

# **Investigating User Experience of Virtual Reality Head-Mounted Display in Maritime Simulator Training**

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## Abstract

The implementation of new technology in education is an unceasing process. For implementing such technologies, evidence of its positive effect needs to be validated. A popular method for evaluating a product is through User Experience testing. How well the user perceives a product has a connection to its effect. This research aims to expand the knowledge base within the maritime simulator domain through User Experience (UX) testing of a virtual reality (VR) head-mounted display (HMD) compared to a traditional desktop computer configuration. The primary focus for this research is to investigate the potential of using a head-mounted VR device in maritime simulator training and contribute to the growing body of knowledge interested in answering: *Will VR HMDs provide a better user experience than a traditional desktop computer configuration?*

A between-subjects experimental design was implemented to compare participants (N=50) between two different conditions: VR and Desktop configurations, each scored by a UX questionnaire. Three out of six dimensions showed a significant difference in favour of VR (Attractiveness, Stimulation, and Novelty). Thus, the positive potential for using a VR HMD for maritime simulator training is deemed to be strong. There are positive consequences for implementing VR HMDs as educational tools. Attractiveness improves the desire to use the tool more often and therefore increases the amount of training.

**Keywords:** Maritime education, Simulation, Training, User experience, Virtual reality

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*Anders Emil Edwinson*

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## Abbreviations

Abbreviation	Explanation
CAL	Computer Assisted Learning
CAVE	Cave Automatic Virtual Reality
DNV-GL	Det Norske Veritas – Germanischer Lloyd
EQ	Ergonomic Quality
EQF	European Qualifications Framework
GISIS	Global Integrated Shipping Information System
HMD	Head Mounted Display
HQ	Hedonic Quality
InnoTraining	Innovating Maritime Training Simulators using Virtual and Augmented Reality
IMO	International Maritime Organisation
ISO	International Organization for Standardization
KDI	Kongsberg Digital
iVR	Immersive Virtual Reality
MET	Maritime Education and Training
NDPCAL	National Development Program in Computer Assisted Learning
NSD	Norwegian Centre for Research Data
SOLAS	International Convention of the Safety of Life at Sea
SSQ	Simulator Sickness Questionnaire
STCW	Standards for Training, Certification, and Watchkeeping
TARG	Training and Assessment Research Group
TUMST	Tokyo University of Marine Science and Technology
UEQ	User Experience Questionnaire

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USN	University of South-Eastern Norway
UX	User Experience
VR	Virtual Reality

*Table 1 “Abbreviations used in this thesis.”*

## 1. Introduction

Technology in education is a combination of educational theories and physical technologies; the latter is the focus of this research. Educational technology has been defined as "the study and ethical practice of facilitating learning and improving performance by creating, using and managing appropriate technological processes and resources" (Richey, Silber, & Ely, 2008, p. 24). Technology is a broad term, in education one can include the abacus and the blackboard as technologies that have facilitated learning for millennia (Sachau, 2013). Computers, as we know them today, have existed in some capacity in education since the 1960's (Suppes, Smith, & Beard, 1977).

Many nations saw the potential in using such information and communication technologies that computers enabled, as an aid to education. In the 1970's Computer Assisted Learning (CAL), the use of a program or file to assist in the learning process, came into focus and development programs were established. Such programs were a result of lower prices, increased computational power, and ubiquity of computers. One such plan was the National Development Program in Computer Assisted Learning (NDPCAL) in the United Kingdom. The program supported "projects covering schools, colleges, universities, industrial and military training" (Avis, 2014). The positive effect and impact CAL has on education have been shown (McDowall & Jackling, 2006; Karakas & Tekindal, 2008). According to Kurtzweil (2001) "... the history of technology shows that technological change is exponential" and states that we will experience the equivalent of 20,000 years of progress in the 21<sup>st</sup> century.

Using technology in education has existed as long as education itself. The tools used have evolved and follows the general evolution of technology. Implementing technology in education is not always the most straightforward process. Educational tools, such as

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computers, different types of media, online collaboration, and simulation, have received much attention over the last decades. The barriers to entry have been researched, such as resistance to change, the attitude of teachers, access and cost among others (Fabry & Higgs, 1997).

However, the positive effects on teachers and students by integrating technology in education have been identified (Christensen, 2002).

Educating mariners is highly complex, requiring specialised knowledge, skills, training, and certification. With the increasing amount of complex technical systems on board a vessel, being an excellent maritime officer is no longer only about good seamanship. Today, one needs a good understanding of the technologies being used as well as leadership skills. Historically, learning ship handling was done by proving themselves and rising in the ranks as the mariners began their career at a young age and lived on board (Kennerley, 2002). Today, future mariners are put through a more formal education system with classroom teachings, projects and trained in simulators over the course of 3-5 years (Kobayashi, 2005). They then perform 12 months supervised training on board a vessel (International Maritime Organization, 2011). Maritime education is today regulated by the Standards of Training, Certification, and Watchkeeping (STCW). This standard is a device of the International Maritime Organisation (IMO) and outlines the minimum competencies required of mariners, guidance for assessment, outlines for hours of work and rest, and so on.

The safety-critical society we live in today has evolved as a response to accidents. The International Convention for the Safety of Live at Sea (SOLAS) was created after the sinking of RMS Titanic in 1912. This event and subsequent codification of safety standards influenced the educational system and use of technology in several areas (Parnas, Van Schouwen, & Kwan, 1990). To educate and train personnel in safety-critical domains, such as medicine, aviation, military, or the maritime industries, can be expensive and potentially dangerous. One cannot place a scalpel in an untrained medical students' hand and tell them to



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cut a person or place students at the helm of a large vessel and tell them to dock at a harbour, without some level of prior knowledge and training.

To gain this required knowledge and experience in performing operations that are safety-critical, but without risk, students train in simulators. The application of virtual environments, i.e. computer-generated simulations, in education is not a new concept. Computer generated simulations have been present in medical education (Chang, Tan et al. 1993), aviation (Popular Mechanics, 1954), and military (Virtual Reality Society, 2017) since the early 1950's. This type of simulation has mostly been limited to the projection of digital information on a flat screen. Simulations today are done through a traditional desktop monitor, projections on a wall, or through more advanced systems like Cave Automatic Virtual Environment (CAVE). Introducing new technologies to education can be difficult, as it demands more from the teachers, and its effects may not always outweigh the capital costs. Educational institutions are slow in adapting to new technology (Hennigan, 2012). However, simulator training is shown to be an essential part of the maritime education all over the world (Latarche, 2017).

Maritime education and training use simulators as a tool. Glenn (2008) calls the current generation of young people as “digital natives” (p. 5). She explains how technology is influencing the way we teach and learn, “enabling multi-modal teaching, changing curricula, and spawning rich forms of online research and collaboration” (Glenn & D'Agostino, 2008, p. 4). The way we learn is, therefore, influenced by the tools used.

In the STCW of 2010, there is an entire section dedicated to simulators, namely Section A-1/12. Although the performance of the simulator and the student is described, the type of simulator to be used is open to interpretation. The simulators themselves are of varying technological complexity and training fidelity, as seen in the list of global maritime simulators provided by IMO at Global Integrated Shipping Information System (GISIS). They

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vary from a simple desktop setup (e.g. a few screens, keyboard, and mouse) to full mission bridge (large 360° projected image around an artificial bridge on a movable platform using hydraulics).

### 1.1. Project Overview

At the University of South-Eastern Norway (USN), there is a research group called Training and Assessment Research Group (TARG). Within this group, there is currently an ongoing research project funded by the Research Council of Norway (Project no. 57860) titled: “Innovating Maritime Training Simulators using Virtual and Augmented Reality” (InnoTraining). It is a project lead by USN in cooperation with Kongsberg Digital (KDI) and includes Politecnico di Milano and Institute for Energy Technology as project partners. The goal of the InnoTraining project is to investigate new methods for delivering maritime educational simulations, specifically with head mounted virtual and augmented environments. To contribute to the overall InnoTraining project this research aims to perform a qualitative and quantitative experimental data collection with human participants. This thesis is performed in connection with the InnoTraining project.

## 1.2. Thesis Contribution

Introducing new technology in an already complex education can be an arduous process. IMO stresses the importance of considering the human element when adding new technology in an organisation (International Maritime Organization, 2003). User Experience (UX) is widely used to assess products. Although this method of collecting information can be considered quantitative, the underlying motivation behind the numbers is individual, and thus subjective. However, the responses given may indicate a person's willingness to continue using a device/tool.

The research done for this thesis aims to contribute to the InnoTraining project and investigate the potential of using virtual reality head-mounted displays (VR HMD) in maritime education and training. The experiment performed for this research was conducted by two "master of maritime management" students, working on different research questions and hypotheses. Henceforth, the author will be referred to as "the researcher" or "researcher A" and the second student, S. Veie, will be referred to as "researcher B". Each researcher had their separate research questions and hypothesis to further expand the knowledge in the project.

Together with their supervisors, an experiment to answer both researchers' questions were developed. Researcher A measured the UX on a VR HMD and desktop, investigating VR as a tool for maritime simulation training, whereas researcher B studied the difference in intrinsic motivation and skill acquisition between a VR and desktop simulator, published in her thesis Veie (2018). The experiment was a navigational task in a labyrinth where participants searched for hidden objects within a set time limit. Half of the participants completed the task on a desktop computer and the other half in VR, in between-subject research design.

### 1.3. Definitions

**Desktop:** Considered as a stationary computer with a single screen, mouse, and keyboard.

**Dimensions:** Aspects or features of a specific situation.

**Education:** The process of gaining new skills or knowledge. In this thesis, the researcher focuses on the education of mariners.

**Experiment:** A controlled scientific procedure to test a hypothesis.

**Fidelity:** Degree of exactness, in this research the level of which reality is reproduced or represented.

**Subjective:** A person's individual opinion dependent on taste, thought or feeling.

**Technology:** The application of scientific knowledge for practical purposes. In this research, the scope of the term, Technology, is limited. In the present research, technology is concerning the application of computers.

**Virtual Environments:** Digitally constructed surroundings.

**Virtual Reality:** VR is defined as a head-mounted display with motion tracking and using motion tracking controllers.

**User Experience:** This term is comprised of two parts; the User, and the Experience. A user is a person using a product, system, device, or a receptor of an experience. Experience is in this research defined as the subjective depiction of a specific event. User Experience is then, the combination of these two parts.

### 1.4. Research question

To explore the potential of using VR HMDs in maritime simulator training, the following research question and hypothesis will be investigated to fill gaps in current knowledge:

*Research question: Will VR HMDs provide a better user experience than a traditional desktop computer configuration?*

*Hypothesis: The subjective user experience score will be higher for VR than for Desktop.*

### 1.5. Necessary ethical considerations and applications

As the experiment collected personal data, the Norwegian Centre for Research Data (NSD) was notified, and all procedures were implemented in accordance with Institute policy and research ethics. The reference number used at NSD was: 57860. Necessary considerations in this project were to create a consent form, to store the data gathered safely, and to keep the data anonymous. Also, the experimental procedure may induce cybersickness and nausea in participants. We, therefore, followed the guidelines of ISO 9241-391:2016 and tracked participants via the Simulator Sickness Questionnaire (SSQ) developed by Kennedy et al. (1993) (Appendix 1).

Participants were clearly instructed that they could leave at any time if they did not wish to continue, without having to provide a reason. The participants were asked in the introduction questionnaire (Appendix 2) if they experience motion sickness, as a pre-screening measure, to limit the number of dropouts.

The ethics application was sent on December 15<sup>th</sup>, 2017 and approved January 25<sup>th</sup>, 2018 (see Appendix 3). Each participant received a 100NOK gift card to the local student canteen upon completing the experiment.

## 2. Literature Review

This chapter outlines the three main literary categories relevant to this research and research question: 2.1. Simulator training: the historical use and its implications, 2.2. VR technology: an overall outlook but focused on the maritime domain, and 2.3. User Experience: how to measure it and the value of UX. There exist vast amounts of literature on these subjects. However, not all are directly linked to the maritime domain. Thus some information is from other fields.

### 2.1. Simulator Training

A maritime simulator is defined as “A device, designed to satisfy objectives which mimics part of real situation in order to allow an operator to practice and/or demonstrate competence in an operation in a controlled environment.” (Hensen, 1999). To extend this concept, Gaba (2004) emphasises that simulation is not a technology, but rather a technique.

The segment with the longest tradition with simulation in professional training is healthcare, dating back to the ancient Mesopotamia using a sheep’s lung to create simple models (Kunkler, 2006). The military also has a long-standing history with simulations. A war game is considered a simulated battle. Sun Tzu (an ancient Chinese military strategist 544-496 BC), is credited with creating the earliest known war game. Weikmann created a more recent game (Koenigspiel) aimed at teaching "communication skills and basic military art and science" to military personnel in 1664 (Aebersold, 2016). When modernising the concept of simulation, the next largest industry to use objects to simulate an activity is the aviation industry. A popular early “Flight simulator” known as Link Trainer was developed in the late 1920s and was essentially a small metal box connected to a motion platform.

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This research focuses on the training of personnel in a digitally aided or constructed environment, primarily in the maritime domain. Even though simulators have a long-standing tradition in education, the maritime domain did not use simulators for training and certification until the 1950's (Sellberg, 2017). A simulators' primary goal is to closely resemble reality and provide the user experience in the situation trained, without risking lives or assets. This is highly related to the overall goal of professional studies; to reduce the amount and severity of accidents. This point has been researched, and simulators have been identified as an essential tool to increase the skills and competencies of mariners, thus reducing the threat of contributing to accidents (Hanzu-Pazara, Barsan, Arsenie, Chiotoroiu, & Raicu, 2008).

Given the widespread use of simulators across industries, some cross-sectional references can be made. As a component of medical training, Kunkler (2006) mentions four overall benefits of using simulators. Improved educational experience, increased patient safety, cost efficiency, and ongoing training opportunities.

An experiment was conducted in the Netherlands using driving simulators to train participants who had never driven a car. The participants were tested on the level of the national assessment; two was deemed to be able to pass the real test (Wierda, 1996). Even with a small sample, Vlakveld (2005) suggest that the experiment "indicates that at least some people can learn to drive on a rather good simulator" (p. 5).

In the literature search, a list of advantages and disadvantages of a simulator was found. Caird & Horrey (2011) identifies nine points in each column for using simulators in training, assessment, and research. Even though this list is based on driving a car, many of the points are also valid for a maritime simulator. The main advantages identified include the potential in placing students in dangerous situations without any real danger, a simulated scenario is controlled and repeatable, and all actions can be recorded and assessed. The main



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disadvantages include the difficulty of relating a simulated occurrence to reality as the consequences are not present, even with extremely high fidelity it is only a representation of reality, responses and actions are adversely affected by the users' belief that the scenario is not real.

Some limitations in using simulators in maritime education can, therefore, be said to have been identified indirectly. Also, there are some contradicting views of the effect of high fidelity simulators. Several studies have shown that fidelity has an impact on training effectiveness (Tidwell, 1990; Roza, 2004; Nimbalkar, et al., 2015). Others state that the level of fidelity is more related to the task to be performed (Caird & Horrey, 2011). There are also those who report that a simulator using motion in addition to the visual and auditory simulation "...did not, in an operationally significant way for the tasks tested, affect either evaluation, training progress, or transfer of training..." (Longridge, Bürki-Cohen, Go, & Kendra, 2001, p. 3). Another study suggests that features of new technologies and computational power might negatively impact training of complex tasks. If introduced incrementally, however, the increased functional fidelity may improve the performance (Hjelmervik, Nazir, & Myhrvold, 2018). Most studies concerning fidelity and validity of simulator training stress that functional fidelity (i.e. how the simulation responds to the user) is far more important than the physical fidelity (i.e. how closely reality is represented) (Dahlstrom, Dekker, Van Winsen, & Nyce, 2009; Saus, Johnsen, & Eid, 2010).

Lee et al. (2013) discuss how a person's behaviour in driving simulators matches on-road behaviour. In their report, they address the interactions between physical fidelity and behavioural fidelity. They relate this to how well the effect of training in simulators translates to the on-road behaviour. The report identifies 17 primary characteristics of a driving simulator and specifies the dimensions for fidelity. These include; Resolution, Field of view, Face validity of cab configuration, control input feel, auditory cues, and motion and vibration.

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They state that “... the effectiveness of a simulator at producing results that are consistent with (or transformable to) the real-world driving experience logically increases as the fidelity of the relevant simulator characteristics increases.” (Lee, et al., 2013, p. 101).

Even though research on Maritime Education and Training (MET) is being conducted, many researchers focus on the application of a simulator or techniques of implementation, and not the simulators themselves. Kobayashi (2005) identifies the elements necessary and methods required for competencies in safe navigation using simulators. Sellberg (2017) concludes after a systematic literature review “that there are more questions than answers regarding the use of simulators in bridge operation training.” (p. 254)

As the maritime domain (and the education of the mariners therein) is highly international, some standard for maritime simulators needed to be established. In the STCW several regulations and sections are outlining the requirements on simulator systems, simulator-based training and assessment, and guidance for assessment. The simulators systems themselves needed a standard as well. DNV-GL divides bridge simulators into four classes; A, B, C, and S as seen in Table 2.

<b>Table A1 Simulator classes for the function area bridge operation</b>	
Class A (NAV)	A full mission simulator capable of simulating a total shipboard bridge operation situation, including the capability for advanced manoeuvring in restricted waterways.
Class B (NAV)	A multi task simulator capable of simulating a total shipboard bridge operation situation but excluding the capability for advanced manoeuvring in restricted waterways.
Class C (NAV)	A limited task simulator capable of simulating a shipboard bridge operation situation for limited (instrumentation or blind) navigation and collision avoidance.
Class S (NAV)	A special tasks simulator capable of simulating operation and/or maintenance of particular bridge instruments, and/or defined navigation/manoeuvring scenarios.

Table 2 “Listing of the simulator classes according to DNV-GL, March 2017” (DNV-GL, 2017)

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In the STCW and class divisions like the one created by DNV-GL, there are specific system function requirements. However, hardware requirement is not explicitly defined. Some guidance for what should be included in a simulator bridge was proposed as “Fundamental components of Ship Bridge” (Hensen, 1999). These components were described as the essential equipment and components needed for a simulated bridge to be as close to reality as possible. Using 3D modelling and animation could satisfy all points on Hensen’s list including fulfilling all requirements of STCW and classifications societies like DNV-GL. The technology used to implement simulator training is, therefore, up for interpretation. Thus, bringing us to the potential next step in the evolution of maritime training simulators.

### 2.2. Virtual Reality

The idea of putting displays on the head of a person enabling them to experience an immersive virtual environment started in 1968 with the system known as the Sword of Damocles (Sutherland, 1968). However, this technology was slow to be adapted and led to various commercial failures in the 1980s and 1990s. Most of the commercial products were only available in public arcades, and the fidelity and computing power was relatively low. In an advisory report by the NATO Advisory Group for Aerospace Research and Development, it is referred to the development of a head-mounted display (AGARD Working Group, 1980). Head-mounted displays (HMD) are, therefore, not a new concept. Invigorated by new and improved technology, the HMD’s have made a commercial comeback and were consumer-ready in 2016 with products such as the HTC Vive, Oculus Rift, and PlayStation VR becoming early market leaders.

Even though development of VR has been performed arguably since the 1830s with stereoscopic photos and viewers, it was not until 1987 that the field gained momentum. Jaron Lanier, a computer philosophy writer, and scientist coined the term “Virtual Reality”, and

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developed several VR products. His company, VPL research, was the first to sell VR goggles in the late 80s, early 90s (Virtual Reality Society, 2017). The cost was quite extensive (EyePhone 1 \$9400, EyePhone HRX \$49,000, and gloves \$9000) compared to the launch prices of today's VR alternatives like; HTC Vive (\$799), Oculus Rift (\$599) and PlayStation VR (\$399).

For VR to be used as a simulation tool in maritime education, some assumptions about the software to be developed must be made. The central assumption being that programming provides almost limitless potential, as everything can become “physical” programming, through 3D modelling, and hardware.

Today's technology is still only a version of the stereoscopic view. The concept of having an interactive virtual reality that is genuinely indiscernible from the actual reality is still far off. Cyber or Simulator sickness is still present for some, Oculus proposes to take 10-15 minutes break every half hour (Oculus VR, LLC., 2018) and HTC warns merely about overuse. A timeframe of 30 minutes is a rather short time for simulating a bridge operation. Through studies made at Tokyo University of Marine Science and Technology (TUMST), the proper length of a maritime training exercise is identified to be 40 to 60 minutes (Kobayashi, 2005). As the potential impact on eyesight and health from long-term VR usage have not been researched, this may be a pitfall for the technology in education.

In medical education research, physical feedback is essential (Dargar, Kennedy, Lai, Arikatla, & De, 2015). “For simulators to be of value, they must provide realistic feedback that allows the user to apply this training in a real procedure” (Bernardo, 2017, p. 1026). This may be more relevant for medical education than for maritime training, as it relates to the physical skill-acquisition, but is still relevant. The amount of repetition of a task may outweigh the value of the fidelity in the educational tool used (Yiasemidou, et al., 2017). However, Dargar et al. (2015) conclude “that immersive virtual reality (iVR) is essential to

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gain mastery.” (p. 21). Amount of training, ease of use and accessibility of a personal HMD compared to a high physical fidelity simulator should be addressed.

The effect of the level of immersion might have a positive impact on learning (Olmos-Raya, et al., 2018), but if there is a consistent long-term value is still not validated. Other research suggests that the method is more important than the medium. Personalization of instructions has a more significant impact on learning than the level of immersion (Moreno & Mayer, 2004). Even though the level of physical presence in their experiment was higher with the HMD, the score for learning outcomes; Retention and Transfer, were not. A VR HMD piloted in nursing education showed high usability ratings, and eagerness to use VR for skill practice (Butt, Kardong-Edgren, & Ellertson, 2018).

There are many kinds of research being done in the VR domain. Physical rehabilitation (Rizzo & Kin, 2005), a tool for assessing training (Jensen, et al., 2016), uses in education (Kilmon, Brown, Gosh, & Mikitiuk, 2010; Fernandez, 2017; Gregory, Lee, Dalgarno, & Tynan, 2016), and even to study burglary (i.e. human behaviour) (Gelder, et al., 2017).

There are some uncertainties around the concept of using VR in education and how to best implement them (Fernandez, 2017), but high-fidelity VR HMDs seem to have tremendous potential in simulator training and greater maritime education. How well a product is received, and the usability of a VR product must be considered. To this end, the end-user’s assessment is paramount. Human-computer interface is vital to assess an HMD for use in education (Dix, 2009). Not only regarding design or usability but as a function of the user's experience. The importance of good design regarding human-computer interface (HCI) influences the user's willingness to use the system again (Ching-I, 2012) and is highly related to the continued usage mentioned by Yiasemidou et al. (2017).

## 2.3. User Experience

User Experience (UX) is “a person's perceptions and responses that result from the use or anticipated use of a product, system or service” (International Organization for Standardization, 2010). Thus, one can assess a person’s experience using a product, system, or service. According to Soegaard and Dam (2013), UX is about transcending the material. How well the product is designed or the materials used are secondary to creating a valuable experience using the device.

The main concept of UX is to measure three major perspectives, as seen in Figure 1. These are the measurable aspects of a users’ experience. The importance of a good foundation must not be forgotten, the inner workings of a product or service need to be stable for the experience to be recognised as “good” by the user. However, as Garret (2010) states, the users only encounter the outside of the product.

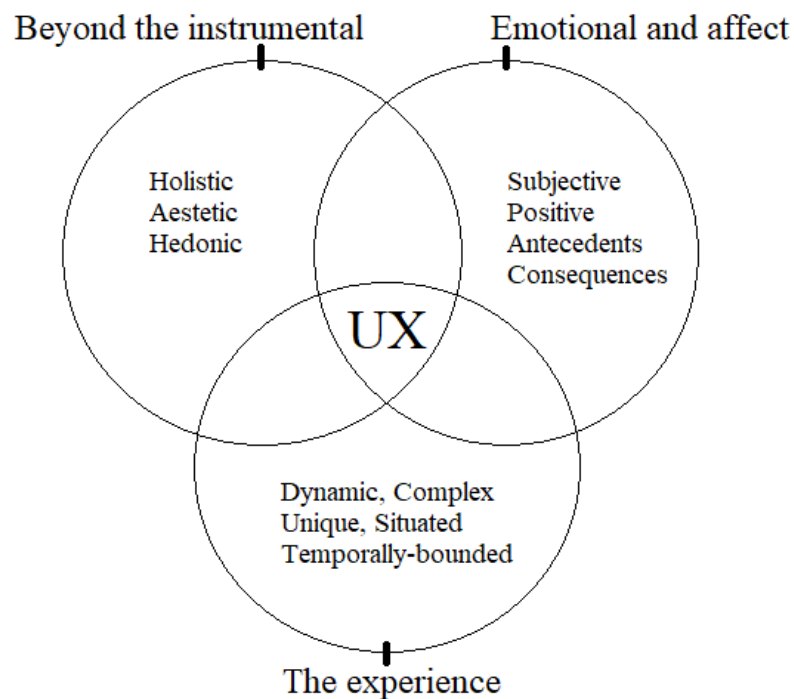


Figure 1 "Facets of UX" (adapted from Hassenzahl & Tractinsky, 2006)

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Most publications on or using UX concerns the usability of a specific product. It is, however, not limited to usability. Figure 2. shows a diagram created by Dan Saffer (2010) depicting the overall disciplines of user experience. This figure shows how complex and multifaceted UX can be. All these aspects of a product can affect the user, some more than others. What the UX aims to measure is the overall desire to reuse the product, but it can be focused to look deeper into a specific area of the user experience design. The information gathered from a UX study is, therefore, determined by the researcher and what information he or she seeks.

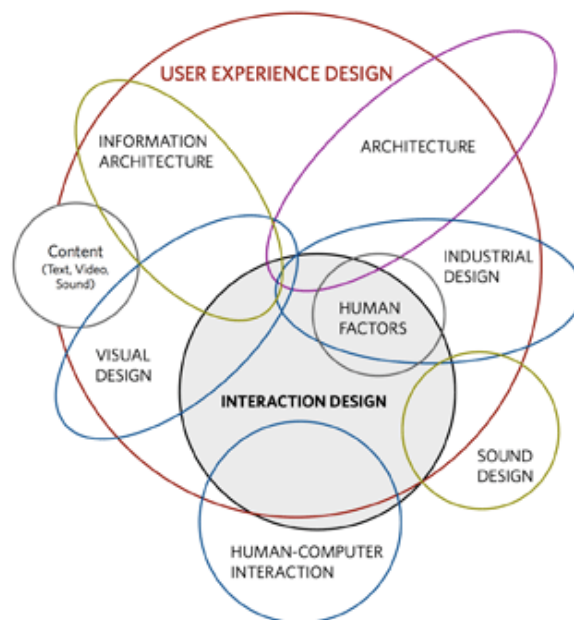


Figure 2 "The disciplines surrounding interaction design" (Saffer, 2010)

This research focuses on the six dimensions of UX defined by Laugwitz, Held, and Schrepp (2006). They developed a standard UX questionnaire (UEQ) (Appendix 4) to measure Attractiveness, Perspicuity, Efficiency, Dependability, Stimulation, and Novelty, defined in Table 3. The questionnaire is based on a theoretical framework by Hassenzhal (2001). He suggests that two primary qualities could be a way to describe a product; Ergonomic Quality (EQ), Hedonic Quality (HQ), and the overall appeal.

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Dimension	Explanation
Attractiveness	How much the user enjoyed it and wished to use it again.
Perspiciuity	How easy it is to learn or understand.
Efficiency	How fast and organised it is.
Dependability	How predictable and secure it is.
Simulation	How exciting and motivating it is.
Novelty	How creative and innovative it is.

Table 3 “definitions of the six dimensions” (Laugwitz, Held, & Schrepp, 2008)

The scores from the six dimensions can be calculated both individually for each participant and as an average score for a group. The questionnaire results in a score for each dimension, and two overall scores, the pragmatic quality, and hedonic quality.

Major technology and automobile companies care profoundly about the experience of the users when testing a new product. The end goal of testing the UX depends on the application. Either to create a product or experience, that sells and performs well. The user wants the end result to be the creation of the best product possible that gives them the best experience possible.

By utilising a user experience questionnaire, one can test the subjective feeling a person had while using a product. It infers not only to the usability of the product, but also the users wish to continue using the product (which speaks to its effect as a training tool). UX can help identify problems or strengths of a product beside the technical and ergonomic aspects. Regarding this research, the questionnaire is used to evaluate the concept or experience itself rather than the system or product being used.



## 3. Methods

### 3.1. Background

The author joined the InnoTraining project team early 2017. A preliminary literature study was done on VR and training, and research questions were established in a meeting after the summer break in 2017. When the research questions were agreed upon, the designing of the experiment was conducted. After a plan had been established, it was concluded that the researchers would perform a pilot study to test the experimental design resulting in a peer-reviewed conference paper (Mallam, et al., 2018) (Appendix 5). The pilot study was performed in the middle of January and refined the experimental design by making incremental improvements to the process based on feedback received. Full data collection began Jan 30<sup>th</sup>, 2018 and ended March 2<sup>nd</sup>, 2018.

### 3.2. Participants

The total number of participants recruited was 52. Participants were mostly recruited from the USN student and faculty population using convenience sampling, word of mouth and the snowball effect. All participants participated voluntarily.

To promote the project and gain as many participants as possible, the researchers set up a stand by the student canteen at USN Campus Vestfold. By introducing by passers to “Oculus Rift”, they gained the attention of fellow students. The potential participants could ask questions about the project and the experiment in which they could participate. The promotional “Poster” and “Flyer” used, is seen as Appendix 6 and 7.

There were 37 male and 15 female participants. The overall age span was 20 to 61 years, the median 25 years, and mean 28,9 years. The participants were able to book a time

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through an online booking service or send the researchers an email. Participants were randomly assigned to the experimental or control group. All were told that participants would be given a gift certificate for the student canteen with a value of 100NOK upon completing the experiment.

### 3.3. Setting

The lab in which the experiments were conducted is located on USN Campus Vestfold. The room is 2,20m x 3,80m, Figure 3. Two desks (A) situated on the opposite end of the room from the entrance (B) facing covered up windows into a hallway. There were no windows to the outside; the room was lit up by fluorescent overhead lights. Because of poor ventilation, a fan was placed by the door to create some circulation of the air. By the desk were two office chairs, by the door a padded wooden chair with armrests. The computer was on top of one of the desks with a monitor next to it. The VR HMD was hanging on the wall (C) with the cords fixed to the roof by an improvised cable management system.



Figure 3 "The VR-Lab"

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## 3.3.1. Pilot Study

The pilot study was conducted in January of 2018 with six participants. They gave many invaluable inputs. There were changes both to the environment (where water was asked to be provided to the participants), the script and the procedure. Contributions given by the participants were unfortunately not recorded, but changes were made immediately to use on the next participant. The data recorded were limited at best, as the researchers had not yet become accustomed to the research procedures.

## 3.4. Materials and Instruments

The measured variables in this experiment were many, but this research only focused on a select few. The independent variable was the Desktop and VR setting. The dependent variable was the participant's perceived experience. The UX assessment was done by a standardised and validated questionnaire.

### 3.4.1. Virtual Environment Platform

The application chosen was the game "Fallout 4" and "Fallout 4 VR" created by Bethesda Game Studios in 2015 and 2017 respectively. In Fallout 4 it is possible to build and customise the environment, it has high graphical realism, and the desktop version is nearly identical in full room-scale VR.

### 3.4.2. Hardware

The equipment used in the experiment was the VR HMD; HTC Vive (Specs: 2xOLED 1080x1200, 90Hz refresh rate, and 110-degree field of view) with motion controllers,

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connected to a powerful desktop computer (Specs: Graphics card: GTX1080, Processor: Intel i7-6700K @ 4.00GHz, Ram: 32Gb). Connected to the desktop computer was a Dell U2717D monitor, an HP mouse and HP keyboard. For sound, the participants were given a pair of “AKG 518 DJ” headphones. Figure 4 shows two people in the different experimental conditions.



Figure 4 “VR setting (Top), Desktop setting (Bottom)”

### 3.4.3. User Experience Questionnaire

Through the literature review, the researcher identified a standard questionnaire. This questionnaire was constructed by Laugwitz, Held, and Schepp (2006). The questionnaire consists of 26 sets of adjectives with its corresponding antonym on a seven-point Likert scale. The assessment of the experience is done by marking one of the seven circles between the two words for each set of word-pairs, the example given in Figure 5.

attractive | ○ ○ ○ ○ ○ ○ ○ | unattractive

Figure 5 “Example of word pair from the User Experience questionnaire.” (adapted from Laugwitz, Held, & Schrepp, 2008)

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## 3.4.4. Familiarisation

The familiarisation took place in a deserted virtual town. The participants followed the path shown in Figure 6, and they saw these scenes, Figure 7. Some of the participants accomplished the familiarisation script faster than others and could roam the town, but not look at the labyrinth. The familiarisation time was set to 10 minutes for all participants. The activities in the familiarisation were; moving, shooting targets, picking up items and exploring an enclosed space. This was to prepare the participants for the experiment without giving them conscious training on the specific task.



Figure 6 “The route all participants took in the familiarisation.”

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Figure 7 “The view of each participant at the locations numbered in Figure 6.”

### 3.4.5. Experiment

The experiment itself was situated inside a labyrinth built in-game by the researcher. The layout can be seen in Figure 8. The creation of the labyrinth was by the researcher. It did not follow any established theories but was tested to be of an appropriate difficulty by the researcher’s supervisor. The labyrinth also validated by the participants in the pilot study and, therefore, deemed to be acceptable. The researcher had to recreate the same labyrinth in VR. Transferring the save files from the base game to the VR version resulted in some graphical complications. The mode of locomotion used in VR was by teleportation. The starting view was the same for all participants in the control group (desktop). For the participants in the VR group, the height difference of the participant had a small effect on his or her perspective in-game. Seen in Figure 9 is the view on the desktop. The participants all entered on the right.

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Figure 8 "An overview of the labyrinth built in-game."



Figure 9 "The view of each participant from outside the labyrinth."

## 3.5. Experimental design

The experimental design for this research was a between-subject design in a laboratory setting. An experiment using between-group comparison was estimated to take a maximum of 90 minutes. This was a timeframe within what we could ethically justify, and still collect valuable data. To limit the effect of training and fatigue was also an important factor. Participants were randomly allocated to the control group and experimental group by when they were booked. This way, every other participant was in the control group. A comparison was made between the participants' subjective evaluation of their experience on a group basis, i.e. the VR group and the Desktop group.

## 3.6. Experimental Procedure

### 3.6.1. Participant Activity and Goals

The overall goal for the participants was to navigate in the labyrinth and locate ten hidden figures within five minutes. Moving around with the character on desktop is done by the standard "WASD-keys" setup in combination with a mouse. In VR movement was more difficult. Although the participants could move their physical body around, it is restricted by the "Play area". In our case, the area was 2,4m by 1,8m. The primary method of movement in VR was teleportation (the act of instantly jumping across a limited distance without moving).

### 3.6.2. Experimental proceedings

The experiment followed the structure outlined in Figure 10.

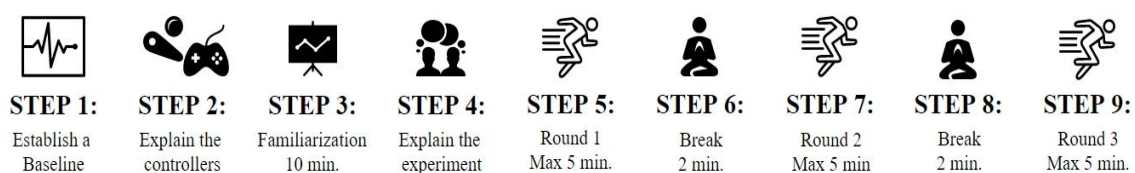


Figure 10 "Step-by-step of the experimental procedure."



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## 3.6.3. Overview

The experimental procedure was meticulously planned and performed based on a manuscript (Appendix 8-11). The overall expected proceedings are organised in Table 4. The timeline is based on maximum estimated time. The actual time spent on each activity varied except for the baseline, familiarisation and break-time between each round.

Timeline	Activity
00:05	Greeting
00:10	Explaining Informed Consent Form
00:15	Providing the Introduction questionnaire
00:20	Equipping the measuring devices
00:25	Establishing a baseline
00:30	Explaining the controllers
00:40	Guide the participants through the familiarisation
00:45	Explain the Experiment scenario
00:50	First round
00:52	Break
00:57	Second round
01:00	Break
01:05	Third and last round
01:07	Subconscious learning questionnaire
01:10	User Experience questionnaire
01:15	Skill acquisition and intrinsic motivation questionnaire
01:17	Simulator sickness questionnaire
01:20	Recollecting the measuring devices
01:27	Exit interview
01:30	Gratitude

Table 4 “An approximation of the schedule from the participant entering the room to exiting.”

As the experiment had become quite complex, the workload was divided in two. One of the researchers would guide the participant through the experiment using the manuscript, and the other would be responsible for the paperwork, timekeeping, and other recordings. Researcher A was always responsible for the physiological recordings.

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The participants were welcomed to the VR Lab and asked to remove warm clothing as the temperature could become uncomfortable in the enclosed space. The researchers asked the participants to set their phones in aeroplane mode to limit distractions and sit down at the computer.

Before collecting any data, each participant had to read and sign an informed consent form (Appendix 12). An entry questionnaire was given, to identify gaming experience and possible medical concerns, e.g. epilepsy or motion sickness.

After signing the consent form and answering the introduction questionnaire, the participants were equipped with the measuring devices (a Polar H10 chest strap for measuring pulse, and an Empatica E4 wristband to measure skin conductance). There is some uncertainty stated in the literature on the application needed for accurate measurements of skin conductance. Whether the device should be placed on the dominant or nondominant hand, or if it should be on just one or both sides of the participant, has not been established. As we had only one device available, the researchers decided to keep consistency between all participants regardless of which hand was dominant. All participants wore the Empatica device on the right hand.

A baseline was established by having the participants sit still in a chair for five minutes while the researchers left the room. This period has previously been used by other researchers (Filipovský, Ducimetière, & Safar, 1992; Honda, et al., 2018; Kim, Rosenthal, Zieliski, & Brady, 2014) and was deemed a sufficient amount of time.

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## 3.6.4. Baseline

After the participants were equipped with the sensors, they were asked to sit on the padded chair by the door. In front of them were placed two sheets of A3 with the controller layout for VR and Desktop, see Figure 11. They were instructed to sit as still as possible with feet flat on the floor and arms resting on the chair or in their lap for 5 minutes.

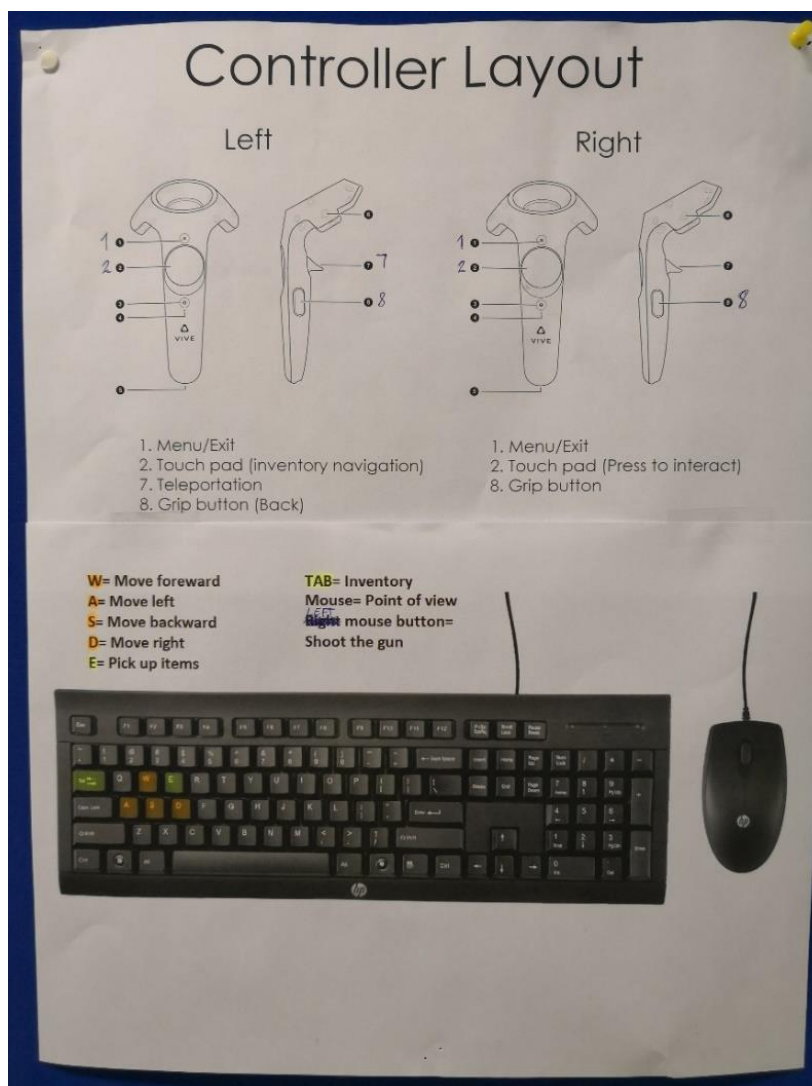


Figure 11 “Controller layout for the different experimental conditions.”

### 3.6.5. Participant Familiarisation Period

After the baseline was established, the participants underwent a familiarisation period of ten minutes. The purpose for the familiarisation was for the participants to acquire the basics skills needed to complete the task. As seen in the manuscript, there was a script written for the familiarisation. There were some nonconformities as certain people reacted differently to instructions or did not do as they were told. Some participants were avid gamers and had either played the exact game or similar before, or they intuitively understood what to do without being told. Other participants had to be told the same thing several times before they realised what they were supposed to do. As the effect of training was outside the scope of the researcher's focus, it was deemed acceptable. After the familiarisation, the participants were asked how long they believe they had been playing. This question was a wish from the InnoTraining project to see if participants have a different perception of time in VR compared to Desktop. It had no impact on this thesis.

### 3.6.6. Experimental Scenario

After the familiarisation, the experiment was conducted. All participants started in the same location outside of the labyrinth. The scenario was explained to them, and the screen recording was started. There were three rounds of five minutes, with a two-minute break between each round where the participants were asked how they felt, how long they believed they had been playing and was given some water if wanted. The participants navigated the labyrinth and looked for small figures called bobbleheads, see Figure 12. If a participant found all bobbleheads within the time limit; the time was noted, and the round ended.

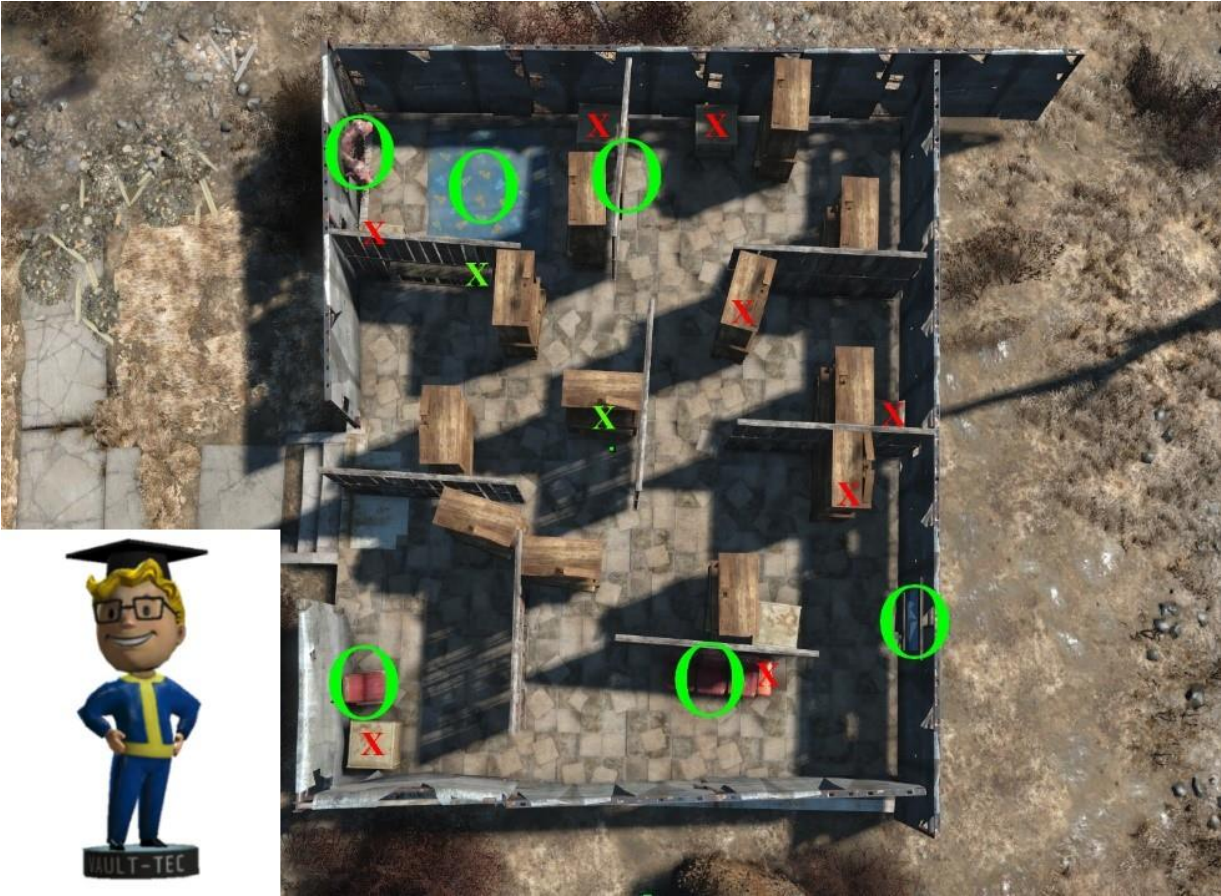


Figure 12 “Mapping of hidden bobbleheads (left corner) and other objects inside the labyrinth.”

The bobbleheads were in the marked positions in Figure 12. The locations marked with a red “X” indicates that the bobblehead was hidden inside containers, e.g. cabinets or boxes. The positions marked with a green “X” indicates the bobblehead was placed visibly in the world.

### 3.6.7. Post-Tests

On completing the three rounds, the participants filled out a set of questionnaires. The only questionnaire directly linked to this thesis was the UX questionnaire. The questionnaires were given in the following order: subconscious learning, UEQ, skill acquisition and motivation, and SSQ. The green circles in Figure 12 are related to the subconscious learning. They mark a two-headed bull on the wall and a blue carpet (top left), a single red chair (bottom left), a red three-seater couch (bottom centre) and two picture hanging on the wall, one of a cat (top centre) and one of a sailboat (Bottom right).

At this point, the experiment was finished, but this experiment was promoted as a VR Experiment, so the control group was taken through familiarisation in VR and completed one round in the labyrinth. Physiological measurements, time, and score were registered, but not part of the results. The screen recording ended at this point.

As a conclusion of the procedure, an exit interview of the participants was conducted to gain any additional information and personal experience the participants may have had. The interview guide is present in Appendix 13.

### 3.7. Data analysis

The user experience questionnaire (UEQ) used has six main dimensions. Each dimension has a set of items measured by a seven-stage scale in a semantic differential format. The first and foremost dimension is (i) Attractiveness. This dimension represents the pure acceptance or rejection of a product based on emotional reactions (Laugwitz, Held, & Schrepp, 2008). This dimension has six items. The remaining five dimensions, (ii) Perspicuity, (iii) Efficiency, (iv) Dependability, (v) Stimulation, and (vi) Novelty have four items each. The dimensions are represented by an average score of all the items they contain.

Each dimension is given an overall average score from all participants. There is not a global score, but the UEQ is designed to be represented by all dimensions individually or by three overall scores. (i) Attractiveness, (ii) Ergonomic quality (represented by Perspicuity, Efficiency, and Dependability), and (iii) Hedonic quality (a combination of Stimulation and Novelty). The analysis was done in two steps. First, the researcher calculated the descriptive statistics, creating a table of the six dimensions and their average scores. T-tests were then performed to see if there is a significant difference between the VR group and the Desktop group.

## 4. Results

### 4.1. Descriptive Statistics

The sample was comprised of 52 participants (37 male, 15 female). There were two participants excluded from the experiment due to nausea, resulting in an actual sample of 50. They reported themselves not fit to continue with the experiment. Both were young males in the desktop group. The next participant took the drop-outs place in the group affected. As only two participants reported nausea to such an extent, a quick visual inspection of the SSQ was performed by the researchers. The answers were predominantly “none” or “slight” for the remaining participants. The researcher deemed the SSQ unnecessary for any further analysis. The experience the participants underwent in this experiment, was measured with the User Experience Questionnaire (UEQ).

The age statistics (mean, standard deviation, and range) for the total experimental sample and the individual groups are depicted in Table 5.

	Mean age (years)	Standard deviation	Range (years)
Total	28,9	10.6	20- 69
VR	29,5	11.2	20-69
Desktop	28,5	10.3	21- 61

Table 5 “Descriptive age statistics.”

Previous experience with games, simulators, and VR is shown in Table 7. Mean gaming experience is shown as the average score reported by the participants on a seven-point Likert scale from 0 (never played before) to 6 (play every day), all possible choices are shown in Table 6 as part of the introduction questionnaire.

No experience	Very little	Some experience	Play regularly (once a month)	Play often	Play several times a week	A lot of experience (play every day)
0	1	2	3	4	5	6

Table 6 “Personal previous gaming experience from the introduction questionnaire.”



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Table 7 also shows the number of participants who have any previous experience with simulators of any kind and with VR systems of any kind.

	Mean gaming experience (0 – 6)	Previous Simulator experience (Affirmative %)	Previous VR experience (Affirmative %)
Total	3,5	60%	44 %
VR	3,2	68 %	48 %
Desktop	3,7	51 %	41 %

Table 7 “Descriptive statistics for previous experience.”

This table shows a high average for previous gaming experience between once a month, and often (but less than several times a week), more than half of the participants have previous experience with simulators, and almost half had experienced VR before.

### 4.1.1. User Experience Questionnaire

The UEQ has 26 word-pairs divided into six dimensions. These dimensions range in value from -3 (horribly bad) to +3 (extremely good) on a seven-point Likert scale. According to Laugwitz, Held, and Schrepp (2008), a result between -0.8 and +0.8 is a neutral score.

Following are the results for VR (Figure 13 and Table 8) and Desktop (Figure 14 and Table 9) according to the participant's subjective responses.

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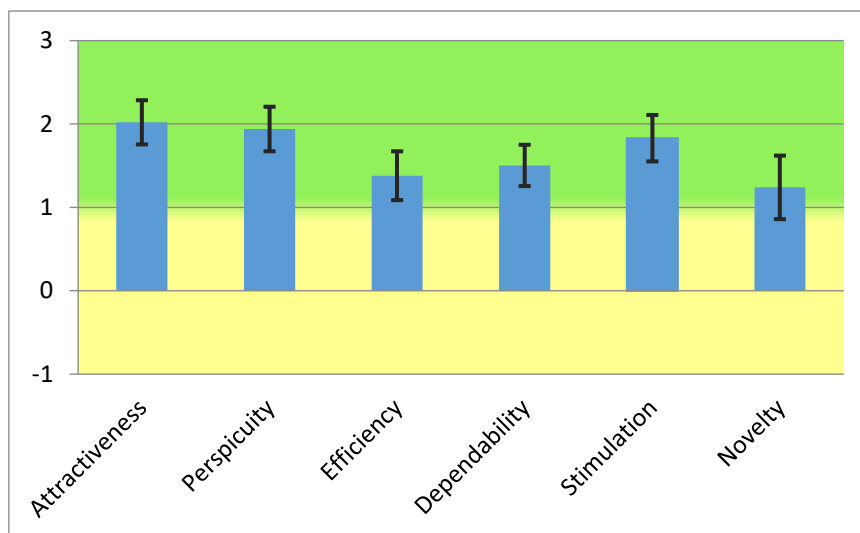


Figure 13 “Representation of average scores with standard deviation for the VR group.”

In this Figure, we see all dimensions are above 1.0. This is indicative of a very good experience according to Laugwitz, Held and Schrepp (2008).

Confidence Intervals (p=0.05) per scale						
Scale	Mean	Std. Dev.	N	Confidence	Confidence Interval	
Attractiveness	2,020	0,676	25	0,265	1,755	2,285
Perspicuity	1,940	0,682	25	0,267	1,673	2,207
Efficiency	1,380	0,747	25	0,293	1,087	1,673
Dependability	1,503	0,632	25	0,248	1,256	1,751
Stimulation	1,830	0,710	25	0,278	1,552	2,108
Novelty	1,240	0,972	25	0,381	0,859	1,621

Table 8 “Numerical representation of the scores from the VR group.”

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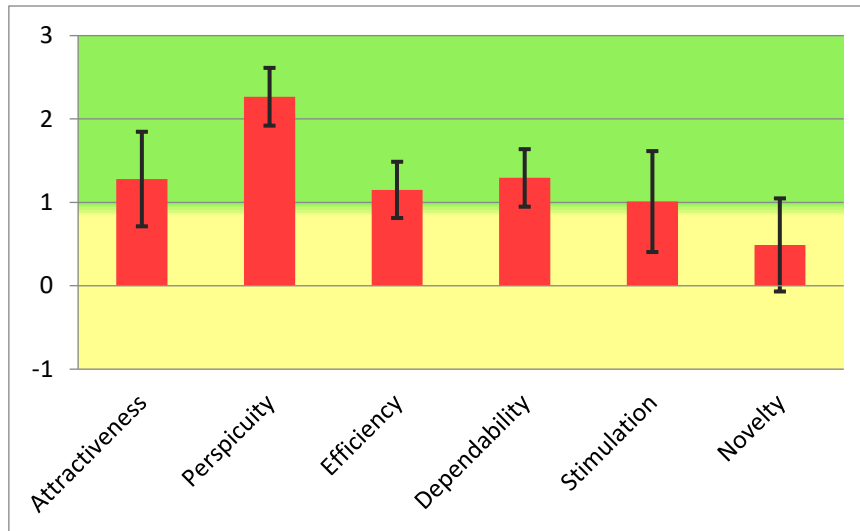


Figure 14 “Representation of average scores with standard deviation for the Desktop group.”

This figure shows overall lower scores, compared to the VR group, apart from Perspicuity which is the highest score measured. Novelty is in the neutral zone and Stimulation on the borderline.

Confidence Intervals (p=0.05) per scale						
Scale	Mean	Std. Dev.	N	Confidence	Confidence Interval	
<b>Attractiveness</b>	1,280	1,446	25	0,567	0,713	1,847
<b>Perspicuity</b>	2,267	0,884	25	0,346	1,920	2,613
<b>Efficiency</b>	1,150	0,860	25	0,337	0,813	1,487
<b>Dependability</b>	1,293	0,880	25	0,345	0,948	1,638
<b>Stimulation</b>	1,010	1,544	25	0,605	0,405	1,615
<b>Novelty</b>	0,490	1,424	25	0,558	-0,068	1,048

Table 9 “Numerical representation of the scores from the Desktop group.”

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In direct comparison, the mean score of the VR group is higher in all categories except for Perspicuity, as seen in Figure 15.

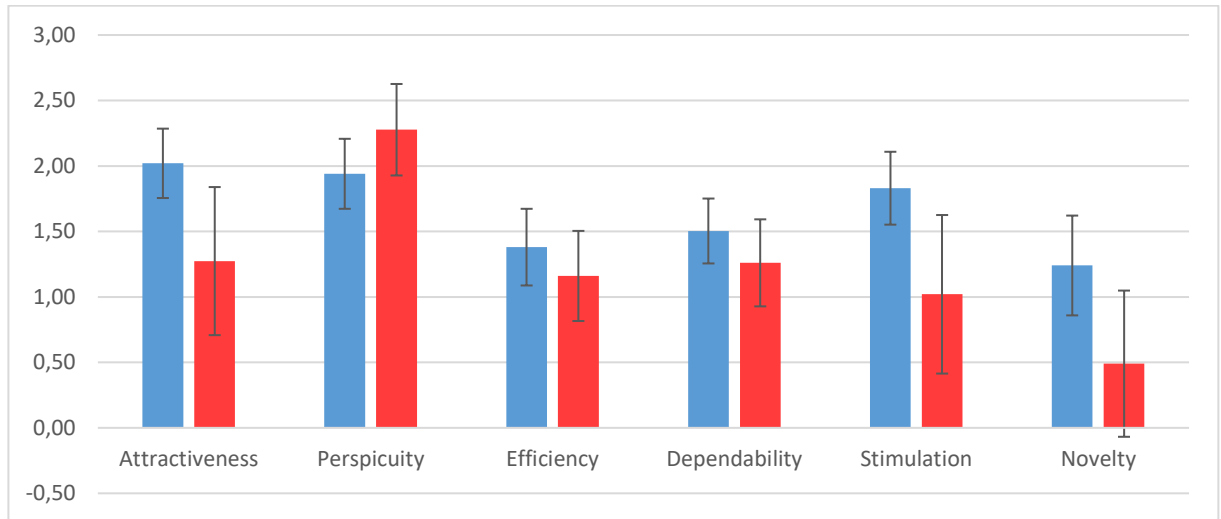


Figure 15 “Side-by-side comparison of the two groups.”

### 4.2. Statistical analysis

The comparison between the VR and Desktop groups was made with a two-sample t-test assuming uneven variance. This analysis showed a significant difference between half of the dimensions: Attractiveness, Stimulation, and Novelty with a Confidence Interval (CI) of 95%. There was no significant difference in the other three dimensions, see Table 10.

Dimension	Calculation	Result
Attractiveness	0,0297	Significant Difference
Perspicuity	0,2242	No Significant Difference
Efficiency	0,3867	No Significant Difference
Dependability	0,3229	No Significant Difference
Stimulation	0,0249	Significant Difference
Novelty	0,0452	Significant Difference

Table 10 “t-test analysis between the VR and Desktop group.”

Cronbach’s Alpha 0.7 was calculated to investigate scale consistencies. Low alpha levels were identified in the dimensions: Efficiency and Dependability within the Desktop group. The same was found in the dimensions: Perspicuity, Efficiency, and Dependability within the VR group. The inconsistency implies that there are some suspicious responses from the participants that create contradictions between the items within the dimension. The internal

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validity of those dimensions might not be good enough to give any valuable results or to be compared between the groups.

To check the influence of the suspicious answers, the researcher decided to remove those participants from the result temporarily. After removing three outliers from the VR group and four from the desktop group, showing two or three, of what Laugwitz et al. calls; “suspicious responses”, the scale consistencies did improve slightly. However, the closest any of the dimensions mentioned above came to have an alpha level above 0.7, was the Efficiency for Desktop group which rose from 0.51 to 0.68. The t-test without the suspicious participants is shown in Table 11.

<b>Dimension</b>	<b>Calculation</b>	<b>Result</b>
<b>Attractiveness</b>	0,0303	<b>Significant Difference</b>
<b>Perspiciuity</b>	0,3996	<b>No Significant Difference</b>
<b>Efficiency</b>	0,2786	<b>No Significant Difference</b>
<b>Dependability</b>	0,2954	<b>No Significant Difference</b>
<b>Stimulation</b>	0,0163	<b>Significant Difference</b>
<b>Novelty</b>	0,0226	<b>Significant Difference</b>

Table 11 “t-test analysis after removing most suspicious responses.”

By removing all suspicious responses (including those with only one suspicious response), the total sample size would be halved from 52 to 27, and the results still remained the same.

The researcher decided that given the small difference removing participants had on the consistency, they will all remain. The comparison between Perspiciuity, Efficiency, and Dependability might not be reliable, but the other dimensions are. The normal distribution for all the dimensions was also skewed slightly to the right (positive).

## 5. Discussion

Ease of use and accessibility to training instruments has been shown to have a positive effect on training (Yiasemidou, et al., 2017). The potential impact of VR HMDs as a tool for educating future mariners in simulated environments is vital to establish for the InnoTraining project. The present research was comprised of a large experiment where a vast amount of both quantitative and qualitative data was collected. The remaining data will be used by the InnoTraining project in the future. The focus of this research was to investigate VR HMDs as a training instrument in maritime education based on User Experience.

The VR group scored their experience higher in all dimension except for Perspicuity. This could be explained by the fact that VR is a new experience for more than half of the participants. The reason the Perspicuity dimension falls short might be for the same reason, i.e. as it is a new technology with unfamiliar controllers. The primary dimension, Attractiveness, is found to be significantly higher and suggests that users are more tempted to use the VR system again, which in turn is linked to VR being a useful tool to promote both mastery learning and retention (Butt, Kardong-Edgren, & Ellertson, 2018). New and exciting products, systems, or devices, have a positive effect on people as emotions affect our judgment of an experience (Jin, Lee, & Lee, 2015).

By performing a t-test, a significant difference can be seen in half of the dimensions measured by the subjective scores (Attractiveness, Stimulation, and Novelty). The most critical dimension, Attractiveness, indicates that VR is significantly more exciting to use than Desktop. Novelty and Stimulation are logically higher for VR, as it is a novel product. The experience naturally follows suit as it speaks to the hedonic quality of the product (Hassenzahl & Tractinsky, 2006).

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The skewness of the result may be due to a limited sample or that the gaming experience was slightly skewed in the same positive direction. As the participants were mostly comprised of gamers, i.e. play games consistently more than once a month, they enjoy playing games. This experiment was implemented using a game and might be more enjoyable for the sample than the general population.

The three dimension that showed no significant difference between the groups is also the dimensions with low Cronbach's alpha. There are several possible reasons for the low alpha level. The low scale consistencies found during analysis of the data may be due to the standardisation of the questionnaire. This research focused on the experience itself and not the devices used; the participants may have become confused by the researcher's influence. It could be because of the nationality of the participants, given that English is a second language for most participants. There is also the possibility that the sample size affected the results. Even though a group of 50 participants is a large size compared to typically published VR experiments (Mölbart, et al., 2018; Cuperus, et al., 2018), they were divided into two even groups. The division of the sample was a result of the research design. The time was limited, and it would be increasingly more complicated to have all participants perform the same experiment in both settings. This division, however, somewhat limits the effect of training within the experiment.

### 5.1. VR in education within the maritime domain.

In a VR HMD simulator, all hardware components that make up a bridge can be made into digital models. In such a simulator, all the elements could be added or taken out with relative ease. A modular bridge could be constructed where all controllers, screens, and systems are configured and placed within the virtual environment, if there exist 3D models of them. This can limit the cost of the high-fidelity systems, as one HMD with controllers could

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substitute both the low-grade monitor simulators and the high-grade “full mission bridges”. This way, a VR HMD simulator can theoretically fill all the classes within the DNV-GL table. Different aspects of vessel navigation and operations can be trained, increasing in difficulty and complexity over time without changing the hardware.

As stated earlier, the attractiveness of a product is connected to a person’s willingness to use it. The willingness again speaks to how often someone will use the product. Novelty, Stimulation and Attractiveness of a product might fade with time, but the significant difference shown in this research suggest VR holds value as an educational tool. Also, the level of fidelity and immersion has a positive effect on learning as well. Several of the participants mentioned they forgot they were in a small room. The level of immersion the VR HMDs provide is in another realm compared to computer monitors or projections on a wall.

There are many obstacles when implementing new technology in education, such as changing curriculum, training the educators, and the cost of both the technology and the implementation of it. In the education of mariners, this process becomes even more complicated as educational institutions need to adhere to international standards. Any system used for maritime training must conform to the STCW standards and guidelines. The way the guidelines are written today, a simulator using VR technology is not explicitly mentioned and can, therefore, not be excluded as a possibility. Given enough programming and processing power, creating a high-quality simulator system to train future mariners should be feasible through current and future VR HMDs. The use of a VR HMD in maritime training needs to be further investigated.



### 5.2. Limitations

If we take the results of the three dimensions with the low alpha level at face value, some factors can explain these. How to control movement was more well known on the desktop and could be the reason for why the dimension Perspicuity is higher in the Desktop group than the VR group. This was further emphasized in the exit interviews, where the participants in both groups were unsatisfied with the mode of movement in VR. The speed of the movement is directly linked to how fast a participant was able to complete the task (Veie, 2018). As one could move more swiftly/more controlled on the desktop compared to in VR, the feeling of efficiency could be assumed to be higher in the Desktop group. The results, however, show that the VR group scored higher, although not significantly. The same is true for dependability.

There are some inherent weaknesses with a subjective questionnaire. Given the perfect set of questions and a high Cronbach's alpha, the results still might not be wholly valid. Even though a person has a good experience using a product, they may score lower than what could be expected. This could be a result of personal ideas or biased thoughts. If the experience does not live up to a person's expectations, this might negatively influence the subjective scores even though they enjoyed it. Some of the participants might also not have taken the questionnaire seriously. These factors may be a factor of the limited sample size. The size, in turn, could explain why the normal distribution became slightly skewed.

The participation in this experiment was entirely voluntary, as such, the people participating in a VR experience most likely have an interest in playing games. Gaming experience had an impact on the participant's performance (Veie, 2018). Moreover, could be considered additional training.

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The participants were tested at different times of the day, where the beginning of each experiment was from 0900 to 1800. The energy of both the participants and researchers might have influenced the overall excitement of the tasks and the experience itself.

The researchers did not consider the eyesight of the participants. This might have affected the results as they did not see as well as others. Not all participants that regularly used glasses could fit their spectacles into the HMD, and there is no way to adjust the lenses to compensate for this. None of the participants gave the impression this was a significant problem.

In the application used (Fallout 4 and Fallout 4 VR), there is a difference when doing the action of “sitting down”. In the base game, there is an animation when sitting down (4 sec), and when standing up (6 sec). This animation does not exist in VR as one simply teleports. Such a time difference somewhat affected the overall time completing the task.

The entirely new way of interacting with a digital medium through new controllers was unknown for many. As most, if not all, of the participants, were familiar with keyboard and mouse, there exists some level of prior training and knowledge about this system that made even inexperienced “gamers” perform better on a desktop computer than in VR. Movement in VR dramatically differs from traditional methods and was difficult to use, even for the participant with the best time and score in the Desktop group.

The UX scores were gathered from a standard questionnaire designed for evaluating the experience using a specific product, as this research was centred on the experience itself rather than the product used, the scores might have been misrepresented. The participants were mostly comprised of Norwegians. With English being their second language, some of the words might have been unfamiliar to them.

### 5.3. Recommendations and further research.

During the fall of 2017 and spring of 2018, the researcher identified many potential research questions and hypothesis that could be tested in the future. The main recommendations related to the current research are listed below.

#### 5.3.1. Recommendations

- Either create a UEQ directed towards the experience itself and not the product or focus the research on the product rather than the experience.
- Increased familiarisation in VR with guided tutorials might help to increase the perspicuity of the experience and smoothen the path for it to be used as a tool for learning.

#### 5.3.2. Future Research

- A comparison between a full mission bridge and the same scenario performed in VR would show a more direct evaluation of VR as a tool for maritime simulator training.
- If novelty has a positive effect on learning, how fast does this effect dissipate? When is a product no longer novel?
- Is there a link between how exciting a product feels to the user, and their training effect? Can the training effect of a tool or device be shown directly by using a UX questionnaire assessing the product?
- The use of physiological measures during maritime training exercises using current maritime simulators. Does the fidelity of the simulator stimulate the emotional arousal, and does it influence learning over an extended period?

### 5.4. Conclusion

The present research has revealed through hypothesis testing, that both attractiveness and the hedonic quality is rated significantly higher by the VR group than by the Desktop group. The attractiveness of a product can be linked to the frequency of its use. In combination with the portability of current VR technologies, the potential for using VR as a substitute or complementary device in simulator training has been shown.

The results of this research show that VR is a more attractive experience than on a desktop computer when performing a simple task. This indicates a general positive potential of the technology for uses in simulator training. The development of a full VR training simulator with functional RADAR and ECDIS systems on a digitally constructed bridge needs to be created to investigate its training effect within the maritime domain thoroughly. The long-term impact of VR HMD's as a tool for maritime simulation training compared to established technologies also requires further investigation.

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## Appendix

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## Appendix 1

No \_\_\_\_\_

Date \_\_\_\_\_

### **SIMULATOR SICKNESS QUESTIONNAIRE**

Kennedy, Lane, Berbaum, & Lilienthal (1993)\*\*\*

Instructions : Circle how much each symptom below is affecting you right now.

1. General discomfort	<u>None</u>	<u>Slight</u>	<u>Moderate</u>	<u>Severe</u>
2. Fatigue	<u>None</u>	<u>Slight</u>	<u>Moderate</u>	<u>Severe</u>
3. Headache	<u>None</u>	<u>Slight</u>	<u>Moderate</u>	<u>Severe</u>
4. Eye strain	<u>None</u>	<u>Slight</u>	<u>Moderate</u>	<u>Severe</u>
5. Difficulty focusing	<u>None</u>	<u>Slight</u>	<u>Moderate</u>	<u>Severe</u>
6. Salivation increasing	<u>None</u>	<u>Slight</u>	<u>Moderate</u>	<u>Severe</u>
7. Sweating	<u>None</u>	<u>Slight</u>	<u>Moderate</u>	<u>Severe</u>
8. Nausea	<u>None</u>	<u>Slight</u>	<u>Moderate</u>	<u>Severe</u>
9. Difficulty concentrating	<u>None</u>	<u>Slight</u>	<u>Moderate</u>	<u>Severe</u>
10. « Fullness of the Head »	<u>None</u>	<u>Slight</u>	<u>Moderate</u>	<u>Severe</u>
11. Blurred vision	<u>None</u>	<u>Slight</u>	<u>Moderate</u>	<u>Severe</u>
12. Dizziness with eyes open	<u>None</u>	<u>Slight</u>	<u>Moderate</u>	<u>Severe</u>
13. Dizziness with eyes closed	<u>None</u>	<u>Slight</u>	<u>Moderate</u>	<u>Severe</u>
14. *Vertigo	<u>None</u>	<u>Slight</u>	<u>Moderate</u>	<u>Severe</u>
15. **Stomach awareness	<u>None</u>	<u>Slight</u>	<u>Moderate</u>	<u>Severe</u>
16. Burping	<u>None</u>	<u>Slight</u>	<u>Moderate</u>	<u>Severe</u>

\* Vertigo is experienced as loss of orientation with respect to vertical upright.

\*\* Stomach awareness is usually used to indicate a feeling of discomfort which is just short of nausea.

Last version : March 2013

\*\*\*Original version : Kennedy, R.S., Lane, N.E., Berbaum, K.S., & Lilienthal, M.G. (1993). Simulator Sickness Questionnaire: An enhanced method for quantifying simulator sickness. *International Journal of Aviation Psychology*, 3(3), 203-220.

Appendix 2

## Introduction Questionnaire

### PERSONAL DEMOGRAPHICS

1. Name
2. Gender
3. Age
4. Nationality
5. E-mail address
6. Current work status (i.e. student, employed, self-employed, etc.)

### GAMING EXPERIENCE

1. Do you have previous experience with video games? (Computer-based, Console-based or other)

No experience	Very little	Some experience	Play regularly (once a month)	Play often	Play several times a week	A lot of experience (play every day)
0	1	2	3	4	5	6

2. Did you play more before than you do now?
  - a. No
  - b. Yes
  - c. If yes, how many years ago was the period you played most?
3. Do you enjoy puzzle games (strategy, problem-solving, maze)?

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- a. Yes
- b. No

4. How often have you played video games during the last 12 months?

Never	Once every other month	About once a month	About once a week	Several times per week	Every day for less than two hours	Every day for more than two hours
0	1	2	3	4	5	6

- a. If other than 0, approximately how many individual playing sessions per week?
- b. If other than 0, approximately how many total hours per session do you play?

5. What gaming systems have you used personally? (Please circle)

- a. Nintendo 64/ X-box/ Atari
- b. VR systems
- c. PC
- d. Wii/ Play Station Move
- e. Mobile phone games
- f. Other (please specify): \_\_\_\_\_

### PREVIOUS SIMULATOR EXPERIENCE

6. Have you used any type of simulator before?

- a. No
- b. Yes
  - i. What kind/for what purpose?
  - ii. What was the exercise/game?

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7. Have you previously used a head-mounted virtual reality system (VR headset/goggles)?
- a. No
  - b. Yes, I have used:
    - i. HTC Vive
    - ii. Oculus Rift
    - iii. Google Cardboard
    - iv. Samsung Gear VR
    - v. PlayStation VR
    - vi. Not sure which
    - vii. Other:\_\_\_\_\_

### HEALTH BACKGROUND

8. Have you ever suffered from epileptic seizures?
- a. Yes, sometimes
  - b. No
    - i. If yes, when did this happen?
9. Have you suffered from motion sickness before?
- i. Yes
  - ii. No
  - b. If yes, please explain:
10. Do you easily get car-sick?
- a. Yes
  - b. No

### EXPECTATIONS FOR STUDY

11. How do you think this experience will be?

Boring	Not very interesting	Of little impact to me	Ok	Somewhat interesting	Highly interesting	Life altering
0	1	2	3	4	5	6



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12. What do you expect from this study?

a. Please explain with a few words: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

13. What motivated you to participate in this study?

Appendix 3



**MELDESKJEMA**

Meldeskjema (versjon 1.6) for forsknings- og studentprosjekt som medfører meldeplikt eller konsesjonsplikt (jf. personopplysningsloven og helseregisterloven med forskrifter).

1. Intro		
Samles det inn direkte personidentifiserende opplysninger?	Ja ● Nei ○	En person vil være direkte identifiserbar via navn, personnummer, eller andre personentydige kjennetegn.
Hvis ja, hvilke?	<input checked="" type="checkbox"/> Navn <input type="checkbox"/> 11-sifret fødselsnummer <input type="checkbox"/> Adresse <input checked="" type="checkbox"/> E-post <input checked="" type="checkbox"/> Telefonnummer <input checked="" type="checkbox"/> Annet	Les mer om hva <a href="#">personopplysninger</a> er. NB! Selv om opplysningene skal anonymiseres i oppgave/rapport, må det krysses av dersom det skal innhentes/registreres personidentifiserende opplysninger i forbindelse med prosjektet.
Annet, spesifiser hvilke	Gender, Age, Work status, Nationality, Educational level	Les mer om hva <a href="#">behandling av personopplysninger</a> innebærer.
Skal direkte personidentifiserende opplysninger kobles til datamaterialet (koblingsnøkkel)?	Ja ● Nei ○	Merk at meldeplikten utløses selv om du ikke får tilgang til <a href="#">koblingsnøkkel</a> , slik fremgangsmåten ofte er når man benytter en <a href="#">databehandler</a> .
Samles det inn bakgrunnsopplysninger som kan identifisere enkeltpersoner (indirekte personidentifiserende opplysninger)?	Ja ● Nei ○	En person vil være <a href="#">indirekte identifiserbar</a> dersom det er mulig å identifisere vedkommende gjennom bakgrunnsopplysninger som for eksempel bostedskommune eller arbeidsplass/skole kombinert med opplysninger som alder, kjønn, yrke, diagnose, etc.

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Hvis ja, hvilke	Gender, Age, Work status, Nationality, Educational level, Experience with video games/virtual reality, susceptibility to motion sickness	NB! For at stemme skal regnes som personidentifiserende, må denne bli registrert i kombinasjon med andre opplysninger, slik at personer kan gjenkjennes.
Skal det registreres personopplysninger (direkte/indirekte/via IP-/epost adresse, etc) ved hjelp av nettbaserte spørreskjema?	Ja <input type="radio"/> Nei <input checked="" type="radio"/>	Les mer om <a href="#">nettbaserte spørreskjema</a> .
Blir det registrert personopplysninger på digitale bilde- eller videoopptak?	Ja <input checked="" type="radio"/> Nei <input type="radio"/>	Bilde/videoopptak av ansikter vil regnes som personidentifiserende.
Søkes det vurdering fra REK om hvorvidt prosjektet er omfattet av helseforskningsloven?	Ja <input type="radio"/> Nei <input checked="" type="radio"/>	NB! Dersom REK (Regional Komité for medisinsk og helsefaglig forskningsetikk) har vurdert prosjektet som helseforskning, er det ikke nødvendig å sende inn meldeskjema til personvernombudet (NB! Gjelder ikke prosjekter som skal benytte data fra pseudonyme helseregistre). <a href="#">Les mer.</a> Dersom tilbakemelding fra REK ikke foreligger, anbefaler vi at du avventer videre utfylling til svar fra REK foreligger.
2. Prosjektittel		
Prosjektittel	Learning in Virtual Reality - A Study Investigation User Motivation and Quality of Experience	Oppgi prosjektets tittel. NB! Dette kan ikke være «Masteroppgave» eller liknende, navnet må beskrive prosjektets innhold.

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3. Behandlingsansvarlig institusjon		
Institusjon	Høgskolen i Sørøst-Norge	Velg den institusjonen du er tilknyttet. Alle nivå må oppgis. Ved studentprosjekt er det studentens tilknytning som er avgjørende. Dersom institusjonen ikke finnes på listen, har den ikke avtale med NSD som personvernombud. Vennligst ta kontakt med institusjonen.  Les mer om <a href="#">behandlingsansvarlig institusjon</a> .
Avdeling/Fakultet	Fakultet for teknologi, naturvitenskap og maritime fag	
Institutt	Institutt for maritime operasjoner	
4. Daglig ansvarlig (forsker, veileder, stipendiat)		

Fornavn	Steven	Før opp navnet på den som har det daglige ansvaret for prosjektet. Veileder er vanligvis daglig ansvarlig ved studentprosjekt. Les mer om <a href="#">daglig ansvarlig</a> .  Daglig ansvarlig og student må i utgangspunktet være tilknyttet samme institusjon. Dersom studenten har eksternt veileder, kan biveileder eller fagansvarlig ved studiestedet stå som daglig ansvarlig.  Arbeidssted må være tilknyttet behandlingsansvarlig institusjon, f.eks. underavdeling, institutt etc.  NB! Det er viktig at du oppgir en e-postadresse som brukes aktivt. Vennligst gi oss beskjed dersom den endres.
Etternavn	Mallam	
Stilling	Postdoctoral Fellow	
Telefon	[REDACTED]	
Mobil		
E-post	steven.mallam@usn.no	
Alternativ e-post	steven.mallam@usn.no	
Arbeidssted	Høgskolen i Sørøst-Norge	
Adresse (arb.)	Raveien 215	
Postnr./sted (arb.sted)	3184 Borre	
5. Student (master, bachelor)		

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Studentprosjekt	Ja <input checked="" type="radio"/> Nei <input type="radio"/>	Dersom det er flere studenter som samarbeider om et prosjekt, skal det velges en kontaktperson som føres opp her. Øvrige studenter kan føres opp under pkt 10.
Fornavn	Anders	
Etternavn	Edwinson	
Telefon	██████	
Mobil	██████	
E-post	██████████████	
Alternativ e-post	██████████████	
Privatadresse	██████████	
Postnr./sted (privatadr.)	██████	
Type oppgave	<input checked="" type="radio"/> Masteroppgave <input type="radio"/> Bacheloroppgave <input type="radio"/> Semesteroppgave <input type="radio"/> Annet	
6. Formålet med prosjektet		
Formål	The aim of the project is to investigate the motivational factors of using Virtual Reality head mounted displays in simulator training and how to objectively assess the Quality of experience. We will collect subjective and objective measures from an adult population with novice experience with VR.	Redegjør kort for prosjektets formål, problemstilling, forskningsspørsmål e.l.
7. Hvilke personer skal det innhentes personopplysninger om (utvalg)?		

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<p>Kryss av for utvalg</p>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Barnehagebarn</li> <li><input type="checkbox"/> Skoleelever</li> <li><input type="checkbox"/> Pasienter</li> <li><input type="checkbox"/> Brukere/klienter/kunder</li> <li><input checked="" type="checkbox"/> Ansatte</li> <li><input type="checkbox"/> Barnevernsbarn</li> <li><input type="checkbox"/> Lærere</li> <li><input type="checkbox"/> Helsepersonell</li> <li><input type="checkbox"/> Asylsøkere</li> <li><input checked="" type="checkbox"/> Andre</li> </ul>	<p>Les mer om forskjellige <a href="#">forskningstematikker og utvalg.</a></p>
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<p>Beskriv utvalg/deltakere</p>	<p>The adult participants will be from the general population: but mainly from the student body (adult students, 18 years of age and older) of University College of Southeast Norway (Vestold campus) and possibly other Norwegian Universities. University employees and the general population from the surrounding area will also likely be recruited. Person's with a history of elliptic seizures will not be allowed to participate in the study, due to the hazard of Virtual Reality systems in potentially contributing to, or triggering a seizure. Participants who report a propensity for motion sickness will be allowed to participate, though all participants cyber/simulator sickness symptoms will be monitored throughout the scenarios, with full recognition that a participant may drop out whenever/if they choose to do so.</p>	<p>Med utvalg menes dem som deltar i undersøkelsen eller dem det innhentes opplysninger om.</p>
<p>Rekruttering/trekking</p>	<p>The participants will be chosen using a convenience sample and snowball methods. This will take place through the research team's personal contact network, on-campus advertising, and online advertising (i.e. through email, social media, etc.).</p>	<p>Beskriv hvordan utvalget trekkes eller rekrutteres og oppgi hvem som foretar den. Et utvalg kan rekrutteres gjennom f.eks. en bedrift, skole, idrettsmiljø eller eget nettverk, eller trekkes fra registre som f.eks. Folkeregisteret, SSB-registre, pasientregistre.</p>
<p>Førstegangskontakt</p>	<p>The research team will utilize their individual contact networks and advertising described in the "Recruitment and sampling" section above. It is likely that all members of the research team will work within the recruitment process, both in person and online. The following will be involved in the recruitment process:</p> <p>Steven Mallam, Post-doc, USN</p> <p>Salman Nazir, Associate Professor, USN</p> <p>Sathiya kumar Renganayagalu, PhD Student, USN</p> <p>Sunniva Veie, Masters Student, USN</p>	<p>Beskriv hvordan førstegangskontakten opprettes og oppgi hvem som foretar den.</p> <p>Les mer om førstegagskontakt og forskjellige utvalg på våre <a href="#">temasider.</a></p>

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	Jorgen Ernstsén, PhD Student, USN Anders Edwinston, Master's student, USN	
Alder på utvalget	<input type="checkbox"/> Barn (0-15 år) <input type="checkbox"/> Ungdom (16-17 år) <input checked="" type="checkbox"/> Voksne (over 18 år)	Les om forskning som involverer <a href="#">barn</a> på våre nettsider.
Omtrentlig antall personer som inngår i utvalget	40-60	
Samles det inn sensitive personopplysninger?	Ja ● Nei ○	Les mer om <a href="#">sensitive opplysninger</a> .
Hvis ja, hvilke?	<input type="checkbox"/> Rasemessig eller etnisk bakgrunn, eller politisk, filosofisk eller religiøs oppfatning <input type="checkbox"/> At en person har vært mistenkt, siktet, tiltalt eller dømt for en straffbar handling <input checked="" type="checkbox"/> Helseforhold <input type="checkbox"/> Seksuelle forhold <input type="checkbox"/> Medlemskap i fagforeninger	
Inkluderes det myndige personer med redusert eller manglende samtykkekompetanse?	Ja ○ Nei ●	Les mer om <a href="#">pasienter, brukere og personer med redusert eller manglende samtykkekompetanse</a> .
Samles det inn personopplysninger om personer som selv ikke deltar (tredjepersoner)?	Ja ○ Nei ●	Med opplysninger om tredjeperson menes opplysninger som kan identifisere personer (direkte eller indirekte) som ikke inngår i utvalget. Eksempler på tredjeperson er kollega, elev, klient, familiemedlem, som identifiseres i datamaterialet. <a href="#">Les mer</a> .

### 8. Metode for innsamling av personopplysninger

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<p>Kryss av for hvilke datainnsamlingsmetoder og datakilder som vil benyttes</p>	<ul style="list-style-type: none"> <li>■ Papirbasert spørreskjema</li> <li>■ Elektronisk spørreskjema</li> <li>■ Personlig intervju</li> <li><input type="checkbox"/> Gruppeintervju</li> <li>■ Observasjon</li> <li><input type="checkbox"/> Deltakende observasjon</li> <li><input type="checkbox"/> Blogg/sosiale medier/internett</li> <li>■ Psykologiske/pedagogiske tester</li> <li><input type="checkbox"/> Medisinske undersøkelser/tester</li> <li><input type="checkbox"/> Journaldata (medisinske journaler)</li> </ul>	<p>Personopplysninger kan innhentes direkte fra den registrerte f.eks. gjennom spørreskjema, intervju, tester, og/eller ulike journaler (f.eks. elevmapper, NAV, PPT, sykehus) og/eller registre (f.eks. Statistisk sentralbyrå, sentrale helseregistre).</p> <p>NB! Dersom personopplysninger innhentes fra forskjellige personer (utvalg) og med forskjellige metoder, må dette spesifiseres i kommentar-boksen. Husk også å legge ved relevante vedlegg til alle utvalgs-gruppene og metodene som skal benyttes.</p> <p>Les mer om <a href="#">registerstudier</a>. Dersom du skal anvende registerdata, må variabelliste lastes opp under pkt. 15 Les mer om <a href="#">forskningsmetoder</a>.</p>
	<ul style="list-style-type: none"> <li><input type="checkbox"/> Registerdata</li> </ul>	

	<ul style="list-style-type: none"> <li>■ Annen innsamlingsmetode</li> </ul>	
<p>Oppgi hvilken</p>	<p>Both objective and subjective data will be collected from participants. Objective physiological data will be collected, including:</p> <ul style="list-style-type: none"> <li>- Heart Rate</li> <li>- Heart Rate Variability</li> <li>- Electrodermal Activity (skin conductance)</li> <li>- Blood Volume Pulse (BVP)</li> <li>- Skin Temperature</li> <li>- Limb Movement</li> </ul> <p>Additionally, a post-hoc analysis of the participants virtual reality exercises will be analyzed for performance metrics (time of completion, error rates, movement tracking within the virtual world).</p> <p>The participants will also fill out introduction and exit questionnaires detailing as a screening process (e.g. their gaming experience, susceptibility to motion sickness), and their experience of the experiment and the virtual reality exercise with an exit questionnaire and exit interview (e.g. motivation, work load, quality of experience). The participant will also be monitored using a standardized simulator sickness scale during and after the familiarization and experimental protocols.</p>	



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Tilleggsopplysninger	<p>The physiological data will be collected by 2 noninvasive devices. We stress, we are not collecting or storing any biological material, just using non-invasive consumer products to collect basic physiological measurements:</p> <ul style="list-style-type: none"> <li>- Empatica E4 wristband: <a href="https://www.empatica.com/eneu/research/e4/">https://www.empatica.com/eneu/research/e4/</a></li> <li>- Polar H10 Heart Rate Monitors: <a href="https://www.polar.com/en/products/accessories/H10_heart_rate_sensor">https://www.polar.com/en/products/accessories/H10_heart_rate_sensor</a></li> </ul>	
9. Informasjon og samtykke		
Oppgi hvordan utvalget/deltakerne informeres	<ul style="list-style-type: none"> <li><input checked="" type="checkbox"/> Skriftlig</li> <li><input checked="" type="checkbox"/> Muntlig</li> <li><input type="checkbox"/> Informeres ikke</li> </ul>	<p>Dersom utvalget ikke skal informeres om behandlingen av personopplysninger må det begrunnes.</p> <p><a href="#">Les mer.</a> Vennligst send inn mal for skriftlig eller muntlig informasjon til deltakerne sammen med meldeskjema.</p> <p>Last ned en veiledende mal <a href="#">her</a>.</p> <p>Les om <a href="#">krav til informasjon og samtykke</a>.</p> <p>NB! Vedlegg lastes opp til sist i meldeskjemaet, se punkt 15 Vedlegg.</p>
Samtykker utvalget til deltakelse?	<ul style="list-style-type: none"> <li><input checked="" type="radio"/> Ja</li> <li><input type="radio"/> Nei</li> <li><input type="radio"/> Flere utvalg, ikke samtykke fra alle</li> </ul>	<p>For at et samtykke til deltakelse i forskning skal være gyldig, må det være frivillig, uttrykkelig og <a href="#">informert</a>.</p> <p>Samtykke kan gis skriftlig, muntlig eller gjennom en aktiv handling. For eksempel vil et besvart spørreskjema være å regne som et aktivt samtykke.</p> <p>Dersom det ikke skal innhentes samtykke, må det begrunnes. <a href="#">Les mer</a>.</p>
10. Informasjonssikkerhet		

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<p>Hvordan oppbevares navnelisten/ koblingsnøkkelen og hvem har tilgang til den?</p>	<p>Participant data will be stored both electronically and on paper forms. The paper forms will be filed and stored within a locked office within the personal office of the researchers at the Vestfold campus (Borre) of the University of Southeast Norway. The electronic spreadsheet will be stored on the researchers work computer. Only members directly working within the Training and Assessment Research Group at the Department of Maritime Operations who are working on the subsequent data analysis and writing will have access to any of the projects sensitive information, including participant names and research data.</p>	
<p>Oppbevares direkte personidentifiserbare opplysninger på andre måter?</p>	<p>Ja <input type="radio"/> Nei <input checked="" type="radio"/></p>	

<p>Spesifiser</p>		<p>NB! Som hovedregel bør ikke direkte personidentifiserende opplysninger registreres sammen med det øvrige datamaterialet. Vi anbefaler <a href="#">koblingsnøkkel</a>.</p>
<p>Hvordan registreres og oppbevares personopplysningene?</p>	<ul style="list-style-type: none"> <li>■ På server i virksomhetens nettverk</li> <li><input type="checkbox"/> Fysisk isolert PC tilhørende virksomheten (dvs. ingen tilknytning til andre datamaskiner eller nettverk, interne eller eksterne)</li> <li>■ Datamaskin i nettverkssystem tilknyttet Internett tilhørende virksomheten <input type="checkbox"/> Privat datamaskin</li> <li>■ Videooptak/fotografi</li> <li>■ Lydoptak</li> <li>■ Notater/papir</li> <li>■ Mobile lagringsenheter (bærbar datamaskin, minnepenn, minnekort, cd, ekstern harddisk, mobiltelefon)</li> <li>■ Annen registreringsmetode</li> </ul>	<p>Merk av for hvilke hjelpemidler som benyttes for registrering og analyse av opplysninger.</p> <p>Sett flere kryss dersom opplysningene registreres på flere måter.</p> <p>Med «virksomhet» menes her behandlingsansvarlig institusjon.</p> <p>NB! Som hovedregel bør data som inneholder personopplysninger lagres på behandlingsansvarlig sin forskningsserver.</p>
<p>Annen registreringsmetode beskriv</p>	<p>The physiological measures will be stored on a personal (password secured) online account registered with Polar and Empatica</p>	<p>Lagring på andre medier - som privat pc, mobiltelefon, minnepinne, server på annet arbeidssted - er mindre sikkert, og må derfor begrunnes. Slik lagring må avklares med behandlingsansvarlig institusjon,</p>

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		og personopplysningene bør krypteres.
Hvordan er datamaterialet beskyttet mot at uvedkommende får innsyn?	The paper forms will be filed and stored within a locked office of the researchers at the Vestfold campus (Borre) of the University of Southeast Norway. The electronicbased data will be stored on the researchers work computer, belonging to USN, and are password protected. The online accounts registered with Polar and Empatica are personal and password protected.	Er f.eks. datamaskintilgangen beskyttet med brukernavn og passord, står datamaskinen i et låsbart rom, og hvordan sikres bærbare enheter, utskrifter og opptak?
Samles opplysningene inn/behandles av en databehandler (ekstern aktør)?	Ja <input checked="" type="radio"/> Nei <input type="radio"/>	Dersom det benyttes eksterne til helt eller delvis å behandle personopplysninger, f.eks. Questback, transkriberingsassistent eller tolk, er dette å betrakte som en <a href="#">databehandler</a> . Slike oppdrag må kontraksreguleres.
Hvis ja, hvilken	The physiological measures will be stored on a personal (password secured) online account registered with Polar and Empatica	
Overføres personopplysninger ved hjelp av e-post/Internett?	Ja <input checked="" type="radio"/> Nei <input type="radio"/>	F.eks. ved overføring av data til samarbeidspartner, databehandler mm. Dersom personopplysninger skal sendes via internett, bør de krypteres tilstrekkelig.
Hvis ja, beskriv?	Participant data will likely be sent through email between the research teams secured USN email accounts.	Vi anbefaler ikke lagring av personopplysninger på nettskytjenester. Bruk av nettskytjenester må avklares med behandlingsansvarlig institusjon. Dersom nettskytjeneste benyttes, skal det inngås skriftlig databehandleravtale med leverandøren av tjenesten. <a href="#">Les mer</a> .
Skal andre personer enn daglig ansvarlig/student ha tilgang til datamaterialet med personopplysninger?	Ja <input checked="" type="radio"/> Nei <input type="radio"/>	

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Hvis ja, hvem (oppgi navn og arbeidssted)?	<p>Steven Mallam, Post-doc, USN</p> <p>Salman Nazir, Associate Professor, USN</p> <p>Sathiya kumar Renganayagalu, PhD Student, USN</p> <p>Sunniva Veie, Masters Student, USN</p> <p>Jorgen Ernstsens, PhD Student, USN</p> <p>Anders Edwinston, Master's student, USN</p>	
Utleveres/deles personopplysninger med andre institusjoner eller land?	<ul style="list-style-type: none"> <li>• Nei</li> <li>○ Andre institusjoner</li> <li>○ Institusjoner i andre land</li> </ul>	F.eks. ved nasjonale samarbeidsprosjekter der personopplysninger utveksles eller ved internasjonale samarbeidsprosjekter der personopplysninger utveksles.
11. Vurdering/godkjenning fra andre instanser		
Søkes det om dispensasjon fra taushetsplikten for å få tilgang til data?	Ja ○ Nei •	For å få tilgang til taushetsbelagte opplysninger fra f.eks. NAV, PPT, sykehus, må det søkes om <a href="#">dispensasjon fra taushetsplikten</a> . Dispensasjon søkes vanligvis fra aktuelt departement.
Hvis ja, hvilke		
Søkes det godkjenning fra andre instanser?	Ja ○ Nei •	I noen forskningsprosjekter kan det være nødvendig å søke flere tillatelser. Søkes det f.eks. om tilgang til data fra en registreier? Søkes det om tillatelse til forskning i en virksomhet eller en skole? Les mer om <a href="#">andre godkjenninger</a> .
Hvis ja, hvilken		
12. Periode for behandling av personopplysninger		

Prosjektstart	15.01.2017	Prosjektstart Vennligst oppgi tidspunktet for når kontakt med utvalget skal gjøres/datainnsamlingen starter.
Planlagt dato for prosjektslutt	16.05.2018	
		Prosjektslutt: Vennligst oppgi tidspunktet for når datamaterialet enten skal anonymiseres/slettes,

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		eller arkiveres i påvente av oppfølgingsstudier eller annet.
Skal personopplysninger publiseres (direkte eller indirekte)?	<input type="checkbox"/> Ja, direkte (navn e.l.) <input type="checkbox"/> Ja, indirekte (identifiserende bakgrunnsopplysninger) ■ <input type="checkbox"/> Nei, publiseres anonymt	<p>Les mer om <a href="#">direkte</a> og <a href="#">indirekte</a> personidentifiserende opplysninger.</p> <p>NB! Dersom personopplysninger skal publiseres, må det vanligvis innhentes eksplisitt samtykke til dette fra den enkelte, og deltakere bør gis anledning til å lese gjennom og godkjenne sitater.</p>
Hva skal skje med datamaterialet ved prosjektstutt?	<input checked="" type="checkbox"/> Datamaterialet anonymiseres <input type="checkbox"/> Datamaterialet oppbevares med personidentifikasjon	<p>NB! Her menes datamaterialet, ikke publikasjon. Selv om data publiseres med personidentifikasjon skal som regel øvrig data anonymiseres. Med anonymisering menes at datamaterialet bearbeides slik at det ikke lenger er mulig å føre opplysningene tilbake til enkeltpersoner.</p> <p>Les mer om <a href="#">anonymisering av data</a>.</p>
<b>13. Finansiering</b>		
Hvordan finansieres prosjektet?	Any associated costs with this project are financed by RCN project number 269424: Innovating maritime training simulators using Virtual and Augmented Reality (InnoTraining)	Fylles ut ved eventuell ekstern finansiering (oppdragsforskning, annet).
<b>14. Tilleggsopplysninger</b>		
Tilleggsopplysninger		Dersom prosjektet er del av et prosjekt (eller skal ha data fra et prosjekt) som allerede har tilrådning fra personvernombudet og/eller konsesjon fra Datatilsynet, beskriv dette her og oppgi navn på prosjektleder, prosjektittel og/eller prosjektnummer.

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15. Vedlegg		
Vedlegg	<p>Antall vedlegg: 7.</p> <ul style="list-style-type: none"><li>● exit_interview_guide.pdf</li><li>● introduction_questionnaire.pdf</li><li>● quality_of_experience_questionnaire.pdf</li><li>● skill_acquisition_and_motivation_questionnaire.pdf</li><li>● informed_consent_form.pdf</li><li>● simulator_sickness_questionnaire.pdf</li><li>● vr_experimental_script.pdf</li></ul>	

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## Appendix 4

Please assess the product now by ticking one circle per line.

	1	2	3	4	5	6	7		
annoying	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	enjoyable	1
not understandable	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	understandable	2
creative	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	dull	3
easy to learn	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	difficult to learn	4
valuable	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	inferior	5
boring	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	exciting	6
not interesting	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	interesting	7
unpredictable	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	predictable	8
fast	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	slow	9
inventive	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	conventional	10
obstructive	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	supportive	11
good	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	bad	12
complicated	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	easy	13
unlikable	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	pleasing	14
usual	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	leading edge	15
unpleasant	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	pleasant	16
secure	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	not secure	17
motivating	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	demotivating	18
meets expectations	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	does not meet expectations	19
inefficient	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	efficient	20
clear	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	confusing	21
impractical	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	practical	22
organized	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	cluttered	23
attractive	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	unattractive	24
friendly	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	unfriendly	25
conservative	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	innovative	26

Appendix 5 (The conference Paper)

## **A Pilot Study Investigating User Motivation and User Experience in Virtual Reality**

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**Abstract.** Virtual Reality has long been advocated as a tool for enhancing education experiences and learning outcomes. The use of computer-generated simulations and virtual environments have been standard practice in a wide range of tertiary and vocational education and training applications for decades. The growing ubiquity, relative affordability, increasing computing power and functionality of Virtual Reality headsets are creating new opportunities for personalized, immersive simulation experiences that trainees can use anywhere and anytime. In order for Virtual Reality headset experiences to be sustainable and appropriate for long-term usage in education and training programs, it is critical to investigate the practicalities of implementing such a technology. Thus, the investigation of emerging Virtual Reality technologies against conventional training systems can provide a better understanding of their impact. This paper presents an experimental design used to compare performance, user motivation and user experience of searching tasks in identical virtual environments between two system configurations: (i) Virtual Reality Head-Mounted Display and a (ii) traditional desktop computer. A pilot study (participants N=5) was performed with a mixed-methods between-group experimental design, using objective physiological and performance measures (Heart Rate, Electrodermal Activity and task success rate) and subjective measures (questionnaires and interviews). The outcomes of this study and the lessons learned from developing, testing and refining the experimental design contribute to the broader knowledge on comparative testing and validation of Virtual Reality Head-Mounted Displays for education and training applications.

**Keywords:** Immersive Environments, Simulation, Experimental Design, Computer Based Training, Heart Rate, Electrodermal Activity



# Experience Virtual Reality

Participate in a virtual reality experiment here on  
campus this winter!

Get a free lunch!

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Scan Me!



## TARG

Training and Assessment Research Group

Appendix 7

(FRONT)


**Experience  
Virtual Reality!**

Participate in a virtual reality experiment as part of the master theses organized by Sunniva Veie and Anders Edwinson in co-operation with TARG.

The experiment takes approx. 1.5h

Recieve a lunch voucher!  
(100nok)

Book by following the description on the back



**TARG**  
Training and Assessment Research Group

(BACK)

**Procedure for participation**

**Book at:**

**[hsnvrexp.gettimely.com](https://hsnvrexp.gettimely.com)**

Or:

Send an email to: [hsnvrexp@gmail.com](mailto:hsnvrexp@gmail.com)

With the following information:

- Name
- Telephone number
- Desired dates and times

Please suggest at least three times and/or dates you are available to participate, you will receive an email for your confirmation.

If you are available Tuesday 27/02 from 11-13, you write “T2 27/02”.

The timeslots are depicted below.

	Monday	Tuesday	Wednesday	Thursday	Friday
09:00 - 11:00	M1	T1	W1	Th1	F1
11:00					
12:00 - 14:00	M2	T2	W2	Th2	F2
14:00 - 16:00	M3	T3	W3	Th3	F3
16:00 - 18:00	M4	T4	W4	Th4	F4
18:00 - 20:00	M5	T5	W5	Th5	F5

**Dates available from 22.01 to 02.03**

Sunniva Veie: 93698825  
Anders Edwinson: 99302225

Appendix 8

**VR Manuscript Experiment**

Task	Script	Time
Entry/ welcome	<p>Hi and welcome to the TARG lab. Thank you for participating. This is where the VR experience will take place.</p> <p>*introduction*</p> <p>In this VR exercise, you will be asked to fill out some information forms before and after the experience. You will participate in a VR exercise lasting approximately 20 min. The entire process will take approx. 90 min.</p> <p>Before entering the VR exercise, you will go through a familiarization period to become familiar with the system and the controls.</p> <p>We will be measuring your heart rate by a belt worn around your torso and skin conductance by a wristband.</p> <p>After you have completed the experiment in VR, you will fill out a few short questionnaires and a short exit interview will be conducted to hear more about your experience. We will explain more details as we go along.</p> <p>Please set your phone in airplane mode and put it in your jacket, to avoid distractions.</p>	5 min
Consent form	<p>Before we begin, we must ask you to fill out this consent form. This is to confirm that you are aware of what you are participating in and that we will be collecting data from this experiment to use in our papers. Please notice the part about not speaking about the experiment with anyone else, as they can be potential participants.</p>	10 min
Questionnaire	<p>Next is a short entry questionnaire to get some basic information about you, your previous gaming experience and health. Please fill this out as correctly as possible.</p>	5 min
Fitting	<p>To enable measurement of your bodily response to the exercises, we will need you to wear this wristband/ watch (right hand) and the belt.</p> <p>I will help you put on the wristband (attaching the wristband).</p> <p>And I will show you how to put on the belt, so you can do it yourself. This is a standard fitness device. Just make sure that the sensor is positioned in the center of your torso, right below your chest. The rubber part of the belt will be moist, to achieve the best contact with your skin.</p> <p>If you want some assistance positioning the belt, I can help you.</p>	5 min

## INVESTIGATING USER EXPERIENCE OF VR HMD

Baseline	<p>To be able to analyse and compare the measurements we get from the equipment you are now wearing, we need to measure your baseline. This means that we need to measure how your body is when you are relaxed and not doing anything. To get accurate measurements, we will need you to sit as still as possible for 5 minutes. Feet flat on the floor, and arms resting on the chair or in your lap. Please do not use your phone or any other distracting device. You can study the picture of the controllers.</p> <p><b>*Press wristband button*</b></p>	5 min
Familiarisation	<p><b>*Press wristband button*</b></p> <p>A short explanation of controllers:</p> <p>Left:</p> <p>The round button works much like a mouse pad, you can swipe and also click on it. The trigger button is used for moving around by teleportation. When you hold the button, an icon will appear on the ground in either green or blue to indicate where you end up. When you release the button, you move. The button on the side is the “back-button” for exiting menu’s aso.</p> <p>Right:</p> <p>Here you only need to worry about the round touch-pad. By pointing the controller toward objects, you can pick things up or open drawers by clicking the middle of the pad once.</p> <p>Now you will go through a trial period in VR, to familiarise with the system and controls. Do not do anything, until we tell you to. Afterward, you will be able to do what you want for a few minutes.</p> <p>Please put the headset on. (Assisting with putting on the headset, and correct the lenses/straps)</p> <p>Before we begin: You are now standing in the middle of the room. If you raise your hands out to the side, you will see the grid of the room. This is the limits of your space in the real world. Please move over to the wall/grid, just to see where the wall is... Position yourself in the middle of the room again, before we begin.</p> <p>Introduction to location:</p> <p>You are, as you see, in a deserted town. In this task, there are no other people or creatures.</p> <p><b>*Explain the scenario:*</b></p> <p>Your first task is to navigate across the street. By pressing the trigger button on the left controller, and point in front of you. Please navigate to the house across the street, and enter it.</p>	10 min

## INVESTIGATING USER EXPERIENCE OF VR HMD

	<p>In the middle of the room, there is a table and a shelf with cans. Position yourself behind the table facing the shelf with the cans. As this is a virtual environment, you can see that you cannot physically interact with the table, your hand will go right through it.</p> <p>Use the gun in your right hand to shoot down the cans with the trigger button on the right controller.</p> <p>Now, walk into the hallway and into the room on your right. In this room, there is a suitcase and a cabinet. With your right hand, point at the suitcase, you can see there is something inside. If you look at the circle initiated below the inventory area, the position of your thumb on the pad is indicated. You can use this to ensure that your thumb is in the center of the button. Press the middle of the round touch-pad on the right controller to pick up the item and get it in your inventory. As you can see, the suitcase is now empty. Behind you, on top of the cabinet, there is a bobblehead figure to pick this up, aim at the figure with the right hand and press once in the middle of the touchpad. If you press up on the touch-pad, you open a menu. This might happen when you are trying to push the middle to pick things up. This menu is hard to use, thus the best thing to do when this happens is to exit the menu by pressing one of the side buttons.</p> <p>Raise your left arm. Press up on the touchpad and swipe up to get to misc. Here you can see the bobbleheads in your inventory.</p> <p>Look at the cabinet and aim with your right hand. If you miss the middle of the touchpad and press up, you will enter a menu. Press up on the touchpad to see this. If you at any time have pushed a button opening a new screen or something similar, you can press the button on the side of your right controller (with your middle finger). This will take you back.</p> <p>Now you can leave the house. Teleport over to the big tree. From here you see a blue house. Please enter the house. Here you can play around, search and find things, collect or just pick them up. If you click one short click, it collects things into your inventory. If you hold down the touch-pad button, you lift things up without collecting them. So be sure to only press once and not hold. You can find things inside boxes or cabinets here as well.</p> <p><b>*Press wristband button*</b></p> <p>If you are hot, please remove a layer of clothing before we start. You will not be able to do it during the experiment.</p> <p><b>How long does it feel like you have been in the game now?</b></p>	
Description	<p><b>*Press wristband button*</b></p> <p>Explain the scenario and tasks:</p>	5 min

INVESTIGATING USER EXPERIENCE OF VR HMD

	<p>You will start with a navigation task in a small labyrinth. In this labyrinth, there are ten figures hidden. Your task is to walk around, find and collect as many of these bobbleheads as possible, within five minutes. Lift your left arm and navigate to misc in inventory, so that you can at any time lift your left arm to see how many figures you have collected.</p> <p>You will complete three rounds. The score and time from each round will be collected and compared.</p> <p>You can end the experiment at any time if needed.</p> <p>There will be a two-minute break between each round.</p> <p>Now, given the “training” you have had so far. How well do you think you will perform in this task on a level from 1 to 5? (1= very bad, 5= very good)</p> <p><b>*Note down answer*</b></p> <p><b>*Start recording PC*</b></p>	
Experiment	<p>We/I will not be assisting you at all through the experiment, verbally or otherwise. So, you will have to navigate on your own, without our help. If you are struggling, try to go slow, and remember what you have learned in the familiarization.</p> <p>You have five minutes to find the figures, from now.</p> <p><b>*Press wristband button*</b></p> <p>Finished</p> <p><b>*Press wristband button*</b></p> <p>There will now be a two-minute break</p> <p>Please stand and look straight ahead so I can load the scenario.</p> <p>The time starts now.</p> <p><b>*Press wristband button*</b></p> <p>Finished</p> <p>There will now be a two-minute break</p> <p><b>*Press wristband button*</b></p> <p>Please stand and look straight ahead so I can load the maze scenario again.</p> <p>The time starts now.</p> <p><b>*Press wristband button*</b></p> <p>Finished.</p>	20 min
Collection	<p><b>*Press wristband button*</b></p> <p>The experiment is now completed.</p>	3 min

## INVESTIGATING USER EXPERIENCE OF VR HMD

	Please remove the equipment and sensors.	
Questionnaire	<p>Now as the experiment is completed, we want you to fill out some questionnaires about your experience and how you felt about the exercise.</p> <ol style="list-style-type: none"> <li>1. Questionnaire subconscious learning</li> <li>2. Quality of experience questionnaire.</li> <li>3. Skill acquisition and motivation questionnaire.</li> <li>4. Simulator sickness questionnaire.</li> </ol>	10 min
Exit interview	The very last thing we wish you to participate in is a short exit interview. This is to get additional information and feedback on your experience. This will be audio recorded.	10 min
“Warning”	Please do not talk about the procedure and tasks in the experiment with any other potential participant, as this may affect the outcome of this study.	
Complete		90 min

Appendix 9

**VR Manus Eksperiment**

Task	Script	Time
Entry/ welcome	<p>Hei og velkommen til TARG-lab. Takk for at du deltar. Det er her VR-opplevelsen vil finne sted.</p> <p><b>*introduksjon*</b></p> <p>I denne VR-øvelsen blir du bedt om å fylle ut noen informasjonsskjemaer før og etter opplevelsen. Du vil delta i en VR-øvelse som varer ca. 20 min. Hele prosessen tar ca. 90 min.</p> <p>Før du går inn i VR-øvelsen, går du gjennom en familiariseringsperiode for å bli kjent med systemet og kontrollene.</p> <p>Vi vil måle hjertefrekvensen med et belte rundt overkroppen og hudledningsevne med et armbånd.</p> <p>Etter at du har fullført 20 min i VR, fyller du ut noen korte spørreskjemaer, og et kort exit-intervju vil bli gjennomført for å høre mer om din erfaring. Vi vil forklare flere detaljer etter hvert.</p> <p>Kan du skru mobilen på flymodus og legge den i jakken, for å unngå distraksjoner?</p>	5 min
Consent form	<p>Før vi begynner, må vi be deg om å fylle ut dette samtykkeskjemaet. Dette er for å bekrefte at du er klar over hva du deltar i, og at vi skal samle inn data fra dette eksperimentet for bruk i våre oppgaver. Vær oppmerksom på at du ikke kan snakke om eksperimentet med noen andre, da de kan være potensielle deltakere.</p>	10 min
Questionnaire	<p>Neste er et spørreskjema med kort oppføring for å få grunnleggende informasjon om deg, din tidligere spillopplevelse og helse. Vennligst fyll ut dette så godt som mulig.</p>	5 min
Fitting	<p>For å muliggjøre måling av kroppslig respons under øvelsene, trenger vi deg til å bruke dette armbåndet (høyre hånd) og beltet.</p> <p>Jeg vil hjelpe deg å sette på armbåndet (festet på armbåndet).</p> <p>Og jeg vil vise deg hvordan du setter på beltet, slik at du kan gjøre det selv. Dette er en standard treningsenhet. Bare vær sikker på at sensoren er plassert på midten av overkroppen, rett under brystet. Gummidelen av beltet skal være fuktig for å oppnå best kontakt med huden din.</p> <p>Hvis du vil ha hjelp med å plassere beltet, kan jeg hjelpe deg.</p>	5 min
Baseline	<p>For å kunne analysere og sammenligne målingene vi får fra utstyret du har på deg, må vi måle dine baseverdier. Dette betyr at vi må måle hvordan kroppen din er når du er avslappet og ikke gjør noe. For å få nøyaktige målinger må du sitte så stille som</p>	5 min



	<p>mulig i 5 minutter. Føttene flatt på gulvet, og armer hviler på stolen eller i fanget ditt. Vennligst ikke bruk telefonen eller andre distraherende enheter. Du kan studere bildet av kontrollerne.</p> <p><b>* Trykk på knappen *</b></p>	
Familiarisation	<p><b>* Trykk på knappen *</b></p> <p>Kort beskrivelse av kontroller:</p> <p>Venstre:</p> <p>Den runde knappen fungerer som en musematte, du kan sveipe og også klikke med den. Utløserknappen på baksiden av kontrolleren brukes til å bevege seg rundt ved teleportering. Når holder inne knappen kommer et ikon på bakken i enten grønn eller blå for å indikere hvor du ender. Når du slipper knappen flytter du deg. Knappen på siden er "tilbakeknapp" for å avslutte menyens osv.</p> <p>Høyre:</p> <p>Her trenger du bare å bekymre deg for den runde touch-pad'en. Ved å peke kontrolleren mot objekter, kan du plukke ting opp eller åpne skuffer ved å klikke på midten av pad'en en gang.</p> <p>Nå går du gjennom en prøveperiode i VR, for å bli kjent med systemet og kontrollene. Ikke gjør noe før vi forteller deg det. Etterpå vil du kunne gjøre det du vil ha i noen få minutter.</p> <p>Sett hodesettet på. (Hjelp med å sette på hodesettet og rette linsene / stroppene)</p> <p>Før vi begynner: Du står nå midt i rommet. Hvis du løfter hendene dine ut til siden, vil du se rutenettet på rommet. Dette er grensene for ditt rom i den virkelige verden. Vennligst gå over til veggen / rutenettet, for å se hvor veggen er ... Plasser deg selv i midten av rommet igjen, før vi begynner.</p> <p>Introduksjon til plassering:</p> <p>Du er, som du ser, i en øde by. I denne oppgaven er det ingen andre mennesker eller skapninger.</p> <p><b>* Forklar scenariet: *</b></p> <p>Din første oppgave er å navigere over gaten. Ved å trykke på utløserknappen på den venstre kontrolleren, og peke foran deg. Vennligst naviger til huset over gaten, og gå inn.</p> <p>I midten av rommet er det et bord og en hylle med bokser. Plasser deg selv bak bordet mot hyllen med boksene. Siden dette er et virtuelt miljø, kan du se at du ikke fysisk kan samhandle med bordet, hånden din går rett gjennom den.</p> <p>Bruk pistolen i høyre hånd for å skyte ned boksene med utløserknappen på høyre kontroller.</p>	10 min

	<p>Gå nå inn i gangen og inn i rommet til høyre. I dette rommet er det en koffert og et skap. Med din høyre hånd, pek på kofferten, kan du se at det er noe inni. Hvis du ser på det runde feltet, kan du se hvor tommelen din er på berøringsplaten. Dette kan du bruke for å forsikre deg om at du trykker midt på. Trykk midt på den runde berøringsplaten på høyre kontroller for å hente elementet og få det i ditt inventar. Som du kan se er kofferten tom. Bak deg, på toppen av kommoden, er det en figur. For å plukke den opp, sikt på figuren med høyre hånd og trykk en gang midt på pekefeltet. Hvis du trykker opp på berøringsplaten, åpner du en meny. Dette kan skje når du prøver å plukke opp ting. Denne menyen er unødvendig og litt vanskelig, derfor er det best å gå ut av denne menyen. Dette gjør du ved å trykke på en av exit knappene på sidene.</p> <p>Løft venstre arm. Trykk opp på berøringsplaten da kommer du til inventar og sveip opp for å komme til misc. Her kan du se figurene i inventaret ditt.</p> <p>Se på skapet og sikte med høyre hånd. Hvis du bommer på midten av pekefeltet og trykker opp, kommer du inn i en meny. Trykk på pekefeltet for å se dette. Hvis du når som helst har trykket på en knapp som åpner en ny skjerm eller noe lignende, kan du trykke på knappen på siden av høyre kontrolleren (med langfingeren). Dette tar deg tilbake.</p> <p>Nå kan du forlate huset. Teleporter til det store treet. Herfra ser du et blått hus. Vennligst gå inn huset. Her kan du leke rundt, søke og finne ting, samle inn eller bare plukke dem opp. Hvis du klikker et kort klikk, samler du ting inn i beholdningen. Hvis du holder nede pekefeltet, løfter du opp ting uten å samle dem. Så vær sikker på at du bare trykker en gang og ikke holder. Du kan finne ting i bokser eller skap her også.</p> <p><b>* Trykk på knappen *</b></p> <p>Hvis du er varm, vennligst fjern et lag med klær før vi starter. Du vil ikke kunne gjøre det under forsøket.</p> <p><b>Hvor lenge tror du at du har vært i spillet nå?</b></p>	
<p>Description</p>	<p><b>* Trykk på knappen *</b></p> <p>Forklar scenario og oppgaver:</p> <p>Du vil starte med en navigasjonsoppgave i en liten labyrint. I denne labyrinten er det ti figurer skjult. Din oppgave er å gå rundt, finne og samle så mange av disse figurene som mulig innen fem minutter. Løft venstre arm og naviger til misc i inventaret ditt, slik at du når som helst kan løfte venstre arm for å se hvor mange figurer du har samlet.</p> <p>Du vil fullføre tre runder. Poeng og tid fra hver runde vil bli samlet og sammenlignet.</p>	<p>5 min</p>

INVESTIGATING USER EXPERIENCE OF VR HMD

	<p>Du kan avslutte eksperimentet når som helst, hvis det er ønskelig.</p> <p>Det vil være en to minutters pause mellom hver runde.</p> <p>Gitt treningen du nå har fått. Hvor bra tror du at du klarer å gjennomføre oppgavene på en skala fra 1 til 5? (1= veldig dårlig, 5= veldig bra)</p> <p><b>*Noter svar*</b></p> <p><b>* Start opptak PC *</b></p>	
Experiment	<p>Vi / jeg hjelper deg ikke i det hele tatt gjennom eksperimentet. Så, du må navigere på egen hånd, uten vår hjelp. Hvis du sliter, prøv å gå sakte, og husk hva du har lært i familiariseringen.</p> <p>Du har fem minutter å finne figurene, fra nå.</p> <p><b>* Trykk på knappen *</b></p> <p>ferdig</p> <p><b>* Trykk på knappen *</b></p> <p>Det blir nå en to minutters pause</p> <p>Vennligst stå og se rett fram, så jeg kan laste opp scenariet.</p> <p>Tiden starter nå.</p> <p><b>* Trykk på knappen *</b></p> <p>ferdig</p> <p>Det blir nå en to minutters pause</p> <p><b>* Trykk på knappen *</b></p> <p>Vennligst stå og se rett fram, så jeg kan laste labyrintscenariet igjen.</p> <p>Tiden starter nå.</p> <p><b>* Trykk på knappen *</b></p> <p>Ferdig.</p>	20 min
Collection	<p><b>* Trykk på knappen *</b></p> <p>Forsøket er nå fullført.</p> <p>Vennligst fjern utstyr og sensorer.</p>	3 min
Questionnaire	<p>Nå som forsøket er fullført, vil vi at du skal fylle ut noen spørreskjemaer om din erfaring og hva du følte om øvelsen.</p> <ol style="list-style-type: none"> <li>1. Spørreskjema underbevisst læring</li> <li>2. Kvaliteten på erfaringskjemaet.</li> <li>3. Ferdighet oppkjøp og motivasjon spørreskjema.</li> </ol>	10 min

## INVESTIGATING USER EXPERIENCE OF VR HMD

	4. Simulator syke spørreskjema.	
Exit interview	Den aller siste tingen vi ønsker deg å delta i, er et kort avslutningsintervju. Dette er å få mer informasjon og tilbakemelding på din erfaring. Dette blir tatt opp.	10 min
“Warning”	Vennligst ikke snakk om prosedyren og oppgavene i eksperimentet med noen andre, da dette kan påvirke utfallet av dette studie.	
Complete		90 min

Appendix 10

**Desktop Manuscript Experiment**

Task	Script	Time
Entry/ welcome	<p>Hi and welcome to the TARG lab. Thank you for participating. This is where the experiment will take place.</p> <p>*introduction*</p> <p>In this exercise, you will be asked to fill out some information forms before and after the experience. You will participate in an exercise lasting approximately 20 min. The entire process will take approx. 90 min.</p> <p>The first part will be on desktop and the second part in VR.</p> <p>Before entering the exercise, you will go through a familiarization period to become familiar with the system and the controls.</p> <p>We will be measuring your heart rate by a belt worn around your torso and skin conductance by a wristband.</p> <p>After you have completed the 20 min exercise, you will fill out a few short questionnaires and a short exit interview will be conducted to hear more about your experience. We will explain more details as we go along.</p> <p>Please set your phone in flight-mode and place it in your jacket, to avoid distractions.</p>	5 min
Consent form	<p>Before we begin, we must ask you to fill out this consent form. This is to confirm that you are aware of what you are participating in and that we will be collecting data from this experiment to use in our papers. Please notice the part about not speaking about the experiment with anyone else, as they can be potential participants.</p>	10 min
Questionnaire	<p>Next is a short entry questionnaire to get some basic information about you, your previous gaming experience and health. Please fill this out as correctly as possible.</p>	5 min
Fitting	<p>To enable measurement of your bodily response to the exercises, we will need you to wear this wristband/ watch (right hand) and the belt.</p> <p>I will help you put on the wristband (attaching the wristband).</p> <p>And I will show you how to put on the belt, so you can do it yourself. This is a standard fitness device. Just make sure that the sensor is positioned in the center of your torso, right below your chest. The rubber part of the belt will be moist, to achieve the best contact with your skin.</p> <p>If you want some assistance positioning the belt, I can help you.</p>	5 min
Baseline	<p>To be able to analyse and compare the measurements we get from the equipment you are now wearing, we need to measure your baseline. This means that we need to measure how your body is</p>	5 min

## INVESTIGATING USER EXPERIENCE OF VR HMD

	<p>when you are relaxed and not doing anything. To get accurate measurements, we will need you to sit as still as possible for 5 minutes. Feet flat on the floor, and arms resting on the chair or in your lap. Please do not use your phone or any other distracting device. You can study the picture of the controllers.</p> <p><b>*Press wristband button*</b></p>	
Familiarisation	<p><b>*Press wristband button*</b></p> <p>A short explanation of keyboard:  W is moving forward.  A and D is moving sideways.  S is moving backward.  To pick up things you press E.  TAB is inventory.  Esc is the back-button.  You can change your point of view/ look around by moving the mouse.</p> <p>Now you will go through a trial period, to familiarise with the system and controls. Do not do anything, until we tell you to. Afterward, you will be able to do what you want for a few minutes.  Please sit down.</p> <p>Introduction to location:  You are, as you see, in a deserted town. In this task, there are no other people or creatures.</p> <p><b>*Explain the scenario:*</b></p> <p>Your first task is to navigate across the street. This is done by using the keys to move, and the mouse to change viewpoint. Please navigate to the house across the street and enter it.</p> <p>In the middle of the room, there is a table and a shelf with cans. Position yourself behind the table facing the shelf with the cans.</p> <p>Use the gun in your right hand to shoot down the cans, by pointing the mouse towards it and pressing the left mouse button.</p> <p>Now, walk into the hallway and into the room on your right. In this room, there is a suitcase and a cabinet. If you use the mouse to “point” toward the suitcase, you can see there is something inside. Press the E button to pick it up and put it in your inventory. As you can see, the suitcase is now empty. Behind you, on top of the cabinet, there is a bobblehead figure to pick this up, aim at the figure with the mouse and press E. To see into your inventory, press TAB. In MISC you can see the bobbleheads in your inventory.</p>	10 min

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	<p>If you at any time have pushed a button opening a new screen or something similar, you can press the ESC button to go out of the menu.</p> <p>Now you can leave the house. Walk over to the big tree. From here you see a blue house. Please enter the house. Here you can play around, search and find things, collect or just pick them up. If you click one short click, it collects things into your inventory. If you hold down the E button, you lift things up without collecting them. So be sure to only press once and not hold, if you wish to save them in your inventory. You can find things inside boxes or cabinets here as well.</p> <p><b>*Press wristband button*</b></p> <p>If you are hot, please remove a layer of clothing before we start. You will not be able to do it during the experiment.</p> <p><b>How long does it feel like you have been in the game now?</b></p>	
Description	<p><b>*Press wristband button*</b></p> <p>Explain the scenario and tasks:</p> <p>You will start with a navigation task in a small labyrinth. In this labyrinth, there are ten figures hidden. All figures are hidden inside the walls of the maze, no figures are placed on the outside. Your task is to walk around, find and collect as many of these bobbleheads as possible, within five minutes. Press TAB and navigate to misc in inventory, so that you can at any time press TAB to see how many figures you have collected.</p> <p>You will complete three rounds. The score and time from each round will be collected and compared. There will be a two-minute break between each round.</p> <p>You can end the experiment at any time if needed.</p> <p>Now, given the “training” you have had so far; How do you think you will perform in this task on a level from 1 to 5? (1= very bad, 5= very good)</p> <p><b>*Note down answer*</b></p> <p><b>*Start recording PC*</b></p>	5 min
Experiment	<p>We/I will not be assisting you at all through the experiment, verbally or otherwise. So, you will have to navigate on your own, without our help. If you are struggling, try to go slow, and remember what you have learned in the familiarization.</p> <p>You have five minutes to find the figures, from now.</p> <p><b>*Press wristband button*</b></p> <p>Finished</p> <p><b>*Press wristband button*</b></p> <p>There will now be a two-minute break</p>	20 min

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	<p>Please stand and look straight ahead so I can load the scenario.</p> <p>The time starts now.</p> <p><b>*Press wristband button*</b></p> <p>Finished</p> <p>There will now be a two-minute break</p> <p><b>*Press wristband button*</b></p> <p>Please stand and look straight ahead so I can load the maze scenario again.</p> <p>The time starts now.</p> <p><b>*Press wristband button*</b></p> <p>Finished.</p>	
Collection	<b>*Press wristband button*</b>	3 min
Questionnaire	<p>Now we want you to fill out some questionnaires about your experience and how you felt about the exercise.</p> <ol style="list-style-type: none"> <li>1. Questionnaire subconscious learning</li> <li>2. Quality of experience questionnaire.</li> <li>3. Skill acquisition and motivation questionnaire.</li> <li>4. Simulator sickness questionnaire.</li> </ol>	10 min
Testing VR	<p>Now you can go through a round in the VR system before we conduct the exit interview. If we have more time, you can also try another game.</p> <p>The experiment is now completed.</p> <p>Please remove the equipment and sensors.</p>	5 min
Exit interview	The very last thing we wish you to participate in is a short exit interview. This is to get additional information and feedback on your experience. This will be audio recorded.	10 min
“Warning”	Please do not talk about the procedure and tasks in the experiment with any other potential participant, as this may affect the outcome of this study.	
Complete		90 min



Appendix 11

**Desktop Manus eksperiment**

Oppgave	Manus	Time
Velkommen	<p>Hei og velkommen til TARG-lab. Takk for at du deltar. Det er her eksperimentet finner sted.</p> <p>*introduksjon*</p> <p>I denne øvelsen blir du bedt om å fylle ut noen informasjonsskjemaer før og etter opplevelsen. Du vil delta i en øvelse som varer ca. 20 min. Hele prosessen tar ca. 90 min.</p> <p>Den første delen av eksperimentet vil være på PC, mens andre del vil være i VR.</p> <p>Før du går inn i øvelsen, går du gjennom en kort periode for å bli kjent med systemet og kontrollene.</p> <p>Vi vil måle hjerterefrekvensen med et belte rundt overkroppen og fuktighet med et armbånd.</p> <p>Etter at du har fullført øvelsen, vil du bli bedt om å fylle du ut noen korte spørreskjemaer og et kort exit-intervju vil bli utført for å høre mer om din erfaring. Vi vil forklare mer etter hvert.</p> <p>Kan du skru mobilen på flymodus og legge den i jakken, for å unngå distraksjoner.</p>	5 min
Samtykkeskjema	<p>Før vi begynner, må vi be deg om å fylle ut dette samtykkeskjemaet. Dette er for å bekrefte at du er klar over hva du deltar i, og at vi skal samle inn data fra dette eksperimentet for bruk i våre oppgaver. Vær oppmerksom på at du ikke kan snakke om eksperimentet med noen andre, da de kan være potensielle deltakere.</p>	10 min
Spørreskjema	<p>Neste er et kort spørreskjema for å få grunnleggende informasjon om deg, din tidligere spillopplevelse og helse. Vennligst fyll ut dette så godt som mulig.</p>	5 min
Tilpassing	<p>For å muliggjøre måling av kroppslig respons på øvelsene, trenger vi at du bruker dette armbåndet / klokken (høyre hånden) og beltet. Jeg vil hjelpe deg å sette på armbåndet (festet på armbåndet).</p> <p>Og jeg vil vise deg hvordan du setter på beltet, slik at du kan gjøre det selv. Dette er en standard treningsenhet. Bare vær sikker på at sensoren er plassert på midten av overkroppen, rett under brystet. Gummidelen av beltet skal være fuktig for å oppnå best kontakt med huden din.</p> <p>Hvis du vil ha hjelp med å plassere beltet, kan jeg hjelpe deg.</p>	5 min
Baseverdier	<p>For å kunne analysere og sammenligne målingene vi får fra utstyret du har på deg, må vi måle dine baseverdier. Dette betyr at vi må måle hvordan kroppen din er når du er avslappet og ikke gjør</p>	5 min

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	<p>noe. For å få nøyaktige målinger trenger vi at du sitter så stille som mulig i 5 minutter. Føttene flatt på gulvet, og armer hviler på stolen eller i fanget ditt. Vennligst ikke bruk telefonen eller andre distraherende enheter. Du kan studere bildet av kontrollene.</p> <p><b>* Trykk på knappen *</b></p>	
Familiarisering	<p><b>* Trykk på knappen *</b></p> <p>Kort forklaring av tastaturet:</p> <p>W går fremover.</p> <p>A og D beveger seg sidelengs.</p> <p>S beveger seg bakover.</p> <p>For å hente ting du trykker på E.</p> <p>TAB er inventar.</p> <p>Esc er tilbakeknappen.</p> <p>Du kan endre synsvinkelen din / se deg rundt ved å flytte musen.</p> <p>Nå skal du gjennom en prøveperiode, for å bli kjent med systemet og kontrollene. Ikke gjør noe før vi forteller deg det. Etterpå vil du kunne gjøre det du vil i noen få minutter.</p> <p>Vennligst sitt ned.</p> <p>Introduksjon til plassering:</p> <p>Du er, som du ser, i en øde by. I denne oppgaven er det ingen andre mennesker eller skapninger.</p> <p><b>* Forklar scenariet: *</b></p> <p>Din første oppgave er å navigere over gaten. Dette gjøres ved å bruke tastene for å flytte, og musen for å endre synsvinkelen. Vennligst naviger til huset over gaten, og gå inn.</p> <p>Ser du hyllen med blikkboksene? I midten av rommet er det et bord. Plasser deg selv bak bordet, slik at du står mot hyllen med boksene.</p> <p>Bruk pistolen i høyre hånd for å skyte ned boksene, ved å peke musen mot den og trykke på venstre museknapp.</p> <p>Gå nå inn i gangen og inn i rommet til høyre. I dette rommet er det en koffert og et skap. Hvis du bruker musen til å "peke" mot kofferten, kan du se at det er noe inni. Trykk på E-knappen for å plukke den opp og legg den i inventariet. Som du kan se er kofferten nå tom. Bak deg, på toppen av skapet, er det en figur for å plukke opp dette, sikte på figuren med musen og trykk på E. For å se på beholdningen, trykk på TAB. I MISC kan du se figurene i inventaret ditt.</p>	10 min

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	<p>Hvis du når som helst har trykket på en knapp som åpner en ny skjerm eller noe lignende, kan du trykke på ESC-knappen for å gå ut av menyen.</p> <p>Nå kan du forlate huset. Gå over til det store treet. Herfra ser du et blått hus. Vennligst gå inn i huset. Her kan du leke rundt, søke og finne ting, samle inn eller bare plukke dem opp. Hvis du klikker et kort klikk, samler det ting inn i beholdningen. Hvis du holder nede E-knappen, løfter du opp ting uten å samle dem. Så vær sikker på at du bare trykker en gang og ikke holder, hvis du ønsker å lagre dem i beholdningen. Du kan også finne ting i bokser eller skap her også.</p> <p><b>* Trykk på knappen *</b></p> <p>Hvis du er varm, vennligst fjern et lag med klær før vi starter. Du vil ikke kunne gjøre det under forsøket.</p> <p><b>Hvor lenge føler du at du har vært i spillet nå?</b></p>	
Beskrivelse	<p><b>* Trykk på knappen *</b></p> <p>Forklar scenario og oppgaver:</p> <p>Du vil starte med en navigasjonsoppgave i en liten labyrint. I denne labyrinten er det gjemt ti figurer. Alle er gjemt innenfor disse veggene på labyrinten, ingen er utenfor. Din oppgave er å gå rundt, finne og samle så mange av disse figurene som mulig innen fem minutter. Trykk på TAB og naviger til inventaret, slik at du når som helst kan trykke på TAB for å se hvor mange figurer du har samlet.</p> <p>Du vil fullføre tre runder. Poeng og tid fra hver runde vil bli samlet og sammenlignet. Det vil være en to minutters pause mellom hver runde.</p> <p>Du kan avslutte forsøket når som helst, hvis det er nødvendig.</p> <p>Gitt «treningen» du nå har fått; Hvor bra tror du at du klarer å gjennomføre oppgavene på en skala fra 1 til 5? (1= veldig dårlig, 5= veldig bra)</p> <p><b>*Skriv ned svar*</b></p> <p><b>*Start opptak PC*</b></p>	5 min
Eksperiment	<p>Vi / jeg hjelper deg ikke i det hele tatt gjennom eksperimentet, verbalt eller annet. Så, du må navigere på egen hånd, uten vår hjelp. Hvis du sliter, prøv å gå sakte, og husk hva du har lært.</p> <p>Du har fem minutter å finne figurene, fra nå av.</p> <p><b>* Trykk på håndtaksknappen *</b></p> <p>Ferdig</p> <p><b>* Trykk på håndtaksknappen *</b></p> <p>Det blir nå en to minutters pause</p>	20 min

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	<p>Vennligst stå og se rett fram, så jeg kan laste opp scenariet.</p> <p>Tiden starter nå.</p> <p><b>* Trykk på håndtaksknappen *</b></p> <p>ferdig</p> <p>Det blir nå en to minutters pause</p> <p><b>* Trykk på håndtaksknappen *</b></p> <p>Vennligst stå og se rett fram, så jeg kan laste labyrintscenariet igjen.</p> <p>Tiden starter nå.</p> <p><b>* Trykk på håndtaksknappen *</b></p> <p>Ferdig.</p>	
Innsamling	<b>* Trykk på håndtaksknappen *</b>	3 min
Spørreskjema	<p>Nå vil vi at du fyller ut noen spørreskjemaer om din erfaring og hvordan du følte ift øvelsen.</p> <ol style="list-style-type: none"> <li>1. Spørreskjema underbevisst læring</li> <li>2. Kvaliteten på erfaringskjemaet.</li> <li>3. Ferdighet oppkjøp og motivasjon spørreskjema.</li> <li>4. Simulator-syke spørreskjema.</li> </ol>	10 min
Test VR	<p>Nå kan du gå gjennom en runde i VR-systemet før vi utfører avslutningsintervjuet. Hvis vi har mer tid, kan du også prøve et nytt spill.</p> <p>Forsøket er nå fullført.</p> <p>Vennligst fjern utstyr og sensorer.</p>	5 min
Exit intervju	Den aller siste tingen vi ønsker deg å delta i, er et kort avslutningsintervju. Dette er å få mer informasjon og tilbakemelding på din erfaring. Det vil bli gjort lydopptak.	10 min
“Advarsel”	Vennligst ikke snakk om prosedyren og oppgavene i eksperimentet med noen annen potensiell deltaker, da dette kan påvirke utfallet av dette studiet.	
Ferdig		90 min

Appendix 12

Training and Assessment Research Group  
Department of Maritime Operations  
Faculty of Technology, Natural Sciences & Maritime Sciences  
University College of Southeast Norway

## Informed Consent Form

**Title:** Learning in Virtual Reality – A study investigating user motivation and quality of experience. (Project nr. 57860 registered at NSD)

**Researchers:** Steven Mallam, Salman Nazir, Sathiya K. Renganayagalu, Sunniva Veie, Anders E. Edwinson, Jørgen Erntsen  
Department of Maritime Operations, University College of Southeast Norway

### **Background & Purpose of Study:**

You are invited to take part in a research project entitled: “*Learning in Virtual Reality – A study investigating user motivation and quality of experience*”. The development of high fidelity head mounted virtual reality display technology have been greatly enhanced the last ten years, and now the equipment has reached a level of usability enabling valid research on the effectiveness of training in such environments. With the emergence of the head mounted virtual reality display, the potential of implementing this technology in simulator training is not yet sufficiently investigated. Thus, this study aims to examine whether the increased immersion of virtual reality simulators will positively affect skill acquisition and motivation for learning, and to validate objective measurements as an assessment tool for Quality of Experience.

### **What you will do in this study:**

You will be asked to fill out a questionnaire before and after the VR experience. A ten-minute familiarization period will be initiated before you perform a set of given tasks in the virtual environment. Finally, you will participate in a short exit interview providing information on the experience. All data collected will be made anonymous.

### **Length of time:**

The experimental procedure will last approximately 60-90 minutes.

### **Withdrawal from the study:**

It is voluntary to participate in this project, and you can at any time choose to withdraw your consent without stating any reason. If you decide to withdraw from the study, all your personal data may be made anonymous.

### **Possible Benefits & Risks:**

As a participant in this study you will be contributing to the testing and validation of the head mounted virtual reality simulator. You will be providing information on the comfort and effectiveness of such a training platform, by sharing your experience and results. The possible risks of this research study are low, but the equipment may affect the well-being of the participant by inducing simulator sickness. Symptoms of simulator sickness is nausea, dizziness, or similar bodily discomforts.

### **Confidentiality, Anonymity and Storage of Data:**

There is a difference between confidentiality and anonymity: confidentiality is ensuring that identities of participants are accessible only to those authorized to have access (i.e. the USN researchers). Anonymity is a result of not disclosing participant's identifying characteristics (such as name or description of physical appearance). Any published material as a result of this study will ensure your name and personal information is anonymized. Your personal information, measurements, video- and audio recording will be securely stored on the University of Southeast Norway campus and secured work computers, with access only being given to the listed researchers and members of the Training and Assessment Research Group at the Department of Maritime Operations at USN.

### **Recording of Data:**

The experiment will be "video recorded" by screen capture, physiological measurements will be collected through sensors fastened to your body, and the exit interview will be audio recorded while the interviewer may take notes.

### **Processing of data:**

The main objective for this study is to produce master theses, journal papers and conference papers. All information collected will remain in the InnoTraining project, and will be accessible to the researchers involved in InnoTraining. The end date of this project will be December 31<sup>st</sup>, 2019. All data material will be made anonymous by this date. The data will be retained for maximum one year after end of project, after which it will be deleted.

### **Dissemination of Results:**

The collected data from the interview participants will be used for two public master theses, and scientific paper(s) planned to be published in the latter half of 2018.

### **Questions:**

You are welcome to ask questions at any time during your participation in this research. If you would like more information about this study, please contact:

# INVESTIGATING USER EXPERIENCE OF VR HMD

*Steven Mallam, University College Southeast Norway (+4731009252;  
[steven.mallam@usn.no](mailto:steven.mallam@usn.no))*

The study has been notified to the Data Protection Official for Research, NSD - Norwegian Centre for Research Data.

## **Consent for Participation in the Study:**

Your signature on this form means that:

- You have read the information about the research.
- You have been able to ask questions about this study.
- You are satisfied with the answers to all your questions.
- You understand what the study is about and what you will be doing.
- You understand that you are free to withdraw from the study at any time, without having to give a reason.
- You are entitled to a copy of this form if desired.
- You understand that any data collected from you up to the point of your withdrawal may be retained by the researcher for use in the research study.
- You may request that your personal data is made anonymous, if you choose to withdraw.

## **Participant's Signature:**

I have read and understood what this study is about and appreciate the risks and benefits and that my interview will be audio recorded. I have had the opportunity to ask questions and my questions have been answered. I also understand that I will not share any details of the procedure or tasks of the experiment, with any other potential participants.

- I agree to participate in the research project understanding the risks and contributions of my participation, that my participation is voluntary, and that I may end my participation at any time.

---

Signature of Participant

---

Date

## **Researcher's Signature:**

I have explained this study to the best of my ability. I invited questions and gave answers. I believe that the participant fully understands what is involved in being in the study, any potential risks of the study and that he or she has freely chosen to be in the study.

---

Signature of Researcher

---

Date

## Exit interview Guide

1. How was the experience?
  - a. What emotions did you feel? (scared/happy/stressed/etc.)
  - b. Was it enjoyable? If so why?
  - c. What aspects did you not enjoy?
  - d. Did you learn anything?
  - e. Did you have any strategy in the task?
  
2. What do you feel could be done to improve the experience?
  
3. How did the equipment feel?
  - a. Any discomfort?
  
4. What effect do you think VR can have on education in the future if any?
  
5. Do you see any other applications for a VR system?
  
6. Any other comments on the experiment in general?