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The effect of player expertise on customisation of heads-up displays in first person shooter games

by

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Abstract

This project evaluates the effect of player expertise on the customisation of heads-up displays in first person shooter games. A focus is placed on the spatial organisation, composition, and usefulness of each individual heads-up display element. Although there have been studies that evaluated the effect of heads-up displays on player expertise, no study has been carried out that allows players to customise their own heads-up displays. To achieve this aim, an observational study, covering 40 AAA games and their HUD organisations and compositions was carried out, identifying the most reoccurring HUD elements. A prototype tutorial of a First-Person shooter game was created using Unity 3D that included the HUD elements from the observational study and a heads-up display customisation tool, that allowed players to modify each element of the heads-up display. A user study on the game was conducted by 30 participants, 14 inexperienced and 16 experienced first-person shooter players, followed by a survey and an interview. The study proved that a player's most played first-person shooter game had a significant impact on the HUD layout that they came up with. It also showed a potential trend among inexperienced players to place HUD elements at the top of the screen. No difference between how participants view composition was noted. The HUD tool improved experienced participant's game experience through allowing them to get used to the HUD quicker, while inexperienced participants' experienced was enhanced by a sense of freedom and control while using the tool. Whilst there was a difference between the two participant groups in how they valued HUD elements, based on the information they provided, more participants are required for a complete evaluation of this topic.

Table of Contents

1. Introduction/Context

1.1 Introduction

From their conception, the rate at which games have evolved could be considered very impressive. Started from 2D pixelated pastimes, in the span of 50 years they have evolved to experiences that are able to inject players into realistic 3D virtual worlds, through various technologies such as virtual reality. And from the freedom that was achieved because of these technological advances, a wide range of video game genres have been developed.

The first-person shooter (FPS) is one of the most popular game genres according to Clement J. (2020). It is a game in which the player sees through the eyes of the avatar, and the main mechanics relate around the shooting of a weapon. One of its main goals being achieving mental immersion (Grimshaw 2007), also known as *engrossment* (Brown, Cairns 2004).

It could be suggested that immersion is one of the main goals of game design. In order to achieve full immersion, the player must feel like they are part of the game world (Browne, Cairns 2004). Although technologies like virtual reality are taking steps of making a player feel like they are inside the virtual world, more traditional and accessible methods of engaging with games, like consoles, mobile phones and computers remain very restrictive. Information needs to be conveyed to the players for them to feel part of the game world and allow them to reach a state of flow. One of the ways this information is transmitted to the user is through the Heads-Up Display (HUD).

Heads-up displays or HUDs are a means of projecting computer generated information, around the peripherals of the user (Shneiderman 1997). One of the most common examples of HUDs in real life are the ones seen in cars and airplanes in the form of speed gauges placed on the peripherals of the drivers' and pilots' views. Since then, HUDs have been used in all kinds of different fields, however the focus of this paper is on the heads-up displays seen in games.

All genres of games make use of HUDs since they are a very powerful tool of displaying information directly to the user. From casual games like Angry Birds (Rovio, 2012), showcasing information like scores and high scores (Figure 1), to FPS games like Battlefield 2042, displaying an abundance of information about the player's location, objective, health, ammo, and weapons.

Figure 1: Angry Birds by Rovio (Left), Battlefield 2042 by DICE (Right)

This study focuses on non-diegetic HUD elements. As Fagerholt and Lorentzon (2009) describe, non-diegetic elements within the HUD are parts of the visual user interface (UI) of a game that is not part of the game's fiction or the game's world and are overlayed on the computer screen. They further claim that they are a very common occurrence in FPS games.

1.2 Aims & Objectives

The aim of this paper is to evaluate HUD elements' spatial organisation, composition, and usefulness in first person shooters, by taking into account player preference and expertise. Instead of designing the most ideal HUD, a tool is created as part of a first-person shooter game, made with Unity 3D, allowing players to customise the spatial position and composition of the HUD throughout their playthrough.

The following objectives are covered to achieve this aim:

1. To conduct a literature review on the effects of HUDs on the overall user's experience in a first-person shooter.
2. To create a table of the most reoccurring HUD compositions and their spatial organisation in first person shooters.
3. To create a game tutorial prototype with a HUD customisation tool as part of the tutorial
4. To conduct a user study with participants of varying game experience in first person shooters and having them play the prototype game and describing their experience.
5. To answer the research questions with data collected from the user studies.

The following research questions and hypothesis are formed:

<u>Research Questions</u>

1. To what extent do experienced players design their HUD layouts based on the HUD layout of their most played games?

2. What impact does agency over the HUD customisation have on the gameplay experience?

3. How do players rate the usefulness of different HUD elements based on their experience?

2. Background/Related Work

2.1 Heads-up Display

Heads-up Displays serve as mental notes, a way to use technology to remind the users of information. A person's short term memory can hold up to between 5 and 7 unrelated concepts at once, hence having reminders in your peripherals can help access that information, when needed, faster (Norman 1998, p.191)(Yablonski 2020, p.35). If a piece of information can be shown to the user instead of them having to remember it in their short or long term memory, it can reduce the user's cognitive load, and allow them to focus on other parts of a task.

However, critics of HUDs that there is a loss off essential skills as a result of the technological automation present in them (Norman 1998, p.192). Norman (1998, p.193) responds: "If a task can be automated, it is not essential". Norman prefers a task being accessible to a wider audience, and a skill barrier is deemed unnecessary if it can be removed through automation. Nonetheless, when it comes to video games, where challenge and the development of skills are desired for meaningful play, HUDs might not always be desirable.

There has been a significant amount of research done in the past decade on the topic of HUDs in games (Caroux 2016)(Fagerholt 2009). HUDs have been a crucial part of video games for a long time (Figure 3). They have proven to be a useful tool to communicate a wide range of information. One of the most notable HUD uses is to display the concept of health (Brooksby 2008) which is part of the *avatar status* (Fricker 2012). According to Fricker (2012), other methods of visual feedback given to the player are *enemy status*, such as the enemy health and position, *equipment status*, for example, ammo and weapon damage, *spatial awareness* such as a mini-map or a compass, *mission status & objectives*, including objective markers and reminders. Other than that they can display *rewards & achievements* (e.g. *XP* gained and rewards unlocked) and *help & guides* (e.g. hints and tutorials).

Figure 2: Battlefield 3 visual feedback through Heads-up Display (1: Avatar Status, 2: Equipment Status, 3: Mission status & objectives, 4: Spatial awareness, 5: Enemy status)

All these forms of visual feedback present in the game HUD allow the player to reduce their short term memory load, in order to have it focused on other aspects of the game, allowing them to look back and retrieve that piece of information when necessary.

2.2 User Experience, Spatial Organisation & Composition Guidelines

Over time, HUD designs in games have evolved. While the core information of the visual feedback remains similar (e.g. health, ammo, objectives), the method of presenting them has evolved. HUDs have shifted from a design that looks similar to the design of an airplane cockpit (Figure 3), to one that is more subtle, and in the corners of the screen (Figure 2). This change in the HUD's *spatial organisation* (the process of distributing the different HUD elements on screen) and its *composition* (the elements that are chosen to be part of the HUD) implies that it plays a part in the player's overall experience.

When it comes to the spatial organisation and composition of the HUD elements present in games, there is a lot to unpack. Yablonski (2020, p.1), when defining the *Jakob's Law,* claims that users can transfer their skills from using one product to the other if they work similarly. This would also be applicable in game HUDs. If a player has plenty experience on the HUD layout of their favourite first person shooter, they could be able to transfer it to a new first person shooter with a similar HUD layout. This might be one of the reasons why some game genres have similar HUDs, for example, in FPS games released in the last 20 years, the majority of the games have the ammo counter placed on the bottom right corner of the screen (Figure 2)(Table 1).

Figure 3: Doom (1993), one of the first entries to the first person shooter genre (id Software 1993) (Left). Heads-Up Display of an airplane (Right).

Yablonski (2020) also goes on to suggest that providing the user with too much information at once can slow down the decision making process. While this HUD setup might be very useful for an experienced player, a new player presented to an interface like the one in Figure 3, would be very confused and lost, and making any decision would certainly take a long amount of time.

Similarly Fricker (2012) also suggests that consistency is an important part of a user interface, and thinks that a strict colour scheme should be followed and all the elements on screen should be easily discernible. Furthermore, the information present on the screen should have a small mental load on the player's memory, by using easy to understand or common icons. Adding to this, only relevant information for the task at hand should be present, for example, there is no need to display the weapon ammo if the player is not using a weapon. This is why HUD composition is to be heavily considered when designing a game.

2.3 The impact of HUD on the First Person Shooter and Immersion

Heads-up display composition is especially important when designing a game that comes with many non-diegetic HUD elements, such as the First Person Shooter genre (Fagerholt, Lorentzon 2009). Almost every FPS game has some sort of HUD in order to inform players of information they can't directly see.

But why is the heads-up display important? Fagerholt and Lorentzon have proven that immersion is indeed affected by a games user interface, and heads-up display. HUD elements provide information that allows the player to understand the virtual world and they can improve the game experience.

However, a different study claims that sometimes the HUD can get in the way of gameplay (Caroux 2011), therefore making HUD design and the balance of information displayed an important part of the FPS design.

In order to justify the impact, a definition of immersion in games is required. As mentioned before, engrossment is an important aspect of first-person shooter games, hence if the HUD hinders the player's immersion, it can be harmful to the overall game experience. But what is engrossment?

Immersion in games is defined and evaluated in three stages (Brown, Cairns 2004). The stages are *Engagement*, *Engrossment* and *Full Immersion*. The stage of immersion is decided based on three investments in which the player contributes to: *time*, *attention,* and *effort*.

- Time: the amount of real time spent with game

- Attention: Willingness to engage with the game

- Effort: Patience and engagement to learn the game

The more of these factors the player invests in, the higher the level of immersion that is achieved.

However, there is two barriers that get in the way of immersion. *Access* refers to the subjective preferences of a player and the game as well as their capability of understanding and using the game controls. If the player does not like the particular genre or theme, or alternatively, they find it challenging to understand the basic controls of the game, it can prevent them from achieving *Engagement*. Engagement is achieved once the two barriers are overcome.

The second stage of immersion, *Engrossment*, happens when time, attention and effort are high enough to the point where the player gets emotionally involved with the game. In this stage, while the player is still aware that they are engaging with a game, they don't want to stop playing. It could be said that a player-game relationship is built at that point due to the emotional connection invested.

Finally, the hardest form of immersion to be achieved is Full-Immersion which requires the player to forget that they are playing a game. Maximum time, attention and effort is required from the player to achieve this state.

2.4 Related Work

One study that was done on the HUD and its impact on player expertise and immersion had users play through two versions of a popular first person shooter, Battlefield 3, one with the game's default HUD and one with no HUD (Iacovides 2015). The study aimed to see if there was a difference in enjoyment and frustration that players experienced, however it found that the HUD did not form a significant barrier to player engagement.

The second method that was carried out, had participants sampled based on their experience with first person shooters. This time, between-subject design was chosen, unlike the first method, in order to mitigate order bias. The results of the second method showed that experienced players have no use for certain HUD elements and it can prove to be a distraction.

The study concludes that when designing a HUD, it is important to take into consideration the HUD elements present in the screen. While certain elements can help ease the learning process of the game, they can eventually become redundant and distracting when players become more experienced with the game.

Another study by Caroux and Isbister (2016), explored the effectiveness of HUD elements in first person shooters and RTS games. Several hypotheses were formed in order to fully explore the topic, however the following are the ones are relevant to this study.

One of the hypothesis was that novice players use the HUD less than expert players. That was proven to be false, since in the experiment, where users where recorded using eye trackers, novice players spent more time looking at the HUD elements for information than expert players. This supports the results of the aforementioned study by Iacovides (2015), where he also concluded that expert players do not make much use of the HUD when compared to novice players.

The study also found that the composition (what elements are present) and spatial organization (where the elements are placed on the screen) of the different HUD elements have an impact on the player experience. There was a method carried out to evaluate this claim, by showing novice and experienced participants screenshots of different compositions and spatial organisations of some HUD elements, in the case of the FPS game, the ammo counter and compass.

Results found that the players preferred the original compositions and spatial organisations rather than the modified ones made by the researchers, based on ergonomic principles. They found no significant difference of results regarding player expertise.

In regards to customisation, Adinolf and Turkay (2011) have proven that many players of the massively multiplayer online game genre (MMO) prefer customising their interfaces. However, they also discuss that the user interface and heads-up displays of MMO games are very crucial to the gameplay experience, which is not necessarily the case in FPS games.

2.5 Observational HUD Study

To further understand HUD composition and spatial organization used in first person shooters, an observational study was conducted to gather the most reoccurring HUD elements. A random sample of 40 AAA FPS titles were accumulated and analysed, collecting the most reoccurring elements, their position on the screen and their design. Using python and pandas, the list was grouped by the HUD elements and percentages were calculated.

Table 1: Non-Diegetic HUD Elements and their most reoccurring screen positions and designs

HUD Element	% of games that it appears in	Most Common Position (Percentage)	HUD Element Design (Percentage)
Ammo	100	Bottom Right (72.5%)	Numerical (62.5%)
Crosshair	92.5	Middle (100%)	N/A
Throwables	87.5	Bottom Right (65.7%)	N/A
Vitals	82.5	Bottom Left (45.5%)	Graphic (63.6%)
Selected Weapon	72.5	Bottom Right (58.6%)	N/A
Objective Marker	65	Top Left (36.4%)	N/A
Mini-map / Radar	62.5	Bottom Left (64%)	Circular (60%)
Compass	55	Bottom Left	N/A
Hit-Marker	55	Middle (100%)	N/A
Score	40	N/A	N/A
Damage Numbers	15	Middle	N/A

Out of all the HUD elements the top 6 most reoccurring ones seemed to be the standard elements, that are able to be used in most FPS games, while the rest were very contextual and dependent on the type of game subgenre. An example of this would be the mini-map and compass. FPS games that included expansive, open plan levels, had some form of navigation UI to ease traversal, whether that would be a compass, a mini-map, or a radar, while more linear, single player campaigns with restricted levels did not. Therefore, this was be taken into consideration when designing the game that was used to evaluate these HUD elements.

As for the individual HUD element design, if an element had significant differences from one game to the other, this was noted. A notable example is the Ammo element and the Vitals Element. Some games had these displayed in a numerical value, while others chose a more graphical design for them, or sometimes both, as seen in Figure 4.

Figure 4: Graphical Ammo HUD Element (Left)(Insurgency Sandstorm), Numerical Ammo Element (Right)(Battlefield 4)

2.6 Key takeaways

From previous research it is noticed that heads-up displays do have some impact on the player experience. In particular HUD composition and spatial organisation play a significant role in how a HUD design is perceived. Since *engrossment* is one of the aims of a first person shooter, the HUD should not get in the way of the player achieving it. While HUDs do provide important information that help with a player's access to the game, they decrease the amount of effort they need to put into it, potentially lowering the level of immersion they have.

While there has been research done on the ideal HUD composition and spatial organisation for an FPS game (Caroux, Isbister 2016, Iacovides 2015), no methodology has allowed users to create their HUD based on their own preferences.

These studies are used as a basis for creating the prototype game and analysing the results generated from its user study.

3. Design and Implementation

3.1 Game Summary

Title: SWAT Assault

The game is a realistic first person shooter single player game. The art style is low-poly, in order to ensure that performance is stable, however the gunplay is as realistic as possible to imitate the most popular AAA games on the market. It is a prototype of first person shooter game's tutorial, in which the player is introduced to all of the game mechanics one by one, and prompted to place UI Widgets for each.

The engine used for the creation of the game was Unity. This decision was made due to the 2D support provided by the engine that aided the making of a customisable UI. While Unreal Engine could be a better pick to make the game look more realistic, the implementation of the customisable UI would be more time consuming.

The target audience for this game includes both experienced and novice FPS players of any gender, between the ages of 18-30.

The theme of the game takes place on a modern day hotel, where the player assumes the role of a SWAT officer on their first police raid, learning the ropes while taking down wanted criminals.

Table 2: List of Game Assets and Mechanics that were Custom made or Outsourced

Game Mechanics	Source	Game Assets	Source
First Person Movement	Outsourced	Level Design	Custom
Gun Mechanics	Outsourced	3D Models	Outsourced
Grenade	Custom	Sound Effects	Outsourced
Enemy AI	Custom	2D Sprites	Both
HUD Tool	Custom		
Menu	Custom		

3.2 Game Design

3.2.1 Tutorial

The tutorial of the game serves as a way to both introduce the mechanics to the player as well as allow them to start designing their custom HUD. As they are introduced to different mechanics, they get the ability to place the HUD Elements on the screen, or disable them. Upon entering a room, the players are told how a mechanic works, then their game is paused and the new HUD element is shown as seen in Figure 5.
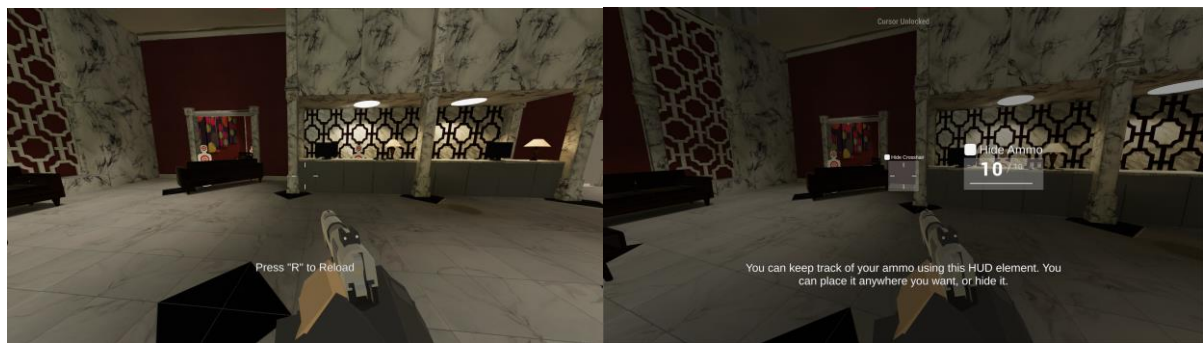

Figure 5: The Player is taught how to reload their weapon and consecutively giving them the HUD element that lets them know when they need to reload

They are first introduced to basic movement and enabling or disabling their crosshair. Consecutively they are taught shooting and reloading. They are then able to place the ammo counter HUD element. After that they are taught how to pick up and throw grenades, being introduced to the second HUD element the grenade counter. In the next room they are prompted to swap their weapon, being able to use the swap weapon HUD element. Consecutively, during their ascent to the combat area of the level, they are presented with the health HUD element along with a tutorial text hinting that their health regenerates over time. Lastly, they get the objective element and a text telling them to eliminate all the remaining enemies.

The reason behind this gradual introduction to the HUD elements, is so that the player understands the use and purpose of each HUD element before they decide where to place it. At the end of the tutorial the player will have a fully customised HUD and should be ready to take on the hostiles on the second floor of the level.

The way the tutorial works is with the use of collision boxes. Upon hitting a collision box, it starts a sequence of tutorial texts to pop up on screen, that go away after a set second interval and by the end of the tutorial texts, it enables the HUD customisation tool to draw the player's attention to the new element that appears, as seen in Figure 5.

3.2.2 Level Design
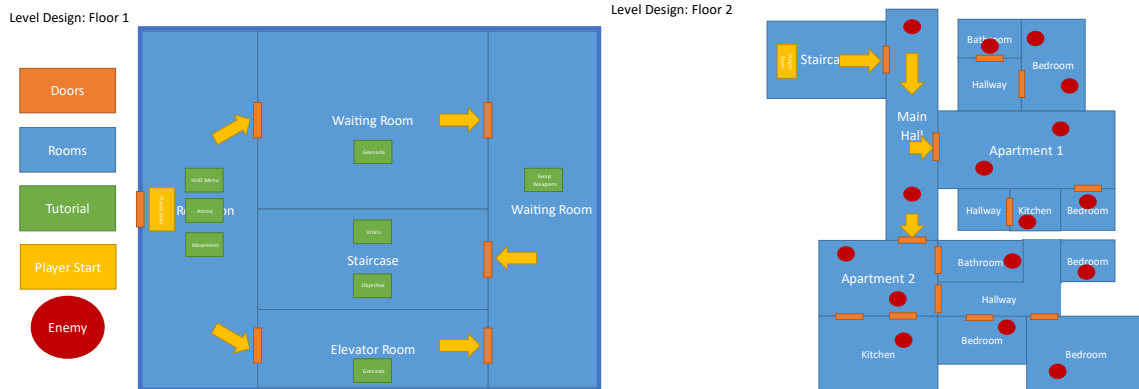
Figure 6: Tutorial Floor (Floor 1)(Left), Challenge Floor (Floor 2)(Right)

The level uses assets from Brick Project Studio's Apartment Kit. It is a multistorey hotel with two accessible floors. The bottom floor is the tutorial part of the level, where by the end of it, the player will have all the knowledge necessary to play the game. The second floor is going to be filled with enemies where the player will be able to engage enemies and test the HUD that they would have designed by then.

Inspiration for the layout of floor one, was derived from the mood board in Figure 7. Reception rooms are usually open, clean, and heavily decorated, with the reception desk being the focal point of the room. The waiting rooms also have a lot of space and often include decorations such as columns.

Level Design Mood board
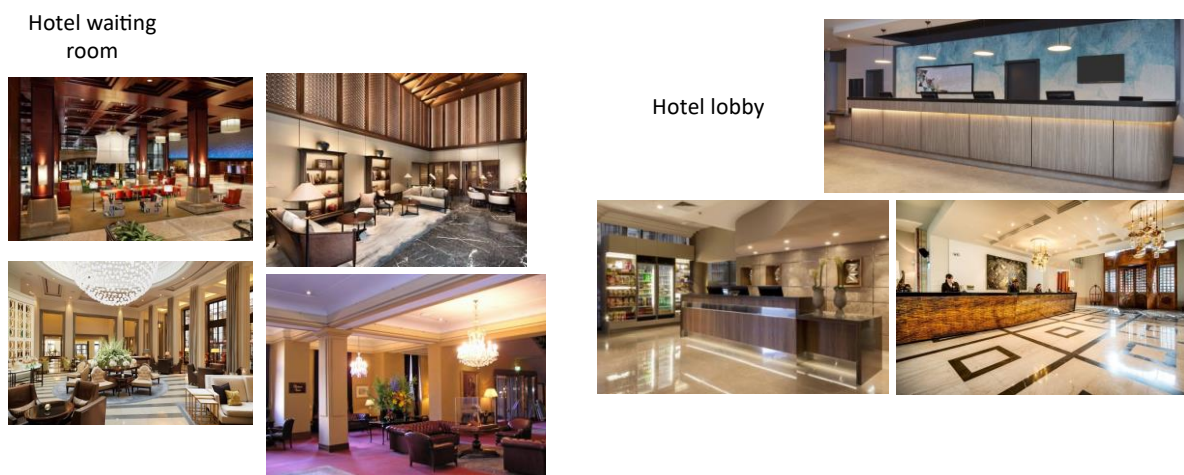
Figure 7: Level Design Mood Board for the 1st Floor of the level

During the level design it was important to distinguish the tutorial area from the combat area of the game, in order to ease the learning process. If the users had to deal with enemies while being taught all the different game mechanics in the same area, their attention would be on the enemy threats rather than the tutorial and HUD customisation tool. Thus they were separated placed into two different floors, one for the tutorial and one for the combat challenge.

The bottom floor consists of four rooms. The first room the player finds themselves in, the reception (Figure 88), teaches them how to use the HUD customisation tool. This is where they also learn the basics of movement, aiming, shooting, and reloading as well as giving them the ammo HUD element.

Figure 8: Reception

As seen in the figure above, the bottom floor has targets around for the player to shoot at. This is to familiarise them with how the weapons work before the face the enemies on the second floor, and to make the tutorial more interactive, since they can test the mechanics they are being taught instantly.

The two secondary rooms (Figure 99) are the *waiting room corridor* and the *elevator room*. Here the player is introduced to the grenades, whom they are able to pick up and throw. They are also introduced to the grenade HUD element.
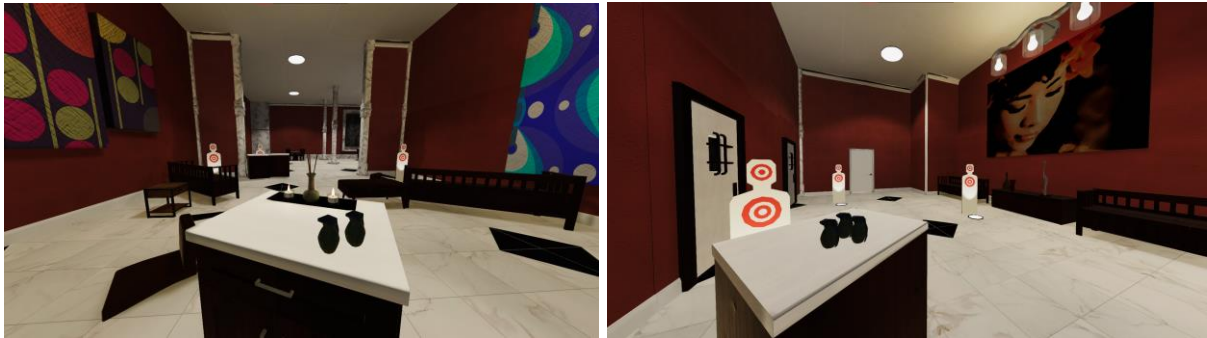
Figure 9: Waiting Room Corridor (Left), Elevator Room (Right)

In the last room of the first floor, the waiting room, they are shown how to swap between their two weapons. The player is now able to swap to their automatic rifle, hence the large number of targets scattered around the room.

Figure 10: Waiting Room

The next point of interest, the staircase, is where they are informed of the health regeneration system. They are then presented to the vitals HUD element. Consecutively, they are informed that their training is over and they are now given a new objective, eliminating all the enemies on the second floor. This is where they receive their last HUD element, the objective marker.

Figure 11: Staircase

Upon clearing the bottom floor and setting up their custom HUD, the players are then able to go onto the second floor, to the apartments, where the enemy AI patrol. To finish the tutorial they have to use what they learnt to clear out the enemies.

Figure 12: Floor 2 Hallway (Top), Apartment 1 (Bottom Left), Apartment 2 (Bottom Right)

3.2.3 Persistent HUD Design

 The persistent HUD refers to all the non-diegetic HUD elements that are fixed on screen throughout the game. The elements chosen are based on the most reoccurring persistent HUD elements seen in first person shooters (Section 2.5).

 The colour scheme of the HUD is restricted to red and white. As per Fricker's suggestion (2012), the colour scheme of a HUD should be consistent, and common icons should be used in order to communicate concepts to the player. This way players are less likely to be overwhelmed by the HUD. It also potentially helps to minimise subjective design bias, allowing players to choose elements based on their functionality rather than their design.

 The two primary HUD element colours were given meanings. White indicates information that does not require the player's immediate attention. This colour is used for most of the HUD elements. Red indicates information that should draw the attention of the player, such as, the player's health, being low on ammo or displaying the direction the player was shot from.

 The HUD elements have minimal designs, avoiding overcomplication. This decision was made to mitigate any subjective biases resulting in the players choosing a HUD element based on its visual design.

Crosshair

The crosshair is the only persistent HUD element that is locked unable to be moved around using the HUD tool. That is because it displays the direction of the bullets when fired from the gun, and displacing it would not make sense. However, players can choose to hide it if they wish.

Figure 13: Crosshair HUD Element

Ammo

 The most reoccurring persistent HUD element in FPS is the Ammo display (Table 1). Since this element is present in every first person shooter game, it is expected to be one of the HUD elements that players deem most important. Its design is numerical as per the results of the observational study, in Table 1.

 This element informs the player of the exact amount of bullets left in their weapon's magazine. Upon reaching 0, the player's weapon is not able to shoot any more bullets until they reload.

 Upon the player reaching low ammo, the HUD element slowly turns closer to red to draw the player's attention.

Figure 14: Ammo HUD Element

Grenade

 The grenade HUD element gives the number of consumable grenades that the player has access to. The counter tracks how many grenades a player has on them. The 2D sprite of a grenade next to the counter shows the player that the counter refers to the amount of grenades available. This sprite should make it easier for the player to understand this element, due to the sprite being simple and easy to understand (Fricker, 2012).
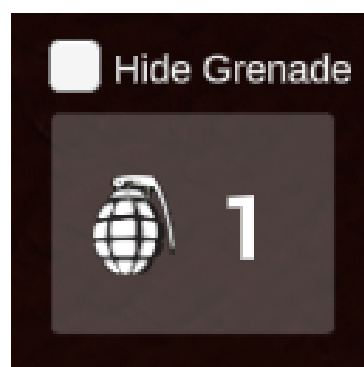
Figure 15: Grenade HUD Element

Vitals

Vitals refers to HUD elements that display the player's health. The most common design of a vital HUD element is graphic, as a *health bar,* as seen in Table 1. The cross next to the bar was added because it is a common icon that is usually related to medical symbols. This way the player can relate this bar with their health (Fricker, 2012).

Figure 16: Vitals HUD Element

Selected Weapon

The Selected Weapon HUD element indicates the current weapon the player is holding. Upon swapping weapon, this element updates to the new weapon the player is holding.
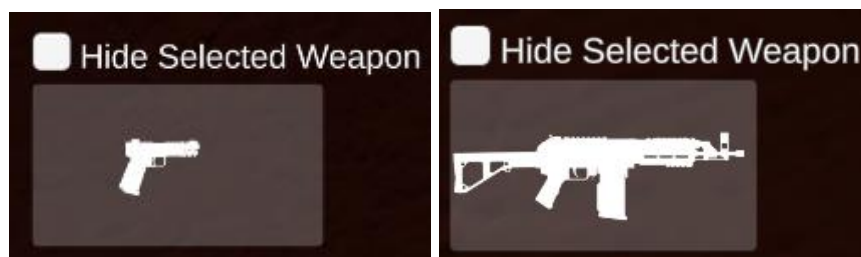
Figure 17: Selected Weapon HUD Element

<u>Objective</u>

The objective marker HUD element keeps count of the enemies defeated in order for the player to finish the tutorial. When the counter reaches 0,

Figure 18: Objective HUD Element

Upon finishing the tutorial, by default the player's screen will look like *Figure 19*. The elements as they show up are placed in the middle of the screen. This is to draw the player's attention to them as they show up, and to incentivize them to use the UI customization tool. If the elements showed up in the corners of the screen as the player moved through the tutorial, they might have had less of an incentive to interact with the HUD customisation tool.

Figure 19: HUD Element Default Position

3.2.4 Non-Persistent HUD Design

Along the persistent HUD elements, there are two non-persistent HUD elements that are used to inform the player of their avatar's current state. Fricker (2012) suggests keeping the visual elements to a minimum to avoid clutter. Although ideally there would be no other HUD elements on screen, during playtesting it was observed that testers were not aware that they had been hit if they did not have the vitals HUD element.

Non-Persistent HUD elements refer to elements that only appear on the screen in certain conditions, for example, the damage indicator will be shown only when the player is hit by an enemy.

Damage Indicator

A damage indicator is required for informing the player when they have been hit. All the FPS games that were part of the observational study (Table 1) provided situational feedback to the player every time they were damaged by an enemy, regardless whether the game included a persistent vital HUD element or not. These damage indicators are often presented as arches in the centre of the screen, pointing towards the position where the player's avatar received damage from (Figure 2020).

Figure 20: Damage indicator (Red Arch). It pops up every time the player is shot and it shows the direction the shot came from

Tutorial Text

The second non-persistent HUD element is the collection of tutorial texts that communicate to the player the main mechanics of the game, discussed in *Section 3.2.1*. A sequence of text explaining to the user that can be seen in Figure 5. These text elements are part of the *help & guides* type of visual feedback (Fricker, 2012). They are placed at the bottom of the screen, though close to the crosshair in order for the players attention to be drawn towards them. They are only present in the tutorial part of the level.

3.2.5 2D Sprite Design

 The damage indicator sprite (Figure 21: Custom Sprite for the Damage Indicator) was designed following the strict colour scheme used for the HUD, being coloured red to signify importance (Fricker, 2012), and an arrowhead to imply the direction the damage came from.

Figure 21: Custom Sprite for the Damage Indicator

The concrete impact VFX (Figure 22) that came with the first person shooter pack (Infima Games, 2021) was modified in order to make a Blood impact VFX. This change was made to give diegetic information to the player when they hit their target. As with the damage indicator, the colour red that is part of the strict colour scheme used for the HUD, drawing the player's attention on the blood VFX (Fricker, 2012). Additionally, saturated red "chunks" were added to the effect to make the bullets feel like they have more impact on enemies.
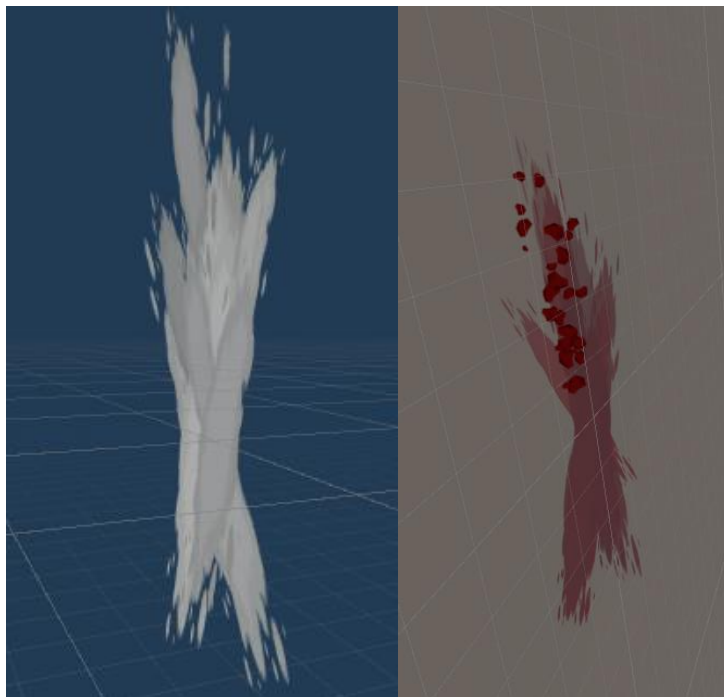
Figure 22: Concrete impact VFX (Left), Blood VFX (Right)

3.3 Game Mechanics

3.3.1 First Person Movement

The character controller is a modified version of the Low Poly Shooter Pack (Infima Games, 2021). The pack offered a FPS character controller, including all necessary animations, models and effects necessary for the creation of this game project. Additional features are added however, such as a grenade throw.

Table 3: Player Equipment

Weapon	Damage	Mag Capacity	Fire Rate
Rifle	30	30	Automatic
Pistol	30	10	Semi-Automatic
Grenade	100	1	N/A

The player will start with a pistol, and later on will get an automatic rifle. They will have unlimited ammo. This is to make sure that inexperienced participants don't run out of ammo.

Upon death the player will be teleported to a nearby checkpoint. There is no death screen, and the enemies will not be reset. This is to accommodate for inexperienced players. If they had to start over from the start of the level, the user studies would take too long to conduct.

3.3.2 Grenades

Grenades were a custom addition to the game to provide the player with a powerful tool they can use to clear very contested rooms. Upon throwing the grenade the player has a 3 second window before it explodes and deals 100 damage to anything within its radius. Due to their power, they are limited in every playthrough.

The player starts with 2 grenades, though they are able to collect up to 6 extra grenades throughout the level. This is to reward the player should they decide to explore.
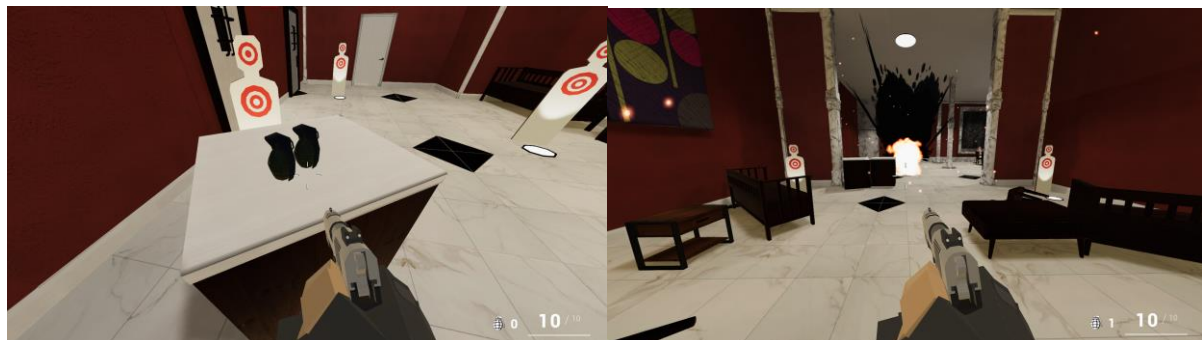
Figure 23: Grenade Pickup (Left), Grenade Explosion (Right)

3.3.3 Enemy NPCs

The non-player characters have been fully animated and designed to provide as close to an authentic game experience to the player. There is two main enemy types, a patrolling enemy and a sentry enemy.

The patrolling enemy patrols between two checkpoints. This enemy AI has three states; Patrol, Chase and Attack. By default the patrolling enemy will be on the *patrol* state. When the player gets into the enemy's sight range, they will *chase* the player until they are in their attack range. Upon entering the attack range, the patrolling enemy will switch to the *attack* state, shooting the player.

The sentry enemy on the other hand will be stationary and will attack the player when they get line of sight with them. However, the sight range of the sentry is higher to accommodate for the lack of mobility they have.

Line of sight has been taken into account by using Unity's Ray cast system. If the player is not blocked by a wall, then the enemy will be able to identify the player. This was done to prevent the enemy from shooting the player through walls.

Both enemies have the same amount of health (100). They take 4 shots from a weapon to be taken down, or one grenade explosion.

Figure 24: Sentry Enemy (Left), Patrolling Enemy (Right)

3.4 HUD Tool Implementation

The HUD Customisation tool was designed to be accessed easily by the player for the purpose of the user research. Upon the player hitting the button "esc", a panel will overlay on the screen to indicate that they are in a menu. Players are now able to drag and drop all the HUD elements on different parts of the screen, or even disable them (Figure 25).

Upon hitting the "esc" button again, they can seamlessly continue playing the game. This way players will not have to navigate through menus to find the ability to customise their HUD, reducing their cognitive load (Yablonski, J., 2020) and having them focus on the decision making process of creating their custom HUD.
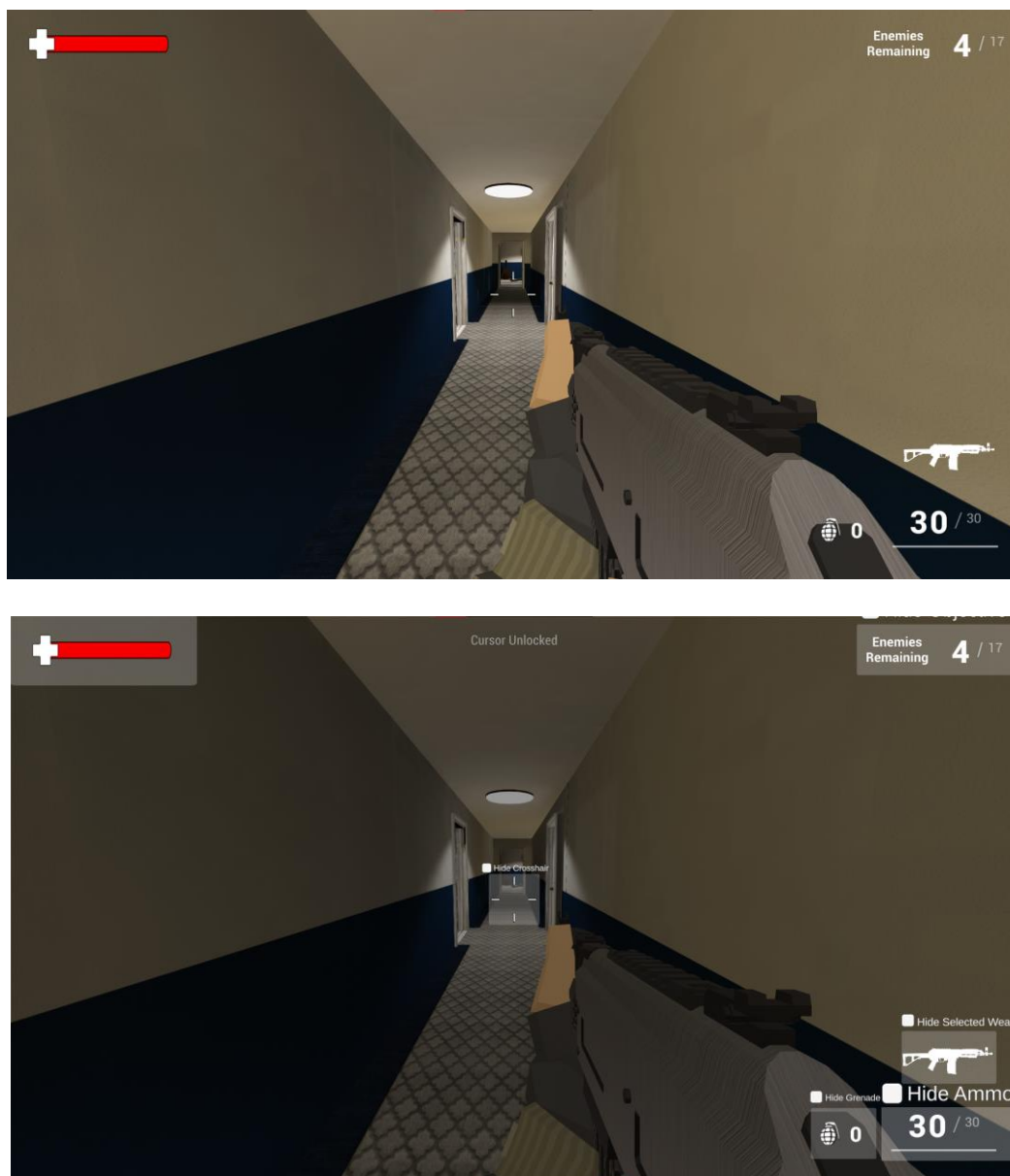
Figure 25: The game before and after activating the HUD Tool.

The HUD tool uses Unity's "IDragHandler" system to handle the movement of the elements. When the tool is enabled, every time the player holds down the left mouse button on the screen, the script detects the draggable objects below the mouse. If the mouse is hovering over a draggable HUD element, the element's position will be updated to the mouse's position. This way, players can smoothly drag and drop their HUD wherever they want on the screen.

Initially the drag and drop mechanic of the HUD Tool worked using Unity's Ray Cast 2D system and colliders. However, the system would be very unreliable, therefore it was replaced by the "IDragHandler" system, that provides the player a smoother experience.

Each HUD element comes with a check box above them, that allows players to hide said element if enabled. If players find an element unnecessary or obstructive, they can turn simply turn it off.

When the HUD tool is activated, each HUD element is surrounded by a grey panel. As illustrated by Figure 26 and Figure 27, to avoid an element being lost when disabled, upon enabling the HUD tool, a grey panel outlines the area where the element was located.
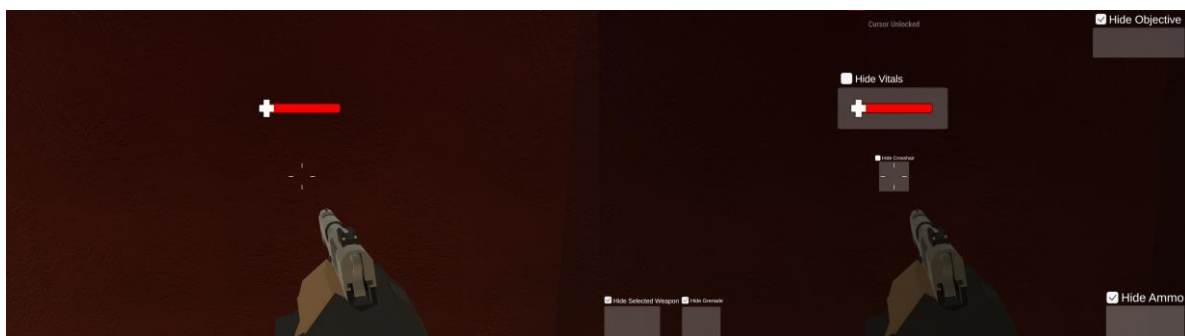
Figure 26: Player Screen with Vitals Enabled. (Left: HUD Tool disabled, Right: HUD Tool enabled)
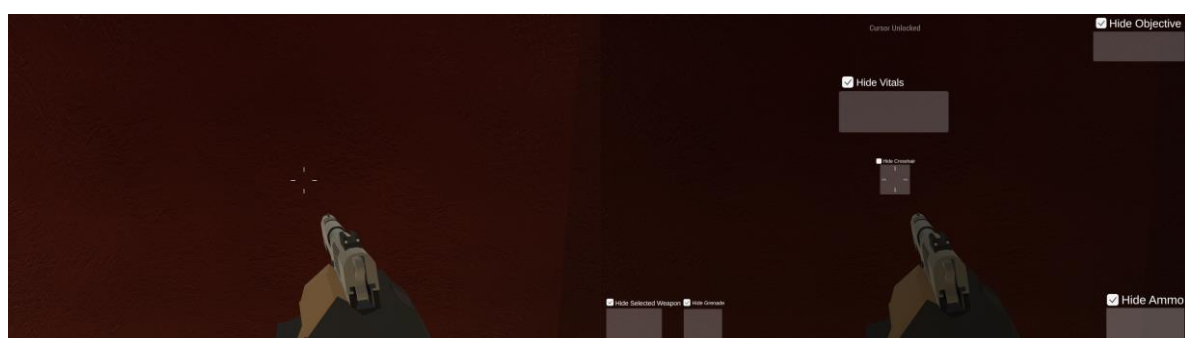
Figure 27: Player Screen with Vitals Disabled. (Left: HUD Tool disabled, Right: HUD Tool enabled)

4. Evaluation and Reflection

4.1 Methodology

4.1.1 Overview

To answer the research questions that were proposed, a 30 minute user study was conducted on 30 anonymous volunteer participants between the ages of 18-30 years of age. All participants had to read an information sheet and sign an agreement form, that informed them of their role in the study (7.2 Appendix 2: Participant Information Sheet).

After being selected based on their expertise in first-person shooters and playing the game that was created for the purposes of this study, they were prompted to answer a survey followed by a short semi-structured interview.

4.1.2 Risk Assessment

Prior to the study, an ethics and risk assessment form was filled out, it can be found in 7.1 Appendix 1: Ethics Checklist. The risk of the study was low. Participants were audio recorded during the interview upon taking part in the study. The audio recordings were used for transcription purposes and were promptly discarded.

4.1.2 Sampling

A convenience and snowball sample of experienced and inexperienced first person shooter players was achieved for this study. The participants were asked informal questions before being selected for the study, to estimate their expertise with the games.

During the study, they were asked to estimate how many hours they spent a week playing games, as well as their most commonly played games. They were promptly questioned as to how many of said hours are spent in FPS games.

With this information, participants were separated based on expertise in FPS games. Participants were deemed "*experienced"* if they played FPS games at least 5 hours a week, or, if one of their most played games was a first-person shooter. If a participant did not meet these requirements they were deemed as "*inexperienced*". To further support this, their performance was closely monitored during gameplay to ensure that their classification was accurate.

4.1.3 Game Study

Upon agreeing to take part in the study and signing the agreement form, participants were invited to play through the whole tutorial level from start to finish under supervision. They were not interrupted at any point, unless they asked for assistance, in which case their next step was hinted at. Each game playthrough lasted 10 to 15 minutes on average.

When they finished the level, the game was programmed to take a screenshot of the HUD they had designed. From this, a collection of captures was amassed to help

compare participants' HUDs to their most commonly played games.

4.1.4 Post-Game Survey

After finishing the game playthrough, participants are given a survey with two sections they have to fill out. The survey was made using *Google Forms*. The data from the survey was analysed using Python.

The first section focuses on questions to classify them based on their expertise, they are also less focused and more personal in order to ease the participants into the survey. Single choice questions were given on the frequency the participants play games. Open ended questions were allowed on their most played games and most played FPS games, since the range of possible answers in these questions where unknown (Drachen 2018, p. 150).

The second section focuses on their game experience and their use of the HUD customisation tool. First, they were given 7-point Likert-type to evaluate their game experience and difficulty. Consecutively they were asked to evaluate the HUD's impact on their game experience. Finally they were tasked with ranking the HUD elements they organised based on their usefulness.

4.1.5 Post-Game Interview

As the survey concluded, a short, semi structured interview was conducted on the participants on their actions during gameplay. Each interview was audio-recorded with the consent of the participants, and lasted 5 minutes on average.

Three of the interview questions were asked on all the participants, however, certain impromptu questions were asked if the participants showed unexpected behaviours during the gameplay session. If these unexpected behaviours were noticed, they were examined at the end of the session as suggested by Drachen (2018, p.167).

The questions during the interview were designed in a way to avoid leading the participant towards an answer, as suggested by Goodman (2012, p.131). Instead of asking "Did you find the ability to customise your HUD good?", which implies that the HUD had a positive impact on their experience, they were asked "Did the ability to customize your HUD impact your game experience? How?". This way participants would not be influenced in any way to give a specific response.

4.2 Findings

4.2.1 In-Game Screenshots

The collection of in game screenshots taken at the end of each participants' playthrough can be found in 7.4 Appendix 4: Participant HUD Screenshots.

4.2.2 Surveys

The surveys gathered information on the player expertise and game experience. The full survey results can be found in 7.5 Appendix 5: Participant Survey Responses.

The first five questions focused on classifying the participants based on their expertise in first person shooters.

Out of all the participants 15 were male (50%), 13 were female (43.3%) and 2 were non-binary (6.7%) (Figure 1). Furthermore, 16 were classed as *experienced* FPS players, while 14 were classed as *inexperienced*, having spent little time with FPS games. This classification was made from responses to the questions in Figure 29, Figure 30 and : Experienced Player's Most Played First-Person Shooter Games.

I am...
30 responses
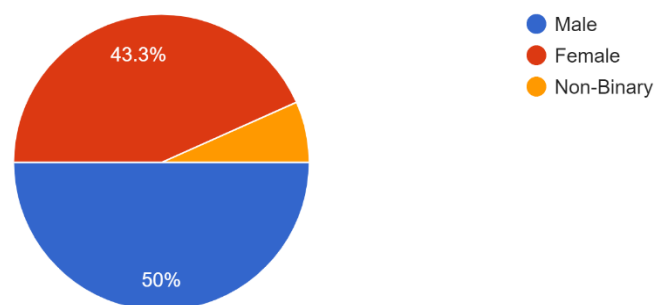
Figure 28: Question 1 Results

How many hours a week do you play video games?
30 responses
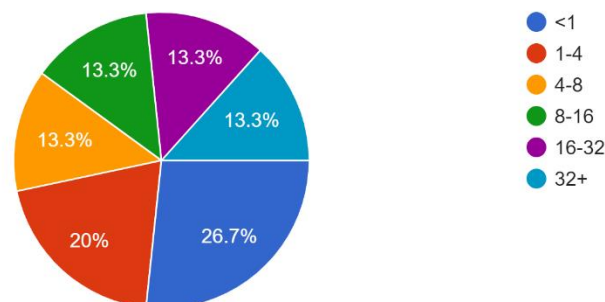
Figure 29: Question 2 Results

How many of those hours are dedicated to First Person Shooters?
30 responses
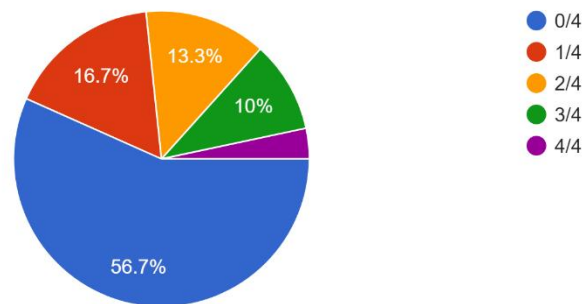
Figure 30: Question 3 Results

 Experienced players were asked to provide their most played first-person shooters. Table 4 includes all the first person shooter games and game franchises mentioned by them.

Table 4: Experienced Player's Most Played First-Person Shooter Games

Games	No. of player mentions
Call of Duty	7
Halo	4
Overwatch	2
Battlefield	2
Team Fortress 2	2
Counter Strike	2
Back 4 Blood	1
DayZ	1
Arma 3	1
Payday 2	1
Doom Eternal	1
HUNT: Showdown	1
Rainbow Six Siege	1
Destiny	1
Star Wars Battlefront 2	1

The following graphs (Figure 31, Figure 32, Figure 33) are from Section 2 of the Survey, which focused on the participant's game experience as a whole. It is seen that most participants had a pleasant game experience though they did not find the game very challenging.

On a Scale from 1 to 7 where 1 is Bad and 7 is Amazing how would you rate your game experience
30 responses
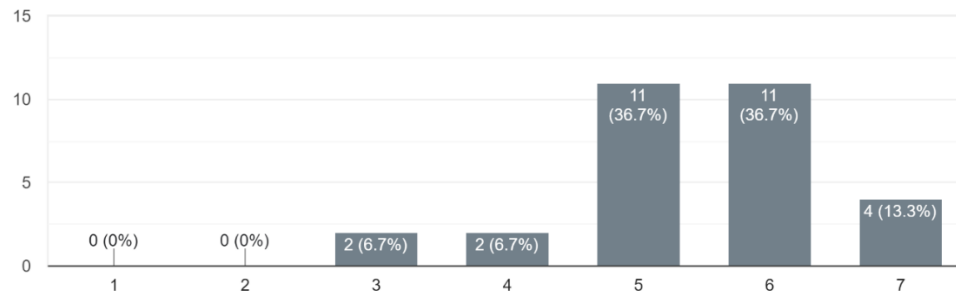
Figure 31: Question x Results

On a scale from 1 to 7 where 1 is No Impact and 7 is Significant Impact how would you rate the impact of the game's HUD on your game experience
30 responses
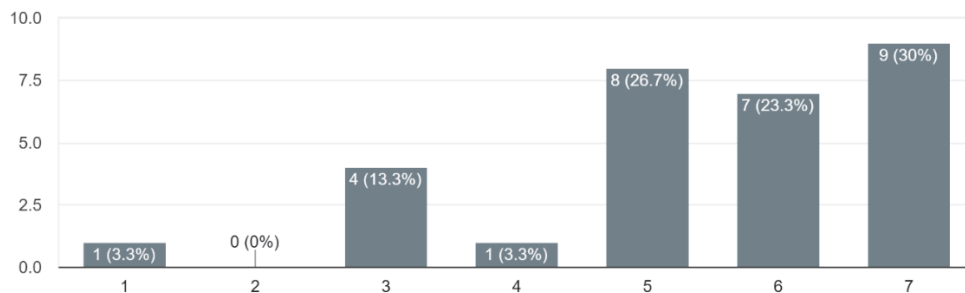
Figure 32: Question x Results

On a scale from 1 to 7 where 1 is Very Easy and 7 is Very Challenging how would you rate the difficulty of the game?
30 responses
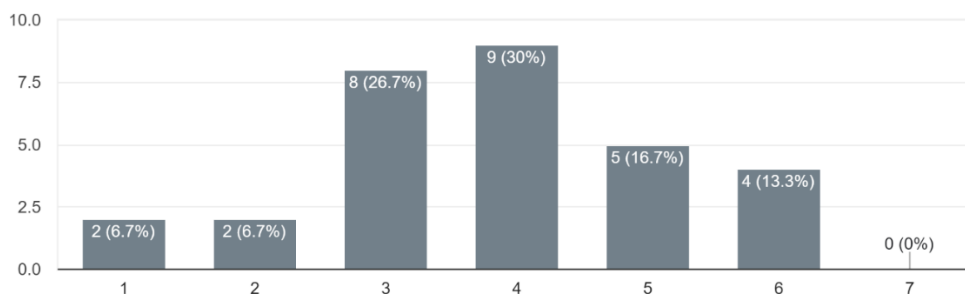
Figure 33: Question x Results

Following the general game experience questions, participants answered how they organized their HUD in the game. They were initially asked to communicate their composition (Figure 34: HUD elements Participants ended not hiding.Figure 34).

What HUD Elements did you end up having on your screen?
29 responses
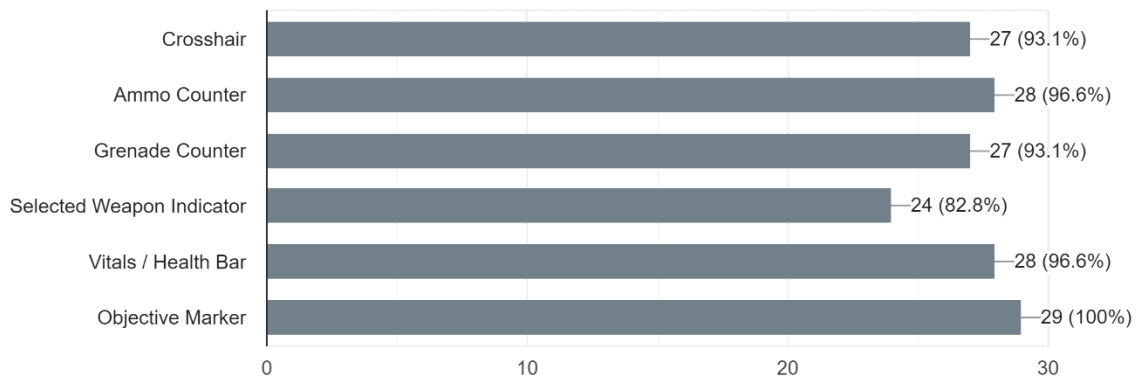
Figure 34: HUD elements Participants ended not hiding.

The graphs were made from data obtained from the surveys and they were processed using python and pandas. Each individual graph is titled after the HUD element position on the screen of the game.
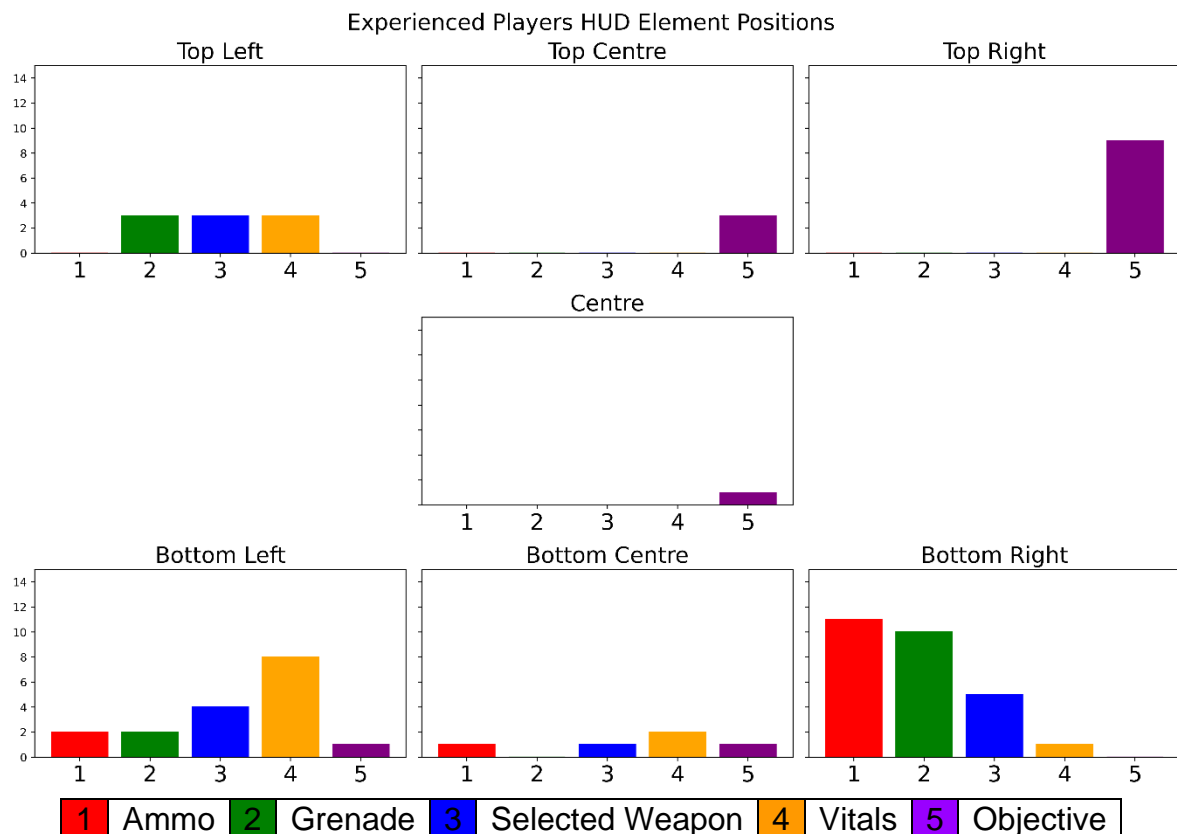
Figure 35: Experienced Player's HUD Element Spatial Organisation
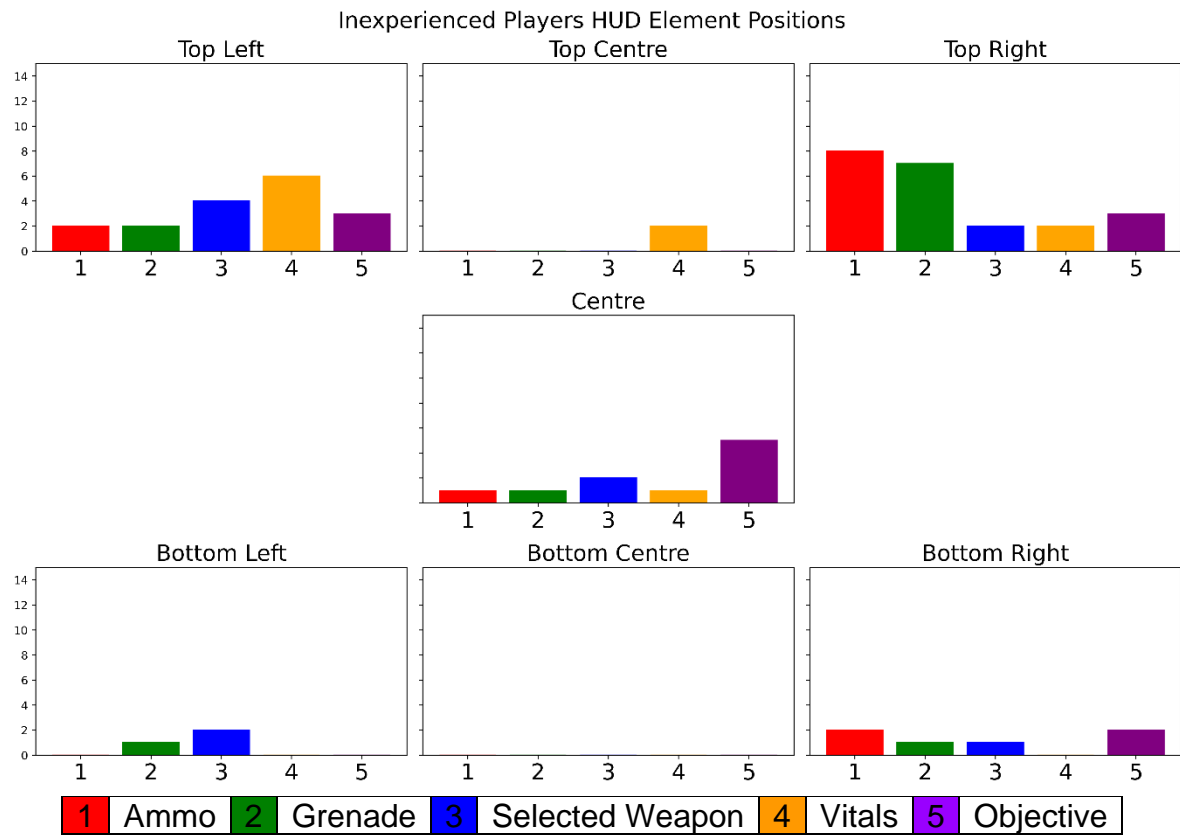
Figure 36: Inexperienced Player's HUD Element Spatial Organisation
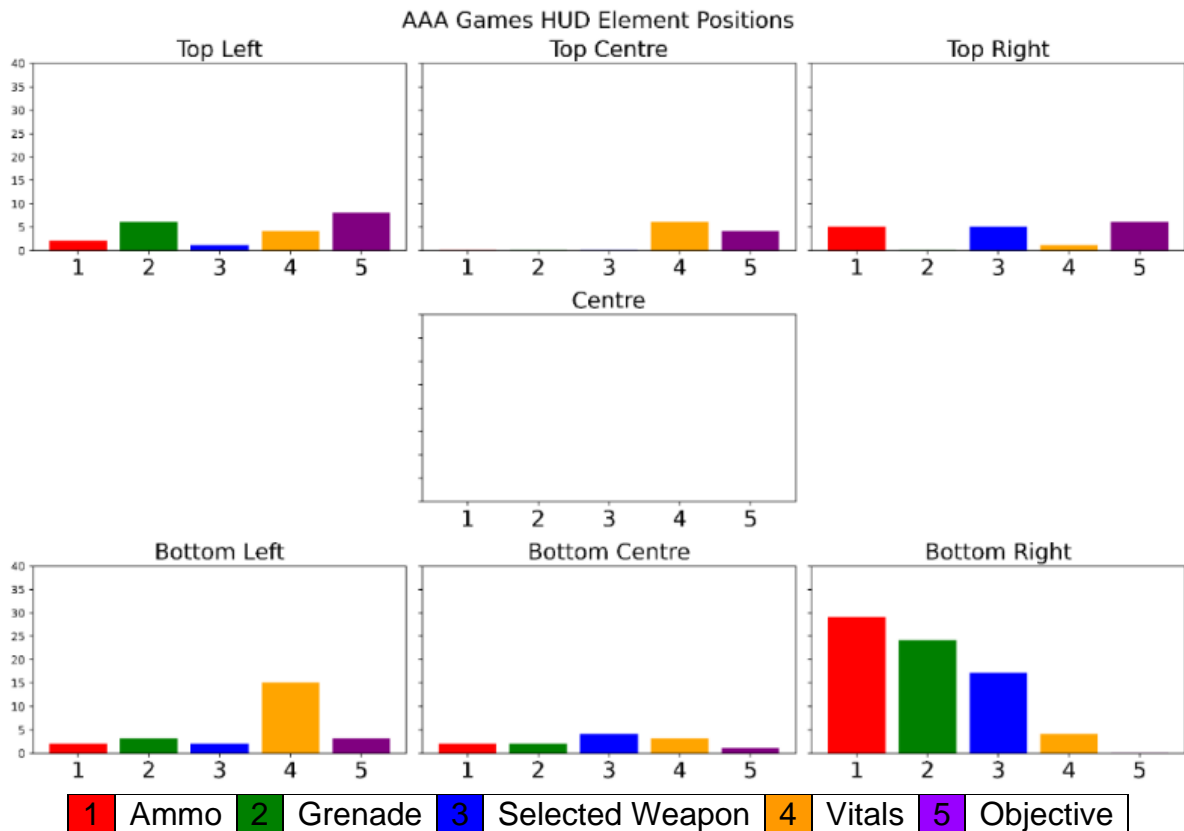
Figure 37: HUD Element Spatial Organisation present in AAA Games
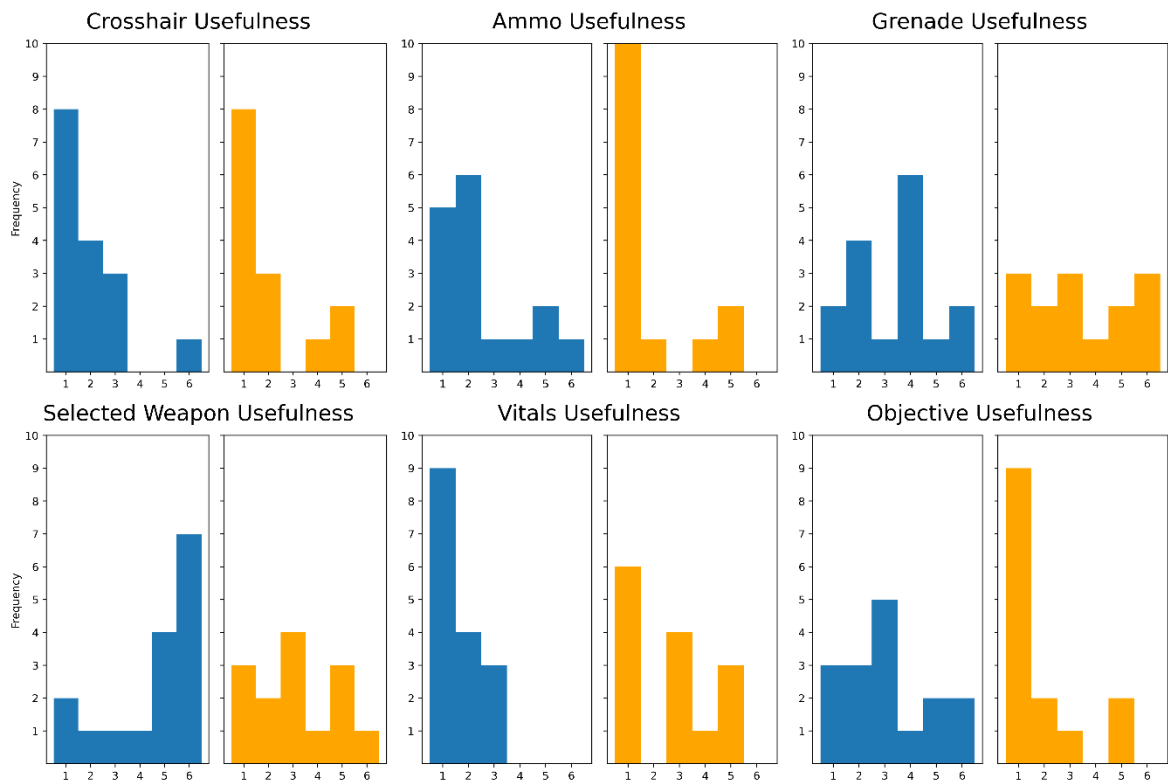
Figure 38: HUD Element Usefulness on a scale from 1 to 6, where one is very useful and 6 is not useful. Experienced participants are coloured blue and inexperienced participants are coloured orange.

4.2.3 Interviews

The responses from the interviews where analysed to extract common themes among the participants. This helped get a deeper understanding of player behaviour in regards to their interactions with the HUD and the HUD tool (Drachen, p.173). Three main themes where identified, based on the questions asked. Consecutively, codes were created for each theme, and where then categorised into sub-themes, resulting in the tables below (Table 5, Table 6, Table 7).

Definitions for the codes, and quotes from interviews associated to them can be found in 7.6 Appendix 6: Interview Codes.

Table 5: Interview Theme 1

HUD Design	
Sub-Theme	**Codes**
Desirable	Familiarity, Grouping elements, Intuitive
Undesirable	Order Bias, Uncertainty

Table 6: Interview Theme 2

HUD Element Evaluation	
Sub-Theme	**Codes**
Crosshair	Performance Enhancer
Ammo	Decision Maker, Secondary, Pointless
Grenade	Secondary, Pointless, Forgettable
Selected Weapon	Secondary, Pointless
Vitals	Decision Maker
Objective	Secondary

Table 7: Interview Theme 3

HUD Tool	
Sub-Theme	**Codes**
Positive Impact	Satisfaction, Avoiding Clutter, Freedom and Control, Easy to learn.
Negative Impact	Indifference, Feeling Forced

4.3 Analysis

RQ1: To what extent do experienced players design their HUD layouts based on the HUD layout of their most played games?

Two pieces of evidence to support the answer to this question have been gathered. First players assigned the positions they placed each HUD element on the survey, then they were asked to explain the reason behind their HUD's spatial organisation and composition during the interviews.

Starting with the position assigned, as seen in Figure 39 and Figure 40, most of the experienced participants set up a HUD similar to the most popular HUD seen in AAA first person shooter games.

Figure 39: Experienced Participants' HUD Layout (Left), HUD Layout found in AAA First Person Shooter Games (Right)

Figure 40: Approximation of the most Common HUD layout for experienced participants (Left) and the ones found in AAA Games (Right)

At a first glance, the resemblance between the HUD layouts seems to be nearly identical. The ammo and grenade elements are the ones that are most frequently seen on the bottom right in both charts. This could be because they are frequently seen grouped together in most games. If this is the case, the data could suggest that experienced players place their ammo and grenade HUD elements on the bottom right because they are used to it because of the games they play.

Additionally, the vitals most common position is on the bottom left, as seen on both instances in Figure 39.

However, the selected weapon element, while in the case of the experienced participants is not as consistent as the data seen in the AAA games. Experienced participants seem divided when placing the selected weapon element throughout their screen. While their most common placement for this element is the bottom right (38.5%), it cannot be assumed that this is because of AAA games' influence, since the spread of the element is wider compared to the previous two.

Consecutively, there is a similar occurrence with the objective element. Experienced participants deemed it was best placed on the top right (60%), while AAA games' position of this element does not appear to be consistent.

From the comparison between two graphs in Figure 39, it is noted that significant similarities exist between the placement of the ammo, grenade and vital HUD elements by experienced participants and AAA games.

This point can be further reinforced by analysing how inexperienced players set up their HUDs. If inexperienced players set up their HUD layouts differently AAA games HUD layouts, then it could be suggested that player expertise does influence experienced players' HUD layouts.
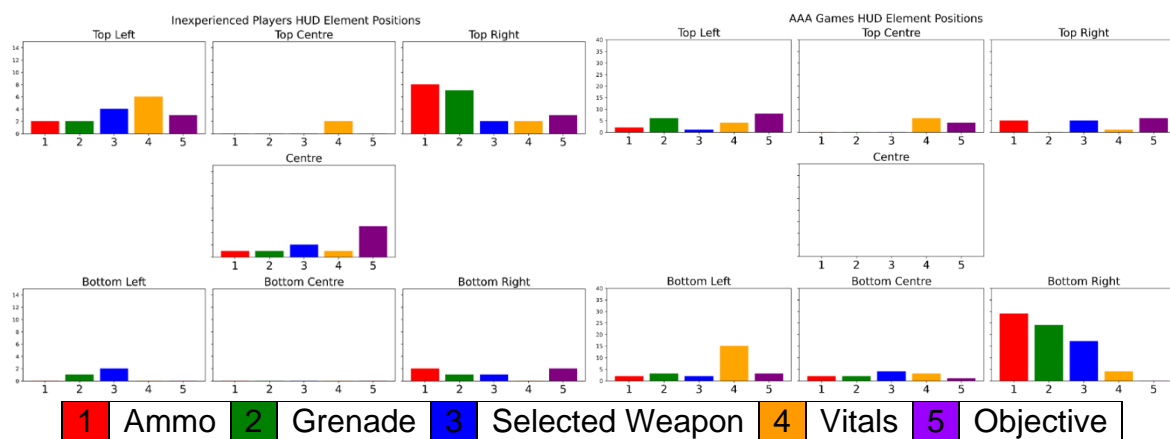
Figure 41: Inexperienced Participants' HUD Layout (Left), HUD Layout found in AAA First Person Shooter Games (Right)
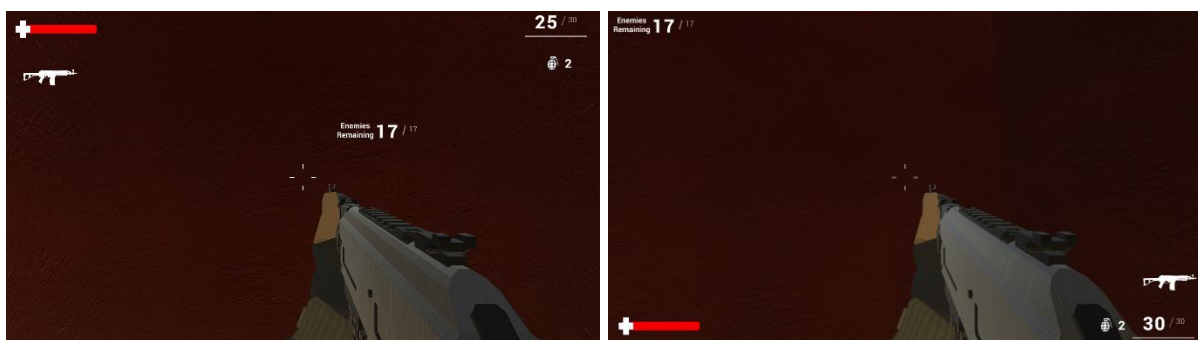
Figure 42: Approximation of the most Common HUD layout for inexperienced participants (Left) and the ones found in AAA Games (Right)

As proven in the figures above, it is evident that inexperienced participants have a significantly different layout on average than the one found in AAA games. Participants that have had minimal to no experience with first person shooters preferred having their ammo (61.5%) and grenade (58.3%) elements on the top right part of the screen. Furthermore, the most popular position for the Vitals is on the top left (54.5%). This is in great contrast to what is seen in experienced participants and AAA games. Hence it can be assumed that AAA games do in fact, have some degree of influence on the way experienced players set up their out HUD layouts.

It is also noted that novice participants prefer their HUD elements be placed on the top side of the screen rather than the bottom. This is in great contrast compared to AAA games, where most of the positions of the ammo, grenade, vitals, and selected weapon element positions are on the bottom side of the screen. It is suggested that this occurs due to the Jakob's Law (Yablonski 2020), meaning participants bring transferable skills from other applications they might have used in the past, outside of games.

To explain the participant behaviours seen in the graphs above, participants were questioned on their design decisions in the interviews. Their responses to the questions where categorised and codified and presented on the table below.

Table 8: Interview Codes on the Participant's HUD Design Choices (Interview Code definitions in 7.6.1 Theme 1: Participant HUD Design Decisions)

HUD Design	
Sub-Theme	**Codes**
Desirable	Familiarity, Grouping Elements, Intuitive
Undesirable	Order Bias, Uncertainty

For experienced players, 11 out of 16 of participants mentioned creating the HUD based on Familiarity. One participant even mentioned thinking of the HUD layout of their favourite game while designing theirs. When questioned on their design decisions P1 responds:

> "Being honest, I was sort of recreating the Overwatch HUD, I am quite used to having weapon information on the bottom right, health information on the bottom left. I put the objective marker at the top, yet again, I think that was Overwatch again…"

This is very evident in P1's HUD layout in Figure 43:

| 1 Ammo | 2 Grenade | 3 Selected Weapon | 4 Vitals | 5 Objective |
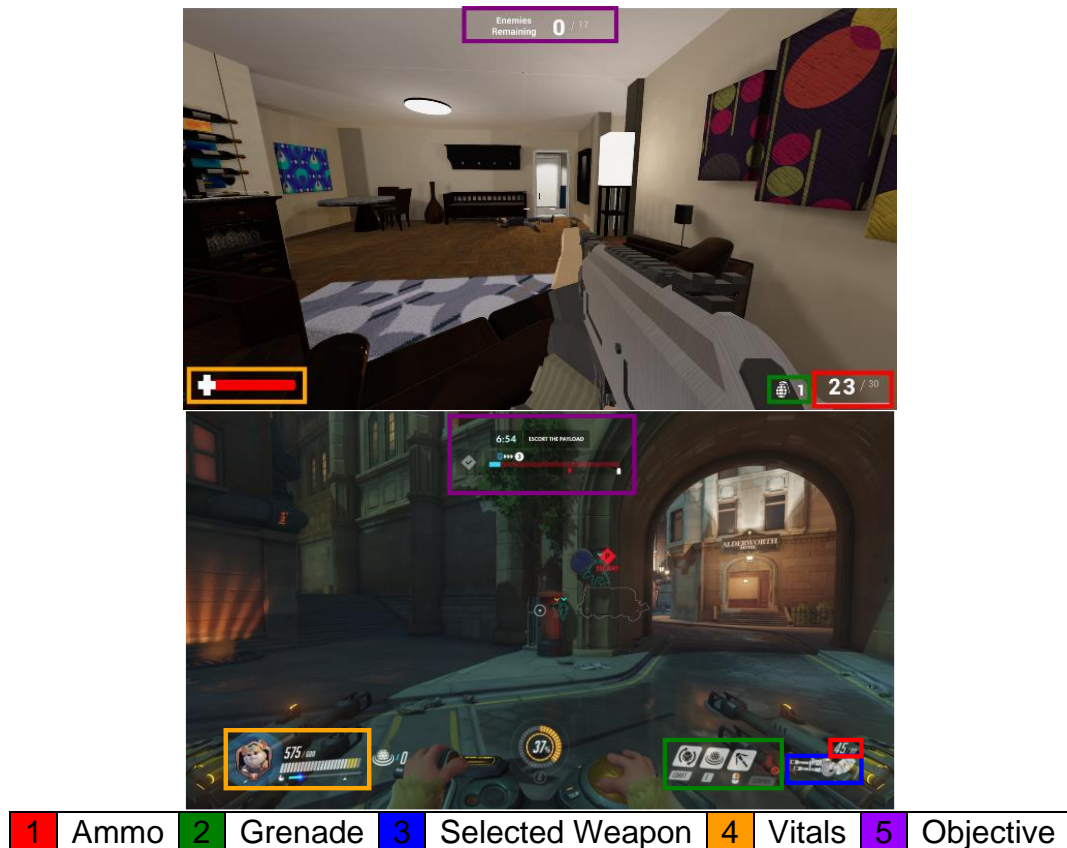
Figure 43: P1's HUD Design (Top) compared to Overwatch's HUD Design (Bottom)

However, P1 chose not to copy the Selected Weapon position present in their favourite game (Figure 43). They described the element as pointless, since the weapon is present on their screen. This could suggest that while the HUD layout of experienced players' can have some effect on their decision making when making their own, the composition of their favourite game has a lesser effect.

Another common reason behind experienced participants' HUD designs was grouping HUD elements that made sense together. P4 explains:

> "Stuff to do with the weapons I am used to having bottom right and I wanted them close together".

This can give context to the reason behind the ammo, grenade and selected weapon being very popular on the bottom right of the screen. Participants could be placing them there because they thought they fit together thematically, as they all give information about the players' *equipment status* (Fricker, 2012).

To summarize, experienced players are to a significant extent, influenced by their most played games. This influence is mostly seen on the spatial organization of the HUD, particularly on the ammo, grenade and vital HUD elements, as they are the most popular and consistently placed HUD elements in FPS games (Table 1). Nonetheless, when it came to composition, some players chose functionality over replication, hiding certain HUD elements even though they were present in their most played games.

The discussion on the impact of HUD customisation on the game experience will be split into two parts based on the two abilities the players had, composition and spatial organisation. Composition refers to the choice of hiding or showing the HUD elements that the players had at their disposal. Spatial organisation refers to the choice of positioning each individual HUD element on the screen.

Composition

When it comes to HUD composition, few players chose to hide elements to increase the challenge of the game. P21 chose to hide all the HUD elements. They explain:

> "Once I sort of knew the different information that was available to me, I decided the information that was necessary for me to play the game and I thought that as I didn't need to know the total ammo, it would add more challenge to not see it. Same with the crosshair, it would add more challenge if I hid it."

Many players mentioned the crosshair being a "performance enhancer" and the ammo being a "decision maker". By removing it two of the experienced players felt like they added a layer of challenge to the game.

Other players hid a few elements they considered "pointless". For example, P1 hid the selected weapon element because they thought it was redundant, even though it was present in their most played game (Figure 43).

Unfortunately, not many other players chose to hide many elements. Both novice and expert players mention feeling uncertain when it came to hiding a HUD element because either they didn't know its use, or they were not sure whether they were going to need it down the line. Others mentioned that "they didn't get in the way", hence there was no reason to hide them. It could be suggested that players didn't have enough time to get accustomed to the HUD elements in order to make such a decision.

Spatial Organisation

The feature that had a bigger impact on participants' game experience was the ability to customize their HUD's spatial organization. The most common feeling among experienced players was the fact that the HUD was "easier to learn". They describe that this was because they could set up the HUD elements similarly to how their favourite games have them organised, and it took them less time to get used to them. This is reinforced by *Jakob's Law* (Yablonski 2020), where users transfer skills from one experience to another.

Inexperienced players mentioned feeling in control of their own HUD. Eight participants mentioned they enjoyed the freedom the HUD tool gave them, as well as the control they had over the position of each individual element. Novice players feeling in control is crucial for the first stages of the game, as it increases the confidence, as P22 mentioned. Increased confidence in the basic game elements means that the novice player is able to overcome one of the barriers to engagement, allowing for increased immersion (Browne, Cairns 2004).

On the other hand, both novice and expert players mentioned that the HUD Tool had little to no impact to their game experience. They describe that while they did not mind the inclusion of the HUD tool, they wouldn't feel a significant difference between a predefined HUD and their own custom HUD.

Furthermore, an inexperienced participant mentioned feeling forced to interact with the HUD Tool. According to them, they felt pressured to move the HUD elements around, where they would rather spend time engaging with the shooter aspect of the game more. While not many participants mentioned this, it should be taken into consideration, as frustration can greatly harm a players engagement with a game ().

To conclude, the impact that the HUD customisation tool has on the player experience varies from player to player. Both expert and novice players mentioned similar feelings when interacting with the HUD tool. The overall feelings on the HUD tool were positive and could improve the game experience (Figure 44), however possible downsides were seen to have an adverse effect.
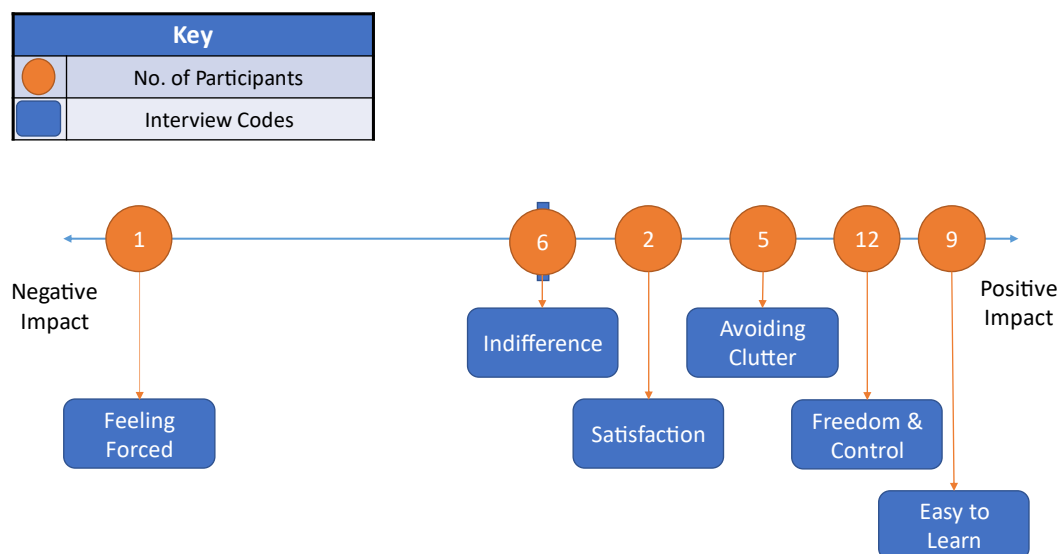
Figure 44: The impact of the HUD Tool on the game experience. (Interview Codes definitions found on Appendix 7.6.3 Theme 3: HUD Impact on the game Experience)

In order to answer this question participants were asked to rank the HUD elements based on their usefulness during the survey. An average was calculated for experienced and inexperienced participants to assess what elements each participant found most useful (Table 9). The smaller the average number, the more useful players found the HUD element. Results will be explained with responses given about each element through interviews.

Table 9: Average Usefulness Score on a scale from 1-6 per HUD element, where 1 is the most useful and 6 is the least useful (Based on Figure 38)

HUD Element	Experienced Players Mean Score	Inexperienced Players Mean Score	P Value
Crosshair	2.00	1.94	0.91
Ammo	2.50	1.86	0.28
Grenade	3.38	3.42	0.93
Selected Weapon	4.56	3.14	0.03
Vitals	1.63	2.64	0.04
Objective	3.13	1.86	0.04

Starting with the most significant difference between the two groups, the selected weapon element. The majority of experienced participants found the element pointless, claiming that they didn't need to have it because they could see their weapon in their hands. On the other hand, inexperienced participants were more divided on this topic. This may imply that experienced participants have stronger opinions about HUD elements they find less useful or that experienced participants prefer diegetic ways of receiving information.

Expert participants found the vitals HUD element to be very useful. Participants claimed that the element was a decision-maker, for example, they would make sure that their health bar was full before they engaged in combat. On the other hand, while inexperienced participants made the same claims on health bars, they rated them less useful. This might indicate that experienced participants put more emphasis on death than inexperienced participants.

Lastly, the objective marker. Novice participants found this element to be the most useful along the ammo element. They claimed that it was important for them to know what they are doing and where to go, and this element provided that information. Experienced players claimed that they were going to explore the whole map anyways, so this objective was not as important to them. This could illustrate the importance of guidance for new players to the FPS genre.

Unfortunately, the p values of the crosshair, ammo and grenades were not low enough to make comparisons between the two participant groups. However both groups did give insightful information on the elements themselves.

Participants stated that the crosshair was very useful to them because it helped them aim better, therefore improving their performance, and allowing them to die less. P19 claims that:

> "The crosshair is useful as it allows you to know where you are shooting and it can be difficult to aim without it."

While experienced participants found the ammo HUD element less useful than inexperienced participants, it cannot be claimed this was not a coincidence, because more responses would be needed on both sides. However interesting reasons were given by the experienced players on why they rated the element lower than inexperienced participants. They pointed out that the ammo element was not as useful due to the fact that ammo was unlimited, and knowing how many bullets were in their magazine was not necessary. They would reload after every engagement out of habit. Hence, it can be assumed that transferable skills some experienced players brought over from other games they played, rendered this specific element less useful.

The usefulness of the grenade element was divisive among both groups, and hence did not provide any significant differences. This might be because of the way they were implemented. Grenades were not necessary to beat the level so many players claimed that they did not need to use them, or that they forgot they were a mechanic. More participants would be needed to evaluate this element.

In conclusion, there was insightful differences between the way experienced and novice players rate different HUD elements. Experienced players found the vital elements more useful than novice players, as they seemed to prioritise game staying alive. Inexperienced participants found the objective marker most useful, as it gave it clearly defined their goals, something experienced players already knew. However, as mentioned above, the grenade, crosshair and ammo elements cannot be used reliably, as more participants are required to ensure that the data presented are not coincidences.

5. Conclusions and Future Work

5.1 Critical Reflection of the Project

While the game created for the purpose of this study is mostly clean of major bugs and performance issues, testing the game through 30 participants revealed a couple of points of improvement.

As mentioned in RQ3: How do players rate the usefulness of different HUD elements based on their experience? either the game design or the tutorial failed at convincing players to use the grenade mechanic more. Hence the results for the grenade HUD element's usefulness evaluation could not be accurately assessed.

Other than that the game would benefit from a more immersive tutorial. The tutorial could combine hints with narrative, and give more of a cohesive story rather than explicit instructions. This way the players would get a more authentic FPS experience rather than feeling they are playing a prototype. However, this implementation could confuse inexperienced participants if the hints were too vague, but it is considered that it would improve the overall game experience and authenticity.

5.2 Critical Reflection of the Study

As for the user study, while the target of 30 participants was reached, it was seen from calculations that, the usefulness evaluation of the grenade, ammo and crosshair HUD elements were not enough to be considered significant. It is believed that by doubling the number of participants, more a more accurate evaluation could be carried out for both groups of volunteers.

Other than that, eye tracking technology could be used during the study to evaluate the usefulness of the HUD elements. There was instances, though rare, that participants rated an individual element high on the list, but in the ensuing interview describing that they didn't actually find the element all that useful. Hence, rather than relying on participant memory, which can be unreliable, the study would be relying on a tool that would provide factual evidence.

Lastly, due to time constraints participants played through 15 minutes of the game. It is possible that with more time spent with the game, participant's opinions on the HUD organisation, composition and usefulness could change. It is possible that participants would interact with the composition of the HUD more if they had more time with the game.

5.3 Conclusion

To conclude, the aim of this study, to evaluate the effect of player expertise on the customisation of the heads-up display's spatial organisation, composition and effectiveness in first person shooter games. The study was inspired by the overuse of HUD elements in many modern first person shooters. The study was successful in identifying key differences in HUD layouts between novice and experienced players. It was proven that experienced participants are, to a large extent, influenced by modern FPS HUD displays when making their own, while inexperienced participants might be influenced by other applications they might use. Experienced participants found HUD elements that kept them alive for longer most useful, while novice participants found HUD elements that gave them contextual information most useful.

The impact of the HUD Customisation tool was very positive, and a suggestion is made for future first person shooter games, to include a similar version to the HUD tool, where players can modify the position and hide each individual HUD element, in a way that does not force the players to interact with it.

Future study suggestions include inviting the player to choose between a predefined HUD or allow them to create their own using a version of the HUD Customisation Tool, to evaluate whether players would rather customise their own HUD at the beginning of the game, or prefer to get straight into the game instead.

6 References

6.1 Academic References

1   Adinolf, S. and Turkay, S., 2011, June. Controlling your game controls: Interface and customization. In Proceedings of the 7th international conference on Games+ Learning+ Society Conference (pp. 13-22).

2   Andersen, E., O'rourke, E., Liu, Y.E., Snider, R., Lowdermilk, J., Truong, D., Cooper, S. and Popovic, Z., 2012, May. The impact of tutorials on games of varying complexity. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (pp. 59-68).

3   Bowman, B., Elmqvist, N. and Jankun-Kelly, T.J., 2012. Toward visualization for games: Theory, design space, and patterns. IEEE transactions on visualization and computer graphics, 18(11), pp.1956-1968.

4   Brooksby, A., 2008. Exploring the representation of health in videogames: a content analysis. CyberPsychology & Behavior, 11(6), pp.771-773.

5   Brown, E. and Cairns, P., 2004, April. A grounded investigation of game immersion. In CHI'04 extended abstracts on Human factors in computing systems (pp. 1297-1300).

6   Browne, K. and Anand, C., 2012. An empirical evaluation of user interfaces for a mobile video game. Entertainment Computing, 3(1), pp.1-10.

7   Cairns, P., Pandab, P. and Power, C., 2014, April. The influence of emotion on number entry errors. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (pp. 2293-2296).

8   Cardamone, L., Yannakakis, G.N., Togelius, J. and Lanzi, P.L., 2011. Evolving interesting maps for a first person shooter. In Applications of Evolutionary Computation: EvoApplications 2011: EvoCOMPLEX, EvoGAMES, EvoIASP, EvoINTELLIGENCE, EvoNUM, and EvoSTOC, Torino, Italy, April 27-29, 2011, Proceedings, Part I (pp. 63-72). Springer Berlin Heidelberg.

9   Caroux, L. and Isbister, K., 2016. Influence of head-up displays' characteristics on user experience in video games. International Journal of Human-Computer Studies, 87, pp.65-79.

10 Caroux, L., Isbister, K., Le Bigot, L. and Vibert, N., 2015. Player–video game interaction: A systematic review of current concepts. Computers in human behavior, 48, pp.366-381.

11 Caroux, L., Le Bigot, L. and Vibert, N., 2011. Maximizing players' anticipation by applying the proximity-compatibility principle to the design of video games. Human Factors, 53(2), pp.103-117.

12 Drachen, A., Mirza-Babaei, P. and Nacke, L.E. eds., 2018. Games user research. Oxford University Press.

13 Fagerholt, E. and Lorentzon, M., 2009. Beyond the HUD-user interfaces for increased player immersion in FPS games.

14 Federoff, M.A., 2002. Heuristics and usability guidelines for the creation and evaluation of fun in video games (Doctoral dissertation, Indiana University).

15 Fragoso, S., 2014. Interface design strategies and disruptions of gameplay: Notes from a qualitative study with first-person gamers. In Human-Computer Interaction. Applications and Services: 16th International Conference, HCI

International 2014, Heraklion, Crete, Greece, June 22-27, 2014, Proceedings, Part III 16 (pp. 593-603). Springer International Publishing.

16 Fricker, H., 2012. Game user-interface guidelines: creating a set of usability design guidelines for the FPS game user-interface (Doctoral dissertation, University of Huddersfield).

17 Galuzin, A., 2016. Preproduction blueprint: How to plan game environments and level designs. World of Level Design.

18 Goodman, E. and Kuniavsky, M., 2012. Observing the user experience: A practitioner's guide to user research. Elsevier.

19 Grimshaw, M., 2007. Sound and immersion in the first-person shooter.

20 Iacovides, I., Cox, A., Kennedy, R., Cairns, P. and Jennett, C., 2015, October. Removing the HUD: the impact of non-diegetic game elements and expertise on player involvement. In Proceedings of the 2015 Annual Symposium on Computer-Human Interaction in Play (pp. 13-22).

21 Isbister, K, & Hodent, C (eds) 2022, Game Usability : Advice from the Experts for Advancing UX Strategy and Practice in Videogames, Taylor & Francis Group, Milton. Available from: ProQuest Ebook Central.

22 Jennett, C., Cox, A.L., Cairns, P., Dhoparee, S., Epps, A., Tijs, T. and Walton, A., 2008. Measuring and defining the experience of immersion in games. International journal of human-computer studies, 66(9), pp.641-661.

23 Llanos, S.C. and Jørgensen, K., 2011, September. Do players prefer integrated user interfaces? A qualitative study of game UI design issues. In Proceedings of DiGRA 2011 Conference: Think Design Play (pp. 1-12).

24 Llanos, S.C., 2013. What Does the HUD Tell Us?: The Heads Up Display: as a Meta-communication in Videogames. In HCI International 2013-Posters' Extended Abstracts: International Conference, HCI International 2013, Las Vegas, NV, USA, July 21-26, 2013, Proceedings, Part II 15 (pp. 713-717). Springer Berlin Heidelberg.

25 Loh, C.S. and Sheng, Y., 2015. Measuring the (dis-) similarity between expert and novice behaviors as serious games analytics. Education and Information Technologies, 20, pp.5-19.

26 Marre, Q., Caroux, L. and Sakdavong, J.C., 2021. Video game interfaces and diegesis: the impact on experts and novices' performance and experience in virtual reality. International Journal of Human–Computer Interaction, 37(12), pp.1089-1103.

27 Nacke, L.E. and Lindley, C.A., 2010. Affective ludology, flow and immersion in a first-person shooter: Measurement of player experience. arXiv preprint arXiv:1004.0248.

28 Norman, D., 2013. The design of everyday things: Revised and expanded edition. Basic books.

29 Peacocke, M., Teather, R.J. and Carette, J., 2014, October. Diagetic vs. non-diagetic game displays. In 2014 IEEE Games Media Entertainment (pp. 1-2). IEEE.

30 Peacocke, M., Teather, R.J., Carette, J. and MacKenzie, I.S., 2015, October. Evaluating the effectiveness of HUDs and diegetic ammo displays in first-person

shooter games. In 2015 IEEE Games Entertainment Media Conference (GEM) (pp. 1-8). IEEE.

31 Peacocke, M., Teather, R.J., Carette, J., MacKenzie, I.S. and McArthur, V., 2018. An empirical comparison of first-person shooter information displays: HUDs, diegetic displays, and spatial representations. Entertainment computing, 26, pp.41-58.

32 Rosyid, H.A., Pangestu, A.Y. and Akbar, M.I., 2021, October. Can Diegetic User Interface Improves Immersion in Role-Playing Games?. In 2021 7th International Conference on Electrical, Electronics and Information Engineering (ICEEIE) (pp. 200-204). IEEE.

33 Shneiderman, B., Plaisant, C., Cohen, M.S., Jacobs, S., Elmqvist, N. and Diakopoulos, N., 2016. Designing the user interface: strategies for effective human-computer interaction. Pearson.

34 Thevathasan, M., 2014. Modeling HUD Layouts for Selection Based Video Games (Doctoral dissertation).

35 Yablonski, J., 2020. Laws of UX: Using psychology to design better products & services. O'Reilly Media.

6.2 Bibliography

36 Harrison, C.B. (2018). When it comes to HUD, Less UI can be more UX. [online] Medium. Available at: https://blog.prototypr.io/when-it-comes-to-hud-less-ui-can-be-more-ux-e77eb20d2f7a [Accessed 10 March 2023]. Clement, J. (2021).

37 Leading gaming genres worldwide 2020. [online] Available at: https://www.statista.com/statistics/240990/global-online-games-genre-breakdown/. [Accessed 10 March 2023].

6.3 Ludography Digital References

38 Aaron, 2018. Airbus A320 Cockpit - MUC to CGN Jumpseat Experience! – Pilotstories [photograph]. Available at: https://pilotstories.net/airbus-a320-cockpit/

39 Blizzard Entertainment, 2016. Overwatch [video game].

40 Booked.net, n.d. 1274821348.jpg [photograph]. Available from: https://continental-hotel-budapest.booked.net/#lg=331657&slide=1274821348 [Accessed 13 January 2023]

41 Booking.com, n.d. *435990980.jpg* [photograph]. Available from: https://www.booking.com/hotel/fr/achotelnice.en-gb.html?activeTab=photosGallery [Accessed 13 January 2023]

42 Brick Project Studio, 2022. *Apartment Kit*. Unity Asset Store. Available from: https://assetstore.unity.com/packages/3d/environments/apartment-kit-124055 [Accessed 13 January 2023]

43 Broken Vector, 2018. *Low Poly Cars*. Unity Asset Store. Available from: https://assetstore.unity.com/packages/3d/vehicles/land/low-poly-cars-101798 [Accessed 13 January 2023]

44 Clipground, n.d. *Grenade Clipart* [photograph]. Available from: https://clipground.com/grenade-clipart.html [Accessed 13 January 2023]

45 Corinthia Hotel London, n.d. *Untitled* [photograph]. Available from: https://www.kiwicollection.com/hotel-detail/corinthia-hotel-london [Accessed 13 January 2023]

46 DICE, 2011. Battlefield 3 [video game]. Electronic Arts.

47 DICE, 2013. Battlefield 4 [video game]. Electronic Arts.

48 DICE, 2021. Battlefield 2042 [video game]. Electronic Arts.

49 Disabled Access Holidays.com, n.d. Lobby [photograph]. Available from: https://www.disabledaccessholidays.com/disabled-holidays/wheelchair-accessible-accommodation/Toronto_City_Breaks_Sheraton_Centre.asp [Accessed 13 January 2023]

50 Game Stuff Studio, 2018. *Grenades Lowpoly*. Unity Asset Store. Available from: https://assetstore.unity.com/packages/3d/props/grenades-lowpoly-120047 [Accessed 13 January 2023]

51 Hotel Windsor, 2008. Melbourne Windsor Hotel Lobby.jpg [photograph]. Available from: https://commons.wikimedia.org/wiki/File:Melbourne_Windsor_Hotel_Lobby.jpg

52 Id Software, 1993. *Doom* (1993) [video game].

53 Infima Games, 2021. *Low Poly Shooter Pack - Free Sample*. Unity Asset Store. Available from: https://assetstore.unity.com/packages/templates/systems/low-poly-shooter-pack-free-sample-144839 [Accessed 13 January 2023]

54 LateRooms.com, n.d. 127721806.jpg [photograph]. Available from: https://www.laterooms.com/en/hotel-reservations/89304_jurys-inn-southampton.aspx

55 New World Interactive, 2018. Insurgency: Sandstorm [video game].

56 NumFOCUS, Inc. 2009. Pandas [2023]. [computer program].

57 Python Software Foundation, 2000. Python 2.0. [computer program].

58 Retail Design Blog, n.d. *Historic site transformed into luxury hotel by BLINK Design Group, Shanghai – China* [photograph]. Available from: https://www.pinterest.es/pin/113504853092612124/

59 Rovio, 2012. *Angry Birds* [video game].

60 u/Tronika, 2012. *Ammo part of the HUD, the bar with a lock in it... what is it?* [screenshot]. Available from: https://www.reddit.com/r/battlefield3/comments/osbdx/ammo_part_of_the_hud_the_bar_with_a_lock_in_it/

61 Unity Technologies, 2021. *Unity [2021.3.9f1].* [computer program].

7 Appendices

7.1 Appendix 1: Ethics Checklist

Bournemouth University

Research Ethics Checklist

About Your Checklist

Ethics ID	48635
Date Created	01/03/2023 13:36:19
Status	Approved
Date Approved	25/04/2023 08:49:01
Risk	Low

Researcher Details

Name	George Karambasis Rodriguez (s5215512)
Faculty	Faculty of Science & Technology
Status	Undergraduate (BA, BSc)
Course	BSc (Hons) Games Design

Project Details

Title	Evaluating the most reoccurring HUD elements in first person shooter games
Start Date of Project	06/02/2023
End Date of Project	22/05/2023
Proposed Start Date of Data Collection	16/04/2023
Supervisor	Vedad Hulusic
Approver	Vedad Hulusic

Summary - no more than 600 words (including detail on background methodology, sample, outcomes, etc.)
The project will involve the making of a game that will be used as part of a user study in order to evaluate the involvement of the heads-up displays in the player experience.

Filter Question: Does your study involve Human Participants?

Participants

Describe the number of participants and specify any inclusion/exclusion criteria to be used
I will need at least 30 participants. They will be adults from the ages of 18 to 30. I am looking for both experienced and inexperienced gamers. Ideally a balanced male to female ratio will be present.

Do your participants include minors (under 16)?	No

Are your participants considered adults who are competent to give consent but considered vulnerable?	No
Is a Disclosure and Barring Service (DBS) check required for the research activity?	No

Recruitment

Please provide details on intended recruitment methods, include copies of any advertisements.	
I am going to recruit from my course mates and friends of friends.	
Do you need a Gatekeeper to access your participants?	No

Data Collection Activity

Will the research involve questionnaire/online survey? If yes, don't forget to attach a copy of the questionnaire/survey or sample of questions.	Yes
How do you intend to distribute the questionnaire?	
face to face	
Will the research involve interviews? If Yes, don't forget to attach a copy of the interview questions or sample of questions	Yes
Please provide details e.g. where will the interviews take place. Will you be conducting the interviews or someone else?	
I will be conducting the interviews and they will take place in the University Campus	
Will the research involve a focus group? If yes, don't forget to attach a copy of the focus group questions or sample of questions.	No
Will the research involve the collection of audio recordings?	Yes
Will your research involve the collection of photographic materials?	Yes
Will your research involve the collection of video materials/film?	Yes
Will any photographs, video recordings or film identify an individual?	No
Please provide details	
Screenshots and video clips will be taken solely of the game. No audio or video will be recorded of the participant	
Will any audio recordings (or non-anonymised transcript), photographs, video recordings or film be used in any outputs or otherwise made publicly available?	No
Will the study involve discussions of sensitive topics (e.g. sexual activity, drug use, criminal activity)?	No
Will any drugs, placebos or other substances (e.g. food substances, vitamins) be administered to the participants?	No
Will the study involve invasive, intrusive or potential harmful procedures of any kind?	No
Could your research induce psychological stress or anxiety, cause harm or have negative consequences for the participants or researchers (beyond the risks encountered in normal life)?	No
Will your research involve prolonged or repetitive testing?	No

What are the potential adverse consequences for research participants and how will you minimise them?

Consent

Describe the process that you will be using to obtain valid consent for participation in the research activities. If consent is not to be obtained explain why.
I will be giving the participant a copy of a filled in participant information sheet. They will have to sign it to consent in taking part in the study.

Do your participants include adults who lack/may lack capacity to give consent (at any point in the study)?	No
Will it be necessary for participants to take part in your study without their knowledge and consent?	No

Participant Withdrawal

At what point and how will it be possible for participants to exercise their rights to withdraw from the study?
At any point during the study

If a participant withdraws from the study, what will be done with their data?
If it is during the study, their data will be deleted and not used for the study. If it is after the study has concluded, the data will be anonymous and unidentifiable, hence it would not be possible to delete the specific data to a participant.

Participant Compensation

Will participants receive financial compensation (or course credits) for their participation?	No
Will financial or other inducements (other than reasonable expenses) be offered to participants?	No

Research Data

Will identifiable personal information be collected, i.e. at an individualised level in a form that identifies or could enable identification of the participant?	No
Will research outputs include any identifiable personal information i.e. data at an individualised level in a form which identifies or could enable identification of the individual?	No

Storage, Access and Disposal of Research Data

Where will your research data be stored and who will have access during and after the study has finished.
The data will be stored in a Personal Computer and potentially a Cloud Storage. The individuals with access to the data during the study will be the researcher and the project supervisors.

Once your project completes, will your dataset be added to an appropriate research data repository such as BORDaR, BU's Data Repository?	No

Please explain why you do not intend to deposit your research data on BORDaR? E.g. do you intend to deposit your research data in another data repository (discipline or funder specific)? If so, please provide details.
UG Student

Final Review	
Are there any other ethical considerations relating to your project which have not been covered above?	No

Risk Assessment	
Have you undertaken an appropriate Risk Assessment?	No

Filter Question: Does your study involve the use or re-use of data which will be obtained from a source other than directly from a Research Participant?

Additional Details	
Please describe the data, its source and how you are permitted to use it	The data will be the age, gender and answers to questions related to the HUD study. It will be sourced from the interviews and/or questionnaires that the participants will respond to. It will be used for this project and potentially future projects that could use the results of this study.

Attached documents
Participant Information Sheet (s5215512)_V1.docx - attached on 02/03/2023 12:58:11
Participant Agreement Form (s5215512)_V1.docx - attached on 02/03/2023 13:54:51
Participant Agreement Form (s5215512)_V1_VH.docx - attached on 28/03/2023 16:49:04
Participant Information Sheet (s5215512)_V1_VH.docx - attached on 28/03/2023 16:49:04
Participant Agreement Form (s5215512)_V1_VH.docx - attached on 13/04/2023 17:42:43
Participant Information Sheet (s5215512)_V2.docx - attached on 13/04/2023 17:45:15
Participant Agreement Form (s5215512)_V2.docx - attached on 13/04/2023 17:45:22
Participant Agreement Form (s5215512)_V3.docx - attached on 24/04/2023 16:24:27

7.2 Appendix 2: Participant Information Sheet

BU
Bournemouth
University

Participant Information Sheet

The title of the research project

Evaluating the most reoccurring HUD elements in first person shooter games

Invitation to take part

You are being invited to take part in a research project. Before you decide it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Ask us if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part.

What is the purpose of the project?

The project will involve the making of a game that will be used as part of a user study in order to evaluate the involvement of the heads-up displays in the player experience.

Why have I been chosen?

Because you are between the ages of 18-30 and have at least some knowledge of video games.

Do I have to take part?

It is up to you to decide whether or not to take part. If you do decide to take part, you will be given this information sheet to keep and be asked to sign a participant agreement form. We want you to understand what participation involves, before you make a decision on whether to participate.

If you or any family member have an on-going relationship with BU or the research team, e.g. as a member of staff, as student or other service user, your decision on whether to take part (or continue to take part) will not affect this relationship in any way.

Can I change my mind about taking part?

Yes, you can stop participating in study activities at any time and without giving a reason.

If I change my mind, what happens to my information?

After you decide to withdraw from the study, we will not collect any further information from or about you.

As regards to the information we have already collected before this point, it will be scrapped and excluded from the study.

What would taking part involve?

You will be playing through a prototype game tutorial of a first person shooter from start to end. Then you will be asked to fill in a questionnaire and/or and take part in an interview. The whole duration of the study will take up to 45 minutes.

Will I be reimbursed for taking part?
No.

What are the advantages and possible disadvantages or risks of taking part?

Whilst there are no immediate benefits for those people participating in the project, it is hoped that this work will ~~build~~ inform the research and gaming community of the impact of the HUD and its elements in first person shooters.

This study does not entail any risks for you.

What type of information will be sought from me and why is the collection of this information relevant for achieving the research project's objectives?

The information recorded will be the answers you give to the interviews/questionnaires. Your gender and age will be noted but no personal details to identify you will be recorded.

Will I be recorded, and how will the recorded media be used?

The audio recording of the interview and video recordings of your activities made during this research will be used only for analysis and the transcription of the recording(s) for illustration in conference presentations and lectures. No other use will be made of them without your written permission, and no one outside the project will be allowed access to the original recordings. All recordings will be used as anonymous.

I

How will my information be managed?

Bournemouth University (BU) is the organisation with overall responsibility for this study and the Data Controller of your personal information, which means that we are responsible for looking after your information and using it appropriately.   Research is a task that we perform in the public interest, as part of our core function as a university.

Undertaking this research study involves collecting and/or generating information about you. We manage research data strictly in accordance with:

- Ethical requirements; and
- Current data protection laws. These control use of information about identifiable individuals, but do not apply to anonymous research data: "anonymous" means that we have either removed or not collected any pieces of data or links to other data which identify a specific person as the subject or source of a research result.

BU's Research Participant Privacy Notice sets out more information about how we fulfil our responsibilities as a data controller and about your rights as an individual under the data protection legislation. We ask you to read this Notice so that you can fully understand the basis on which we will process your personal information.

Research data will be used only for the purposes of the study or related uses identified in the Privacy Notice or this Information Sheet. To safeguard your rights in relation to your personal information, we will use the minimum personally-identifiable information possible and control access to that data as described below.

Publication
You will not be able to be identified in any external reports or publications about the research without your specific consent.   Otherwise your information will only be included in these materials in an anonymous form, i.e. you will not be identifiable.

Security and access controls
BU will hold the information we collect about you in hard copy in a secure location and on a BU password protected secure network where held electronically.

Personal information which has not been anonymised will be accessed and used only by appropriate, authorised individuals and when this is necessary for the purposes of the research or another purpose identified in the Privacy Notice. This may include giving access to BU staff or others responsible for monitoring and/or audit of the study, who need to ensure that the research is complying with applicable regulations.

The audio interviews will be transcribed and linked with the other data using an ID, thus making it anonymous. The original audio recordings will then be permanently deleted. All other data recorded will be completely anonymous.

Sharing your personal information with third parties
As well as BU staff and the BU student working on the research project, we will not need to share personal information in non-anonymised way with anyone.

Further use of your information
The information collected about you may be used in an anonymous form to support other research projects in the future and access to it in this form will not be restricted. It will not be possible for you to be identified from this data.

Keeping your information if you withdraw from the study
If you withdraw from active participation in the study we will keep information which we have already collected from or about you, if this has on-going relevance or value to the study. This may include your personal identifiable information. As explained above, your legal rights to access, change, delete or move this information are limited as we need to manage your information in specific ways in order for the research to be reliable and accurate. However if you have concerns about how this will affect you personally, you can raise these with the research team when you withdraw from the study.

You can find out more about your rights in relation to your data and how to raise queries or complaints in our Privacy Notice.

Retention of research data

Project governance documentation, including copies of signed participant agreements: we keep this documentation for a long period after completion of the research, so that we have records of how we conducted the research and who took part. The only personal information in this documentation will be your name and signature, and we will not be able to link this to any anonymised research results.

Research results:

As described above, during the course of the study we will anonymise the information we have collected information about you as an individual. This means that we will not hold your personal information in identifiable form after we have completed the research activities.

You can find more specific information about retention periods for personal information in our Privacy Notice.

We keep anonymised research data indefinitely, so that it can be used for other research as described above.

Finally

If you decide to take part, you will be given a copy of the information sheet and a signed participant agreement form to keep.

Thank you for considering taking part in this research project.

7.3 Appendix 3: AAA Game HUD Elements

Games	Vitals	Vitals_Pos	Vitals_Design	Minimap	Minimap_Pos	Minimap_Design	Ammo	Ammo_Pos	Ammo_Design	Compass	Compass_Pos	Compass_Design	Crosshair	Score	Score_Pos	Score_Design	DamageNumb	Hitmarker	ObjectiveMarker	CurrentObjective	CurrentObjective_Pos	Selected_Weapon	Selected_Weapon_Pos	Throwables	Throwables_Pos	Gamemode
Borderlands 2	TRUE	Bottom Left	Both	TRUE	TopRight	Square	TRUE	Bottom Right	Both	TRUE	TopRight	Integrated	TRUE	TRUE	BottomMiddle	Graphic	TRUE	FALSE	TRUE	TRUE	Top Right	FALSE	N/A	TRUE	Bottom Right	Singleplayer
Battlefield V	TRUE	Bottom Centre	Both	TRUE	BottomLeft	Square	TRUE	Bottom Right	Numerical	TRUE	BottomLeft	Integrated	TRUE	FALSE	N/A	N/A	FALSE	TRUE	TRUE	TRUE	Top Centre	FALSE	N/A	TRUE	Bottom Right	Multiplayer
Far Cry 5	TRUE	Bottom Right	Graphic	FALSE	N/A	N/A	TRUE	Bottom Right	Both	TRUE	TopMiddle	Standalone	TRUE	FALSE	N/A	N/A	FALSE	FALSE	TRUE	TRUE	Top Left	FALSE	N/A	TRUE	Bottom Right	Singleplayer
Call of Duty: Modern Warfare 2 Remastered	FALSE	N/A	N/A	FALSE	N/A	N/A	TRUE	Bottom Right	Both	TRUE	BottomMiddle	Standalone	TRUE	FALSE	N/A	N/A	FALSE	TRUE	TRUE	TRUE	Top Left	FALSE	N/A	TRUE	Bottom Right	Multiplayer
Far Cry 3	TRUE	Bottom Left	Graphic	TRUE	BottomLeft	Circle	TRUE	Bottom Right	Both	TRUE	BottomLeft	Integrated	TRUE	TRUE	BottomLeft	Graphic	FALSE	FALSE	TRUE	TRUE	Top Left	FALSE	N/A	TRUE	Bottom Right	Singleplayer
Far Cry 4	TRUE	Bottom Left	Graphic	TRUE	BottomLeft	Square	TRUE	Bottom Right	Both	FALSE	N/A	N/A	TRUE	TRUE	MiddleLeft	Graphic	FALSE	FALSE	TRUE	TRUE	Top Left	FALSE	N/A	TRUE	Bottom Right	Singleplayer
Far Cry 6	TRUE	Bottom Centre	Graphic	TRUE	BottomLeft	Circle	TRUE	Bottom Right	Numerical	TRUE	BottomLeft	Integrated	TRUE	TRUE	TopMiddle	Graphic	FALSE	FALSE	TRUE	TRUE	Top Left	FALSE	N/A	TRUE	Bottom Right	Singleplayer
Deus Ex: Human Revolution	TRUE	Top Left	Both	TRUE	BottomLeft	Square	TRUE	Bottom Right	Numerical	FALSE	N/A	N/A	TRUE	FALSE	N/A	N/A	FALSE	FALSE	TRUE	FALSE	N/A	TRUE	Bottom Centre	TRUE	Bottom Left	Singleplayer
Destiny	TRUE	Top Centre	Graphic	TRUE	TopLeft	Circle	TRUE	Bottom Left	Numerical	FALSE	N/A	N/A	TRUE	FALSE	N/A	N/A	TRUE	TRUE	TRUE	TRUE	Top Right	TRUE	Bottom Left	TRUE	Bottom Left	Singleplayer
Destiny 2	TRUE	Top Centre	Graphic	TRUE	TopLeft	Circle	TRUE	Bottom Left	Numerical	FALSE	N/A	N/A	TRUE	FALSE	N/A	N/A	TRUE	TRUE	TRUE	TRUE	Top Right	TRUE	Bottom Left	TRUE	Bottom Left	Singleplayer
Call of Duty: Black Ops 4	TRUE	Bottom Left	Both	TRUE	TopLeft	Circle	TRUE	Bottom Right	Both	TRUE	TopLeft	Integrated	TRUE	TRUE	BottomRight	Both	FALSE	TRUE	TRUE	TRUE	Top Left	TRUE	Bottom Right	TRUE	Bottom Centre	Multiplayer
Deathloop	TRUE	Top Left	Graphic	FALSE	N/A	N/A	TRUE	Bottom Centre	Numerical	FALSE	N/A	N/A	TRUE	FALSE	N/A	N/A	FALSE	TRUE	TRUE	FALSE	N/A	TRUE	Bottom Centre	TRUE	Bottom Centre	Singleplayer
Bulletstorm: Full Clip Edition	FALSE	N/A	N/A	FALSE	N/A	N/A	TRUE	Bottom Right	Numerical	FALSE	N/A	N/A	TRUE	TRUE	BottomLeft	Numerical	FALSE	FALSE	TRUE	FALSE	N/A	FALSE	N/A	TRUE	Bottom Right	Singleplayer
Battlefield 4	TRUE	Bottom Right	Numerical	TRUE	BottomLeft	Square	TRUE	Bottom Right	Numerical	TRUE	BottomLeft	Integrated	TRUE	FALSE	N/A	N/A	FALSE	TRUE	TRUE	TRUE	Bottom Left	FALSE	N/A	TRUE	Bottom Right	Multiplayer
Borderlands 3	TRUE	Bottom Left	Both	TRUE	TopRight	Square	TRUE	Bottom Right	Numerical	TRUE	TopRight	Integrated	TRUE	TRUE	BottomMiddle	Graphic	TRUE	FALSE	TRUE	TRUE	Top Right	TRUE	Bottom Right	TRUE	Bottom Right	Singleplayer
Apex Legends	TRUE	Bottom Left	Graphic	TRUE	TopLeft	Square	TRUE	Bottom Right	Numerical	TRUE	TopMiddle	Standalone	TRUE	TRUE	TopRight	Numerical	TRUE	TRUE	FALSE	TRUE	Top Right	TRUE	Bottom Right	TRUE	Bottom Right	Multiplayer
Battlefield 1	TRUE	Bottom Right	Both	TRUE	BottomLeft	Circle	TRUE	Bottom Right	Numerical	TRUE	BottomLeft	Integrated	TRUE	FALSE	N/A	N/A	FALSE	TRUE	TRUE	TRUE	Top Centre	TRUE	Bottom Right	TRUE	Bottom Right	Multiplayer
Crysis 2	FALSE	N/A	N/A	TRUE	BottomLeft	Square	TRUE	Bottom Right	Numerical	TRUE	BottomLeft	Standalone	TRUE	FALSE	N/A	N/A	FALSE	TRUE	TRUE	TRUE	Top Centre	TRUE	Bottom Right	TRUE	Bottom Right	Singleplayer
Halo Infinite	TRUE	Top Centre	Graphic	TRUE	BottomLeft	Circle	TRUE	Bottom Right	Numerical	TRUE	BottomLeft	Integrated	TRUE	FALSE	N/A	N/A	FALSE	TRUE	TRUE	TRUE	Top Left	TRUE	Bottom Right	TRUE	Bottom Right	Singleplayer
Call of Duty: Warzone	TRUE	Bottom Left	Graphic	TRUE	TopLeft	Circle	TRUE	Bottom Right	Numerical	TRUE	TopMiddle	Standalone	TRUE	TRUE	TopRight	Numerical	FALSE	TRUE	FALSE	FALSE	N/A	TRUE	Bottom Right	TRUE	Bottom Right	Multiplayer
Counter Strike: Global Offensive	TRUE	Bottom Left	Both	TRUE	TopLeft	Circle	TRUE	Bottom Right	Numerical	FALSE	N/A	N/A	TRUE	TRUE	TopLeft	Numerical	FALSE	FALSE	FALSE	FALSE	N/A	TRUE	Bottom Right	TRUE	Bottom Right	Multiplayer
Call of Duty: WWII	TRUE	Bottom Left	Graphic	FALSE	N/A	N/A	TRUE	Bottom Right	Numerical	FALSE	N/A	N/A	FALSE	FALSE	N/A	N/A	FALSE	TRUE	TRUE	FALSE	N/A	TRUE	Bottom Right	TRUE	Bottom Right	Singleplayer
Doom (2016)	TRUE	Bottom Left	Both	FALSE	N/A	N/A	TRUE	Bottom Right	Both	TRUE	TopMiddle	Standalone	TRUE	TRUE	TopRight	Graphic	FALSE	FALSE	FALSE	FALSE	N/A	TRUE	Bottom Right	TRUE	Bottom Right	Singleplayer
Doom Eternal	TRUE	Bottom Left	Both	FALSE	N/A	N/A	TRUE	Bottom Right	Numerical	TRUE	TopMiddle	Standalone	TRUE	TRUE	TopRight	Graphic	FALSE	FALSE	FALSE	FALSE	N/A	TRUE	Bottom Right	TRUE	Bottom Right	Singleplayer
Insurgency: Sandstorm	FALSE	N/A	N/A	FALSE	N/A	N/A	TRUE	Bottom Right	Both	FALSE	N/A	N/A	FALSE	FALSE	N/A	N/A	FALSE	FALSE	TRUE	TRUE	Bottom Centre	TRUE	Bottom Right	TRUE	Bottom Right	Multiplayer
Call of Duty: Black Ops III	FALSE	N/A	N/A	TRUE	TopLeft	Square	TRUE	Bottom Right	Numerical	TRUE	TopLeft	Standalone	TRUE	TRUE	BottomRight	Both	FALSE	TRUE	TRUE	TRUE	Bottom Left	TRUE	Bottom Right	TRUE	Bottom Right	Singleplayer
Battlefield 2042	TRUE	Bottom Right	Both	TRUE	BottomLeft	Square	TRUE	Bottom Right	Numerical	TRUE	BottomMiddle	Standalone	TRUE	FALSE	N/A	N/A	FALSE	TRUE	TRUE	TRUE	Bottom Left	TRUE	Bottom Right	TRUE	Bottom Right	Multiplayer
Deep Rock Galactic	TRUE	Bottom Left	Graphic	FALSE	N/A	N/A	TRUE	Bottom Right	Numerical	TRUE	TopMiddle	Standalone	TRUE	FALSE	N/A	N/A	FALSE	FALSE	TRUE	TRUE	Top Right	TRUE	Bottom Centre	TRUE	Bottom Right	Singleplayer
Back 4 Blood	TRUE	Bottom Left	Both	FALSE	N/A	N/A	TRUE	Bottom Right	Numerical	FALSE	N/A	N/A	TRUE	TRUE	BottomLeft	Numerical	FALSE	TRUE	FALSE	TRUE	Top Left	TRUE	Bottom Right	TRUE	Bottom Right	Singleplayer
Dishonored	TRUE	Top Left	Graphic	FALSE	N/A	N/A	TRUE	Top Left	Numerical	FALSE	N/A	N/A	TRUE	FALSE	N/A	N/A	FALSE	FALSE	TRUE	FALSE	N/A	TRUE	Top Left	FALSE	N/A	Singleplayer
Alien Rage	FALSE	N/A	N/A	FALSE	N/A	N/A	TRUE	Bottom Right	Numerical	FALSE	N/A	N/A	TRUE	TRUE	TopLeft	Numerical	TRUE	FALSE	TRUE	FALSE	N/A	FALSE	N/A	FALSE	N/A	Singleplayer
Hell Let Loose	FALSE	N/A	N/A	FALSE	N/A	N/A	TRUE	Bottom Right	Numerical	TRUE	BottomMiddle	Standalone	FALSE	FALSE	N/A	N/A	FALSE	FALSE	TRUE	TRUE	Top Centre	TRUE	Bottom Right	FALSE	N/A	Multiplayer
BioShock Infinite	TRUE	Top Left	Graphic	FALSE	N/A	N/A	TRUE	Bottom Right	Numerical	FALSE	N/A	N/A	TRUE	TRUE	BottomLeft	Numerical	FALSE	FALSE	TRUE	FALSE	N/A	TRUE	Bottom Right	FALSE	N/A	Singleplayer
Hunt Showdown	TRUE	Bottom Centre	Graphic	FALSE	N/A	N/A	TRUE	Bottom Centre	Both	TRUE	TopMiddle	Standalone	TRUE	FALSE	N/A	N/A	FALSE	TRUE	FALSE	FALSE	N/A	TRUE	Bottom Centre	FALSE	N/A	Multiplayer
Halo 2: Anniversary	TRUE	Bottom Left	Graphic	TRUE	BottomLeft	Circle	TRUE	Top Right	Both	FALSE	N/A	N/A	TRUE	FALSE	N/A	N/A	FALSE	FALSE	FALSE	FALSE	N/A	TRUE	Top Right	TRUE	Top Left	Singleplayer
Halo: Reach (Master Chief Collection)	TRUE	Bottom Left	Graphic	TRUE	BottomLeft	Circle	TRUE	Top Right	Both	TRUE	TopMiddle	Standalone	TRUE	FALSE	N/A	N/A	FALSE	FALSE	FALSE	FALSE	N/A	TRUE	Top Right	TRUE	Top Left	Singleplayer
Halo 3 (Master Chief Collection)	TRUE	Top Centre	Graphic	TRUE	BottomLeft	Circle	TRUE	Top Right	Both	FALSE	N/A	N/A	TRUE	FALSE	N/A	N/A	FALSE	FALSE	FALSE	FALSE	N/A	TRUE	Top Right	TRUE	Top Left	Singleplayer
Halo 4	TRUE	Top Centre	Graphic	TRUE	BottomLeft	Circle	TRUE	Top Right	Both	FALSE	N/A	N/A	TRUE	FALSE	N/A	N/A	FALSE	FALSE	FALSE	FALSE	N/A	TRUE	Top Right	TRUE	Top Left	Singleplayer
Halo 5: Guardians	TRUE	Top Centre	Graphic	TRUE	BottomLeft	Circle	TRUE	Top Left	Both	FALSE	N/A	N/A	TRUE	FALSE	N/A	N/A	FALSE	FALSE	FALSE	FALSE	N/A	TRUE	Top Right	TRUE	Top Left	Singleplayer
Halo: Combat Evolved Anniversary	TRUE	Top Right	Graphic	TRUE	BottomLeft	Circle	TRUE	Top Left	Both	FALSE	N/A	N/A	TRUE	FALSE	N/A	N/A	FALSE	FALSE	FALSE	FALSE	N/A	FALSE	N/A	TRUE	Top Left	Singleplayer

7.4 Appendix 4: Participant HUD Screenshots
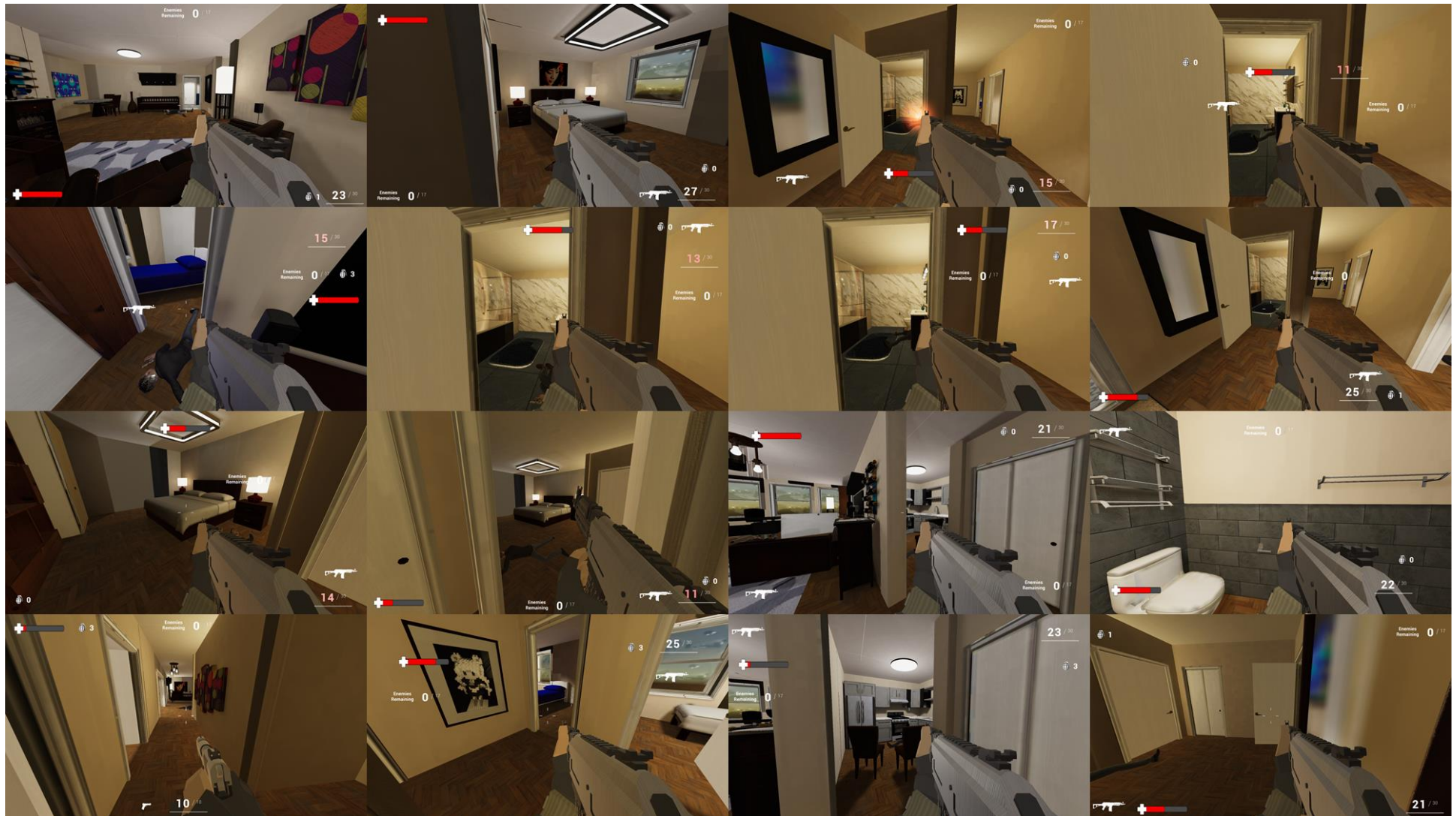
7.5 Appendix 5: Participant Survey Responses

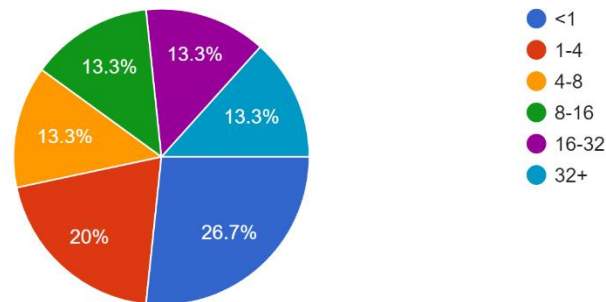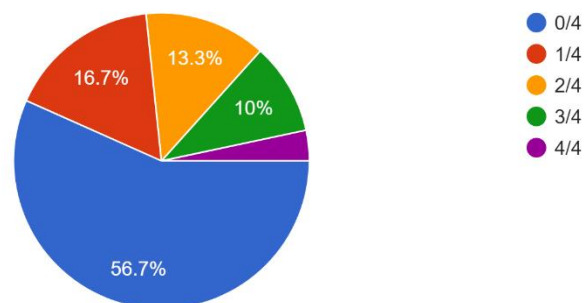I am...

30 responses
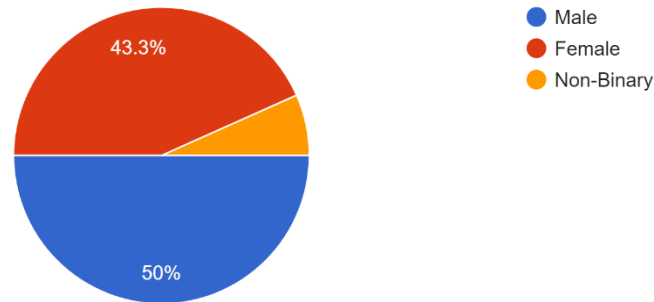
●	Male
●	Female
●	Non-Binary

How many hours a week do you play video games?

30 responses

●	<1
●	1-4
●	4-8
●	8-16
●	16-32
●	32+

How many of those hours are dedicated to First Person Shooters?

30 responses

●	0/4
●	1/4
●	2/4
●	3/4
●	4/4

What are your top 3 most played games? (Leave blank if none)

27 responses

Overwatch, Dead by Daylight, Hades

Team Fortress 2, World of Warcraft, Dota 2

Back 4 Blood, Elden Ring, Returnal

Resident Evil 7, Bloodborne, Bayonetta 3

dead by daylight, disco elysium, sims4

The Sims, Duolingo language learning games, Candy crush

Halo

8 Ball pool, 2024, Mariokart

Sims 3, Sims 4, MARIO

POKEMON, ANIMAL CROSSING, MINECRAFT

Fall Guys, FIFA, GTA

HUNT SHOWDOWN, SIEGE, TF2

The witcher 3, Skyrim, Dino Crisis (OG)

Halo, Sekiro, Valheim

GTA 5, Call of Duty, Overwatch

sailwind, euro truck simulator, dredge

League of Legends, Rocket League, Insurgency Sandstorm

Garry's Mod, Mount & Blade and DayZ

CS:GO

Monopoly madness

Valorant, abd Destiny

Call of Duty, Fortnite, Rainbowsixsiege

Minecraft/Stardew Valley/Super Mario
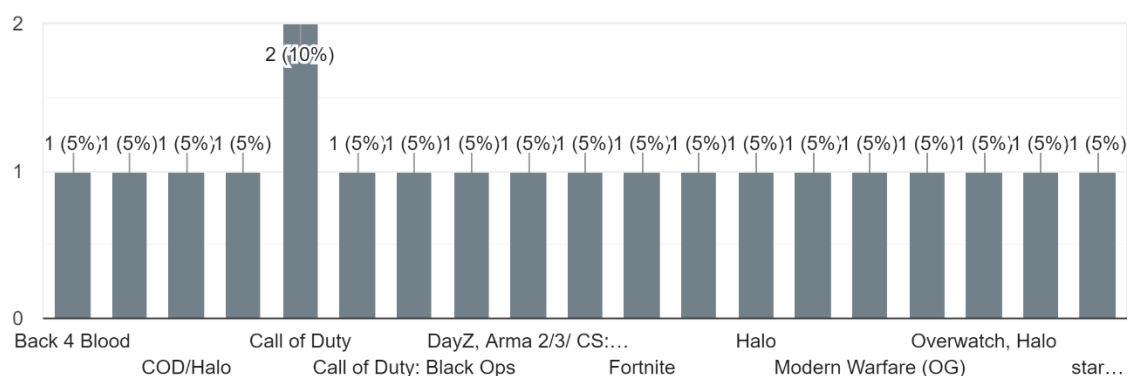
Solatire, Township, Sudoku

Portal 2, Stardew Valley, Sims 4

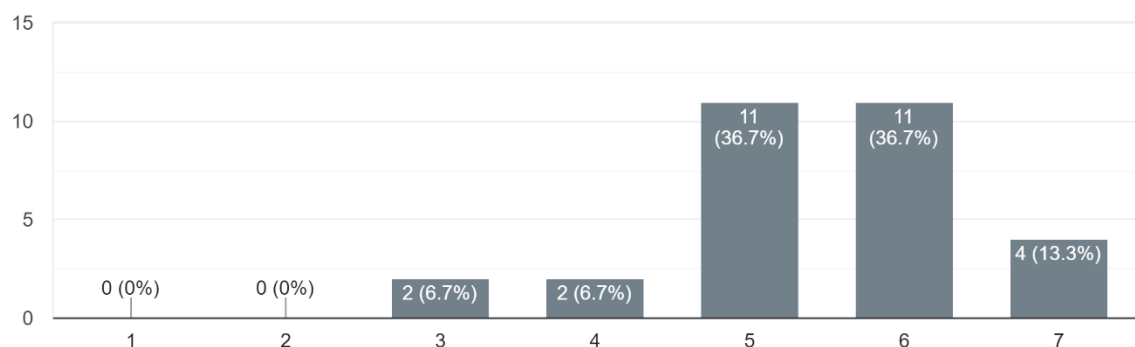SUBWAY SURF, CAR PARKING, FIFA, GTA

the division, gta 5, fortnite

What are your most played First Person Shooters? (Leave blank if none)
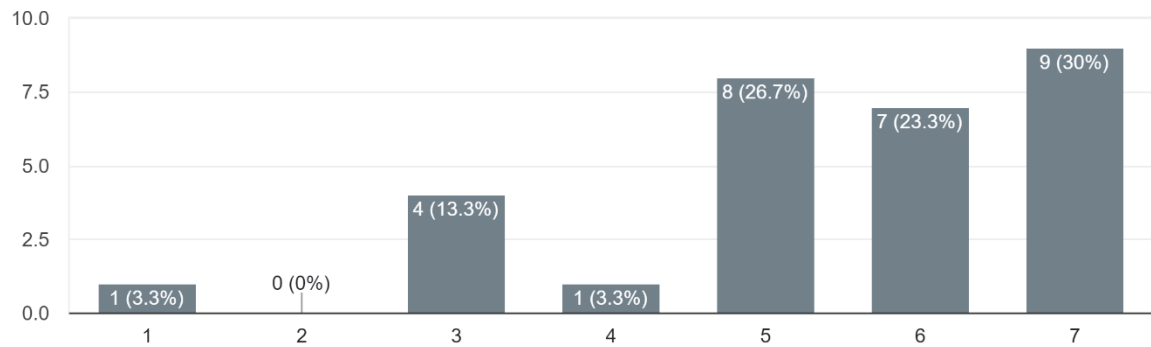20 responses

On a Scale from 1 to 7 where 1 is Bad and 7 is Amazing how would you rate your game experience
30 responses

On a scale from 1 to 7 where 1 is No Impact and 7 is Significant Impact how would you rate the impact of the game's HUD on your game experience

30 responses

On a scale from 1 to 7 where 1 is Very Easy and 7 is Very Challenging how would you rate the difficulty of the game?
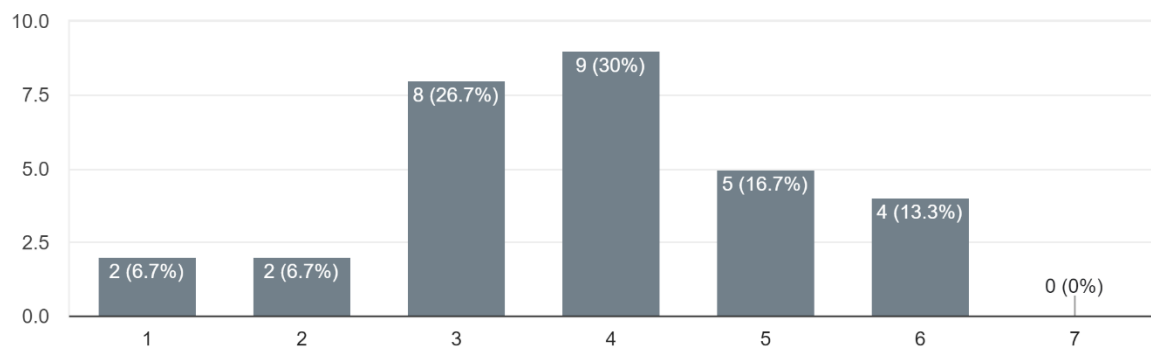
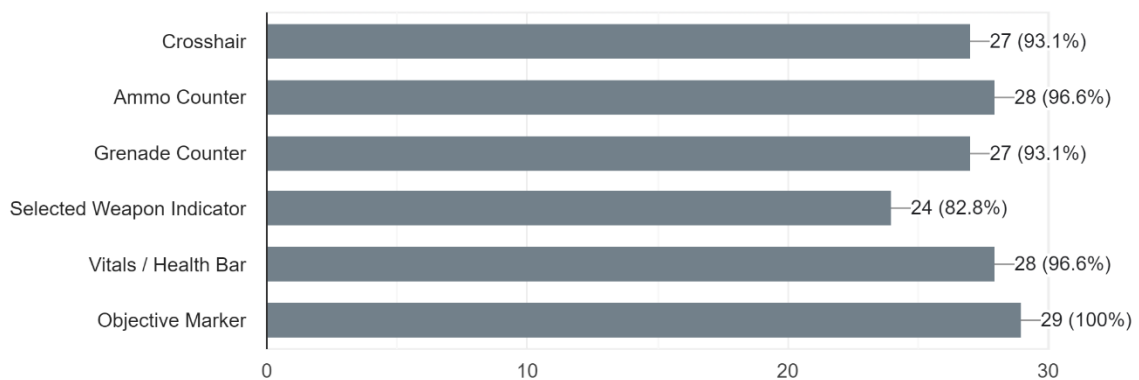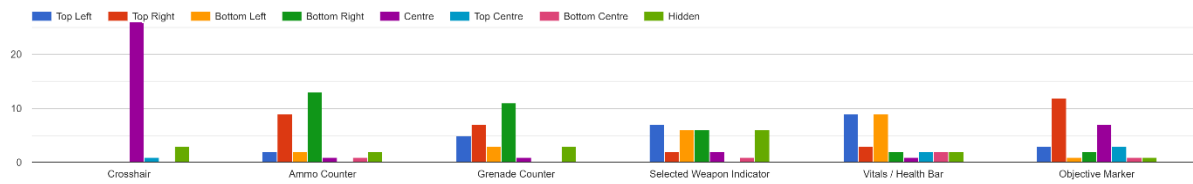30 responses

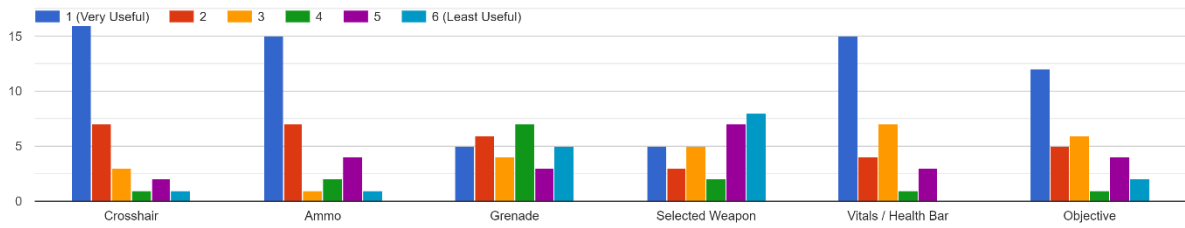What HUD Elements did you end up having on your screen?

29 responses

Where did you place this element on the screen?

On a Scale from 1 to 6, where 1 is the most useful and 6 is the least useful, rank the HUD elements usefulness

7.6 Appendix 6: Interview Codes

7.6.1 Theme 1: Participant HUD Design Decisions

Experienced Participants

Code	Definition	Quote	Number of times Mentioned
Familiarity	Players express that they designed the HUD based on other games they've seen or played	" I'm unsure why I went with this selection, I believe it may be because majority of fps games have a tendency to put the most vital HUD elements such as ammo/health on the bottom of your screen and then work their way up." – P20 "Ammo and grenades where in bottom right because it is traditional for fps games. I put it there because I am used to it." – P16 "I put all the "equipment" to the bottom left, because it is how the games usually do it. I remember most of the games do it bottom left." – P23 "Ammo counter was at the bottom right cause most games do it and that's where the gun is" – P2 "To be honest I was basing it of past games that I have played." – 30 "It is mainly due to what I am used to with other games, I am used for health in top or bottom left and ammo on the right hand side because it is related to the gun." – P17	10

		"Trying to have everything in a familiar space that would help with what I'm used to." – P7	
		"It was mostly influenced by other FPS games that I have played." – P15	
		"Being honest, I was sort of recreating the overwatch HUD, I am quite used to having weapon information on the bottom right, health information on the bottom left. I put the objective marker at the top, yet again, I think that was overwatch again…" – P1	
		"Basically copied how it usually is in every game I played." – P13	
Intuitive	Players express that they placed HUD elements on parts of their screen based on what they felt was intuitive	"I put the health bar at the middle because it felt better there compared to bottom left." – P16	3
		"The difference is that many people put health on bottom left but I like the access from top left to bottom right." – P14	
		"Ammo counter was at the bottom right cause most games do it and that's where the gun is" – P2	
		"I prefer bottom left cause that's where my eyes glance to. Top right is least important part of the screen." – P18	
Grouping elements	Players mentioned grouping elements that fit together	"I then placed all weapon related HUD elements on the bottom left as a result so that they were grouped together" – P20	4
		"I put all the 'equipment' to the	

		bottom left, because it is how the games usually do it. I remember most of the games do it bottom left. – P23	
		" I put ammo and grenades in the same category." – P14	
		"I put "nades" next the ammo because that's how my brain works" – P18	
		"I liked having it all grouped together. And having most of the information on the top right corner. the weapon choice and the grenade where next to each other because I didn't use it as much" – P9	
		"Stuff to do with the weapons I am used to having bottom right and I wanted them close together" – P4	
Order Bias	Players mentioned the order in which elements showed up on screen affected their placement on the screen.	"Most FPS game's I believe tend to have the ammo indicators on the bottom right of the screen, however I think the flow of showing each HUD element one at a time made me instinctively place it on the bottom left." – P20	1
Uncertainty	Players mentioned feeling unsure about the decisions they made.	"I didn't hide any because I still like to see them, because I didn't know what was going to happen." – P24	2
		"I was thinking about what would give me the most see what is going on without the HUD obstructing. was leaving room for a mini-map." – P7	

Inexperienced Participants

Code	Definition	Quote	Number of times Mentioned
Familiarity	Players express that they designed the HUD based on other games they've seen or played	"Part of it is familiarity, I tend to look to my top left and right. The things at the bottom right I didn't pay as much attention to. My eyes move to top left and top right." – P22	1
Intuitive	Players express that they placed HUD elements on parts of their screen based on what they felt was intuitive	"It makes more sense to keep these options in one specific place, so you can keep your eye on all of them" – P28 "For the HUD I prefer to have everything in the same place, I like having more things to the right because I am right handed." – P6 "The ammo I put on the right because I look to my right always" – P27 "I put them on the top because you are looking at the top of the screen more rather than looking on the ground." – P11 "I think I just put it out of the way, but in a place that I could see it quickly." – P26	5
Grouping elements	Players mentioned grouping elements that fit together	"The weapons, ammo counter, including grenades, all felt best to be in the top right corner. I actually put the selected weapon option at the bottom left corner, however, upon thinking again, it would look better amongst these other settings in the top right corner." – P28	1
Order Bias	Players mentioned the order in which elements showed		0

	up on screen affected their placement on the screen.		
Uncertainty	Players mentioned feeling unsure about the decisions they made.	"I didn't really think too much about it, centre of attention is the gun and the crosshair and as long as everything else is close around it is good." – P12	1

7.6.2 Theme 2: HUD Element Evaluation

Experienced Participants

Code	Definition	Quote	Number of times Mentioned
Decision-maker	Participants mentioned that a HUD element was the main decision maker within the game	"Most useful was the health bar, I didn't know that you could regen health while time was passing, but when I realised it slowly goes up I made many decisions because of that UI. That was my main decision making." - P23 "I also found the health and ammo to be very useful, as it allows me to see whether I can keep fighting or I need to retreat to reload or let my health regenerate" – P19 "I found the health bar to be the most useful as I checked it very regularly to avoid risk of death. I found the ammo counter to be useful for the same reason." – P15 "The health is the most useful one, because it is very important to understand how much health you have, in order to make or not make daring plays." – P17 "Ammo counter, cause it is something that I interact with a lot, health is the same because health lets me know if I can engage in the next situation." – P18	5
Secondary	Participants mention a HUD element being useful, but it wasn't	"The objective I read at the beginning, I knew I had to kill people and I didn't look at it again. But it was useful to know	7

	used consistently.	what I had to do in the game." – P23	
		"The current objective element was decently useful as it gave me an idea of how many enemies I could expect." – P19	
		"When I switch between guns I like seeing which gun is on the side. Since when I play shooters I always have the selected weapon there. Sometimes you're switch the weapon that you are switching and you can see the indicator." – P30	
		"I found the crosshair useful as I often chose to shoot enemies without aiming down sights." – P15	
		"They allow you to see the status of your weapons, health and how many enemies are left, this one I relied on the most as towards the end of the game I had one enemy remaining which was behind a door that I had not checked so I knew that I had missed one somewhere once I reached the last room." – P20	
		"The enemy objective one was okay for completing the game, but I was gonna explore regardless." – 21	
		"Enemies remaining is very useful but for a linear story focused game is not necessary so it varies in usefulness." – P4	
Performance	Participants claimed that the	"The crosshair is useful as it allows you to know where you	2

enhancer	presence or absence of a HUD element had an effect on their game performance	are shooting and it can be difficult to aim without it." – P19 "The crosshair was very useful because it meant I didn't have to aim down sights, so I would say that's why it was the most useful, for speed and stuff as well." – P14	
Pointless	Participants mentioned that a HUD element had no use to them whatsoever	"I found the current weapon indicator to the most useless of the elements, as it doesn't provide much information I already couldn't see." – P19 "I found the current weapon display to be the least useful, because it provided no extra information (such as a weapon name), as I already could see which of the 2 guns I was holding." – P15 "The objective marker and current gun were least useful, because I am used to FPS , for the selected weapon I could see it on the screen so it was not needed." – P17 "Which gun I had was the least useful because the gun was on my screen. The grenade one was also pretty useless, because it was an easy number to track." – P21 "The ammo is pretty useless because it is unlimited." – P13 "Ammo feature was useless because the game has infinite ammo." – P2	6

| Forgettable | Participants mentioned forgetting that a HUD element was there. | "The grenade status was also not that useful to me as I simply forgot to use them." – P19

"The grenade one was the least useful, because once I ran out I forgot about it." – P24 | 2 |

Inexperienced participants

Code	Definition	Quote	Number of times Mentioned
Decision-maker	Participants mentioned that a HUD element was the main decision maker within the game	"Health was so useful because I could tell when it could get full and then I could move." – P6 "health bar was very useful because it literally corrected my strategy and behaviour. I died a lot because I didn't know life replenished. So I waited before rushing into a room." – P3 "The ammo one was more useful because when I was going towards enemies seeing the number of bullets that I had helped not to rush and I could reload before attacking. And the vitals one because it reminded me to stop and heal before I went in to attack." – P10 "The health was the most useful because you keep dying if you don't keep an eye on it." – P12 "Most important was the bullets I had left, because I needed to be prepared in order to attack." – P22	5
Secondary	Participants mention a HUD element being useful, but it wasn't used consistently.	"The remaining enemy/objective bar was super useful in knowing what I needed to do, and made it simple to follow orders." – P28 "the number of bullets was very useful because it showed me when I had to reload." – P6 "number of enemies was helpful	3

		to know when the game was over or if I had to find another person." - P6	
Performance enhancer	Participants claimed that the presence or absence of a HUD element had an effect on their game performance		
Pointless	Participants mentioned that a HUD element had no use to them whatsoever	"I hid the weapons, because there is only two weapons." – P27

"Least interesting was the grenade element, because I only used one and I wasted it." – P3 | 2 |
| Forgettable | Participants mentioned forgetting that a HUD element was there. | "The more I get used to the game the more I will interact with the grenade but because it was my first time I stuck to the gun, reloading and shooting." – P6

"The Grenade was the least useful, because I didn't remember it was there." – 22

"I liked the grenades but I forgot I could use them because I was way too focused on shooting. I was more focused on other things" – P26 | 3 |

7.6.3 Theme 3: HUD Impact on the game Experience

Experienced Participants

Code	Definition	Quote	Number of times Mentioned
Indifference	Participants expressed indifference in interacting with the HUD tool	"I would most likely never change any HUD settings in most fps shooters if given the option" – P20 "I wouldn't say it made a huge impact, but I would have the same experience if I had a pre-set UI." - P2 "Moving it so it is in the edge of the screen was good so I could see the gameplay but other than that it didn't play a big role." - 13	3
Freedom & Control	Participants expressed that they had a positive impact with the tool due to the freedom it provided	"You set it up how you prefer it" – p23 "I put the things in the normal places, knowing that I could change it if I wanted was a nice feature." – P14 "The extra control over the game increases enjoyment. More games should have that." - p16 "It did because it allowed me to place everything where I wanted rather than coming predefined." – P7 "Putting them where I want, adaptive, change in game was	4

		good, make it feel comfortable transferable skills" – P1	
Avoiding Clutter	Players expressed that by customising their HUD they avoid situations where HUD doesn't match their preferences	"Sometimes you play (games) and the experience is not that good, because of the way they've designed the UI, but this way everyone can be happy with the UI because they've designed it" – P23 "Yes, because If the HUD is full of different elements it can get overwhelming and you don't see much of what is happening. The ability to spread the elements in the corners was very important so they don't get in the way." – P17 "Yes - I found it to be a unique and satisfying feature, since a lot of FPS games suffer from a cluttered HUD and no way to customise it." – P15 " you can choose what you can display on your HUD and I really like that. Some players might want less items on the screen some more." – P30	4
Easy to learn	Players felt like they got used to the HUD faster through customisation.	"Because I decided where to put it, there was no time lost on learning the UI. I just knew already, because I created it" – P23 "I think it was interesting, because if I customise it myself I get used to it faster than if the game customised it for me. If I put it in a certain place I would remember it." – P25	5

		"It allowed me to understand all the systems I had to interact them. Once I understood them I could immerse myself more." – 21	
		"That level of customisability meant I can jump into the experience without having to train my eyes to get used to the HUD." – P18	
		"Putting them where I want, adaptive, change in game was good, make it feel comfortable transferable skills" – P1	
Satisfaction	Players expressed that the HUD tool was satisfying to use	"It made it so much better, because I found it fun dragging them around like puzzle pieces." – P4	1
Feeling Forced	Participants mention that the element felt forced on them, they didn't want to use it		0

Inexperienced Participants

Code	Definition	Quote	Number of times Mentioned
Indifference	Participants expressed indifference in interacting with the HUD tool	"Not mine, cause I put them where I expect them to be." – P5 "Being able to put them where I want was fine but it didn't really impact the experience." – P8 "I zoom in and I kind of forget about the other things surrounding my screen. It's happening so fast so I focus on the screen." – P25	3
Freedom & Control	Participants expressed that they had a positive impact with the tool due to the freedom it provided	"Yes, as I feel as though it gave me the free option to place them wherever I want, almost customising the playthrough. This felt refreshing and something I've never seen in a game before - normally, these options are present and you don't have much free will around these options, even if they are not to your specific liking." - P28 "It impacted it in a positive way. It let me be in control. Being able to move them around lets me put everything where I want it and it doesn't get in the way. I prefer to have it this way." – P10 "Yes because it felt like I had control over the game and everything was where I wanted it to be. I would prefer the game that let me put things where I wanted." – P6	8

		"I like the ability of being able to group it together based on my preferences." – P9	
		"It gave me a lot of freedom in the beginning and I can set it up like the games that I play" – P3	
		"Because I had that control, it made me feel more confident." – P22	
		"I liked having control over what was going on." – P26	
		"I prefer it, because I like choosing what I hide." – P29	
Avoiding Clutter	Players expressed that by customising their HUD they avoid situations where their gameplay gets hindered by the HUD	"It was good cause then I didn't get in the way." – P3	1
Easy to learn	Players felt like they got used to the HUD faster through customisation.	"When it is already set it takes longer to get used to HUD." – P6	4
		"Yeah, it helped because I could place things where I wanted. If they already have set it for you I have to memorize where they put it. I am more of hands on, if I put it there, it is easier to know where it is." – P27	
		"Putting them in specific places made them easy to remember where they were rather than having to remember them. If they were in set places I would have a slower learning curve." – P11	

		"Yes. I felt like it made my life a lot easier. It did help me to know what I was doing" – P26	
Satisfaction	Players expressed that the HUD tool was satisfying to use	" I like organising and putting stuff where I want them to be." – 25	1
Feeling Forced	Participants mention that the element felt forced on them, they didn't want to use it	"It felt a bit too invasive because there was a pressure to move it around in my head. It was too much freedom, I was worrying too much about placing things rather than playing the game." – P12	1