Increasing Motivation and Engagement in Learning Safe Humane Hunting Skills Through VR and Digital Games

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This Master's Thesis is carried out as a part of the education at the University of Agder and is therefore approved as a part of this education. However, this does not imply that the University answers for the methods that are used or the conclusions that are drawn.

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Abstract

This research discusses to what degree a digital learning game can affect motivation, engagement and participation in learning humane and safe hunting, and how a VR version compares to a screen-based version. Additionally, it discusses whether a digital learning game about humane and safe hunting can make learners more confident when taking the "Jegerprøve" exam and dealing with real-life hunting situations. A game working on both computers and VR equipment was developed using the human-centred design process. The game went through two iterations, and usability testing was conducted on both of them. The results of the testing were analyzed and compared to existing theory in order to answer the research questions. Through these findings, it was concluded that the game has a positive effect on motivation, engagement and participation. The VR version of the game was more motivating and engaging than the screen-based version, but the accessibility of VR makes the screen-based version still relevant. The game also made the players more confident in passing the "Jegerprøve" exam and dealing with real-life hunting situations.

Preface

This thesis is a culmination of all I have learned during my two years studying for my master's degree in Multimedia and Educational Technology. During these years, I have learned a lot about technology, pedagogy and interaction design. I have gotten to use my creativity and work on some exciting projects.

I would like to thank my supervisors on this project, Ghislain Maurice Norbert Isabwe and Morgan Konnestad, who gave me valuable advice and feedback throughout this whole project.

I would also like to thank all the test participants, interviewees and everyone else contributing to this research. Without them, this research wouldn't exist.

It's been a pleasure studying at the University of Agder, but now I'm excited for what the future brings.

Eirik Steinsland

Contents

1 Introduction

In Norway, you have to pass "Jegerprøven" before you can legally hunt[1]. This is a course about hunting and deals with topics such as the hunter's responsibility, laws and regulations, weapon handling, humane hunting, wildlife awareness and hunting methods. The Norwegian environment directorate has the professional responsibility for educating new hunters. In addition to the "Jegerprøve" course itself, they currently offer e-learning material consisting mostly of videos and multiple-choice tasks. The course is 30 hours long, where most of the gatherings are theoretical, while two of the gatherings are practical. One of the practical gatherings is 3 hours and focus on practical hunting; how to find good hunting positions, what do you have to consider when hunting, how to move around in the forest when carrying a weapon and other safety concerns while traversing the environment. The other practical gathering is about weapon handling and how to fire weapons, both rifle and shotgun. The gathering is about 6 hours long and the participants have to fire 25 rounds of ammunition, so that they have some weapon experience before they start hunting. The course ends with a theoretical test.

According to an interview conducted for this research, the most common ways to study for the theoretical test is through reading or going through an example test over and over again online. People learn in different ways and some might learn better or at least be more motivated to learn through games.

The aim of this research is to find out if a learning game based on the "Jegerprøve" syllabus can help engage and motivate the players into learning. The research also aims to find out how a VR game impacts motivation and engagement compared to a screen-based game.

1.1 Problem Statement

The most common cause of wounding an animal without killing it when hunting is not due to some fault with the weapon or ammunition; it is because people misjudge the situation. For example, people shoot from too long distances or shoot moving animals, the greater the speed of the animal, the greater the risk of wounding the animal without killing it. The reason for these misjudgments can be that there isn't enough practical training about the different aspects you have to consider when you face an animal while hunting. Currently, the practical training people get out of the "jegerprøve" course is based mostly on weapon handling and how to find good hunting positions. Practical training in humane and safe hunting can be hard because it involves wild animals, which are unpredictable. While there are many hunting simulators out there (some of them with VR functionality)[2][3][4], there doesn't seem to be many hunting games that aim to teach the user about humane and safe hunting.

The current e-learning material provided to aspiring hunters also don't seem to be optimal. According to data from a questionnaire that was made for this project, the current e-learning material worked poorly and was cumbersome to navigate. One of the problems with the e-learning course was the use of pictures. You were shown pictures of animals along with information about that animal, and then in the quiz, you would get the same exact picture that you would have to link to the name of the animal. This way you could just memorize the picture itself rather than memorize the characteristics of the animals.

People learn in different ways. Some people might be completely fine with an instructivist approach to learning, while others might prefer active learning. Although, it can be argued that active learning might also take place even if instructivist approaches are used.

1.1.1 Hypothesis and Research Questions

Based on the problem statement, this research aims to investigate the following:

RQ1: To what degree can a digital learning game affect motivation, engagement and participation in learning humane and safe hunting?

RQ2: How does a VR hunting game compare to a screen-based hunting game when it comes to motivation, engagement and participation in learning?

RQ3: Can a digital learning game about humane and safe hunting make learners more confident when taking the Jegerprøve exam and dealing with real-life hunting situations?

From the research questions, the hypothesis was defined as:

Hypothesis
VR and digital games support experiential learning and can increase motivation, engagement and participation in learning humane and safe hunting, and makes learners more comfortable dealing with real-life practical situations similar to those in the VR/gaming experience.

1.2 Scope

As a part of this project, a digital game was developed by using the human-centred design process. The game was made with the Unity game engine and has both a computer screen-based version and a VR version. The most important aspect of the game is a tutorial with different objectives where players will be put into different situations one can come across when out hunting, and be told what to do in these situations and why it needs to be done like this. If the players fail the objective, the player will get an explanation of what went wrong and how the player should have handled the

situation. If the player successfully executes the objective, the player can move on to the next objective. An Example of a situation the player will learn about is what to do when you come across a mother deer with a calf. Should you shoot the mother or the calf? In this situation, if you choose to shoot one of them, it should be the calf. The reason for this is that a calf most likely won't survive the winter without a mother. Once the player has finished the tutorial, the player can enter a gameplay mode called "Free Hunt". Here the player will be put in a forest and situations like the ones experienced in the tutorial can randomly occur. The player will not be told what to do in these situations, but will get points based on how well the situation was handled.

1.2.1 Expected Outcomes

The research will examine if supporting aspiring hunters with a serious game available as a VR version and as a screen-based version will engage them and make them more motivated towards learning. Lastly, the game will be tested on aspiring hunters to see if it can engage them and help motivate their learning.

1.2.2 Limitations

The COVID-19 outbreak has put some limitations on the project. For example, one of the research questions is "*How does a VR-game compare to a screen-based game when it comes to motivation, engagement and participation?*". This question has been hard to research as it requires testing with VR equipment, something most people don't own themselves, and would therefore require to bring the equipment to the test participant and do the testing face to face, something that has not been recommended in this period. The testing that involves VR has therefore been limited. Another thing that limited the project was the fact that all "Jegerprøve" courses were canceled,

making it hard to get in touch with the target audience for this game, as well as looking at whether or not this game can have any impact on the peoples' results on the "Jegerprøve" exam. The testing also relied on remote-based user testing, which could affect the results and observations.

1.3 Thesis Outline

In this thesis, literature related to the problem statement will be discussed. The thesis will take a look at VR technology and games, what motivates learners, different pedagogical approaches, and how VR and games can be used to motivate learning. Continuing from there, the thesis will look into the methodology used for developing and testing the product, describing the Human-centred Design process and methods used for collecting data. While going through the design process, the thesis will go into detail on the different aspects of the product and the thought behind why things were implemented the way it was. In the end, the thesis will go through the findings from the testing of the product, and analyze and discuss these results based on the literature reviewed at the beginning of the thesis and assess the potential of future development of the product and answer the research questions proposed for this thesis.

2 Theory

2.1 Games in Education

In recent years games have become significantly more important. Games used to be mostly about entertainment, but now they can be about much more than that. People play in a variety of different ways; some play on their computer, some play on their television, some play on their phones. The variety of platforms, channels, genres available to the gaming audience is immense and has made gaming a mainstream activity[5]. When discussing games in education, gamification and serious games are prominent concepts. Gamification is the use of game aspects in serious contexts, like for example the ability to earn points or badges. This is done to motivate and engage the user of the system, and if done right can be very effective[6]. Serious games is the other prominent concept when discussing games in education. To fully understand what makes a serious game different from other games, it is important to know what the definition of a game is.

2.1.1 Definition of a Game

Johan Huizinga states in his book *Homo Ludens* (1938) the following about play:

> *[Play] is an activity which proceeds within certain limits of time and space, in a visible order, according to rules freely accepted, and outside the sphere of necessity or material utility. The play-mood is one of rapture and enthusiasm, and is sacred or festive in accordance with the occasion. A feeling of exaltation and tension accompanies the action, mirth and relaxation follow.*[7]

By Looking at this definition, we can describe play with these characteris-

tics[8]:

- Play is played out within a specific time and space.
- Play is based on a set of rules.
- Play is voluntary.
- There is no material gain or profit to be made from play.
- Play is just pretend, it is not related to 'real life'.
- Play is immersive and takes up the player's full attention.
- As a result of the above points, play is fun.

These characteristics can also be applied to games, whether it is card games, board games, digital games or sports.

In addition to play, games also consist of other aspects; challenge and conflict. These aspects are formed by the relationships between the components of a game.[9]

Figure 2.1: Components, relationships and aspects of a game.[9]

Take the board game chess for example. The game is represented by the chess pieces that correspond with rules that are agreed upon by the players. The rules define the goal, which is to eliminate the other player's king, and this drives the player's motivation. The player also have an opponent, bringing indeterminism to the game. The opponent also tries to achieve the goal of the game, which is an obstruction for the player. This forms the aspects of a game; play, challenge and conflict.[8]

2.1.2 What sets a serious game apart from a regular game?

What sets a serious game apart from a regular game is the fact that most games are made for entertainment purposes and is meant to be a fun and enjoyable way to pass the time. However, serious games don't have entertainment as their primary goal, as their goal is to have a carefully thought-out purpose, whether it be teaching, training, rehabilitation, spreading awareness etc. Even though it is not the primary goal, serious games can still be fun and entertaining.[10]. Serious games might sound similar to simulation, but they are not the same. Simulations imitates real life situations[11], and while serious games can include simulation, they can also include game aspects like competition, challenge and play to drive the motivation of the learners.[8]

2.1.3 Learning Practical skills through games

There are many games that are made to teach the user practical skills, and in some cases, VR games have been used to teach users practical skills. Kookiet Likitweerawong and Patison Palee[12] developed a VR serious game that aims to provide players with knowledge about driving and getting them ready for basic driving lessons before they start driving a real car on the real road. They made this serious game using Unity 3D. "Woodlands" is another VR serious game that aims to teach the user practical skills[13]. The aim of this game is to teach children about road safety, so that they may for example

cross the road unsupervised. The way they do this is by implementing game-based learning principles and following the best practice for serious game design, like for example making educational components essential to successful gameplay or instructional scaffolding. Medicine is another field where VR has been used for learning practical skills, like for example VR surgical simulations[14].

2.2 Virtual Reality

Virtual reality, often shortened to VR, is a technology that gives the user the illusion that they are in a different environment. In this virtual environment, the user can look around and in some cases interact with the virtual environment. If the virtual reality is lifelike enough, the user will get immersed and lose sense of the real-life environment surrounding the user. The feeling of immersion can be enhanced with for example sound effects and vibrations in addition to the graphics[15]. VR can be used for a number of things; video games are one of the most common fields of use for the average person. The technology has for a long time been used for training in areas that would have otherwise been expensive or high risk, for example airplane and boat simulators. Other examples are technical procedures in the medical field, like surgery. This lets the surgeon train on procedures close to reality without the risk of bringing harm to a patient. Other areas where VR is used are psychiatric treatment, for example by exposing people to their fears to train them to cope with those fears[15].

Creating the illusion that we are present somewhere else goes back to the nineteenth century, where the earliest attempt at virtual reality is 360-degree murals or panoramic paintings that was intended to fill the entire field of view of the viewer, giving them the feeling that they are present at a historical event or scene[16]. In 1838 Charles Wheatstone presented the first stereoscope and demonstrated that the brain processes different two-dimensional images for each eye into a single three-dimensional object. By

viewing two stereoscopic images side by side through a stereoscope, the user would get a sense of depth and immersion. The design principles of the stereoscope are still used today for modern VR head-mounted displays[16].

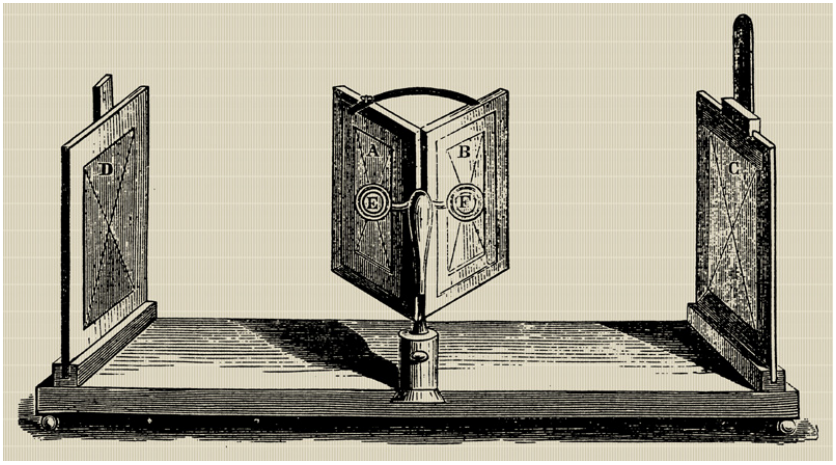

Figure 2.2: Wheatstone mirror stereoscope.[16]

In 2016 VR was brought to the mass market, when three different VR headsets were released by major companies, with the HTC Vive, the Playstation VR and the Oculus Rift[17]. The Vive was developed by HTC in collaboration with video game developer and publisher company, Valve[18]. It works plugged into a PC and uses two 1200p x 1080p displays that refresh at 90 frames per second, which according to HTC, "eliminates jitter" and achieves "photorealistic imagery". The device uses a gyrosensor, accelerometer and laser position sensors to track head movement as precisely as one-tenth of a degree.

Figure 2.3: The HTC Vive headset and controllers.

Playstation VR is Sony's VR headset, which works connected to the Playstation 4. The player moves their hands and interact with objects in the virtual world using Playstation Move Controllers. The movement of the player is tracked by a Playstation Eye (a camera for the Playstation 4), using the lights on the headset and controllers [19].

Figure 2.4: The Playstation VR headset. The lights on the headset is used by the Playstation Eye to track the players position.[19]

Oculus initiated a kickstarter campaign in 2012 to help fund the development of the Oculus Rift. The fundraising proved to be successful, getting contributions from around 10,000 people and rasing almost 2.5 million dollars[20]. In March 2014, Oculus was bought by Facebook for 2 billion dollars[21]. Oculus Rift entered the consumer market in 2016[22]. It needs to be connected to a computer and uses two external sensors to track the player's position, and the player uses two Oculus Touch controllers to interact with the virtual environment. In 2018, the Oculus Go released, and the

Figure 2.5: The Oculus Rift headset, Oculus Touch controllers and sensors.

next year the Oculus Quest was released. These are standalone VR headsets that don't require any connection to a computer. The cost of VR headsets has also dropped dramatically in recent years, making VR technology more mainstream[16].

2.2.1 Virtual Reality Sickness

One problem with current VR technology is the tendency for some users to experience virtual reality sickness, both during and after the VR experience[23]. Virtual reality sickness is similar to motion sickness, but different in that the user is often stationary and it is caused by the visual perception of self-motion, rather than self-motion itself. The symptoms of both motion sickness and virtual reality sickness includes[23]:

- Eye strain
- Headache
- Pallor
- Sweating
- Mouth dryness

- Stomach fullness
- Disorientation
- Vertigo
- Ataxia
- Nausea
- Vomiting

There are also a number of other potential issues and challenges with VR technology[24]. An example is the fact that VR requires open space. When you are in a virtual environment, you are less aware of your physical surroundings. This may cause you to walk into walls, objects or people, something that can cause harm to yourself or others. Also, some VR equipment is wired, and if the VR experience requires movement, it is important to be aware of all the wires so that you don't accidentally pull them out or trip over them. Hygiene can also be an issue, as sharing a VR headset between multiple people can spread germs. Even though the cost of VR technology has gone down in recent years[16], the cost can still be quite high for the average consumer[24].

2.3 Motivation

To understand how games and VR used in learning can motivate learners we need to know how people are motivated. This section will take a closer look at intrinsic and extrinsic motivation.

2.3.1 Intrinsic Motivation

According to Richard M. Ryan and Edward L. Deci's definition[25], intrinsic motivation is the motivation that is driven by inner feelings like curiosity, enjoyment and the sense of achievement, rather than external rewards, pressure or praise. Even though exterior rewards don't drive intrinsic motivation, one could say that the reward is the intrinsically motivated activity itself. The first acknowledgment of Intrinsic motivation came after being discovered during studies on animal behavior that many organisms engage in exploratory, playful and curiosity-driven behaviors, even when there is no exterior pressure or reward. Humans also show this type of behavior as they are born curious and playful, with the will to explore and learn. This natural motivation is crucial to intellectual, social and physical development, as it is through pursuing inner interests that knowledge and skills grow. In order to maintain intrinsic motivation it is essential that the person is interested and feels competent at the task.[25][8]

2.3.2 Extrinsic Motivation

Most tasks and activities people do are not intrinsically motivated, something that becomes more apparent as a person grows up and has to take on responsibilities due to social demands. These societal responsibilities might require the person to do activities that might not be intrinsically interesting to the person. When a person is not intrinsically motivated to perform a task, the person needs to be motivated in other ways. Extrinsic motivation is driven by external factors, like earning a reward or avoiding punishment. These external factors are an easy way to motivate someone to work towards a goal, but extrinsic motivation will only last as long as the outcomes are satisfying. In summary, we could say extrinsically motivated tasks are done because of the instrumental value, rather than the enjoyment of the task itself.[25][8]

2.4 Pedagogical approaches

Learning can be defined as gaining knowledge, skills and attitudes through study, teaching, instruction or experience. In order for computer games and VR to give learners a good learning experience the right pedagogical approach needs to be used. In this section we will take a look at some of the relevant pedagogical approaches for this research.

2.4.1 Behaviorism

According to behaviorism, learning occurs when a person or an animal responds to external stimuli. An example of this is if a person is presented with a math equation like 5 x 4, and the person answers 20, the equation is the stimulus and the answer is the associated response.[26] These responses can be reinforced with rewards, and if reinforcement keep following the response to a stimulus, the response becomes more likely in the future.[27] One example is mice that is trained to push a button to receive cheese.

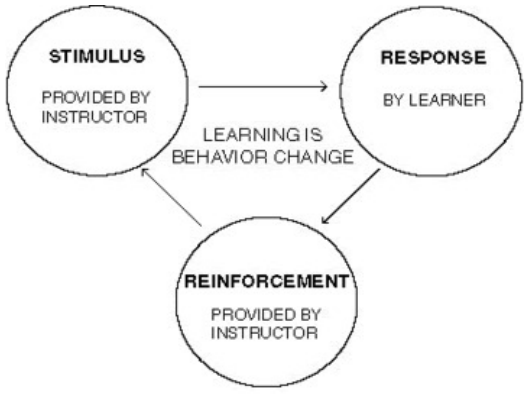

Figure 2.6: Behavioral learning.[28]

2.4.2 Cognitivism

Cognitivism focuses on conceptualizing the student's learning process and how information is received, organized, stored and retrieved by the brain. Information needs to be organized, sequenced and presented in a way that is understandable and meaningful for the learner.[29] A cognitivistic approach aims to assist learners in adding new information to existing knowledge and making connections, by for example using the existing knowledge to solve new types of tasks.[30] Environmental conditions play a significant role in aiding learning. Examples of ways to guide learners are instructional explanations, demonstrations, illustrative examples[29].

2.4.3 Constructivism

According to the constructivism theory, learning comes from creating your own meaning and understanding from the learning material. The theory states that humans create meaning, rather than acquire it.[29] Constructivism focuses on the student, rather than on the teacher. Instead of giving lectures, the teacher takes on the role of a facilitator and is there to help the learners reflect and create their own understanding. Ultimately, the goal is to encourage learners to become critical thinkers. Social constructivism extends constructivism to learning through discussion and collaboration.[31]

2.4.4 Experiential Learning

Experiential learning is a pedagogical approach that focus on learning experiences and can be defined as learning by doing or more accurately, learning through reflection on doing[32]. The experiential learning process includes the learners performing an action that creates and experience, reflection on the action and experience, draw abstractions from the reflection and apply the abstractions to new experiences and actions[33].

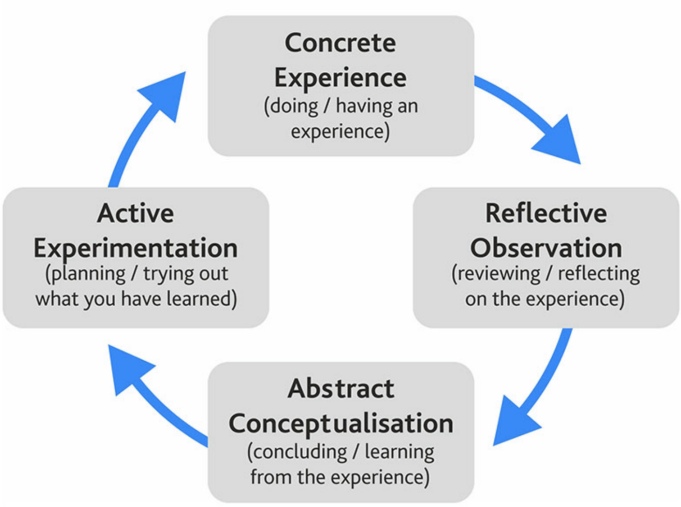

Figure 2.7: The experiential learning cycle.[34]

By repeating the experiential learning cycle, the knowledge will be better retained and can be applied to similar situations[35]. Critics of an experiential learning approach could argue that learners are too immature to know what is in their best interests when it comes to new experiences and that they require knowledge from non-experiential approaches first.[36]

3 Human-Centred Design Process

In designing this product, the human-centred design (HCD) process was used. HCD is an iterative process that starts with planning and research to understand and specify the context of use, as well as specifying the user requirements. Once you have the user requirements, you can start producing design solutions to meet the user requirements. You then have to perform tests on the product and evaluate the design against the user requirements. If the designed solution doesn't meet the user requirements, you iterate where appropriate until the designed solution meets the user requirements[37].

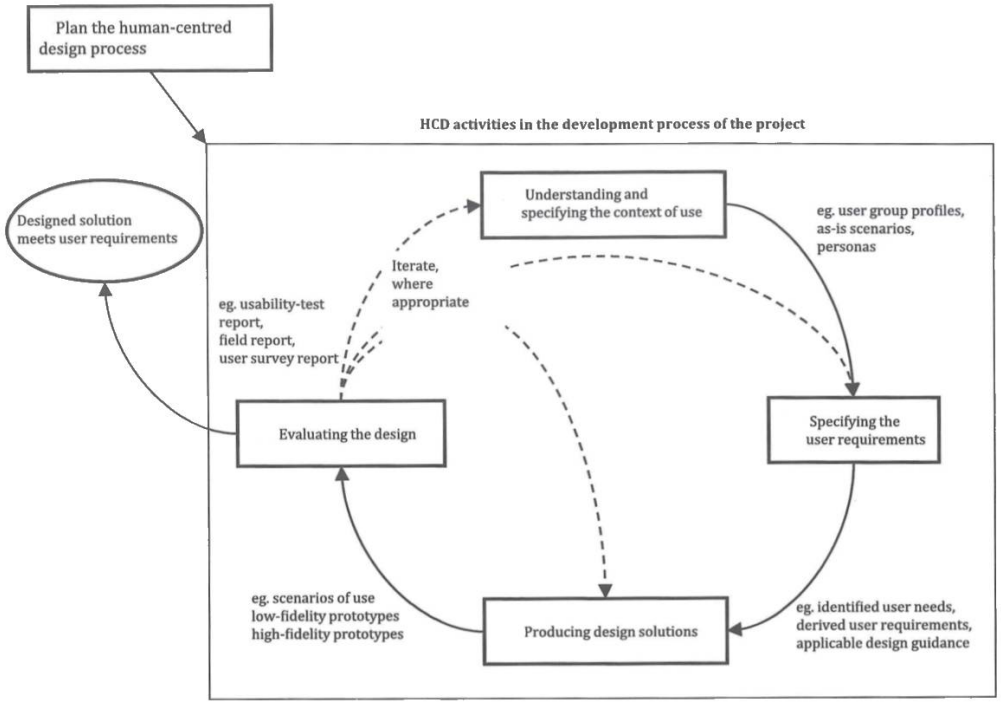

Figure 3.1: Interdependence of human-centred design activities.[37]

The first two parts of the HCD process required data to be collected and analyzed. This was done through questionnaires and interviews with experi-

enced hunters and instructors from the *Norwegian Association of Hunters and Anglers*, as well as studying the "Jegerprøve" syllabus. By reading *Jegerprøveboka* by Stein Lier-Hansen and Bjørn Wegge, a good overview of what you learn through the "jegerprøve" course was gathered[38]. Interviews were conducted to gather qualitative data and information on what was needed to be included in the game. In order to get interviewees, various branches of the Norwegian Association of Hunters and Anglers were contacted, including branches from Kristiansand, Søgne, Lillesand, Grimstad and Arendal. Before conducting the interviews, an interview guide was made to ensure that all the important topics were covered and to give the interviewee a proper introduction to the project. After being introduced to the project, the interviewees were asked the following questions:

- What is the process of a hunt like, from start to finish?
- When hunting, what are the most important aspects you have to consider in terms of humane and safe hunting?
- How was your learning process of hunting? Was there anything that was hard? Was there anything that could have been improved?
- What are your preferred ways of learning? (reading, watching videos, playing a game, verbal communication, etc.) Why is this your preferred way of learning?
- What do you think is the best way for a new hunter to learn the syllabus of "jegerprøven"? Why is this?
- What are your preferred technology tools for learning new things? (mobile device/ smartphone, tablet, laptop/desktop, VR device, etc.) Why?
- Do you think a hunting game that teaches you about what to do and what to not do while hunting could be helpful? Could a tool like this help motivate and engage new hunters? Why or why not?

- Are you familiar with any other tools like this? What did they do right? What did they not do so well?
- Are there any other tools you think can be helpful for a new hunter's learning process? Why?
- Do you have any suggestions for what needs to be included in this tool?

Audio recordings of the interviews were made so that they could be further analyzed.

3.1 Context of Use

The first part of the HCD process was specifying the context of use, which includes users and stakeholders, user tasks and goals, and finally, the environment the product will be used in. In order to specify the context of use, the "Jegerprøve" syllabus was studied and data was collected and analyzed through interviews and questionnaires.

3.1.1 Users and Stakeholders

The product is mainly targeted at Norwegian people aged 14 and up who are taking the "jegerprøve" course, but also people interested in learning about hunting and hunters who need to refresh their knowledge of the rules and responsibilities that come with being a hunter. Other stakeholders are the "jegerprøve" course lecturers, "Norges Jeger- og Fiskerforbund" (NJFF) and "Miljødirektoratet", who are the ones responsible for the "jegerpøve" courses.

3.1.2 User Tasks and Goals

Users will solve tasks related to humane and secure hunting. The tasks will be solved inside the game, either by playing with mouse and keyboard or playing with a VR headset and hand controllers. The user will move around in a forest while being equipped with a hunting rifle. The forest will contain deer the user can hunt.

Examples of tasks are making sure the bullet hit the right spot on the animal so that the shot is fatal, making sure the distance, angle, movement speed and field of view makes for a fatal shot, making sure that no animals are hurt needlessly, consider the safety for you and fellow hunters, for example dangers of ricochets. If a task is failed, the user will get feedback in the form of an explanation of what went wrong, why this is wrong and how to avoid this, often accompanied by an illustration.

Other tasks that were recommended were recognizing different kinds of animals and consider whether they are huntable or not and make sure that to follow the different rules set for that specific animal, for example shooting distance. This was something that was not included in the final game due to the need of realistic 3D models with animation for each of the animals, which would either take time to model and animate, or cost money.

Ultimately, the goal is to teach the user about some of the most important aspects of "jegerprøven", which includes humane and safe hunting.

3.1.3 Environment

The product activities will be locked to a location where a computer is available. Additionally, if you are playing in VR you would need some open space to use as a play area. As long as the computer has a Windows or Mac OS X operating system, the unity game should be able to run, however, if you are using VR you will need VR equipment, which can be expensive. Due

to this, the intended environment for the VR version of the game will be at the venue where the “jegerprøve” course is held. However, the screen-based version of the game can easily be played by most people at their homes, as long as they have a computer with a mouse and keyboard. The game will be played by one user at a time and does not feature any cooperation or multiplayer aspects.

3.2 User Requirements

In order to specify the user requirements, data gathering and analysis were important. In order to collect as much relevant data as possible, experienced hunters and various local branches of NJFF (Norwegian Association of Hunters and Anglers) were contacted and asked to meet up for an interview or answer a questionnaire. Before the interview was done, an interview guide was prepared. The goal of the interview was to find out more about the hunting process and the most important things a hunter has to consider when hunting humanly and safe, as required by Norwegian laws.

One of the interviews was with a former ”jegerprøve” instructor from the Søgne branch of NJFF. According to him, there isn't enough hours of the course dedicated to practical training, and the practical training already included in the course covers mainly weapon handling and how to find good hunting positions. As of now, there is no practical training in how to handle different hunting situations you come by when facing an animal. The reason for this is that situations like this are unpredictable and can't be planned. The most common cause of wounding an animal is shooting when an animal is moving too fast or shooting from too long distances. This is something that is often a consequence of bad judgment of the situation, so it is important that the hunter is properly trained and know what to do in these situations. It was therefore important for the former instructor that the game covers as many realistic situations as possible.

In order to teach the users about humane and safe hunting, and make them able to handle the most common situations that hunters might face when hunting, the game should teach the users to:

- Make sure that the animal stands still or is moving slowly before you shoot. Never shoot an animal that is fleeing.
- Make sure that the angle is right. The target is much easier to hit when the animal is standing sideways compared to when it is facing you or away from you.
- Make sure the distance is not too long. For deer that means no further than 75 meters when the animal is standing still and no further than 35 meters if it is in slow movement. The hunter should always be aware of the distances that apply to the animals they are hunting.
- Make sure that the animal is not standing in a pack of other animals. Only shoot when the animal is standing by itself and there is no danger of wounding other animals.
- Make sure that the field of view is completely clean in front of the animal. If a bullet hits a branch, the bullet will expand and flatten before it penetrates the animal and because of this, most likely wound the animal without killing it.
- Make sure that the background is safe. For example, make sure that there is no danger for ricochets or that there is no chance for a person or another animal to come up from behind the horizon.
- Make sure that you don't kill a mother animal, as the children most likely won't be able to survive the winter by themselves.

Other aspects the game could cover that don't have to do with humane hunting, but are important In terms of safety was also brought up during the interviews. The game could for example teach the users things you need to

be aware of from the moment you leave your house and get home again, for example:

- How to transport a weapon in your car.
- How to traverse the woods with a weapon.
- What to do when you meet other people in the woods.
- Make sure the animal is not positioned on a public road, to avoid making a roadblock. However, if it is positioned on a private road, it can be natural to kill it there as it is an open area with no obstructions, as well as in a good position for transport.

To make it easy for the user to learn all this, it is important that the game gives proper instructions and feedback when something is done wrong or could be handled differently.

3.2.1 Usability and User Experience Goals

In addition to teaching the users the learning material, the users also require the game to give them a good user experience. Jakob Nielsen defined a list of important Usability goals[39]:

- Learnability
- Efficiency
- Memorability
- Low error rates
- Satisfaction

In order to make sure the learnability is good, the user needs to get proper instructions on the current task and appropriate feedback when doing something wrong or should be doing something differently. The terms and language used should be easy for the user to understand, and in some cases accompanied by illustrations to make the task at hand even more clear. Voiceover could also be an addition.

In order to let the user efficiently perform their tasks, it is important that the menu navigation and the tasks are logical and coherent. It is also important the users don't have to go through too many steps to achieve their goal.

In order for the memorability to be good, it is important that game controls and menus are logical and simple, only doing what is necessary. It should also follow conventions and standards.

The game also needs low error rates. If the user ends up encountering an error, it is important that the user can recover easily and get back to the previous state. To avoid errors, the game needs to be tested thoroughly.

The game should also be satisfying and fun to play in order to motivate and engage the user. To achieve this, the game can use visual and auditory cues when the player does something right. The player should be rewarded points when doing something right. The game needs to be challenging enough to make the player feel satisfied when completing a goal, but not so challenging that it becomes frustrating.

3.3 Producing Design Solutions

Parts of the product had already been developed using Unity in a previous course, prior to the requirements being established[40]. Once the requirements had been established, further development of the product could begin.

The game was to be further developed with Unity 3D, using the C# programming language. Unity works with both Mac OS X and Windows operating systems. Since the game was supposed to work in VR, VR equipment was also needed. The VR equipment available was HTC Vive and Oculus Rift. It was originally decided to go for the Oculus Rift, and the reason for this was because the Oculus Rift hand controllers have joysticks, something that makes it easier to move around a virtual space without actually moving in physical space. Another reason was that it seemed to be more tutorials online on how to use Oculus Rift with Unity. The Oculus Rift is wired and needs to be connected to a computer. Because of this, testing would have to be done inside, near a power outlet. But eventually, the faculty acquired the newer Oculus Quest equipment, which is wireless VR equipment, something that would make it easier to bring along for testing, and could be tested anywhere, as long as there is enough space to move around. With wireless VR equipment, you also avoid getting tangled up in wires when moving around in a virtual environment. A decision was made to switch from Oculus Rift to Oculus Quest.

3.3.1 The Player Controller

The first and most basic features the game needed was a controller that the player could use to interact with the game world. A design choice needed to be made on whether the game should be played from a first-person perspective or a third-person perspective. The different perspectives would give the player distinctive experiences regarding the immersion and perception of the game world [41]. A first-person perspective would allow the player to perceive the game world through the eyes of the playable character, giving the player a clear view of the surroundings and most likely giving the player a more immersive feel[41, 42]. Alternatively, the player could perceive the game through a third-person perspective, observing the playable character in action. This approach wouldn't make the player as immersed in the world, but would make the player more attached to the playable character, some-

thing that works well for story-based games where you want the player to care about the character[43]. Since the goal of the game was to immerse the player in different situations that could occur while hunting, a first-person perspective was the clear choice.

Unity already had a first-person controller as a part of their Standard Assets. This controller lets the player move around and look in the direction of choice by using the computer mouse, but this asset doesn't come with the ability to carry and fire weapons, and because of this, modifications to the controller had to be made. The controller needed a 3D model of weapon attached, giving the perception that the player carries a weapon. Next, the player needed to be able to aim their weapon and shoot. The aim function works so that the camera zooms in and a UI element representing the scope becomes visible.

Figure 3.2: *On the left:* The player's view when the controller is not aiming. *On the right:* The player's view while the controller is aiming

To make the controller shoot, the gameobject the player is aiming at needed to return data to the controller. This was done by using Raycasts. Raycasting sends out an invisible line and checks if the line collides with any gameobjects. By hitting a deer, information on the deer gameobject could be returned, and a script attached to the deer could be executed. Raycasts have the ability to collide with multiple gameobject, not just the first gameobject hit, and

in this game it is important to know what is in front or behind the deer the player is shooting at. Examples of situations where this would be important are;

- When another deer is standing behind the deer the player is shooting at.
- When a rock is behind the deer the player is shooting at.
- When tree branches are in front of the deer the player is shooting at.
- When there is no terrain, only the horizon behind the deer the player is shooting at.

To get a list of all gameobjects hit, the function RaycastAll was used. However, there was an issue with RaycastAll; the order of the gameobjects returned in the list was not necessarily in the order the gameobjects was hit. For example, if the trajectory of the bullet would have gone through a deer and then hit the ground, RaycastAll could return the ground first, and then the deer, and because of this, the deer would not take any damage. To fix this, the distance between the weapon and the collision points of the gameobjects had to be measured, and then the list had to be reordered based on the distance, from the closest to the furthest away.

```
    RaycastHit[] hits;
    hits = Physics.RaycastAll(mainCamera.transform.position,
    mainCamera.transform.forward, range);

    if (hits.Length > 0)
    {
        hits = hits.OrderBy(hit => Vector3.Distance(transform.position,
        hit.transform.position)).ToArray();

        for (int i = 0; i < hits.Length; i++)
        {
            //Code for finding out what was hit and in what order
            //used to detect if any errors were made
        }
    }
```

Listing 1: Code snippet of how Raycast was used to detect hits and how the list of hits was sorted.

Most of the player controller had already been finished in the previous project[40], but there were some improvements made in this project. In order to make sure that the player only shoots a deer when the broadside is facing the player, the angle between the gun and the deer needed to be calculated. The angle was calculated by using the forward vector of the gun and the forward vector of the deer hit by the Raycast. If the angle between the direction the gun is pointing and the direction the deer is facing is bigger than 140° or less than 40°, the player will get a message saying that they need to consider the angle.

```
        Vector3 GunDirection = Gun.transform.forward;
        Vector3 targetDirection = hit.transform.root.forward;
        float hitAngle = Vector3.Angle(targetDirection, -GunDirection);

        if(hitAngle > 140 || hitAngle < 40)
        {
            //Code for sending the player feedback
        }
```

Listing 2: Code snippet of how the angle between the gun and the deer was calculated.

Additionally, the ability to detect whether or not a deer is standing on the horizon was added during this project. In order to detect the code had to check whether or not the Raycast hit something after it had a deer. If the Raycast didn't hit anything after hitting a deer, it meant that the deer would be standing on the horizon and the player would get feedback on this, and if the Raycast hit the terrain after hitting a deer, the shot would be accepted. In addition to these improvements, a number of bugs were fixed based on feedback from test participants. These bug fixes will be described in the findings detailed in the next chapter.

3.3.2 Deer AI

The deer needed to take a different amount of damage based on where on the body the deer was hit. Therefore colliders were placed on the different parts of the skeleton of the deer model, and a script that took care of the amount of damage the deer would take was attached to these colliders. The deer was made to be able to randomly wander between a list of predetermined destinations. This was done with the use of NavMesh. NavMesh calculates a route between two destinations without hitting any obstacles, like for example trees or rocks. Some of the deer have calves, and these calves are not able to move randomly. If the mother of the calf moves a certain distance away from the calf, the calf will start following the mother. Extensions to the deer script were made to make the deer behave according to what was needed for the different tutorials[40].

```
        if (alive && fleeing == false)
        {
            int index = Random.Range(minTime, maxTime);
            yield return new WaitForSeconds(index);
            int index2 = Random.Range(1, 3);

            switch (index2){
                case 1:
                    if (alive && fleeing == false){
                        StartCoroutine(RandomMovement());
                    }
                    break;

                case 2:
                    if (alive && fleeing == false){
                        navMeshObstacle.enabled = false;
                        navMeshAgent.enabled = true;
                        animation.SetTrigger("walk");

                        int lastDestination = selectedDestination;
                        selectedDestination = Random.Range(0, destinationPoints.Count);

                        while (selectedDestination == lastDestination){
                            selectedDestination = Random.Range(0, destinationPoints.Count);
                        }
                     navMeshAgent.SetDestination(destinationPoints[selectedDestinatio]
                     .transform.position);
                    }
                    break;}}
```

Listing 3: Code snippet of how to make the deer move randomly using NavMesh.

3.3.3 Message system

In order to make the player learn anything from the game, the player needs to get proper instructions and feedback when something is done wrong. A message system was made that sent the player messages, often accompanied by an illustration. If an error was made by the player, for example shooting from too long distances or shooting a mother animal, a message would be displayed on the screen telling the player what went wrong, how to avoid this and what to do instead. When a message is displayed on the screen, the time slows down and the screen turns black and white. This is done to get

the player's attention. The message system is not only used when the player commits an error, but also at the beginning of tutorials, to give the player instructions[40].

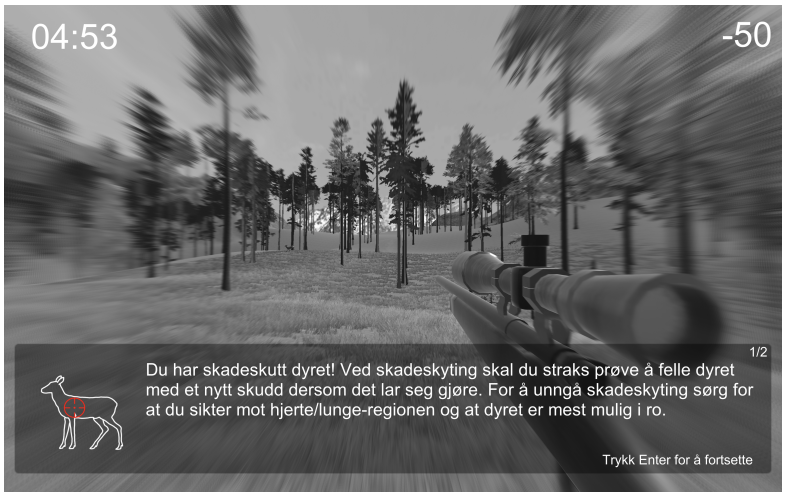

Figure 3.3: Example of a feedback message the player will get if the player don't shoot the deer in the heart/lung-region.

During this project, the message system was further developed. In the tutorials, the player won't get a pop-up box with a message when making errors. Instead, they will be sent to a panel where they would get the option to try again. The message system was upgraded to send the error messages to this panel, including text and illustration. If the player would make more than one error, the messages would be added to a scroll list in order to prevent the messages from overlapping with the buttons on the panel.

3.3.4 Tutorials

The biggest focus of the game is on the tutorial part called "Jaktopplæring". This is where the player will get most of the learning. In the tutorials, the player will not get an immediate message on the screen telling them what

they did wrong. Instead, the tutorial will fail, and a panel will show up that includes the feedback messages and illustrations, as well as buttons to try the tutorial again or return to the main menu. There are currently nine different tutorials, which includes:

1. Placement of the shot
2. Angle between hunter and deer
3. Shooting distance
4. Deer in pack
5. Mother deer with calf
6. Unclean firing range
7. Danger of ricochets
8. Deer in the horizon
9. Deer in fast motion

For this project, new tutorials were added; "Angle between hunter and deer" and "Deer in the horizon". Additionally, the tutorial "Shooting distance" was reworked. In the initial version, the player would have to move closer to the deer in order to shoot it. In the new version, the player would have to judge if the deer was close enough based on their locked position. Since the rules on distance are dependent on whether the deer is moving or not, this version included two deer the player had to kill, one stationary and one in movement. For the player to more easily make the right call, a UI distance indicator where added to the deer in this tutorial.

Figure 3.4: The player aiming at a deer. The distance indicator is visible above the deer, showing 52m (an acceptable distance for a stationary deer).

As with the "Shooting distance" tutorial, a minor change was made to all the other tutorials in this project. With VR in mind, all the tutorials were made so that the player would be stationary in order to avoid virtual reality sickness[23].

3.3.5 Free Hunt

Free Hunt is meant for players that have completed the tutorial. Here the player can move around freely and have to use what they have learned in the tutorial in order to score points. Deer will spawn randomly and move around randomly in the forest. With this randomness, all the situations presented in the tutorial may appear, and in some cases, combinations of these situations. If the player kills a deer without making any mistakes, the player will be rewarded with 100 points. If the player makes a mistake, the player will not lose like in the tutorial, but will get a feedback message via the message system, and the player will lose points based on the severity of the mistakes made. The game mode is timed and ends when the timer hits 0.

The player can choose to play a round lasting 5, 10 or 15 minutes. If the time runs out and the player has made 0 mistakes, the player will be rewarded 500 bonus points. The bonus points are rewarded even if the player haven't killed any deer. This is done to teach the player that a good hunter can't be judged on the number of animals killed, but how the animals are killed and how the hunter behaves when hunting.

3.3.6 VR Version

For this project, a VR version of the game was developed. To make the VR version, the screen-based version was used as a base. The player controller needed to be completely different in order to function in VR. Because of this, the existing player controller was removed. To create a functioning VR player controller, the Oculus Integration package was used. The Oculus Integration package included an Avatar with virtual hands controlled via the hand controllers. The weapon needed to work in a different way in VR, as attaching the weapon to the player wouldn't feel realistic in a VR setting. Instead, the weapon needed to be a grabbable object that the player could move around, rotate and aim with their hands. In the screen-based version of the game aiming the weapon was done by clicking a button, and then the camera would zoom in. This wouldn't work in VR, and a completely different method would need to be used. For VR, the scope needed to work more as it would in the real world, so a zoomed-in camera was attached to the front of the scope, and what was being rendered by the camera would be displayed on a plane attached to the back of the scope, giving the player the impression that they are looking through the scope. However, doing it this way didn't come without problems.

Figure 3.5: *On the left:* The player holding the rifle.
On the right: The player looking through the rifle's scope.

The game world would already be rendered by the eye cameras, and now it would be rendered an additional time by the scope camera, something that affected the performance of the game. Because of this, and because the Oculus Quest is a standalone device not as powerful as a regular computer, the graphics settings needed to be turned down for the VR version of the game. A graphics settings option was added to both versions of the game in order to give the player the experience best suited for their computer or VR equipment.

3.4 Evaluating Design Against User Requirements

3.4.1 Original Plans

To evaluate the design against the established user requirements, user tests had to be conducted. Originally the testing would include testing the VR version of the game, as well as the screen-based version of the game. This turned out to be difficult due to the coronavirus pandemic. Testing the VR version would require a VR headset, and because it can't be expected that the test participants would own a VR headset themselves, testing would be done by setting up meetings where the test participants would use a VR headset provided by the project. This would require to meet up with test participants face to face, something that wasn't recommended by the *Norwegian Institute of Public Health* or *Folkehelseinstituttet* (FHI).

The test participants were originally intended to be Jegerprøve participants, as these are the intended users of the game. In order to come in contact with these potential test participants, an instructor from Kristiansand's branch of *Norwegian Association of Hunters and Anglers* was contacted, and a deal was made so that the project could be presented at next Jegerprøve course in front of the participants, and possibly recruit some test participants. The Jegerprøve course was going to be held throughout March, with an exam at the very end of the month. Unfortunately, due to the coronavirus pandemic, the course was canceled.

3.4.2 Remote Usability Testing

With being somewhat limited when it came to testing the VR version of the game, and being unable to come in direct contact with the target audience and the intended users of the game, the project needed to go in a different direction. Instead of doing the testing in the same room as the test participant, remote usability tests were conducted. This would let test participants

download the game for either Windows or Mac, and play through it on their own computer. The test participant could then play the game on their own, following the instructions provided to them. The instructions included how to install the game and what areas of the game that the test participants should focus on during the testing. The instructor from the Kristiansand branch of *Norwegian Association of Hunters and Anglers* was again contacted to see if he was able to share information and instructions on how to remotely test the game with the people originally signed up for the canceled "Jegerprøve" course. In addition to this information and instructions on how to test the game was sent out to people from the faculty and acquaintances.

After the test participants had played the game, they would answer a questionnaire. The questionnaire would start with getting the demographic of the test participant, including gender, age-range and their familiarity with hunting. Next, the questionnaire had the test participant rate how much they agreed with a statement using a Likert scale. The Likert scale included five levels;

- Strongly disagree
- Disagree
- Neither agree nor disagree
- Agree
- Strongly Agree

This Likert scale was used to measure the games' usability, and the statements included standard usability statements like; The game was too complicated, I would require assistance from a technical person to play this game and would you play this game again. It also included more game-related statements like; The controllers responded as expected, I knew what I was supposed to do to win the game, and the graphics of the game was appropriate for this type of game [44]. In addition to rating the statements on

a Likert scale, the test participant could also comment on the usability of the game in a text field. The next part of the questionnaire focused on the research questions.

The motivation, engagement, learning outcome and other values the game could provide were also measured with a Likert scale. Examples of statements in this part included:

- I found the game entertaining.
- I felt the game motivated me to learn more about hunting.
- I learned something by playing this game.
- I would feel more confident in passing the "Jegerprøve" exam after playing this game.

After rating the statements on the Likert scale, the test participant could choose to further comment on questions like for example what they found motivating and what could be done to make it more motivating. The questionnaire also asked the test participant to report eventual bugs the test participant might have encountered during the testing. After conducting the first round of testing, iterations were made based on the feedback from the questionnaire.

3.4.3 Remote Moderated Usability Testing

Further texting continued on the next iteration of the game. Before the testing started, a usability test plan was made using the *Usability Test Plan Dashboard* by Dr. David Travis[45].

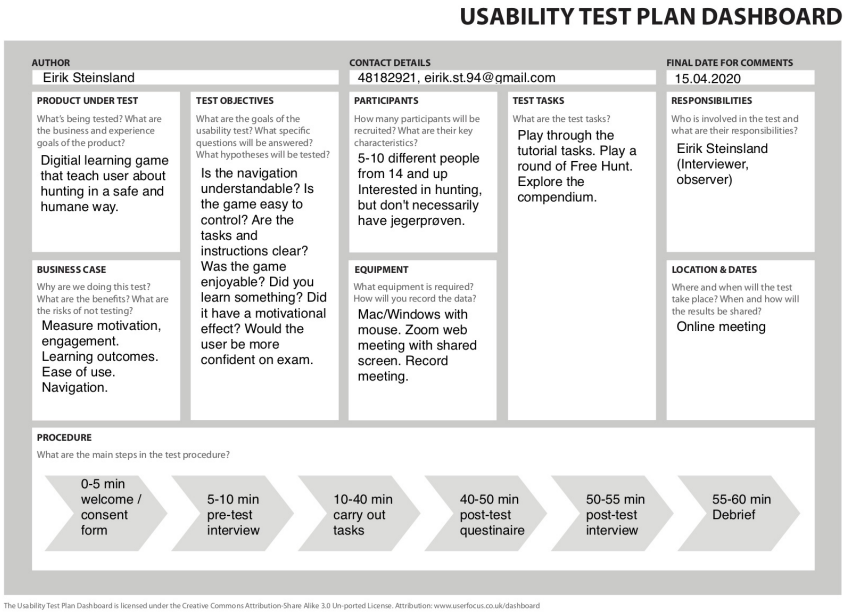

Figure 3.6: Usability test plan followed during the remote usability testing.

As with the previous round of testing, the testing was done remotely, but this time the whole testing process was moderated and observed, instead of leaving the test participants to do all the testing by themselves. The reason for having moderated test sessions was to so see how much time the test participant would use on solving each time, find out specifically where the in the game there were issues, and observe the test participants face expression and voice in order to see if the test participant seem to be enjoying themselves or be frustrated. The testing was done over video meetings using Zoom. With Zoom[1] the test participant could easily share their screen and the whole meeting could be recorded.

[1]Zoom.us. A videoconferencing software program developed by Zoom Video Communications.

When observing the test participants playing through the game, the following was focused on:

- Is the player progressing through the tasks of the game as intended?
- Is the player having any difficulties or any issues?
- Is the player remembering the instructions given in each of the tasks in the game?
- Is the player enjoying the game?
- Is the player getting frustrated?
- Is the game stable and behaving as expected?

Observing while the test participant played the gamed didn't go as smoothly as first envisioned, as the gameplay footage shared in the video meeting could have quite a low frame rate based on the internet connection of the participants. This made it hard to observe whether or not the game was stable and behaving as expected, but observing the progression and whether the test participant enjoyed the game or was frustrated with it could still be observed. When observations were made they were noted down in a text document and questions were prepared for the interview at the end of the testing session.

Once the player had played through the game they were asked to fill out a questionnaire with similar questions to the questionnaire used in the non-moderated testing conducted earlier. After this an interview was conducted. This interview consisted of pre-made questions focusing on what made the game motivating and engaging and how to improve these aspects, as well as what was learned by playing the game, if the test participant noticed any problems and how to improve the game in general. In addition to this, questions were made while the test participant played through the game, based on the observations. After the interview was done, the test session ended with a small debrief.

3.4.4 Testing the VR version

Even though it would be hard to test the VR version, it was decided not to drop the testing of the VR version entirely. In order to test the VR version, it was needed to reach out to people who had access to VR equipment. Three other people on the faculty had access to VR equipment, and these people were asked to download both the VR version and the screen-based version and test them on their own and compare them. After they had tested both versions of the game, they were asked to fill out a questionnaire. In addition to conducting remote unmoderated tests, the VR equipment available for this project was used to perform moderated tests on two other people. In these tests, the test participants played through both versions of the game while being observed, filled out a questionnaire and did an interview.

4 Findings and Discussion

In the previous chapter, the development and testing of the product were discussed. In this chapter, the data gathered during the testing phase will be presented, and the findings, observations and discoveries will be analyzed. Through this analysis, the research questions presented at the beginning of this thesis will be answered.

4.1 Results

As explained in the previous chapter, the testing was performed on three different versions of the game; the first iteration of the screen-based version of the game, the second iteration of the screen-based version of the game and the VR version of the game. The results of testing the different versions of the game will now be presented.

4.1.1 First Iteration of Screen-Based Version

The first round of testing was done on the first iteration of the product and consisted of remote usability tests, where the test participants downloaded the game on their own computer, played through it on their own and answered a questionnaire. The age and gender demographic of the test participants consisted of 50% people from 20-29 years, with 62.5% of the total test participant sample being male. The exact age and gender demographic of the test participants is presented in Figure 4.1.

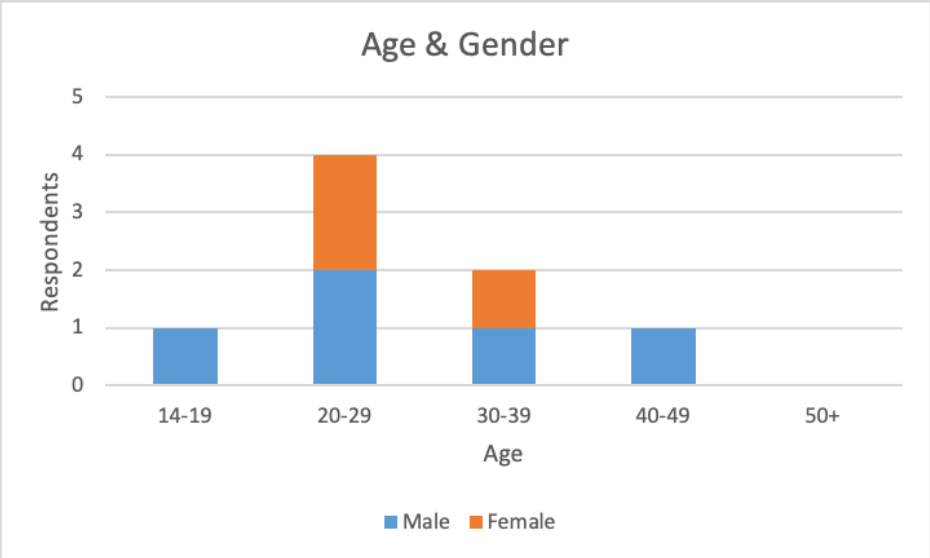

Figure 4.1: The age and gender of the 8 test participants of the first iteration.

Of the 8 test participants who tested the first iteration, only one of them had taken the "Jegerprøven", the rest of them had no experience with hunting. Continuing on with the questionnaire, the test participants evaluated the usability of the game using a Likert scale, specifying their level of agreement or disagreement of the statements presented to them. 50% (4 respondents) of the test participants strongly agreed that the game was easy to play, 37.5% (3 respondents) agreed, and 12.5% (1 respondent) was neutral to whether the game was easy to use or not. Looking closer at the specific areas of the game to find out what makes the game easy to play, it shows that the learnability of the game wasn't a big problem, with most of them strongly agreeing that it was easy to learn, while the rest just agreed. Regarding whether the navigation of the menus in the game was easy, there were more test participants (4 respondents) just agreeing, than strongly agreeing and one test participant that was neutral. The controls seemed to be the biggest factor in why some of the test participants weren't satisfied with how easy the game was to use, with only 1 test participant strongly agreeing that the controls were good.

Most of the test participants just agreed that the controls were good, but there were also test participants who were neutral or disagreed. Overall 50% agreed that they had been frustrated to some degree while playing, while the other 50% disagreed.

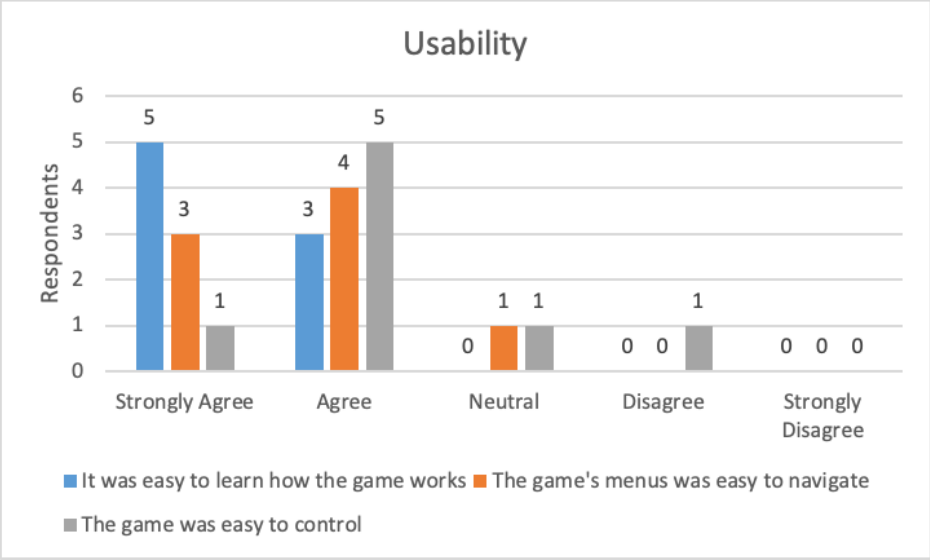

Figure 4.2: A selection of some of the usability statements the test participants rated.

In addition to rating their level of agreement on the Likert scale, the test participants were asked to comment on the usability in a text field. In the comments, there were given feedback stating that the mouse was too sensitive, making it hard to aim at the right spot on the animal. Other problems regarding the controls were that some of the test participants didn't know the controls when they started the game, as there was no explanation at the beginning of the first tutorial, the only way for them to know the controls were to enter the control instructions on the main menu. In addition to this, the instructions of the different tasks in the tutorial weren't always clear enough. Another issue that was brought up by multiple test participants was that when the instructions were given at the beginning of the tutorials,

some players would click the mouse button to try to continue, instead of using the Enter button, which is how you would actually continue. By clicking the mouse button, the player would shoot and immediately fail the tutorial. This was fixed in the next iteration of the game, making it impossible for the player to move or perform any actions before the instructions were read. There were also issues in the game where if the player made more mistakes at once, the player would be presented with too much text to fit the text panel, making the text overlap with buttons. In addition to all of these issues, some players experienced that the game ran slow and was lagging.

The next part of the questionnaire covered the possible values of the game, like entertainment, motivation and whether you can learn something by playing the game. It was found that most of the test participants found the game entertaining to some degree, but some of the bugs present in the game at that stage was frustrating for some and therefore lowered the entertainment value of the game. The bugs reported included:

- If the player double-clicked the mouse button to zoom in, the player's view would be zoomed in permanently, even when not looking through the scope.
- The player could shoot while getting the tutorial instructions, making the player lose before even starting and having to restart the game to continue playing.
- If the player paused the game and then clicked on the continue button, the player would shoot, failing the tutorial or if in Free Hunt, lose points.

Most of the test participants agreed that the game was a motivating way of learning the learning material, compared to for example books. On the statement regarding if they learned something by playing, most of the test participants strongly agreed. In the feedback comments, it was stated that the game could use illustrations to accompany the feedback messages when

the player made mistakes, similar to how illustrations would accompany the instructions at the beginning of the tutorials. All in all, people seemed to like the concept of the game.

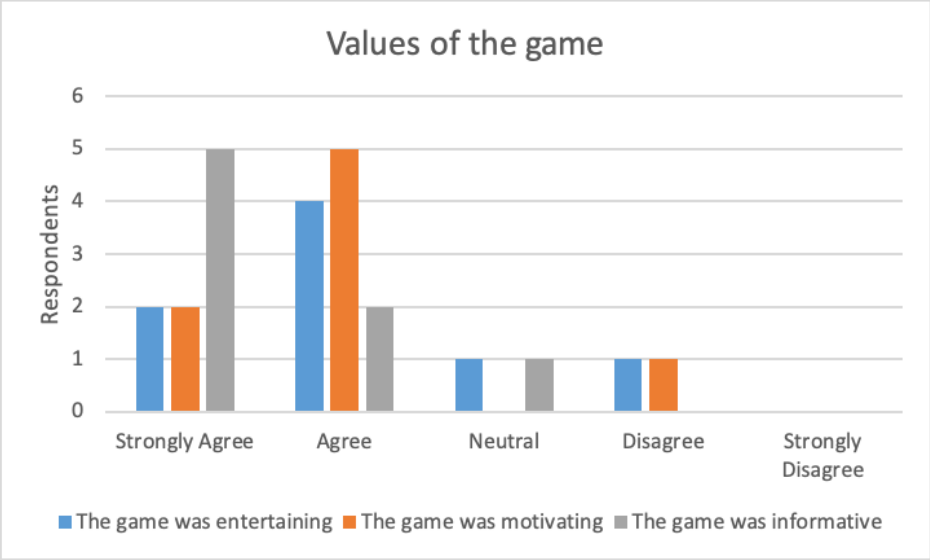

Figure 4.3: A selection of some of the value statements the test participants rated.

4.1.2 Second Iteration of Screen-Based Version

The second round of testing was done on the second iteration of the game. In the second iteration of the game, the bugs mentioned in the first round of testing had been fixed. In addition to this, other improvements had been made based on the feedback, like for example graphics settings and clearer instructions. The testing was done in the form of remote moderated usability tests, where similarily to the testing of the first iteration, the test participant downloaded the game on their own computer and played through it; only this time, they shared their screen and was being observed while playing.

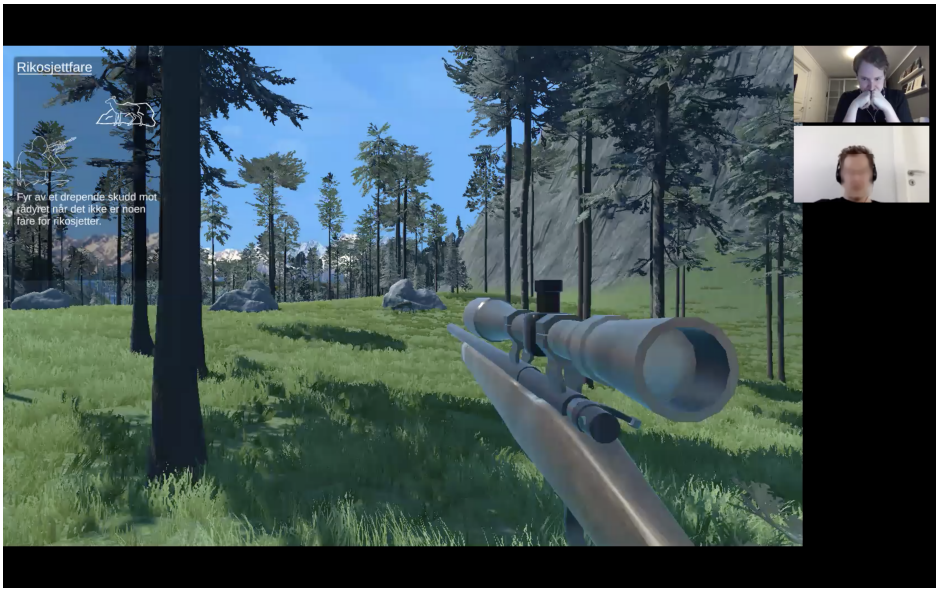

Figure 4.4: Observation of a test participant playing the game and sharing video over zoom. The test participant's face have been blurred out.

After playing through the game, they answered a questionnaire and took part in an interview. All of the test participants of this iterations were between 20-29 years old except one who was under 20 years old. The gender ratio was 60% male and 40% female. The exact age and gender demographic of the test participants are presented in Figure 4.4. Of the test participants, 2 of them had already taken "Jegerprøven" and 1 had plans to take it.

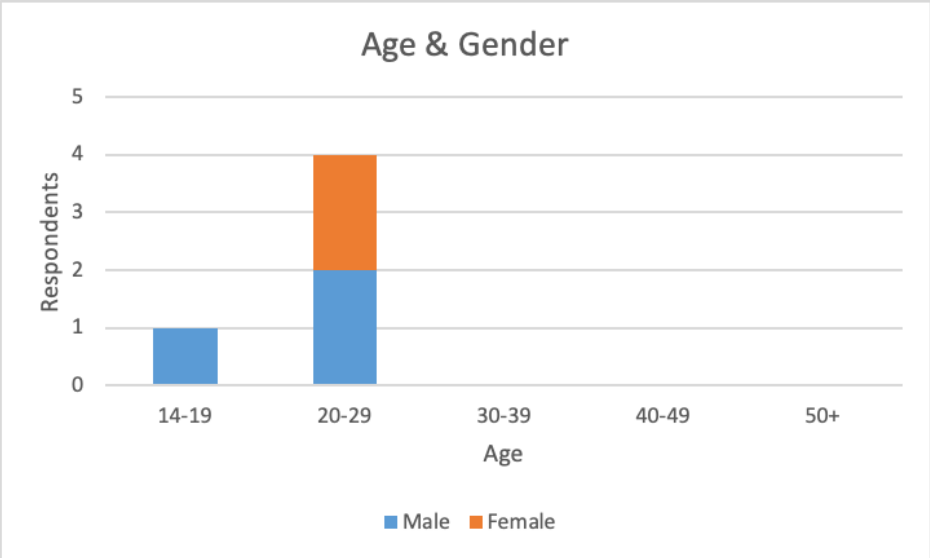

Figure 4.5: The age and gender of the 5 test participants of the second iteration.

Observing as the test participant played through didn't go as smooth as intended, because the shared video of the gameplay could have a very low frame rate, based on the internet connection of the parties involved. But, based on the observations, it was noted that the problem with the mouse being too sensitive was still present, even though this was something that had been improved on between the two test phases. However, it was noted that the test participants who had issues with this had all been playing on a Windows computer, and the ones who had been playing on a Mac didn't show any signs of having issues with this. Due to some of the test participants having issues with the sensitivity of the mouse, some of the tutorial tasks were not completed, in particular the ones requiring precision and timing, like for example the third tutorial where you had to shoot a moving deer from an acceptable distance. Other than that, there didn't seem to be any other issues with completing the tasks, as the instructions seemed to be clear, and they understood what the goal was.

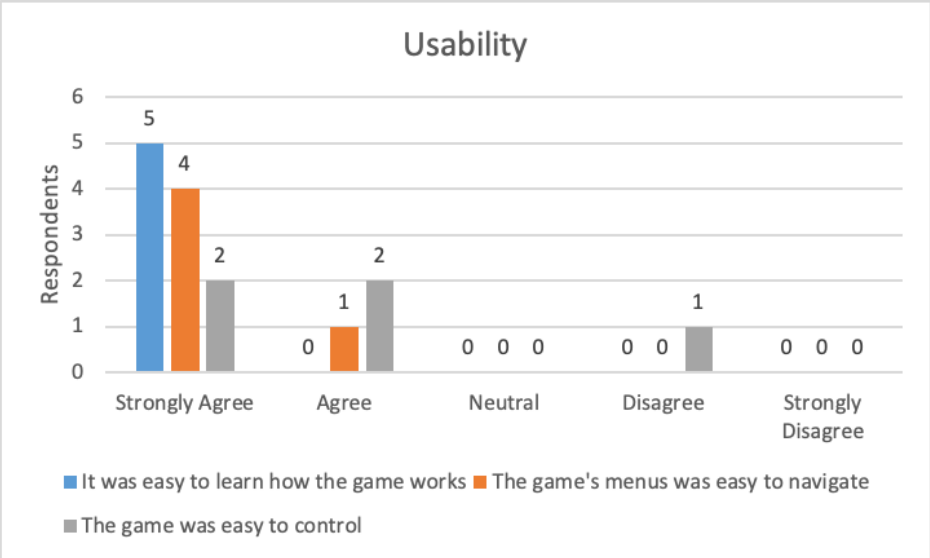

Figure 4.6: A selection of some of the usability statements the test participants rated.

As with the previous round of testing, the test participants were asked to rate the usability using a Likert scale. With improvements made to the instructions in the game, 100% of the test participants strongly agreed that the game was easy to learn, making it an improvement compared to the last round of testing, where 50% strongly agreed and 37.5% agreed. 80% of the test participants strongly agreed that the game's menus were easy to navigate and one 20% just agreed, having some minor issues. Based on the interview, this seemed to be mostly based on the back button being too similar to the other buttons. Overall, the navigation of the menus had improved compared to the last round of testing. An area where there still were major issues were the controls. The mouse was still too sensitive, making it hard for some players to complete some of the tasks.

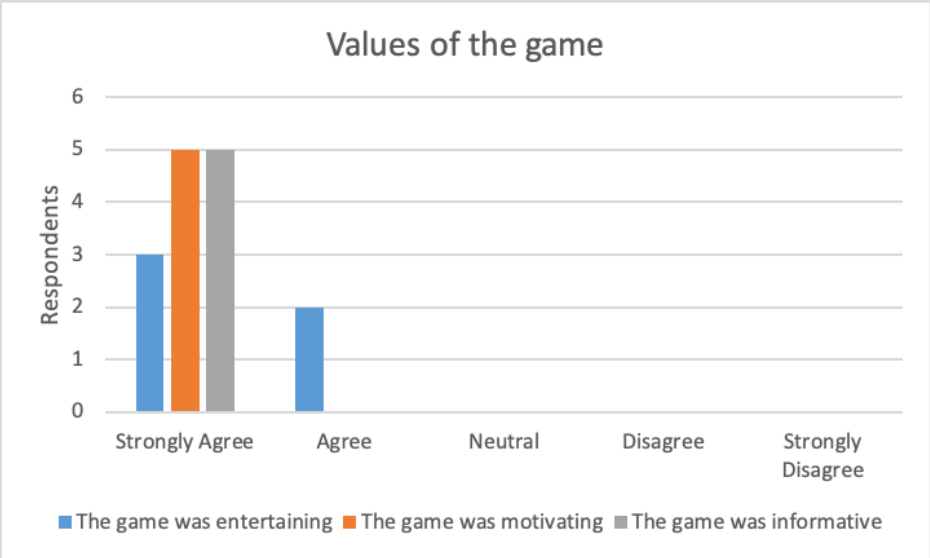

Figure 4.7: A selection of some of the value statements the test participants rated.

When rating the values of the game, all of the test participants strongly agreed that the game was motivating and informative, with the short and concise instructions in the game being brought up as a positive. Regarding the entertainment value, all found it entertaining to some degree, but it was brought up that this wasn't a game that they would pick up and play for the entertainment value alone, they would only play the game if they were to learn how to hunt. Some of the test participants noted that it reminded them of a theoretical drivers test, with different situations being presented, and that this would be a very accessible way for repetition training, making it a good supplement for people taking "Jegerprøven". Based on the interviews, the test participants agreed that having this game as a supplement would make them more confident when taking the theoretical "Jegerprøve" exam and more confident in handling practical hunting situations regarding humane and safe hunting.

By assigning a value from 1 to 5 to each of the categories on the Likert

scale (Strongly agree = 5, Strongly disagree = 1), the mean, median and mode were calculated. If we compare the results of the first iteration and the second iteration, we can see that the second iteration got higher values on all statements, which means that the second iteration was an improvement over the first.

	First Iteration			Second iteration		
Statement	Mean	Median	Mode	Mean	Median	Mode
Easy to learn	4,6	5	5	5	5	5
Menu was easy to navigate	4,3	4	4	4,8	5	5
The game was easy to control	3,8	4	4	4	4	5 & 4
The game was entertaining	3,9	4	4	4,6	5	5
The game was motivating	4	4	4	5	5	5
The game was informative	4,5	5	5	5	5	5

Figure 4.8: Comparison table containing the mean, median and mode of the Likert scale values of the first and second iteration.

4.1.3 VR version

The VR version of the game was tested alongside the screen-based version of the game in order for the test participants to compare the two. The testing consisted of three people testing it on their own using the VR equipment they had available, and two people testing it while being observed, using the VR equipment available for the project. In this case, 60% of the test participants were female and 40% male, with all but one of the test participants being in the age range 20-29. The exact age and gender demographic is shown in Figure 4.7.

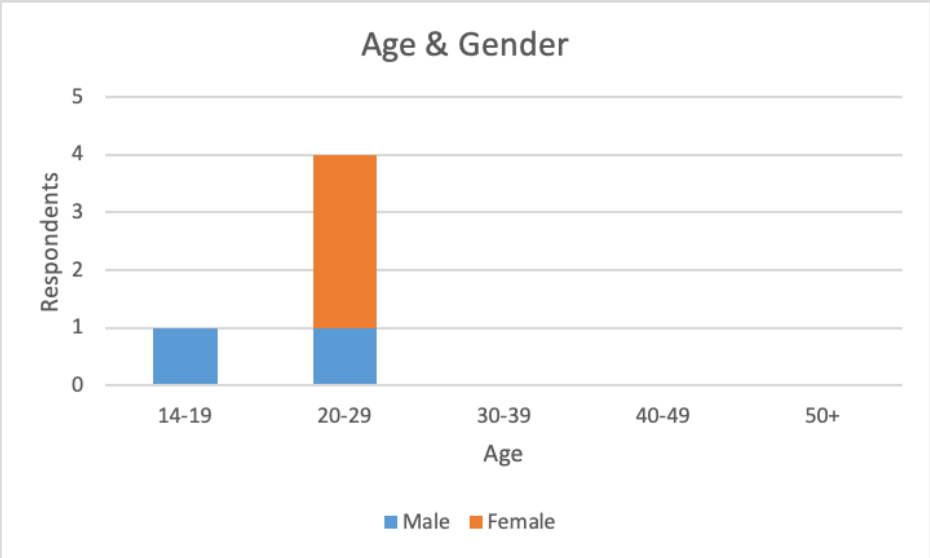

Figure 4.9: The age and gender of the 5 test participants of the VR version.

After having tested both versions of the game, the test participants were asked to rate the usability of the VR version compared to the screen-based version. The results proved to be divisive when it came to the difficulty of the game, with some finding the game harder to play in VR and some finding it easier. The ones finding the VR version easier to play mentioned the issue with the mouse being too sensitive, and because of this, it was easier to aim at the deer in VR. Among the ones finding the VR version harder, it was mentioned that it was harder to hold the weapon completely still in VR, but this is something that can be an issue in real life as well; therefore, it was acceptable that the VR version would be harder. This also correlated to the number of mistakes they made in each of the versions and the time spent on these tasks. In regards to the statement that the VR version was more frustrating, 40% was neutral and the other 60% disagreed in various degrees to the statement.

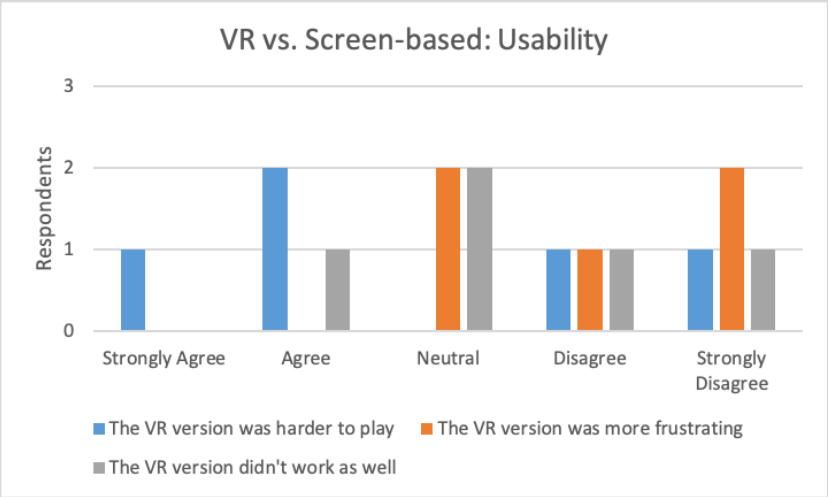

Figure 4.10: A selection of statements rated regarding the usability of the VR version compared to the screen-based version.

There were also disagreements on how well the VR version worked compared to the screen-based. Feedback regarding this mentioned that since the graphics had to be tuned down in the VR version of the game, the low render distance on the trees was very noticeable, with trees suddenly popping up or popping out. I addition to this, the VR version could sometimes show black edges on the outskirts of the player's vision, especially if the player would turn their head fast. Another problem that some of the test participants experiences while playing in VR was motion sickness or more specifically virtual reality sickness. This was not an issue in the tutorials because the controller would be locked to a location, but in the "Free Hunt" part of the game where the player could move around using the joystick, this could become an issue.

All of the test participants agreed that the game was more engaging in VR, with some of the feedback stating that when you played the game in VR, you actually felt like you were out hunting, while playing the screen-based version you always knew you were playing a game. Most of the test participants also found the VR motivating, while one of the test participants found both versions to have the same motivating effect. The motivation

came from the VR version being closer to the experience you would have when hunting in real life. In regards to whether you learned more by playing the VR version, there were some disagreements. Most of the test participants thought they learned about the same amount in both versions, as the tasks were the same in both versions. But there were some who felt they had learned more by playing the VR version.

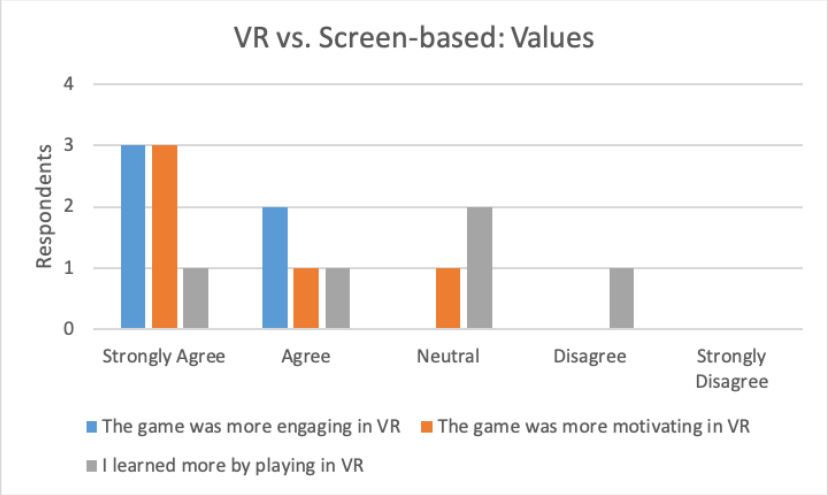

Figure 4.11: A selection of statements rated regarding the values of the VR version compared to the screen-based version.

All of the test participants thought VR was a natural fit for this kind of game and preferred the VR version over the screen-based one. Among the feedback it was stated that better represents the various hunting situations in a realistic way, and because of this will have a better effect on making the hunter more confident when facing real hunting situations.

4.2 Data Analysis and discussion

With the data collected, we can now analyze and discuss the research questions and hypotheses presented in chapter 1 of this thesis based on the theory

from chapter 2 and the results presented in this chapter.

To what degree can a digital learning game affect motivation, engagement and participation in learning humane and safe hunting? If we look at the results, we can see that almost everyone that tested the game found the game motivating. Motivation can be either intrinsic or extrinsic, and intrinsic motivation is driven by inner feelings like curiosity, enjoyment and the sense of achievement[25], and that is something this game can offer. In terms of giving the player some sense of achievement, the game has objectives and tasks, and according to some of the test participants, these tasks are neither too hard nor too easy. The game covers the subject of hunting, and if the player has some interest in hunting, this should cover their curiosity. In addition, the "Free Hunt" part of the game lets the player explore the woods on their own while looking for deer to hunt, something that could also appeal to the player's curiosity. If the game is balanced right, the deer in "Free Hunt" won't appear too frequently nor too infrequently, making the player always on the lookout and engaged in the moment. According to Huizinga's definition of play[7], the game should be voluntary. If the game is not voluntary, the learning experience might no longer be enjoyable and fun, and this way, take away the intrinsic motivation. Because of this, the game should not be a mandatory activity for new hunters, but a voluntary supplement to their learning.

The game can also motivate players extrinsically with the inclusion of points and progression. When a tutorial task is completed, it will be marked as so, and by completing all of the tutorial tasks, the player will be congratulated. "Free Hunt" is where the player can gather points. Points are earned by killing a deer without making any mistakes. If the player makes a mistake, the player will lose points. It is important to note that extrinsic motivation only lasts as longs as the outcomes are satisfying[25], and by looking at feedback on this area, it can be concluded that ways of extrinsically motivating players were lacking. Based on feedback, there are things that can be done to improve this. One example is earning points based on how safe the dis-

tance is, how close to the heart the bullet hits the deer, whether the deer is moving or not, get more points for killing a big buck, etc. Right now, the game rewards the player the same amount of points as longs as no mistakes were made. Other things that can be added are leaderboards, achievements, collectibles, ways for the player to spend their points, for example on unlocking cosmetic rewards, like a new look for your weapon, or unlocking new pages in the compendium. There also needs to be a good balance between how many points the player earns versus how many the player loses when making an error. If the player gathers up a lot of points, the points will start to have a lesser impact on the overall score, and therefore start being less satisfying. The important thing is that the player always has something to work towards and keeps them coming back.

Going back to the findings, all of the test participants found the game engaging to some degree. The game is concerned with making the player hunt in a safe and humane way, so the player can't just mindlessly kill all the animals the player sees. The player has to constantly consider the situation and patiently wait for the right opportunity. Because people learn in different ways and the accessibility of this game, the game could be a good supplement for training new hunters, possibly attracting more learners. In this case, almost all of the test participants stated that they preferred to learn in this way over reading. So, to what degree can a digital learning game affect motivation, engagement and participation in learning humane and safe hunting? As seen by the results in of this research, the game can have a good motivating effect on learning and engage the learners, possibly drawing in more people to learn about hunting. Seeing as the game had a motivating effect on players who don't necessarily have any interest in hunting, the game might have an even bigger effect on the intended users, as they are people who are signed up for "Jegerprøven" and most likely already have an interest in hunting and wants to learn more, something that will trigger the curiosity that drives their intrinsic motivation[25].

How does a VR hunting game compare to a screen-based hunting

game when it comes to motivation, engagement and participation in learning? Based on the findings, players find the VR-version of this game more motivating and engaging, as VR presents the situation and hunting in general in a more realistic and immersive way. In VR, the player actually feels that they are out hunting, getting you closer to the adrenaline rush you would feel in real life. Almost every movement the player does with their body in real life somehow interact with the VR experience, making it more engaging. It is possible that some of the excitement that comes with playing the game in VR comes from that VR is a new experience for the player, seeing as VR is a relatively new technology.

Something that can prevent participation is the fact that even though VR equipment has become more affordable in recent years[16], it is still too expensive to become a household item that everyone has. Even if a VR equipment is available to the player, it still requires an open space to play, and some VR equipment also needs to be connected to a computer. Another issue is that some people are prone to virtual reality sickness[23]. Out of the ones testing the VR version of the game, 40% commented that they experienced virtual reality sickness when moving around in the "Free Hunt" part. However, they didn't experience any virtual reality sickness in the tutorial part where they were stationary. Even though they experienced virtual reality sickness, they still preferred to play the game in VR.

Considering this, we could say that in comparison to a screen-based game, a VR-game does well when it comes to motivation and engagement, and while people might want to participate in playing a VR game, there are some issues with accessibility and virtual reality sickness that might prevent participation.

Can a digital learning game about humane and safe hunting make learners more confident when taking the "Jegerprøve" exam and dealing with real-life hunting situations? In order for the learners to be more confident when taking the "Jegerprøve" exam and dealing with real-life hunting situations by playing this game, the learning material needs to

be presented in a good way. In order to give the best learning experience possible, the game took inspiration from multiple pedagogical approaches. You could say the game features behaviorism in that it has repetitive tasks that are rewarded with points[26]; in this case killing deer, with the deer being the stimulus, shooting it in the heart is the response and the points are the reinforcement. But the game is more complicated than that; the player needs to take many elements into consideration before shooting the deer. Because of this, a cognitivistic approach has been used by presenting different situations using text, illustrations and a 3D environment. This way the player will get a deeper understanding by making connections[30]. By presenting the learning material through a game, the learning experience might have a lasting impression on the players, but it is important that the content is presented in an organized way so that the player doesn't miss out on important knowledge[29]. This is the reason why the tutorial is the biggest focus of the game. After completing the tutorial, the player can move on to "Free Hunt". This is where constructivism[31] comes in, and the player has to use critical thinking to solve the situations that might occur. These situations might be a combination of the situations introduced in the tutorial and requires the player to think for themselves and make their own solution. They will have to create new knowledge based on their existing knowledge and new information.

The most important pedagogical approach for this game was experiential learning. By introducing the player to situations as close as possible to situations that might occur in real life while hunting, and having a focus on the player solving these situations in a humane and safe, the player will get an experience that they can reflect upon and learn from. The player can then apply what they have learned to new experiences, for example when playing the game again or when hunting in real life[33]. By using the game as repetition training, the players might retain their knowledge longer than what they would have by just reading about it[35]. While you could get this knowledge by hunting in real life, this game lets players repeatedly have experiences close to real-life hunting situations without the cost or risk.

Looking at the findings, we can see that the people who played the game found it informative. Most of them had no experience with hunting, but when asked if they would feel more confident in dealing with real-life hunting situations after they had played the game, most of them said yes. So, Can a digital learning game about humane and safe hunting make learners more confident when taking the "Jegerprøve" exam and dealing with real-life hunting situations? By playing the game, the player will get an experience that might have more of a lasting impression than what reading a book might have. The game presents the learning material through text, illustrations, 3D environments and experiences that the player can connect and conceptualize in their head. According to the test participants, the game is easy to learn and presents the learning material in a short and concise way, making it easy to use for repetition training. Through repetition, the knowledge will be retained longer[35], and for this reason, the player can feel more confident when taking the exam or when out hunting in real life.

It is important to take into consideration that the testing performed in this research didn't include testing on the intended users, as COVID-19 made that difficult. The test sample also included some acquaintances, something that could affect the results and make them seem more positive than they actually were, even though they were asked to be honest. In addition to this, the number of people testing the VR version of the game is limited. However, the main goal of user testing was to find out potential usability problems, and since the majority of the test participants are experienced with ICT, they could find out more critical problems compared to the average user. Also, 5 test participants can in principle find about 80% of the usability problems[46].

5 Conclusion

A digital game with both a screen-based version and a VR version was designed using Unity. The goal of this game was to teach hunters about humane and safe hunting, as the most common cause of wounding an animal without killing, is due to people misjudging the situation and making wrong decisions. The reason that people make these misjudgments might be the lack of practical training when it comes to humane and safe hunting. Based on this problem, the research aimed to investigate to what degree a digital learning game could affect motivation, engagement and participation, and how does a VR-game compare to a screen-based game when it came to this. In addition, the research aimed to find out whether a digital learning game about humane and safe hunting could make learners more confident when taking the "Jegerprøve" exam and when dealing with real-life hunting situations.

To answer this, testing of the developed game was conducted. Originally the test subjects were to be people who were in the process of taking the "Jegerprøve" course, but due to the COVID-19 outbreak, all "Jegerprøve" courses were canceled or postponed. Because of this, it was difficult to come in contact with the intended users of the game, and test subjects needed to be found elsewhere. For this reason, the test subjects mostly consist of students from the University of Agder and acquaintances. All test subjects were to test both the VR and the screen-based version of the game, but due to the complications caused by COVID-19, only a small number of the test subjects got to test the VR version. But, 5 test participants can in principle find about 80% of the usability problems[46].

Based on the findings from the testing, it can be concluded that a game can have a positive effect on motivation, engagement and participation. In this case, the majority of the testers found the game to be both motivating and engaging. By having the testers compare the screen-based version of the game to the VR version, we could conclude that the VR version was both more motivating and engaging as it was much closer to reality. However, the

problem with VR is the accessibility and the fact that some people are prone to virtual reality sickness, making the screen-based version still have its use. Based on feedback from testers, It can also be concluded that by playing this game repeatedly and building knowledge based on the experience, players might feel more confident when taking the "Jegerprøve" and when handling real-life hunting situations.

Based on this research it can be concluded that the hypothesis still stands; VR and digital games support experiential learning and can increase motivation, engagement and participation in learning humane and safe hunting, and makes learners more comfortable dealing with real-life practical situations similar to those in the VR/gaming experience.

5.1 Future Work

The game don't cover all areas of "Jegerprøven". Being able to recognize different Norwegian wildlife and know whether or not they can be hunted is a big part of "Jegerprøven". This is something that can easily be added to the game, as long as you have realistic looking and animated 3D models of the animals, something that either takes time to create or will cost money. As mentioned in the discussion, there are also things that can be done to better extrinsically motivate the player, for example earning points based on how safe the distance is, how close to the heart the bullet hits the deer, and whether the deer is moving or not. Additionally, leaderboards, achievements, collectibles, and ways for the player to spend their points, is something that can be added to the game. Things that the player can unlock with their points can be cosmetic rewards, like a new look for your weapon, or unlocking new pages in the compendium. There are also issues mentioned in the findings that need to be improved. The sensitive camera controls frustrated many of the test participants, and even though this was something mentioned while testing the first iteration of the game, the issue persisted throughout all the iterations.

The game never got to be tested on intended users, and this is something that would be interesting to do in order to see if the game can have any effect on the results of the "Jegerprøve" exams and whether the players felt that the game helped them to pass the exam.

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