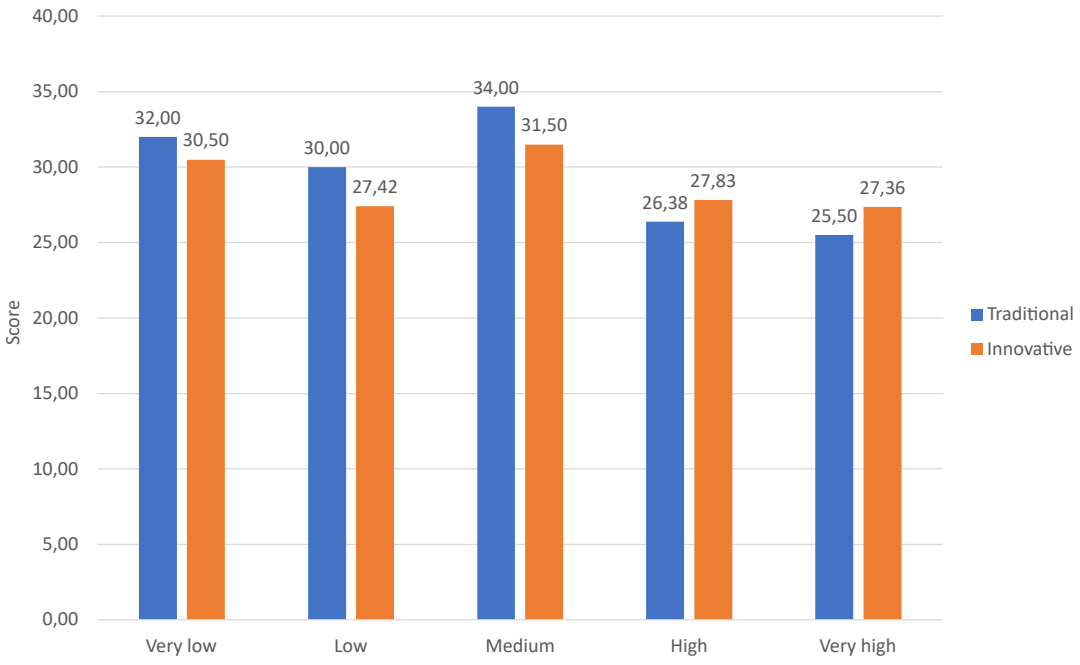

Figure 7.8.: The Score by Experience

7.2. Additional Observations and Comments

The participants were overall positive and open minded during the experiment. Each one was committed to complete the experiment even when they experienced some setbacks when dying. One very skilled player didn't even want to complete the game but rather experiment a little more with the WindBlaster. He tried to "break" the game by boosting himself out of the map - which he did not achieve. Players with "Very low" to "Medium" video game experience got a little frustrated. The controls were the biggest hurdle for them. In order to efficiently complete the rounds, they have to walk and look around at the same time – which is something that higher experienced players have no problem with. Because they were more focused on the controls, they couldn't focus on the enemies and their patterns as well, which lead to some deaths that clearly decreased their motivation because they had to start all over again.

Two participants stated that they felt "powerless" with the WindBlaster and the Teleporter. One explanation could be the use of "weapons" as models: In Section 5.2 we described that we use weapons to represent the different game mechanics because people are familiar with them. With the Assault Rifle and the ForceGun this was fitting. However, with the WindBlaster and the Teleporter this led to some confusion. Even though the instruction videos at the beginning of each round clearly showed how to use the weapon, the first instinct of each player was to aim at the enemy and shoot. Generally this is an understandable action because of the nature of a gun, but the game mechanic suggests to interact with surface areas. This discrepancy led to some deaths and confusions. Both game mechanics need a device that lets the player aim, but maybe another tool which doesn't suggest "shooting" that much would have been a better fit.

One participant stated that he felt "relief" when he had the Assault Rifle at the end. He felt powerful after being limited with the other innovative game mechanics. One explanation to this is that the experiment is pretty combat heavy, and the Assault Rifle is the best fit for that. If an enemy charges at the player, the Assault Rifle supports the easiest way to eliminate the threat by just aiming at it and shoot. With the WindBlaster or the Teleporter you would have to assess the situation much more strategically. With the Teleporter for example, players have to position themselves in such a way, so that they can shoot one portal over the toxic fluid, and the other one in front of them and lure the enemy inside. To tackle this, a map that facilitates more puzzles and more protection from the enemies would lead to more time to think on how to assess certain situations.

More experienced players commented that the "feeling" of walking, running and jumping was "a bit odd". Implementing basic walking, running and jumping mechanics is fairly easy, but getting the "look and feel" of modern games right is pretty hard. Gamers who play on a regular basis are used to certain little behaviours when moving through a virtual world and can detect any deviation. One player e.g., stated, that when he ran with the character and then jumped he felt that the speed of his character moving through the air was not accurate which led to him jumping into the toxic fluid instead on a platform.

7.3. Statistical Analysis

This section focuses on the statistical analysis of the results to test the proposed hypotheses. To reemphasize, the hypotheses are:

- **H1**: Innovative Game Mechanics provide higher video game satisfaction than traditional Game Mechanics.
- **H2**: Players with varying levels of experience exhibit different preferences between traditional and innovative game mechanics.

7.3.1. Evaluation of Hypothesis H1

Hypothesis H1 proposes a general tendency that players overall prefer inovative over traditional mechanics. In order to analyze this, we had to prepare the data for each game mechanic. We took the total mGUESS scores by each weapon and participant and built the mean score as well as the standard deviation. The result is listed in Table 7.1. With

Weapon	Score	SD
Assault Rifle	27.33	4.19
WindBlaster	27.87	2.83
ForceGun	27.73	4.02
Teleporter	28.33	3.10

Table 7.1.: The mGUESS Score Results with the Standard Deviation (SD)

this data we can test our hypothesis H1. To achieve this, we first divide H1 into three sub hypotheses: **H1a**: The WindBlaster provides higher video game satisfaction than the traditional Assault Rifle. **H1b**: The ForceGun provides higher video game satisfaction than the traditional Assault Rifle. **H1c**: The Teleporter provides higher video game satisfaction than the traditional Assault Rifle. A two-sample t-tests for mean comparison is suitable for our case because we have two independent groups (represented by the same participants trying different game mechanics). Because the differences in the standard deviation of the WindBlaster's as well as the Teleporter's results from the deviation of the Assault Rifle's suggest that the variances are not equal we use a Welch's test for Hypotheses H1a and H1c.

Testing H1a

To test hypothesis H1a ("The WindBlaster reaches a higher video game satisfaction score (mGUESS score) than the traditional Assault Rifle.") we use a Welch Test and choose a significance level of $\alpha = 0.05$.

- H_0: The WindBlaster provides the same satisfaction as the Assault Rifle.
- H_1: The WindBlaster provides more satisfaction as the Assault Rifle.

The input data for the test is as follows: For the Assault Rifle, the sample size is $n_1 = 15$, the mean ($\bar{x}_1$) is 27.33, and the standard deviation (s_1) is 4.19. The WindBlaster dataset also has a sample size of $n_1 = 15$, with a mean ($\bar{x}_1$) of 27.87 and a standard deviation (s_1) of 2.83. The statistical analysis yielded a t-value of -0.4136 with degrees of freedom (df) calculated at 24.573. The critical t-value (t_{critical}) for this analysis is 2.06. The p-value for a one-sided test came out to be 0.34. Because the one-sided p-value of 0.34 exceeds our predetermined significance level of 0.05 the results are insufficient to support the hypothesis that the WindBlaster provides more satisfaction than the Assault Rifle. The results suggest that, although a preference for the WindBlaster may exist, the difference is not statistically significant.

Testing H1b

To test hypothesis H1b ("The ForceGun reaches a higher video game satisfaction score (mGUESS score) than the traditional Assault Rifle.") we use the two-sampled t-test for independent groups with equal variances and choose a significance level of $\alpha = 0.05$.

- H_0: The ForceGun provides the same satisfaction as the Assault Rifle.
- H_1: The ForceGun provides more satisfaction as the Assault Rifle.

The input data for the test is as follows: For the Assault Rifle, the sample size is $n_1 = 15$, the mean ($\bar{x}_1$) is 27.33, and the standard deviation (s_1) is 4.19. For the ForceGun, the sample size is $n_1 = 15$, the mean ($\bar{x}_1$) is 27.73, and the standard deviation (s_1) is 4.02. The statistical analysis yielded a t-value of -0.27 with degrees of freedom (df) set at 28. The critical t-value (t_{critical}) for this analysis is 2.05. The p-value for a one-sided test came out to be 0.41. Because the one-sided p-value of 0.41 exceeds our predetermined significance level of 0.05 the results are insufficient to support the hypothesis that the ForceGun provides more satisfaction than the Assault Rifle. The results suggest that, although a preference for the ForceGun may exist, the difference is not statistically significant.

Testing H1c

To test hypothesis H1c ("The Teleporter reaches a higher video game satisfaction score (mGUESS score) than the traditional Assault Rifle.") we use a Welch Test and choose a significance level of $\alpha = 0.05$.

- H_0: The Teleporter provides the same satisfaction as the Assault Rifle.
- H_1: The Teleporter provides more satisfaction as the Assault Rifle.

The input data for the Welch test is as follows: For the Assault Rifle, the sample size is $n_1 = 15$, the mean ($\bar{x}_1$) is 27.33, and the standard deviation (s_1) is 4.19. For the Teleporter, the sample size is $n_1 = 15$, the mean ($\bar{x}_1$) is 28.33, and the standard deviation (s_1) is 3.10. The statistical analysis yielded a t-value of -0.74 with degrees of freedom (df) set at 25.79. The critical t-value (t_{critical}) for this analysis is 2.05. The p-value for

a one-sided test came out to be 0.23. Because the one-sided p-value of 0.23 exceeds our predetermined significance level of 0.05 the results are insufficient to support the hypothesis that the Teleporter provides more satisfaction than the Assault Rifle. The results suggest that, although a preference for the Teleporter may exist, the difference is not statistically significant.

Discussion of H1

The evaluation of hypothesis H1 aimed to determine whether innovative game mechanics provide generally more satisfaction than traditional ones. This hypothesis was explored through three specific comparisons: H1a (Assault Rifle vs. WindBlaster), H1b (Assault Rifle vs. Teleporter), and H1c (Assault Rifle vs. ForceGun). Upon conducting statistical analyses for each of these sub-hypotheses, the results did not reveal statistically significance in any of the sub-hypotheses, hence we have to reject hypothesis H1. There are no statistical significant differences in player satisfaction between the traditional game mechanic and each of the innovative mechanics. The lack of a statistical significance suggests that player preferences for game mechanics may not be as clear as hypothesized. Another reason might be the different preferences by experience – as shown in the evaluation of hypothesis H2 in the next section.

7.3.2. Evaluation of Hypothesis H2

Hypothesis H2 proposes a relationship between a player's level of gaming experience and their preferences for different game mechanics. To explore this, some data preparation and aggregation was necessary. We divided participants into two groups based on their self-reported gaming experience: one group comprised of players with low to medium gaming experience (classified as "Very Low", "Low", and "Medium"), and the other group consisting of players with high to very high experience levels (classified as "High" and "Very High"). Then we aggregated the individual innovative game mechanics (WindBlaster, ForceGun and Teleporter) score results for each participant into one "innovative" mechanics group. The AssaultRifle represents the "traditional" mechanics group. The next step was to compute the mean differences for the two experience groups. This meant subtracting the innovative mean score from the traditional mean score for each participant, and then calculating the mean for the specific experience group. Alongside the means, we calculated the standard deviations for each group. The prepared data needed for the statistical analysis is listed in Table 7.2. With this data we can test our hypothesis H2. To achieve

Group	Traditional	Innovative	Difference	Difference SD	N
Very low - Medium	31.50	29.21	2.29	0.7	4
High - Very high	25.82	27.53	-1.71	1.20	11

Table 7.2.: The mGUESS Score Results grouped by Innovative/Traditional Mechanics and the Experience Groups

this, we divide H2 into two sub hypotheses: **H2a:** Players with a low to medium level of

video game experience prefer traditional over innovative mechanics. **H2b:** Players with a high level of video game experience prefer innovative over traditional mechanics. A one sample t-test is suitable for H2 because it is designed to compare a single value – in our case the difference between scores of traditional and innovative scores – of a group – our experience groups – to an expected value (0 – for no preference).

Testing H2a

To test hypothesis H2a ("Players with a low level of video game experience prefer traditional over innovative mechanics.") we use the one sample t-test and choose a significance level of $\alpha = 0.05$.

- H_0: There is no difference in preference for traditional versus innovative game mechanics within the group of less experienced players.
- H_1: Players with a low level of video game experience prefer traditional over innovative mechanics.

The input data for the one sample t-test is as follows: the sample mean ($\bar{X}$) is 2.29, the population mean under the null hypothesis (μ_0) is 0, the standard deviation (s) is 0.7, and the sample size (n) is 4. The results of the hypothesis test include a t-value of 6.54 and degrees of freedom (df) of 3. The critical t-value (t_{critical}) for this test is 2.35. The p-value for the one-sided test is 0.004. Because the one-sided p-value of 0.004 is less than our predetermined significance level of 0.05 the results are sufficient to support the hypothesis that lower experienced players prefer traditional game mechanics over innovative. The results suggest that the difference is statistically significant.

Testing H2b

To test hypothesis H2b ("Players with a high level of video game experience prefer innovative over traditional mechanics.") we use the one sample t-tests and choose a significance level of $\alpha = 0.05$.

- H_0: There is no difference in preference for innovative versus traditional game mechanics within the group of more experienced players.
- H_1: Players with a high level of video game experience prefer innovative over traditional mechanics.

The input data for the one sample t-test includes the following: the sample mean ($\bar{X}$) is -1.71, the population mean under the null hypothesis (μ_0) is 0, the standard deviation (s) is 1.20, and the sample size (n) is 11. The hypothesis test yielded a t-value of -4.73 with degrees of freedom (df) of 10. The critical t-value (t_{critical}) for this test is 1.81. The p-value for the one-sided test is 0.0004. Because the one-sided p-value of 0.0004 is less than our predetermined significance level of 0.05 the results are sufficient to support the hypothesis that higher experienced players prefer innovative game mechanics over traditional. The results suggest that the difference is statistically significant.

Discussion of H2

Hypothesis H2 explored whether players with varying levels of experience exhibit different preferences between traditional and innovative game mechanics. Participants were divided into two groups based on their gaming experience: less experienced (Very Low to Medium) and more experienced (High to Very High). Hypothesis H2 was subdivided into H2a and H2b to specifically investigate preferences among players of different experience levels. H2a focused on players with lower experience (Very Low to Medium), revealing a significant preference for traditional game mechanics. Conversely, H2b examined players with higher experience (High to Very High), showing a clear preference for innovative mechanics. Taken both - H2a and H2b - together, these results support the proposition that the gaming experience influences the preference for certain types of game mechanics: less experienced players prefer traditional mechanics while more experienced players favor innovative mechanics.

8. Conclusion

The main goal of this paper was to compare the experiences of using different game mechanics in a fixed video game scenario. Even though not statistically significant, results indicate a tendency of our proposed hypotheses that innovative game mechanics are more enjoyable than traditional ones (H1). Despite overall lower usability scores for innovative mechanics – mainly because of more complex controls – a big factor in overall satisfaction seems to be the creative freedom a game enables. Our results and statistical evaluation indicate that the experience has an impact on the preferred type of mechanic (H2) suggesting that more experienced players prefer innovative mechanics, while less experienced players prefer traditional ones. After evaluating the current state of definitions of game mechanics as well as their categorization suggested by related work, we proposed additional types to further classify them: Spatial Mechanics, Temporal Mechanics, Weapon Mechanics, Economic Mechanics, Social Mechanics, Narrative Mechanics, Narrative Mechanics, Physics-based Mechanics, Progression Mechanics.

8.1. Limitations and Future Work

Even with the results indicating some tendencies for supporting H1, there is no statistical evidence to support this. One major factor is the limited sample size of 15 participants. The innovative game mechanics had a lower usability score than the traditional mechanic, which suggests that participants might need more time to get used to it. In order to tackle this, one could make the rounds much longer. However, if the rounds get too long, it would probably be better to just let one user play one mechanic, not all of them. Another solution to ensure better usability is to redesign certain weapons in a way, so that the expected action is more intuitively. Even though instructional videos were positioned in the starting area, participants did not know how to use certain weapons, died and got frustrated. A possible solution to this problem would be to redesign the map where the player can experiment a little longer before encountering enemies. In the course of this it would also make sense to add more puzzles that enforce more creative thinking.

For future researchers it could also be interesting to investigate the learning curve to master an innovative mechanic – e.g., if the mechanic makes more fun if the player masters it. Additionally, exploring how players make choices when given the freedom to select their weapon or game mechanic during gameplay could also give interesting insights. Such an experiment could measure and analyze the reasons behind players' choices, particularly in how they approach and solve specific challenges or puzzles. Understanding these choices could significantly help to improve game design to create more engaging experiences. The innovative mechanics got rated as more difficult, but also scored higher with more

experienced players. Future researchers might want to investigate if the experience level also correlates with the desire to get challenged more.

Another limitation was the lack of a tool or questionnaire that is specialized on evaluating game enjoyment or engagement for multiple sessions in a row of the same setting, but with another game mechanic. For our method we used the GUESS 18 [KSS+20] and cut out items that did not fit. It served our purpose, but using a dedicated tool that is validated for such situations would be more ideal to get more accurate results.

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A. Appendix

ID	Age	Gend	Exp	Weap	Dths	Clt	Kld	Score	t(m)
1	28	Female	Very low	Assault	2	11	6	32	11.33
2	28	Female	Very low	ForceGun	0	10	6	32	3.65
3	28	Female	Very low	Teleporter	3	10	6	31.5	10.53
4	28	Female	Very low	WindBlaster	2	10	4	28	6.57
5	29	Male	Very high	Assault	0	10	2	26	1.26
6	29	Male	Very high	ForceGun	0	10	6	27.5	1.07
7	29	Male	Very high	Teleporter	0	13	3	27.5	1.19
8	29	Male	Very high	WindBlaster	2	10	3	28	3.46
9	26	Female	Medium	Assault	0	10	6	34	1.98
10	26	Female	Medium	ForceGun	0	14	4	31.5	3.08
11	26	Female	Medium	Teleporter	1	10	5	32.5	5.28
12	26	Female	Medium	WindBlaster	1	18	6	30.5	8.13
13	30	Male	Low	Assault	0	11	6	31.5	2.28
14	30	Male	Low	ForceGun	0	11	5	29.5	2.34
15	30	Male	Low	Teleporter	3	18	5	31	7.97
16	30	Male	Low	WindBlaster	0	14	3	28	3.68
17	29	Male	High	Assault	0	18	7	33.5	2.27
18	29	Male	High	ForceGun	0	18	6	33	2.46
19	29	Male	High	Teleporter	2	18	6	31.5	7.93
20	29	Male	High	WindBlaster	0	18	7	35	3.89
21	26	Male	Very high	Assault	0	10	4	29	1.05
22	26	Male	Very high	ForceGun	1	10	6	29	2.62
23	26	Male	Very high	Teleporter	2	10	4	32.5	2.58
24	26	Male	Very high	WindBlaster	3	10	6	31	4.53
25	31	Male	Very high	Assault	0	10	2	21.5	0.82
26	31	Male	Very high	ForceGun	0	10	1	18	1.21
27	31	Male	Very high	Teleporter	0	12	3	24.5	1.38
28	31	Male	Very high	WindBlaster	0	10	2	24.5	0.98
29	27	Male	High	Assault	0	11	5	24	3.14
30	27	Male	High	ForceGun	0	11	5	25.5	1.97

Table A.1.: Raw Data of All Data Sets (ID, Age, Gender, Experience, Weapon, Deaths, Collected Cores, Killed Enemies, mGUESS Score, Time (m)

ID	Age	Gend	Exp	Weap	Dths	Clt	Kld	Score	t(m)
31	27	Male	High	Teleporter	2	10	7	28	8.03
32	27	Male	High	WindBlaster	0	10	4	26.5	2.09
33	29	Male	Very high	Assault	0	10	5	24	1.85
34	29	Male	Very high	ForceGun	0	10	3	24	1.16
35	29	Male	Very high	Teleporter	0	11	1	28	2.80
36	29	Male	Very high	WindBlaster	0	11	2	28	4.09
37	31	Male	Very high	Assault	1	10	7	23.5	1.74
38	31	Male	Very high	ForceGun	0	13	3	30.5	1.23
39	31	Male	Very high	Teleporter	0	10	4	26	1.40
40	31	Male	Very high	WindBlaster	2	14	5	25.5	6.44
41	29	Male	High	Assault	0	11	5	20.5	0.94
42	29	Male	High	ForceGun	1	10	4	22	1.95
43	29	Male	High	Teleporter	1	10	0	22.5	2.41
44	29	Male	High	WindBlaster	1	10	0	24	3.06
45	33	Male	High	Assault	0	10	7	27.5	1.46
46	33	Male	High	ForceGun	0	12	6	28.5	1.52
47	33	Male	High	Teleporter	2	11	5	29.5	2.34
48	33	Male	High	WindBlaster	3	10	3	28	2.81
49	35	Male	Low	Assault	0	10	7	28.5	1.97
50	35	Male	Low	ForceGun	0	10	5	26.5	1.37
51	35	Male	Low	Teleporter	3	12	6	24.5	6.90
52	35	Male	Low	WindBlaster	3	10	5	25	5.86
53	32	Male	Very high	Assault	0	11	6	26.5	1.26
54	32	Male	Very high	ForceGun	0	10	5	29.5	0.95
55	32	Male	Very high	Teleporter	1	10	0	27	2.25
56	32	Male	Very high	WindBlaster	2	11	2	29	3.06
57	31	Male	Very high	Assault	0	12	7	28	1.04
58	31	Male	Very high	ForceGun	0	12	6	29	1.17
59	31	Male	Very high	Teleporter	2	10	6	28.5	4.06
60	31	Male	Very high	WindBlaster	1	12	5	27	4.60

Table A.2.: Raw Data of All Data Sets – Continuation (ID, Age, Gender, Experience, Weapon, Deaths, Collected Cores, Killed Enemies, mGUESS Score, Time (m)