UiA University of Agder

Master

Virtual reality based learning tool to increase nursing student's motivation in medication management education

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Summary

This master's thesis examines whether and how the use of a virtual reality (VR) based learning tool can affect nursing students' motivation toward learning medication management. Research shows positive results for increased learning engagement among students through the use of VR (Carruth, 2017, p. 2). According to Makary & Daniel (2016, pp. 1-5), medical errors are the third most common cause of deaths in the US. In Norway medical errors also occur, and in 2016 and 2017 there were 3372 reported medication errors (Mulac et al., 2020, pp. 1-3). Based on this statistic, this project has examined why medication errors occur and how a learning tool using VR technology can affect the motivation to learn about medication management. To analyze and examine this statement, the group developed a VR learning tool which we named Virtual Medication Management (VMM). Four participants were recruited to conduct a pretest, whilst five nursing students were recruited for a full-fledged main user test of the VMM tool. This user test included two (mainly) quantitative questionnaires, in addition to qualitative observations and conversations. Results from the questionnaires conducted indicate an increased motivation towards learning. All participants stated that they would like to see a learning tool like the proposed and tested VMM to be implemented as an additional learning method in their curriculum. Further, this project has contributed a VR tool that can enable healthcare professionals to train for stressful and demanding situations in a controlled, safe and emulated environment, that may feel immersive and real.

Key words: Virtual reality, Motivation, Medication management, Medication errors, Learning tool, Interaction, Nursing students, 3D-models, Graphic design

Preface

After five years of attending university, we have come to the end of our journey. We both feel pride and sadness. We therefore want to take this opportunity to thank the University of Agder for all the good experiences and memories through the years. We both completed the bachelor program “Multimedia Technology and Design”, which gave us knowledge that we did not have before. This knowledge was useful when we started our master program, “Multimedia & Educational Technology.” Many hours of frustration, hard work, and dedication have been a part of the road. This has been simultaneously motivating, exciting, and captivating. We are fortunate to have had the opportunity to get to know many skillful students and lecturers. We therefore want to thank all of them who helped us through these five years. Without them, we would never have made it. A special thank you goes to Morgan Konnestad for good mapping of the master’s thesis, Hege Mari Johnsen and Jorunn Aas Handeland for good feedback and information about medication management, and fellow students and participants who participated in user testing of the learning tool.

We also want to express utmost appreciation to our supervisors Martin Wulf Gerdes and Santiago Gil Martinez who have supported, motivated, and believed in our project. Martin holds a Ph.D. in information and communication technologies with specialization in eHealth, and Santiago is a specialist in user-centered design and usability. This combination of expertise and experience made it possible to complete this project.

Table of contents

Figures

Figure 7.8: Results from Question 14.

Tables

Abbreviations and definitions

- CEGEQ = Core Elements of the Gaming Experience Questionnaire
- COVID-19 = Coronavirus disease
- DSRM = Design science research methodology
- HCD = Human-centered Design
- NPE = Norsk pasientskadeerstatning (Norwegian patient injury compensation)
- NSD = Norwegian Center for Research Data
- SDT = Self-determination theory
- SEIPS = System Engineering Initiative for Patient Safety
- SMQ-II = Science Motivation Questionnaire II
- UX = User experience
- VMM = Virtual medications management
- VR = Virtual reality

1. Introduction

Medication errors and the consequences that follow are often a topic covered in the media. DJP Williams' paper on common medication errors explains why and how the various medication errors occur. He mentions three different phases where medication errors can occur: Prescribing errors (which can refer to dosages, drug names that are similar to each other and decimal characters that are misplaced), dispensing errors and administration errors (Williams, 2007, pp. 343-346). After conducting an interview with a third-year nursing student at the University of Agder, they explained: "Medication errors are happening every day in healthcare and hospitals. I also experienced giving wrong medication to a patient in the context of work". This was therefore an interesting topic to examine. This master thesis is therefore based on the nursing students' motivation of learning about medication management. The remainder of this chapter elaborates on the motivation for the master thesis, hypothesis and research questions, explanation of the structure of the report and restrictions related to the coronavirus disease.

1.1 Motivation for the master's thesis' topic

The reason for choosing this master's thesis was the interest in the topic of medication errors. Bergens Tidende, one of Bergen's local newspapers, revealed early this year that a cancer patient died due to receiving ten times more than the required chemotherapy dosage (Otterlei & Drægebø, 2021). The interest in how such a mistake could occur was one of the reasons the group started asking questions about this topic. By doing some research on similar accidents, the group found some interesting data that the Norsk Pasientskadeerstatning (NPE) (Norwegian patient injury compensation state organisation) had collected.

In the last 16 years, the NPE has attended nine compensation cases on medication errors, where they explain what has caused the patient's death or permanent health damage. The mistakes that NPE refer to include misunderstanding a misleading recipe and errors in dispensing a drug (Opheim & Otterlei, 2020). A county doctor in Vestland explained: In most incidents, the failure is related to individual errors, but the main responsibility lies with the management of the companies involved (Otterlei & Drægebø, 2021). Olav Søvik, a physician chief of anesthesia at a hospital in Kristiansand said: With medical simulation, we train in

critical situations without risk to the patient. This improves patient care in real emergency situations. (Wehus, 2019).

The group therefore chose to focus on nursing students, and "medication management" which is one of the subjects in their bachelor program at the University of Agder. After conversations with different nursing students from the University of Agder, the group was told that the subject “medication management” contained a considerable amount of theory learning, and that they were using a game called “the pill game” to learn about medication management. The pill game challenges the nursing students to find the correct medication and dosage and deliver it to the correct patient. The group was given the impression that the nursing students presumed the game had relevant content, but that it was boring and old-fashioned. Technology and digital tools have evolved over many years and are more often used in connection with learning. This aroused the group’s curiosity as to whether a newer and more modern version of the pill game developed for the use of VR would affect the nursing students’ motivation for learning in medication management.

1.2 Hypothesis and research question

This thesis presents the design, development and use of a VR learning tool for nursing students to establish knowledge whether this increases the motivation of learning in the subject “medication management.” The study examines how this type of learning tool affects nursing students and establishes whether this can be an additional tool to the subject “medication management”.

The underlying hypothesis of the group is that a VR learning tool will increase the overall motivation of nursing students to learn about medication management. According to Daniel W. Carruth, the utilization of VR has resulted in a higher form of engagement in learning among students, as opposed to the traditional teaching methods (Pourabdollahian, Taisch, Kerga, 2012, as cited in Carruth, 2017, p. 2). Our research question for this project is therefore as follows:

1. **How does a virtual reality learning tool affect nursing students' motivation in relation to learning medication management?**

1.3 The structure of the thesis

This thesis contains nine chapters. The first chapter explains the motivation for the master thesis, followed by the hypothesis, the research questions and how COVID-19 restrictions impacted this project. The second chapter is about the state of the art and how the use of VR can educate healthcare professionals. Chapter 3 presents the theories that have been followed through this thesis, where the motivation theory is presented first, followed by intrinsic and extrinsic motivation, self-determination theory and learning with technology theory. Chapter 4 addresses the methodology, where the different methods of identifying the problem, objectives and solutions, design and development, demonstration and evaluation together with the human centered design is presented. Chapter 5 describes the materials and tools, including which software and hardware used. Chapter 6 presents the various solutions that were created to meet user requirements, such as design solutions and solutions referred to VMM. Chapter 7 presents the results, including a presentation and explanation of the results of the different questionnaires. The first questionnaire deals with the nursing students' motivations and the other with the game experience. This chapter also presents qualitative feedback from the participants of the user test. Chapter 8 discusses the findings in relation to the research question, including discussion of results from questionnaires, user-experience in relation to age, cybersickness and lastly limitations related to the project. Chapter 9 presents the conclusion, which includes the outcome of the project as well as future work for this project.

1.4 Restrictions in relation to COVID-19

In March 2020, Norway introduced restrictions in response to the spread of COVID-19. These were the strictest restrictions Norway had ever seen. Among these restrictions, there have been limitations on how many people that can gather in the same room. Although the restrictions have changed throughout the months that have passed, there are still strict guidelines. These restrictions have put limitations on this master thesis in several ways. As part of the research process for a project like this, a visit to a hospital to gain a deep understanding of the context of use is crucial. A visit like this would include a tour through the medication room and the patient rooms. However, due to the ongoing COVID-19 situation, we were not allowed to conduct such a tour and were limited to only a meeting with a nurse.

As mentioned, VMM is a learning tool made in VR, which requires a set of VR goggles. As our target group were nursing students at the University of Agder, we were limited to conduct our test on approximately 350 people. Owning a personal set of VR goggles is not that common; the participants would therefore have to meet up with the group physically. User testing took place in April 2021, and the restrictions at that time were limited to two people meeting at the same time.

2. State of the Art

2.1 Using VR to educate healthcare professionals

VR has a varied area of use. Among other things, it is used for gaming, advertisement, entertainment, and education in both private and public sectors (Velev & Zlateva, 2017, p. 34). Although gaming has been the main driving force of VR (Velev & Zlateva, 2017, p. 34), the commitment to educational development could be even greater as VR has the potential to increase students' motivation (Kerawalla et al., 2006, p. 2). A game called "total knee arthroplasty (TKA)" is a serious game developed in VR. The game is developed for students to train for knee surgeries. Hamed Sabria, Brent Cowana, Bill Kapralosa, Mark Ported, David Backsteinc, and Adam Dubrowskie wrote an article on this game and support its development: "By clearly understanding the steps of a procedure and the underpinning surgical decision making processes, when placed in real operative environment, trainees will be able to focus on the technical aspect of the procedure." (Sabri, Cowan, Kapralos, Porte, Backstein & Dubrowskie, 2010, p. 3484).

The Norwegian University of Science and Technology (NTNU) opened a VR-lab in 2018. The VR-lab was opened in conjunction with a program developed for student nurses and doctors to train together for everyday tasks in their workday. Vice Chancellor Anne Borg states that the VR-lab is useful for education aspects that are difficult to accomplish in the real world (NTNU, 2018). Another university in Norway (the Inland Norway University of Applied Sciences) recently launched a learning tool using VR for teacher education. The main focus here is to train students for their "development talks", which is a yearly conversation they have with the parents of the children they teach. Advisor Ingeborg Amundrud states that the transition from theory to the field of practice is a shock for the students (Ringlund, 2021). The purpose of this learning tool is to allow the students to

experience the virtuality of development talks so they are more prepared when facing them in real life. Although this exact learning tool is not for healthcare professionals, the communication aspect of the training could be adapted to other fields.

3. Theory

This chapter elaborates on the theory and research regarding motivation, including an explanation of intrinsic and extrinsic motivation and how self-determination theory can be applied to pedagogical practice. This chapter also examines relevant research and theories on the use of VR in education. These theories are important for this study as they address what motivates and drives human action and the aspects of education that affect intrinsic satisfaction in a positive way. The combination of the theories presented in this thesis is used to develop VMM. As VMM is intended for education and students, it has been important to constantly measure ideas and solutions against the theories. In that manner, it was possible to see if the ideas and solutions were relevant to the education and motivation of the students.

3.1 Motivation

To understand what motivation is, it is necessary to examine the basic factors that describe what drives human action. Ryan and Deci define motivation as: “To be motivated means to be moved to do something.” (Ryan & Deci, 2000, p. 54). Motivated individuals perform activities that they want and that gives them joy. Unmotivated individuals on the other hand are considered to be those who do not feel the same drive to carry out the activity due to poor inspiration and desire (Ryan & Deci, 2000, p. 54).

3.2 Intrinsic and extrinsic motivation

To understand the difference between intrinsic and extrinsic motivation, Ryan and Deci have defined them as follows: “The most basic distinction is between intrinsic motivation, which refers to doing something because it is inherently interesting or enjoyable, and extrinsic motivation, which refers to doing something because it leads to a separable outcome” (Ryan & Deci, 2000, p. 55). When intrinsic factors are satisfied and an individual performs an activity based on these factors, that person is considered to be intrinsically motivated. These

factors can consist of joy, excitement, and inspiration, which positively affect intrinsic satisfaction (Ryan & Deci, 2000, p. 56). Ryan and Deci explain in their research that intrinsic motivation is important but is not the only motivation that exists in individuals. They further explain that from an early age, individuals are curious creatures who display a willingness to explore and learn, and that this is not influenced by external factors (Ryan & Deci, 2000, p. 56).

Ryan and Deci explain that external factors such as requirements and roles with age become the leading factors in performing various activities that do not satisfy intrinsic factors (Ryan & Deci, 2000, p. 60). This can be explained by the example that children do not have the same responsibility to the extent that adults have. Adults have jobs and roles that require them to perform activities they may not want, while children perform activities that they want and that are fun because they do not have the same responsibility. Performing an activity to receive rewards and prevent scolding or punishment is considered extrinsic motivation. Individuals who perform an activity and who do not think about the value the activity provides related to themselves, are motivated by extrinsic factors (Ryan & Deci, 2000, p. 60). In school, for instance, students can experience both intrinsic and extrinsic motivation. A student who feels like the schoolwork they are doing provides for them a beneficial learning outcome, can be considered as a student who is intrinsically motivated. Another student may have strict parents who expect them to obtain a good grade and may even punish them if they do not obtain such a grade. If that is what drives that student to do good, they are extrinsically motivated (Ryan & Deci, 2000, pp. 54-55).

3.3 Self-determination theory

To obtain a better overview of what motivates people to action and what makes humans curious about learning and development, the self-determination theory (SDT) will be presented. Niemiec and Ryan (2009, p. 133) state that SDT is a theory that engages with the focus on people being naturally curious about learning and exploring their own environment. The two researchers state the following:

> “Inherent in human nature is the proactive tendency to engage one’s physical and social surroundings and to assimilate ambient values and cultural practices. That is, people are innately curious, interested creatures who possess a natural love of learning

> and who desire to internalize the knowledge, customs, and values that surround them.“ (Niemiec and Ryan, 2009, p. 133).

Research indicates that intrinsic motivation is important for acquiring knowledge through education. Concurrently, there are various aspects of education that makes it demanding and challenging for students to maintain intrinsic motivation (Niemiec and Ryan, 2009, p. 136). In Niemiec and Ryan's research, they present examples of the SDT that specify four different forms of extrinsic motivation. These are: "external regulation, introjected regulation, identified regulation, and integrated regulation." (Niemiec & Ryan, 2009, pp. 137-138). What these different forms of extrinsic motivation represent is the extent to which they affect the intrinsic and extrinsic factors of individuals and what they are associated with (Niemiec & Ryan, 2009, p. 137). For example, external regulation is associated with an individual who wants to do well in an activity to avoid looking bad for other individuals and thus is controlled by external factors. Integrated regulation is associated with what an individual wants to achieve to live by their own values, which means that this individual is governed by intrinsic factors (Niemiec & Ryan, 2009, pp. 137-138).

Autonomy, competence, and connection are three important psychological needs for students in education. SDT assumes that by satisfying these psychological needs, extrinsic factors will be reconstructed into the student's intrinsic factors, which will affect the autonomous engagement of the studies in a positive way (Niemiec & Ryan, 2009, p. 139). A lecturer has a great responsibility to satisfy the students' autonomy in the classroom. Niemiec and Ryan reveal that pressure and the feeling of coercion should be minimized so that students can feel that they are part of the academic activities and be able to introduce their own opinions. Research points to positive results when it comes to autonomy-supporting teaching practices (Niemiec & Ryan, 2009, p. 139).

3.5 Learning with technology

3.5.1 Technology in education theory

Today, technology is a major part of human life. Therefore, high demands and expectations are placed on technology to be able to help people with daily challenges (King, Tee, Falconer, Angell, Holley & Mills, 2018, p. 7). By focusing on more personalized student-centered

learning, which means that students themselves are responsible for receiving personal learning, technology such as VR is an ideal opportunity to achieve this (King et al., 2018, p. 8). Their research report *"Virtual Health Education"* refers to positive results where collaboration in a virtual environment for nursing students. This makes it possible to compare the virtual and real-life experiences, and that the value in this would positively affect them during the internship period (King et al., 2018, p. 8). Using VR in learning has many benefits. The group of researchers explain it as follows:

> "The potential benefits of place experience for healthcare students is significant; it can provide a range of place educational opportunities, including familiarisation experiences of their clinical work placements during academic theory blocks, even before they commence their very first clinical placements, or prior to subsequent placement areas, which demand different abilities." (King et al., 2018, p. 8).

VR is a technology that can be used to offer safe and peaceful environments to perform different tasks without real life consequences and without any concern (Carruth, 2017, p. 2)

4. Methodology

This chapter presents the methods that have been applied to our studies. It contains seven sections that explain the methods in the various process phases.

4.1 Design science research methodology

Design science research methodology (DSRM) has been used throughout this project. DSRM consists of six different process phases as Figure 4.1 presents: (1) "problem identification and motivation", (2) "definition of the objectives for a solution", (3) "design and development", (4) "demonstration", (5) "evaluation", and (6) "communication". This chapter presents and explains the methods the group has performed in the various phases of DSRM (Peffers, Tuunanen, Rothenberger & Chatterjee, 2007, pp. 16-18).

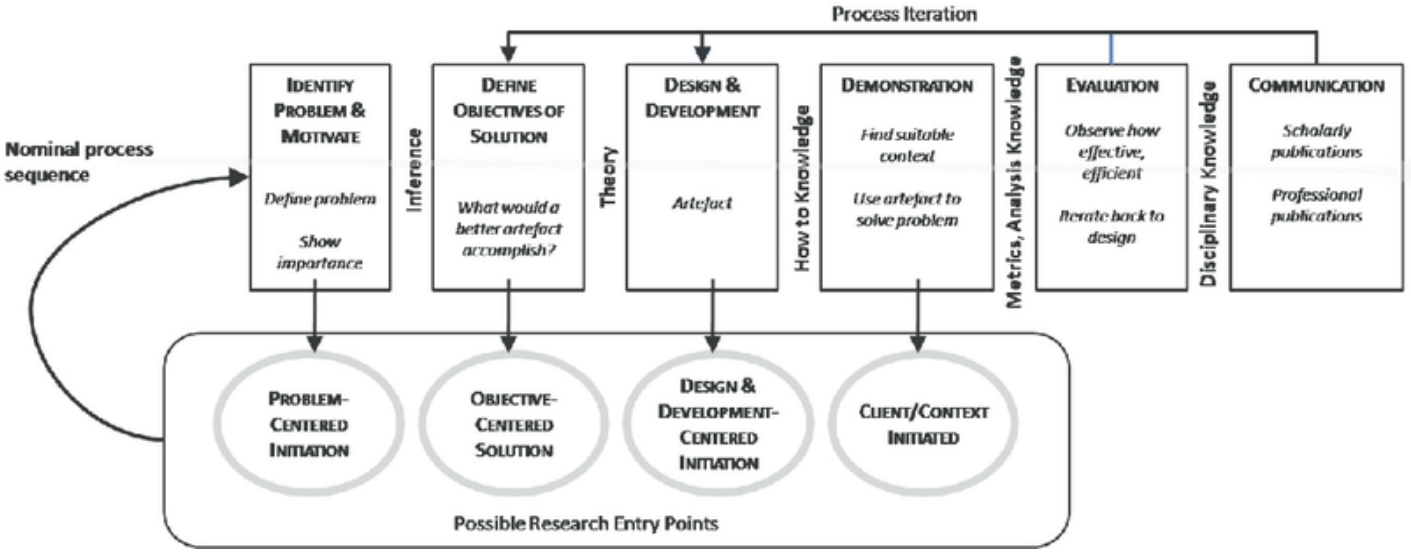


Figure 4.1: Design Science Research Methodology (Myers, n.d.)

4.1.1 Identifying the problem and motivation

Medical staff, as doctors and nurses, are all responsible for their patients. This responsibility is crucial and demanding to the extent that there are many different patients with different needs. Medication must be prescribed with the correct dosage and delivered to the correct patients. Various technology systems such as the System Engineering Initiative for Patient Safety (SEIPS) model are today used to ensure that patients are treated safely. SEIPS is a model that is used as a framework for evaluating different phases of the health service's work systems, such as processes and what effect this has on health services quality and patient safety (Carayon, 2006, as cited in Carayon, Wetterneck, Rivera-Rodriguez, Hundt, Hoonakker, Holden & Gurses, 2013, p. 21). However, medication errors still occur, and in the worst cases, patients pay with their lives. The system that is meant to increase the safety of patients fails to the extent that individual errors occur along the way. What these individual mistakes entail and how they occur may vary (Williams, 2007, pp. 343-346).

For the group to identify this problem at an early stage, unstructured interviews were conducted with doctors at a hospital in Kristiansand and nursing students at the University of Agder. Interviews are an ideal way to gather data that can help develop a system or product. As the group did not have much background information on this topic, unstructured

interviews were conducted. Unstructured interviews are conducted through an open conversation between the interviewer and interviewee by asking open-ended questions (Moyle, 2002, p. 267). No fixed questions were developed in advance of this interview. The group followed Zhang and Wildemuth's description of how unstructured interviews were set up. They explain the procedure as follows: “The researcher comes to the interview with no predefined theoretical framework and thus no hypotheses and questions about the social realities under investigation; rather, the researcher has conversation with interviewees and generates questions in response to the interviewees narration.” (Wildemuth & Zhang , 2009, p. 240).

A semi-structured interview was also conducted with two teachers at the University of Agder. The group felt compelled to conduct this semi-structured interview with experts in the field of healthcare education as the group needed more information on this topic. By conducting semi-structured interviews, it was possible to gain important knowledge about the subject. It was also a conscious choice to use a semi-structured interview as the group wanted the experts to talk and provide as much useful information as possible. The semi-structured interview contains a conversation that does not necessarily consist of yes and no questions (Clifford, 2016, p. 145). The group conducted an interview with Hege Mari Johnsen who is the study program manager for the Master in Health and Social Informatics, and Jorunn Aas Handeland who is a PhD fellow at the University of Agder. The aim of this interview was to gain knowledge about medication management and scenarios that were relevant to students.

4.1.2 Objectives of a solution

The goal was to design a VR learning tool in medication management for nursing students to measure whether the motivation for learning increased with the use of VR. This also provided an opportunity for the nursing students to perform tasks in different scenarios without real-life consequences. Before the group introduced the objectives of a solution, a great deal of research was performed on VR, including the pros and cons of implementing it in education. User testing was also performed with test participants with a low-fidelity prototype to collect the necessary data for further development of the prototype. By performing such a test, it was possible to observe the test participants’ movements and reactions.

4.1.3 Design and development

To achieve the goal, we designed and developed a prototype that would contain different tasks and scenarios that the nursing students were to solve. The prototype VMM was developed using Unity, Cinema 4D, and SteamVR, which made it possible to design a 3D virtual environment. The methods the group used for the development of VMM were to design the environment in the prototype in various software as well as to program all the movements, and so forth, with the help of Visual Studio Code.

The group also took the time to conduct research on finding various reference images that the environment in VMM should consist of. To explain this method in more detail, Figure 4.2 was used as inspiration for how a patient room in the hospital in VMM should look like. Using Cinema 4D, which is a motion graphic software, it was possible to design this environment including all 3D elements and then implement it into Unity. To export 3D objects between these two programs, it was necessary to have a good folder structure so that all the materials and textures were included. By exporting 3D objects as an FBX file, from Cinema 4D, it was possible to import this FBX file into Unity. The results after modeling, designing, exporting, and importing to Unity can be seen in Figure 4.3. In order to make the hospital rooms as similar to reality as possible, several 3D-models were modeled. The sleeping chair (seen to the right in Figure 4.3) is modeled using a tutorial, where techniques such as the use of splines and deformers were used to achieve the desired result (Multimedia 4D Films, 2017, 0:27).

Figure 4.2: Reference image hospital room. (Terelyuk, n.d.)

Figure 4.3: Screenshots from the hospital room in VMM.

4.1.4 Demonstration

To demonstrate how users should use VMM, one of the group members performed a demonstration of VMM. The demonstration was performed while the test users sat in the

same room and observed what to do and how to use the controls. After performing the demonstration, the test users received the VR headset. Further, they were instructed on how to use the controllers. When the test users felt comfortable enough, they could start the user testing of VMM.

4.1.5 Evaluation

The research project was approved before testing began by the Norwegian Center for Research Data (NSD). Evaluation was performed by analyzing the data collected through the user testing. Data was collected by administering questionnaires both before and after the playthrough of VMM, as well as audio and video recordings of the participants while testing VMM. The motivational questionnaire used is built on the "Science Motivation Questionnaire II (SMQ-II)". This questionnaire is originally used to measure students' motivation to learn science in college courses (STEM Learning and Research Center (STELAR), n.d.), but for this project it has been used to measure motivation towards learning medication management. The second questionnaire used is called "Core Elements of the Gaming Experience Questionnaire (CEGEQ)", and is used to understand different gaming experiences variables (Gamez, Cairns, Cox, 2009, p. 65). The CEGEQ is set to a likert scale with seven options, going from "strongly disagree" to "strongly agree". The motivational questionnaire was changed to have a likert scale of seven as well, as this is found to be the optimal number of alternatives (Cox, 1980, as mentioned in Finstad, 2010, p. 223). The video and audio recordings were used to collect real reactions from the test users, while they performed tasks in VMM. If the test users had reactions that the group thought were interesting, they would be asked about the reaction after the user test.

For the pretest, the group recruited two nursing lecturers and two students from Multimedia and Educational Technology. The target group for the pretest was broad and varied from 25–64 years. The group had a total of five main test users who were all nursing students at the University of Agder. Only one of the participants from the main user testing had used VR before. The group recruited one first-year student, three second-year students, and a third-year student for the main user test. These were recruited by contacting another nursing lecturer, who published information about the project to the University's learning management system "Canvas''. Those who were interested were asked to contact the group directly. All participants for the main user test were given the consent form (Appendix C)

before conducting the questionnaires and playing VMM. All of them agreed and signed the consent form. Both pretests as well as the user test were all conducted at the University of Agder.

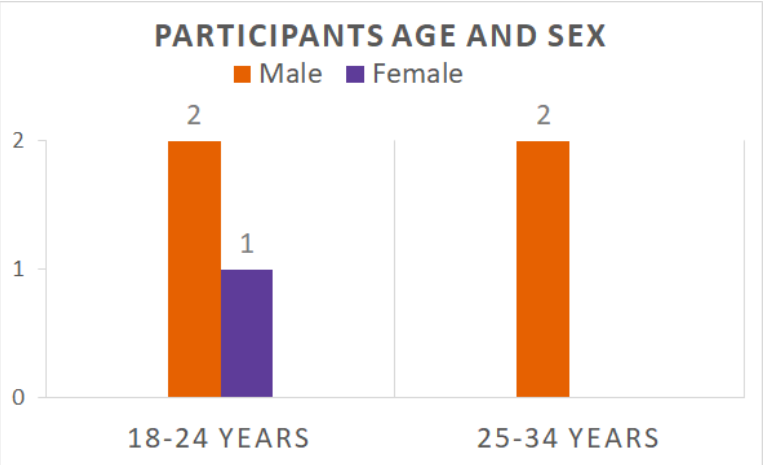


Figure 4.4: Participants' age and sex.

4.1.6 Communication

The group intends to communicate this project by publishing this master thesis, as well as publishing a video presentation of VMM. The video will be presented in a presentation of this thesis, as well as posted online after.

4.2 Human-centered design

Human-centered design (HCD) is a process that develops a system or a product that is tailored to meet users' needs, and where the users are a part of the design process. In their research report, Vechakul, Shrimali, and Sandhu define HCD as follows: "Human-centered design (HCD) or 'design thinking' is a process for innovation that prioritizes the needs and values of the people most affected. HCD provides a framework for moving quickly toward action while retaining a system's perspective" (Vechakul, Shrimali & Sandhu, 2015, p. 2553). Maguire mentions in his research report that HCD consists of four different principles. These four principles are central to HCD because users are involved in the various stages. The four principles Maguire mentions are: (1) "the active involvement of users and clear understanding of user and task requirements", (2) "an appropriate allocation of function

between user and system", (3) "iteration of design solutions", and (4) "multi-disciplinary design teams" (Maguire, 2001, pp. 588-589).

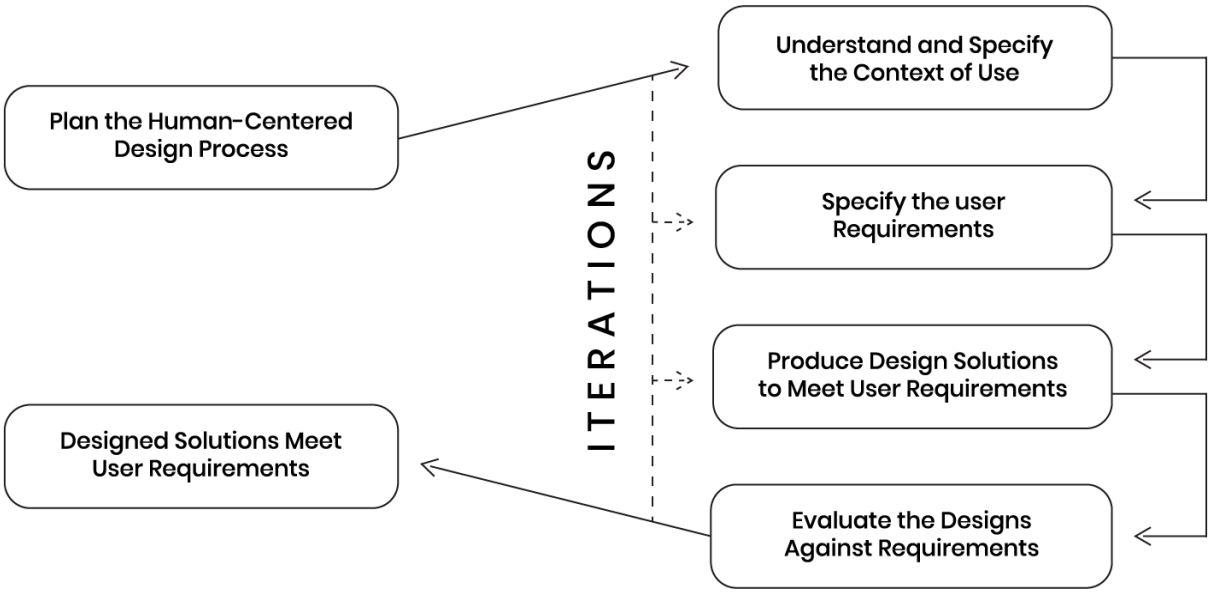


Figure 4.5: The human-centered design cycle. (Adapted from Harte, n.d.)

4.2.1 Understand context of use

To specify and understand the context of use, the group had to collect and analyze information about the characteristics of users, tasks and environment. By collecting this information, it was possible to understand the context of the system (International Organization for Standardization, 2019, p. 12). The group also conducted a PACT analysis (short for people, activities, contexts, and technologies), which consists of identifying people, activities, context, and technology. Joakim Reinius mentions in his article that PACT is a framework that was developed to prevent aspects of human interactions from being left out (Reinius, 2011, p. 15). Personas were also developed, which consist of creating fictitious users of the product the group was to develop. Personas are an important part of understanding and identifying the context of use, where different characters come to life by giving them names, ages, and backgrounds. Guðjónsdóttir reveals that by developing such personas, it is easier to obtain an overview of the personas` problems and challenges, which can help to develop user-friendly products (Guðjónsdóttir, 2010, p. 65).

4.2.2 Specify user requirements

When performing a project like this, it is important to specify the user requirements to end up with a product that users understand and that is easy to use. James and Suzanne Robertson mention in their research "Volere requirements specification template version 18" that they split user requirements into two categories: functional and non-functional requirements. The functional requirements explain what a system must do, and how it works, while the non-functional requirements are about usability and performance (Robertson & Robertson, 2003, p. 4). To specify the user requirements for this project, the group used James and Suzanne Robertson's Volere requirements specification template and developed several Volere's snow cards that would specify the different user requirements. Snow card is a template that makes it possible to understand different requirements using different attributes such as: "requirement number", "requirement type", "use case", "description", "rationale", "originator/source", "fit criterion", "customer satisfaction", "customer dissatisfaction", "priority", "conflicts", "supporting materials" and "history" (Robertson & Robertson, 2009, pp. 1-5). Two examples are presented below where Figure 4.5 describes a functional requirement, while Figure 4.6 describes non-functional requirements. All functional and non-functional requirements can be found in Appendix D and E.

Requirement: #1	**Type:** 9	**Use Case:** 4
Description: The user should be able to move within the environment.		
Rationale: Must be implemented for the user to be able to conduct user tasks.		
Source: Bjørn André Fauske Hjelle		
Fit Criterion: The user is able to use controllers to move within the learning tool.		
Customer Satisfaction: 5		**Customer Dissatisfaction:** 5
Priority: 1		**Conflicts:** 0
Supporting Materials: Figure 6.11		
History: Created October 2, 2020		

Figure 4.6: Volere's snow card: Functional requirements.

Requirement: #6	**Type:** 11	**Use Case:** 0
Description: The environment should be similar to a real-life hospital.		
Rationale: Should be included to experience more immersion.		
Source: Joachim H. Eriksen		
Fit Criterion: The test users can recognize it as a virtual hospital.		
Customer Satisfaction: 5		**Customer Dissatisfaction:** 5
Priority: 1		**Conflicts:** 0
Supporting Materials: Figures 6.1, 6.2, 6.3, 6.6, 6.7, 6.8, 6.9, and 6.10		
History: Created November 10, 2020		

Figure 4.7: Volere's snow card: Non-functional requirements.

"Cybersickness is an uncomfortable side effect experienced by users of immersive interfaces commonly used for VR. It is associated with symptoms such as nausea, postural instability, disorientation, headaches, eye-strain, and tiredness." (Nesbitt & Nalivaiko, 2018, p. 1). For some, VR can be perceived as scary and exceedingly real. Cybersickness can typically occur for first-time users of VR and can also depend on visual graphics, movement, and speed. In VMM's case, neither high speed nor strong visuals occur. On the other hand, the player's movement is a theme, which will be further discussed in the solution and in the discussion.

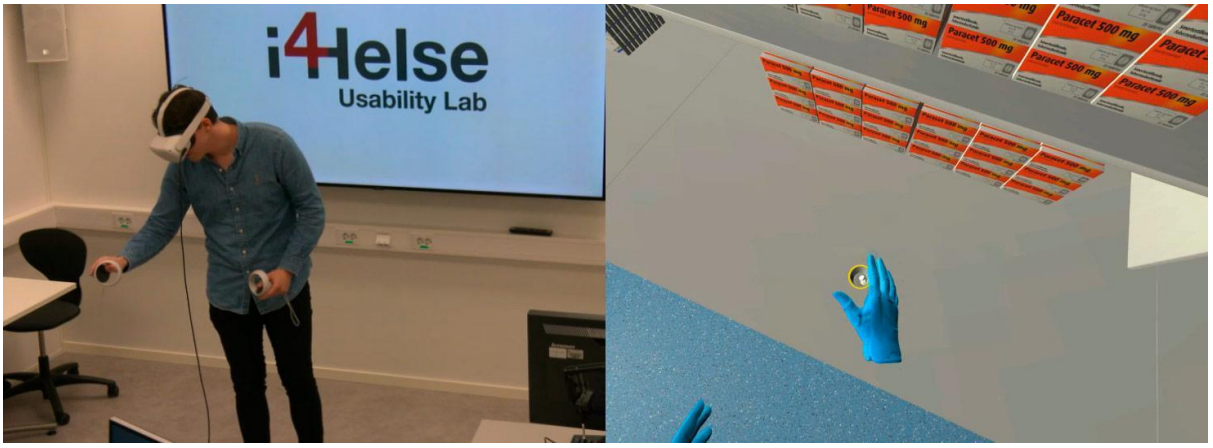


Figure 4.8: A group member testing VMM.

4.2.3 Usability and user experience goals

User experience (UX) and usability goals are easy to confuse with each other. To provide a better understanding of the difference between them, ISO standard 9241-210:2019 has introduced the following definition of usability: “extent to which a system, product or service can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use.” (International Organization for Standardization, 2019, p. 3). Helen Petrie and Nigel Bevan mention in their report, *“The evaluation of accessibility, usability and user experience”* that with the help of several researchers, six aspects that are part of usability have been identified. These aspects consist of effectiveness, efficiency, flexibility, learnability, safety, and memorability. These can be seen as principles that are about the users’ experience by using an interactive system (Petrie & Bevan, 2009, pp. 2-3). ISO standard 9241-210:2019 defines UX as follows: “A person’s perceptions and responses that result from the use or anticipated use of a product, system, or service.” (International Organization for Standardization, 2019, p. 4). Figure 4.9 presents the different aspects around the usability goals. Figure 4.10 presents the desirable aspects around user experience goals.

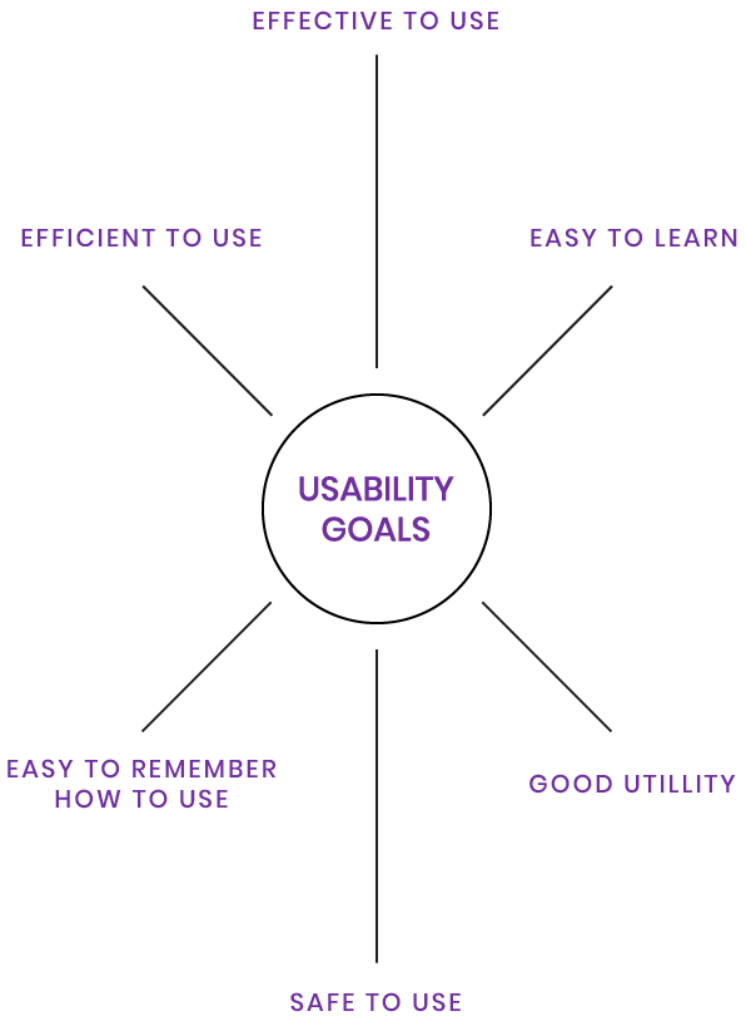


Figure 4.9: Usability goals aspects (Adapted from (Preece, n.d.)).

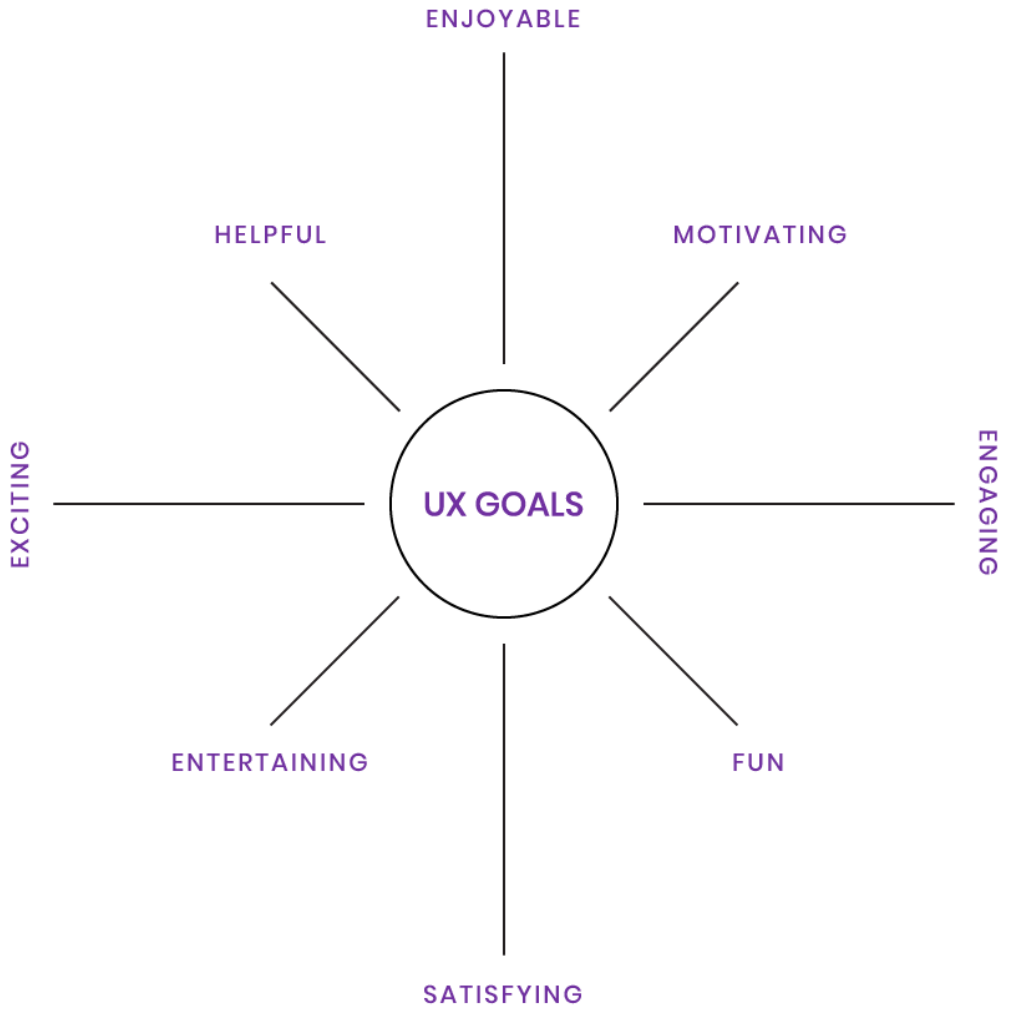


Figure 4.10: User experience goals desirable aspects (Adapted from (Preece, n.d.)).

4.2.4 Design solutions to meet user requirements

To design an interactive system that will work in the best possible way, it is important to implement the categories' conceptual and physical designs (Benyon, 2014, p.188). These categories focus on different aspects of interaction design but will in collaboration with each other offer an ideal end product.

To be able to design a product that will be user-friendly and meet the users' requirements, it is important to perform various methods. The group therefore chose to conduct a workshop with nursing students that included presenting a low-fidelity prototype of the product. A low-fidelity prototype usually contains a storyboard and paper-based design that is designed

to show users how the products are intended to work, as well as facilitate a quick start of design solutions (Rudd, Stern & Isensee, 1996, pp. 79-80). There are both advantages and disadvantages to implementing such a low-fidelity prototype. Gaining a deep understanding of usability and incorrect control is limited with a low fidelity prototype, as the prototype is often only static paper (Rudd et al., 1996, p. 80). After the group had conducted a workshop, the development of a high-fidelity prototype started. A high-fidelity prototype is not a finished product but can offer a sense of a finished product as users can perform various tasks (Rudd et al., 1996, p. 81).

4.2.5 Evaluate against requirements

As described in the chapter “restrictions”, the group encountered several challenges, such as recruiting test users for the prototype. It was important to follow the rules according to COVID-19 restrictions at this time. Since the user test was to be conducted in the usability lab at the University of Agder in Grimstad, it was possible to perform testing in a safe environment. A time-frame of one week was given to perform user testing. A total of five test users were recruited, but it was initially intended to have more. However, COVID-19 restrictions and nursing students having internships made this difficult. The data that was collected after conducting the user testing with the high-fidelity prototype was evaluated. With this data the evaluating the design solutions against the user requirements could be done. As the group chose to specify the user requirements using the James and Suzanne Robertson Volere requirements specification template, it was possible to see that the functional and non-functional requirements of the product were met.

5. Materials and Tools

For the development and test of the VMM prototype, the following hardware and software has been used.

5.1.1 Software

VMM is developed using a real-time development platform called Unity. This platform is one of the two most popular development platforms for building 2D, 3D, and VR games and apps.

Unity is compatible with packages, which allows for frameworks to be integrated. We implemented a framework called SteamVR. This framework is popular for developing VR and was therefore a natural tool to use. SteamVR is developed by a company called Steam and is compatible with HTC Vive and Oculus Rift.

5.1.2 Hardware

In modern times, there are many options for VR headsets. The group decided to invest in one called Oculus Quest 2 as this was one of the newer headsets in the market. This headset was used throughout the development of VMM. As the Oculus Quest 2 is a standalone headset, an additional cable called Oculus Link was used to link it to Unity. This makes the Oculus Quest 2 behave like an Oculus Rift, which is compatible with SteamVR. Although VMM was mainly used with the Oculus Quest 2, it had also been tested on an Oculus Rift as well as on an HTC Vive.

6. Solution

This chapter presents all the design solutions, where it explains why these solutions were chosen and how they were solved.

6.1 Design solutions

When it comes to design for usability and user experience, it was necessary to perform an analysis of the user tasks, what the users were going to do, and how they were going to solve it. By doing this, it was easier to avoid designing unnecessary objects. It also made the whole design process more efficient since the design requirements were defined. The objects the users needed were medications, cups (to transport the medication), patient discharge forms, and patients to administer the medication to.

Figure 6.1: Screenshot from VMM of the medication and the pill cups.

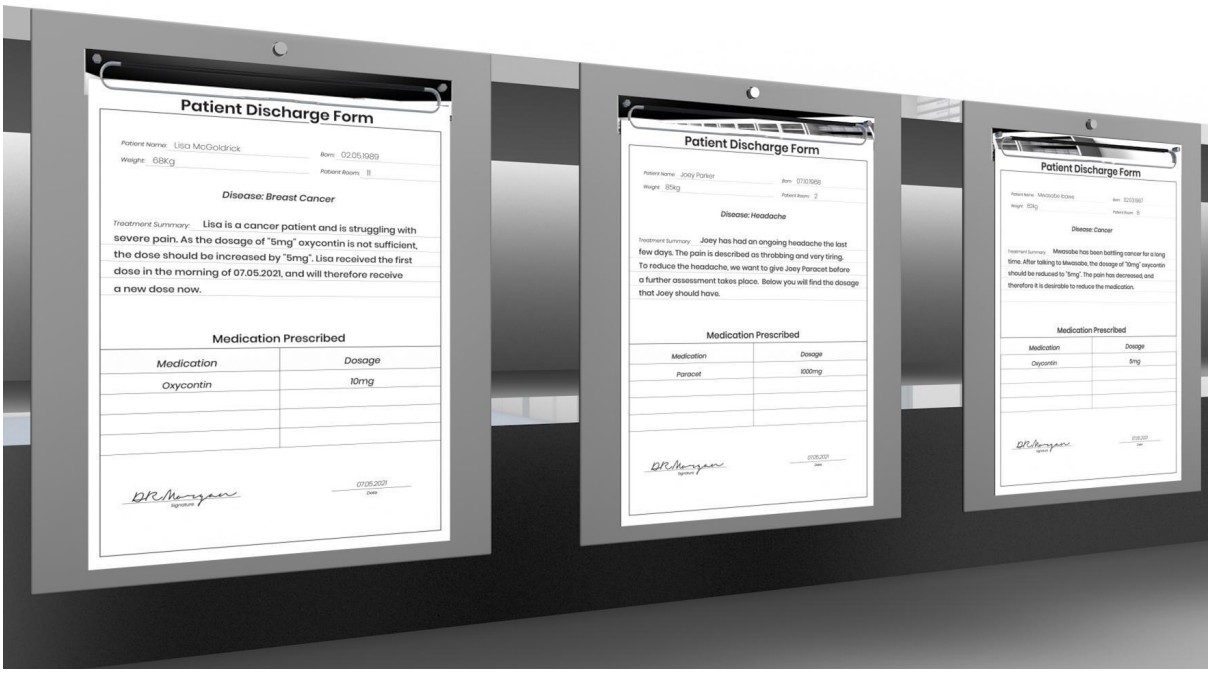


Figure 6.2: Screenshot from VMM of the patient discharge forms.

Figure 6.3: Screenshot from VMM of one of the patients.

The 3D-models for the patients in VMM are not designed by the group. After a conversation with our supervisors and a senior engineer at the University of Agder, it was concluded that it would be time consuming and exceedingly difficult to design people with facial expressions. The 3D character depicted in Figure 6.3 was therefore purchased from an online 3D-model library (Sulepa, n.d.). The group created the rest of the 3D-models with the help of different tutorials on some of the 3D-models. The chairs placed in the hallway in figure 6.6 are modeled using splines, extrusions and symmetry techniques that result in a very realistic feel (samba coulibaly, 2019, 0:10). Figure 6.9 presents the kitchen in VMM and various 3D-models placed on the shelves. The mugs are modeled using circle splines that build the "framework" for the mug. These are extruded together using something called "loft" in Cinema 4D, which gives the mugs their "body" (GOGOLERIUS, 2016, 0:01). Figure 6.10 presents the social room in VMM. To give the social room a feeling of calm, it was decided to design chairs and sofas that people could relax in. The sofas are modeled by drawing a spline using a pen tool that will present the framework for the sofa. This spline is then extruded and a subdivision surface is applied so that the edges are softer and more realistic. The cushions in the sofa are modeled using cubes and subdivision surfaces (GOGOLERIUS, 2020, 0:15). The chairs are modeled in the same way as the sofas (GOGOLERIUS, 2017, 0:19), which means that the design as a whole is connected.

To design a realistic environment as possible, research was conducted on what different hospitals looked like. Since the main users consisted of nursing students, it was therefore important that they felt comfortable and recognized the environment that VMM should consist of. Figure 6.4 presents the corridor that the group wanted VMM to look like, while Figure 6.5 presents the medication room, which has an important role in VMM.

Figure 6.4: Reference image hallway (insta_photos, n.d.)

Figure 6.5: Reference image medication room. (YDP Furniture, n.d.)

Once all the reference images were found, the design phase could start. As the group did not have much experience of modeling in Unity, the group chose to design all 3D-models in Cinema 4D. This was a conscious choice to be able to recreate and develop as realistic 3D-models as possible. Figures 6.6 and 6.7 are the result after modeling and importing to Unity. The group also chose to design 3D-models that users did not need in VMM but which could create an atmosphere of and reflect reality in the best possible way. The 3D-models that were developed as extra material can be seen in Figures 6.8, 6.9, and 6.10.

Figure 6.6: Screenshots from the hallway in VMM.

Figure 6.7: Screenshots from the medication room in VMM.

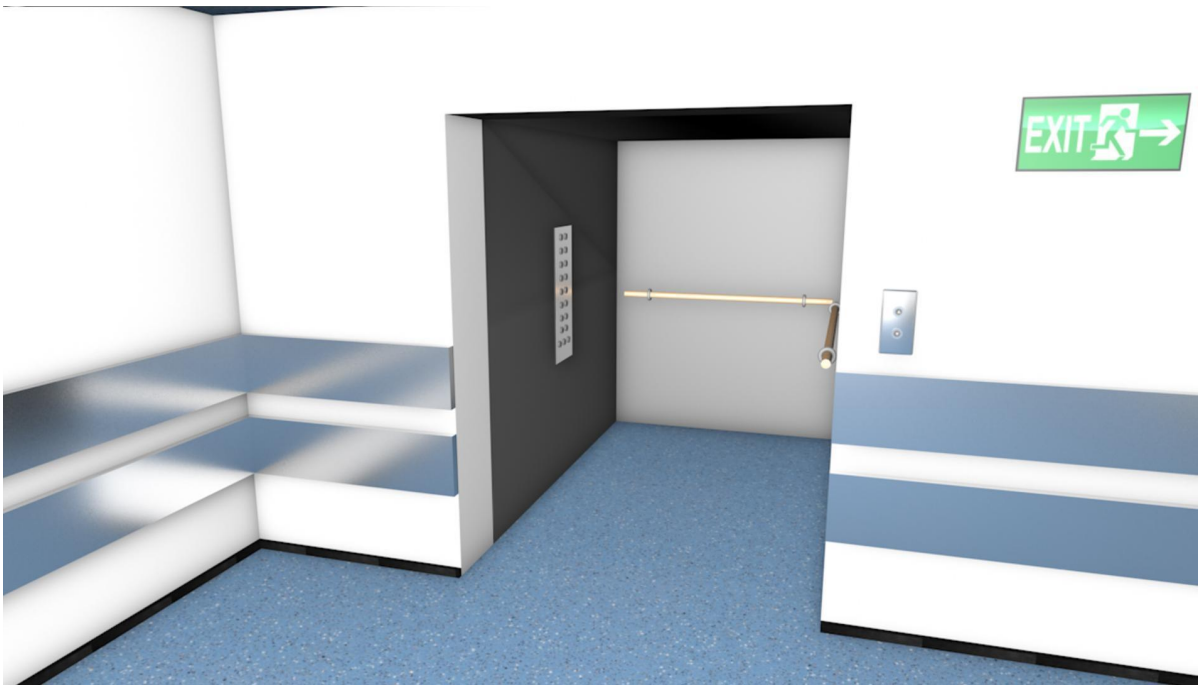


Figure 6.8: Screenshots from the elevator in VMM.

Figure 6.9: Screenshots from the kitchen in VMM.

Figure 6.10: Screenshots from the social room in VMM.

Choosing light-colored textures and materials felt like a normal reference to the hospital environment. This choice also helped to make the environment more accommodating and not scary. Lights were also an important factor to make it possible to navigate and see inside VMM.

6.2 The learning tool "Virtual Medication Management"

VMM is a learning tool developed for nursing students to practically train on medication management. The main target audience is nursing students, partially first year students, but it can also be used by students at different levels of education, as well as fully educated nurses. The learning tool allows the users to train on the practical part of understanding and reading patients' discharge forms, collecting the correct medication with the right dosage, as well as administering the medication to the patient. The learning tool is intended to be interesting and motivating to use.

6.2.1 The controllers

The learning tool, VMM, is played by one person at a time. The player has to use a VR headset with controllers in each hand. The controllers have three different actions (See Figure

6.11). The left “joystick” allows the players to move in any direction. The right “joystick.” is used for the player to move their body 45 degrees either to the right or left. The last action is to interact with objects (pick up, grab, or release). The player uses either “trigger” or “grip” with the corresponding arm to interact with the object.

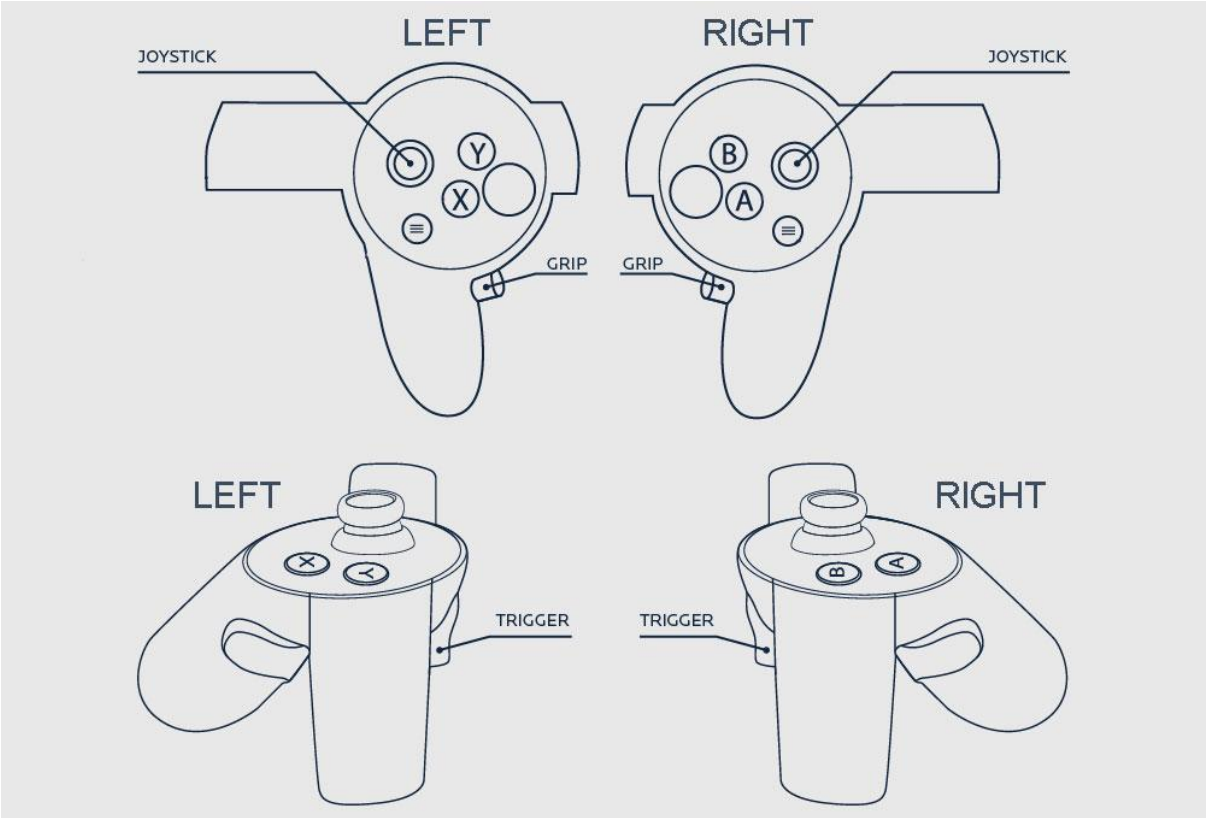


Figure 6.11: Controls when playing VMM. (Adapted from Raw Data, n.d.)

6.2.2 Instructions

A television is the first thing seen when loading into VMM. This is placed in the social room, which is the starting area of the simulation. This television has text that informs the player to press the button in front of them. When the player does so, they are given instructions on the television. The instructions are as follows:

> “In this simulation, you will be given a set of tasks.
> The tasks are as follows:

1. In the room called “Medic Lab,” you will be presented three discharge forms for three different patients with three cups associated with each patient. These forms will give you information about each patient.

2. Help the patients by locating and collecting the relevant medication with the correct dosage. Use the cups to collect multiple pills. Give the cup with the correct medication and dosage by placing it on the white patient table next to the patient. Help one patient at a time.

3. Proceed until you have helped each patient. When you are done, come back here and press the “Done button.” Your results will then be presented.

Good luck!”

When these instructions are read, the player is ready to start their tasks.

6.2.3 Tasks

As stated in the instructions, the player is to enter the medic lab. Here, the player will find the three patients’ discharge forms. The player is to read the discharge forms and then select a patient to help first. The player should then proceed to pick up a pill cup and carry it over to the counter. Here, the player is to locate which medication they need to pick up and then drop the number of pills needed in the cup. With the correct medication and the right dosage, the player is to pick up the glass and enter the hallway. When they have found the correct patient room, they enter it. For each patient, there is another informative form located at the front of the patient’s bed. This form has some of the same information as their discharge form (name, date of birth, weight, and their given room). The player can use the information on this form to confirm they found the correct patient. After doing this, the player has to deliver the pill cup to the patient by placing it on their bedside table. This process is repeated until each patient has been given their medication. When this has been done, the player is to return to the social room and press the button once more. The television then congratulates the player on finishing their tasks and proceeds to provide feedback on each patient. The feedback

displays all medications administered to each patient, and provides information on them either being correct or wrong.

6.3 Cybersickness

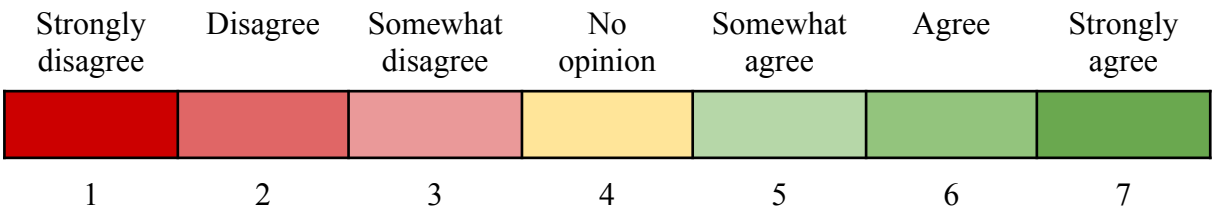
Player movement in VR can be solved in different ways. In the early phase of the development of VMM, player movement was solved by teleporting around in set areas. From the group's own experiences, there was no experience of cybersickness with this method. As this learning tool is supposed to be a simulation of a real-life experience, player movement should be as natural as possible. Teleportation was therefore not the most optimal solution for the final prototype, and it was decided to change this to meet the user requirement. Player movement was then changed from teleportation to movement through the joysticks.

7. Result/Analysis

7.1 Motivation questionnaire

As mentioned earlier, the participants were asked to complete a motivation questionnaire before and after the playthrough of VMM. The results from both before and after the playthrough are displayed in the table below.

Table definitions:
Q*i* = Question *i*
P*i* = Participant *i*



	Before playthrough					After playthrough				
	P1	P2	P3	P4	P5	P1	P2	P3	P4	P5
Q1	7	6	7	7	7	7	7	7	7	7
Q2	7	4	7	7	6	7	6	6	7	5
Q3	6	5	6	6	6	6	5	6	7	6
Q4	7	6	6	7	6	7	6	6	7	7
Q5	7	6	6	7	6	6	6	6	5	6
Q6	6	4	5	7	5	7	6	6	6	5
Q7	7	3	6	7	5	6	4	6	7	7
Q8	6	6	6	7	6	7	6	6	7	7
Q9	7	4	7	7	6	7	7	7	7	7
Q10	6	4	5	5	3	6	2	6	5	3
Q11	6	4	5	4	3	6	2	6	6	4
Q12	7	6	6	7	7	7	6	7	7	7
Q13	7	6	6	7	6	7	6	6	7	6
Q14	7	6	6	7	4	7	6	6	6	5
Q15	5	4	6	6	5	6	4	6	6	6
Q16	7	6	6	7	4	7	6	6	7	7
Q17	6	4	6	5	4	7	4	6	6	6
Q18	5	4	6	4	5	7	2	6	4	6
Q19	7	7	6	7	6	7	7	6	7	6
Q20	7	6	6	5	4	7	6	6	5	4
Q21	7	6	6	7	7	7	7	6	7	7
Q22	6	6	6	7	6	7	6	6	7	7
Q23	7	4	6	7	7	7	6	7	7	7

Table 7.1: Results from motivation questionnaire.

7.1.1 Detailed analysis of selected questions from motivation questionnaire

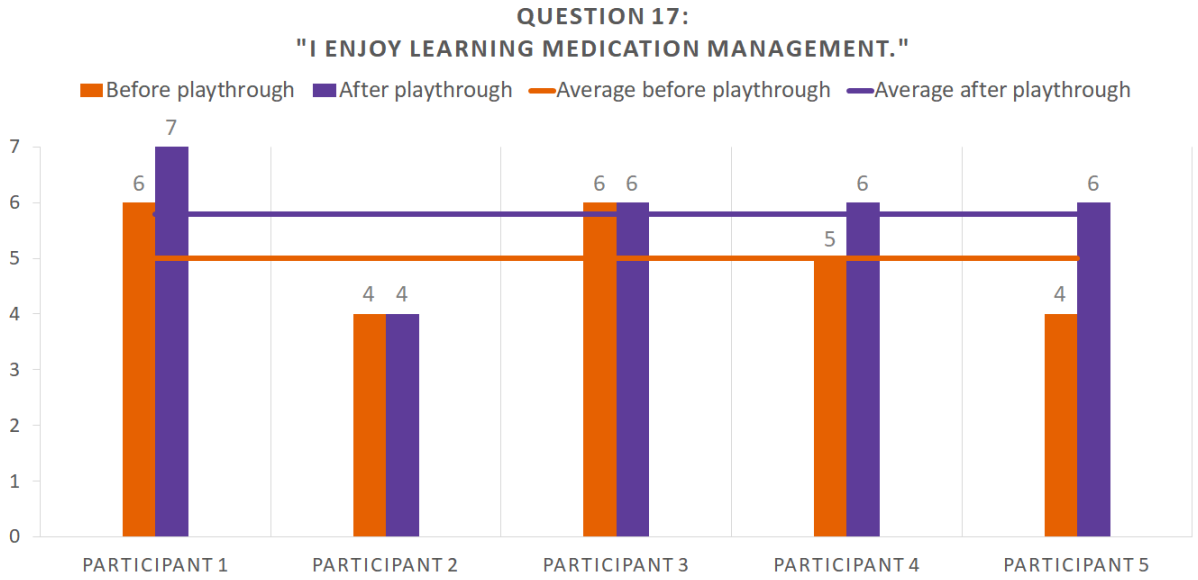


Figure 7.1: Results from Question 17.

As seen in Figure 7.1, three out of five participants changed their answer in a positive manner when asked if they enjoy learning medication management. Participant 3 added a comment while answering this question: "I believe technology should be more implemented into the curriculum in general. I think technology has great potential to motivate more nursing students."

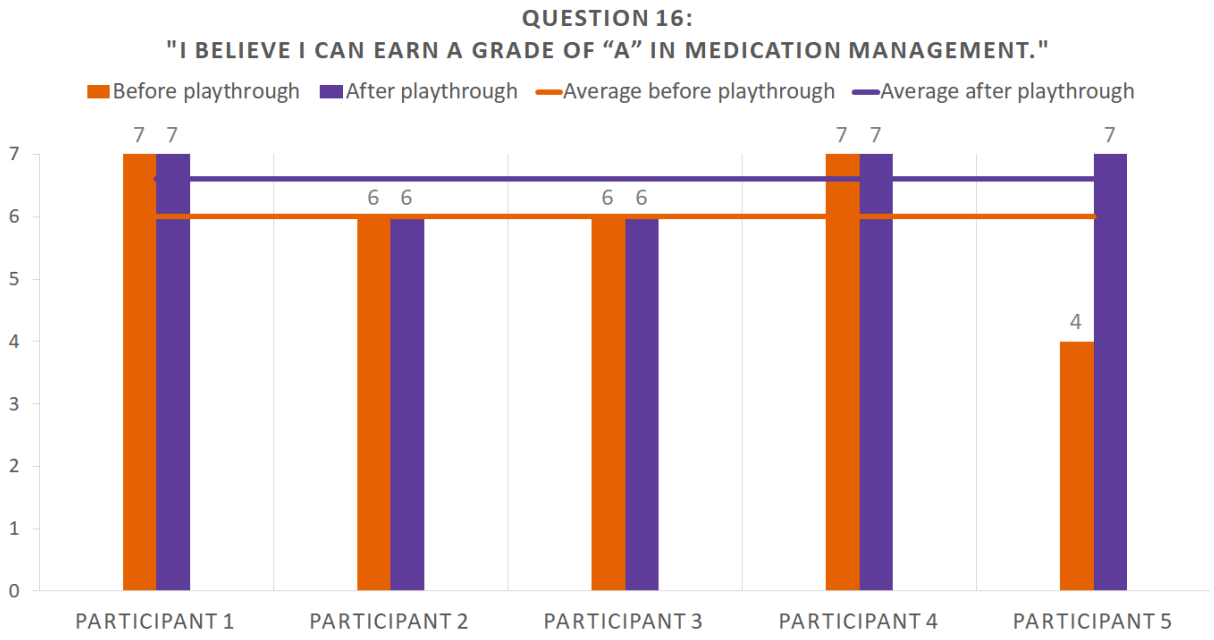


Figure 7.2: Results from Question 16.

Figure 7.2 above presents results from the participants responding to the statement: "I believe I can earn a grade 'A' in medication management." Participant 5 added a comment before answering: "The medication management test requires a score of 100% to pass. This makes me, and probably other students, study hard to pass it.". Participant 5 was the only participant that changed their answer before and after the playthrough.

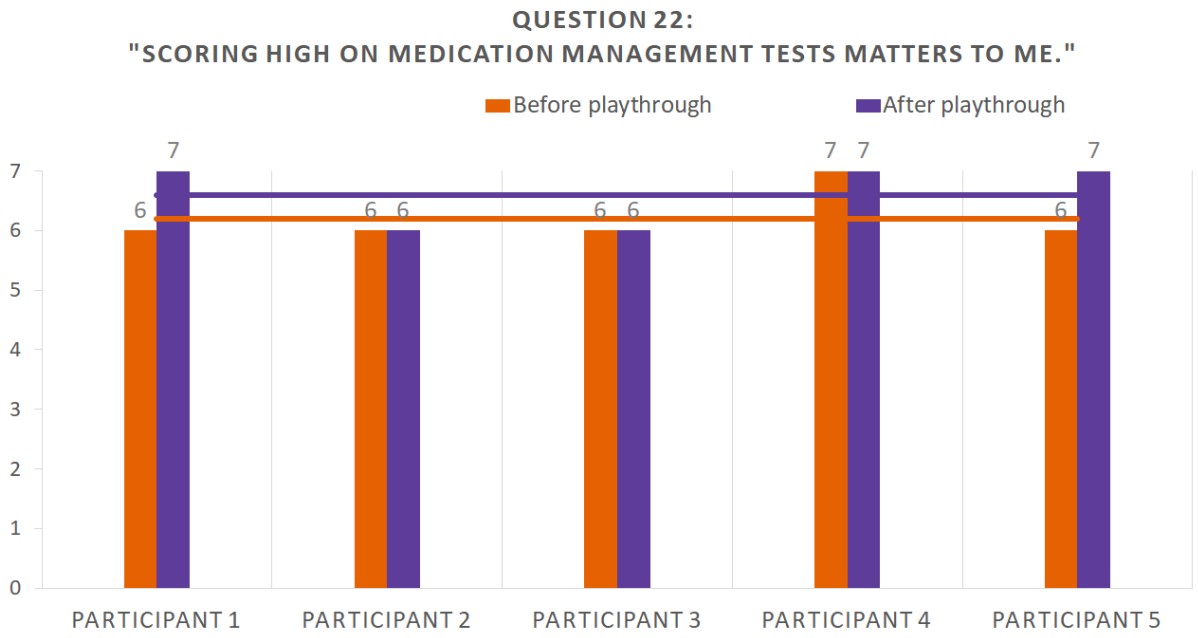


Figure 7.3: Results from Question 22.

Figure 7.3 above displays the results from the statement: “Scoring high on medication management tests matters to me.”. The graph shows that Participants 1 and 5 had a slight increase going from “agree” to “strongly agree” after the playthrough.

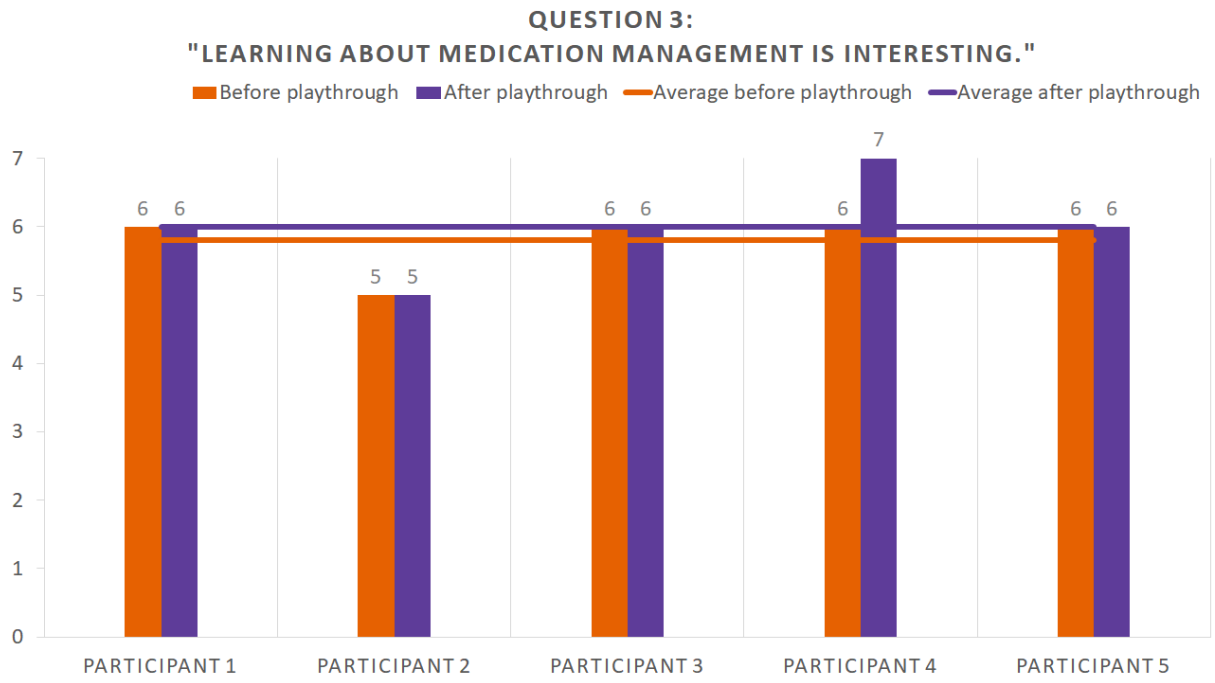


Figure 7.4: Results from Question 3.

Figure 7.4 displays results from Question 3: "Learning about medication management is interesting." The graph shows that only one of the participants changed their answer from "agree" to "strongly agree."

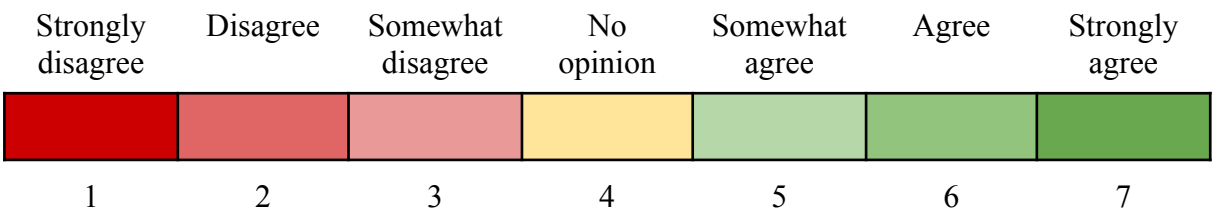
7.2 Game experience questionnaire

Along with a questionnaire measuring the students' motivation toward VMM, they were also asked to complete a questionnaire measuring the game experience itself. The questionnaire is called Core Elements of the Gaming Experience Questionnaire (CEGEQ).

Table definitions:

Q*i* = Question *i*

P*i* = Participant *i*



Questions marked with "*" are negatively framed questions; the scale is therefore reversed for clarification.

	P1	P2	P3	P4	P5
Q1	7	6	7	7	6
Q2*	2	6	2	2	2
Q3	7	6	7	7	6
Q4	7	3	7	7	5
Q5	6	6	7	6	6
Q6	7	5	7	6	6
Q7	6	3	6	7	6
Q8	7	6	7	7	7
Q9	6	5	6	7	6
Q10	4	4	6	7	3
Q11*	2	3	3	1	2
Q12*	4	2	6	4	3
Q13	6	2	7	5	5
Q14	5	1	6	4	1
Q15	6	3	7	4	6
Q16	7	6	7	7	7
Q17	6	2	5	5	2
Q18	6	2	7	7	5
Q19*	2	2	1	1	3
Q20	6	6	5	6	7

Table 7.2: Results from the game experience questionnaire.

7.2.1 Detailed analysis of selected questions from Core Elements of the Gaming Experience Questionnaire (CEGEQ)

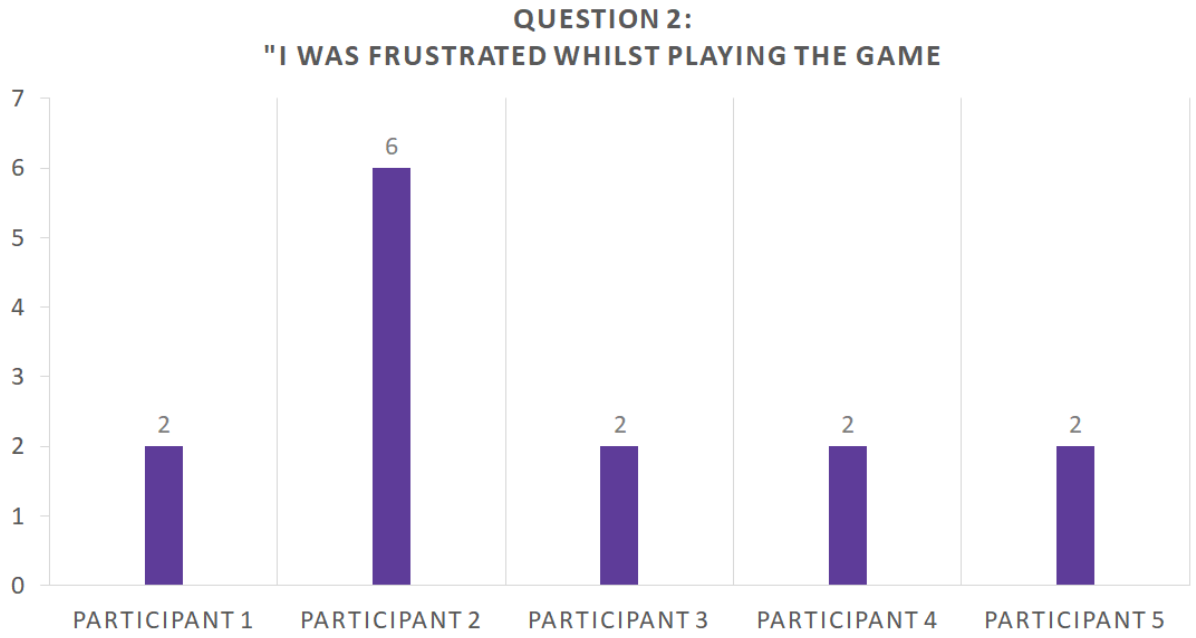


Figure 7.5: Results from Question 2.

Question 2 states the following: “I was frustrated whilst playing the game.”. The results presented in Figure 7.5 reveal that four out of five participants answered “disagree.” Participant 2 answered that he agreed with this statement.

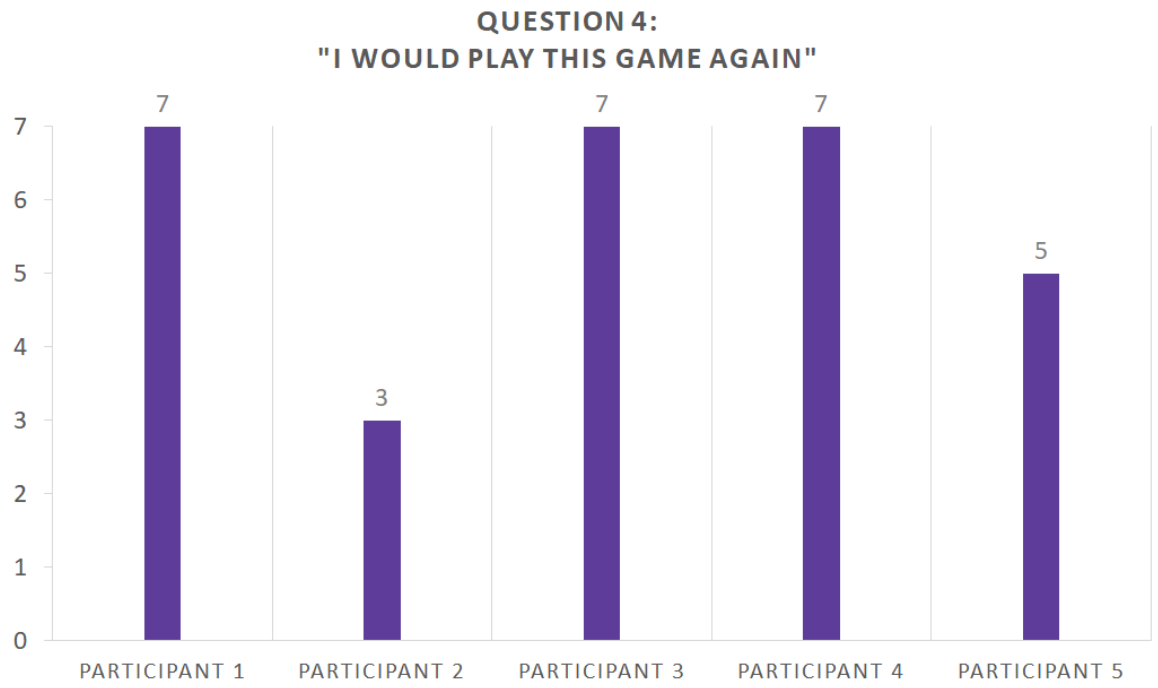


Figure 7.6: Results from Question 4.

Figure 7.6 presents the results from Question 4 stated as follows: “I would play this game again.”. Three out of five participants strongly agreed. Participant 5 answered that they somewhat agreed, while Participant 2 answered that they somewhat disagreed. Participant 2 added a comment while answering this question: “I miss sound effects in the game. Implementing could have made the game more immersive and more realistic.”.

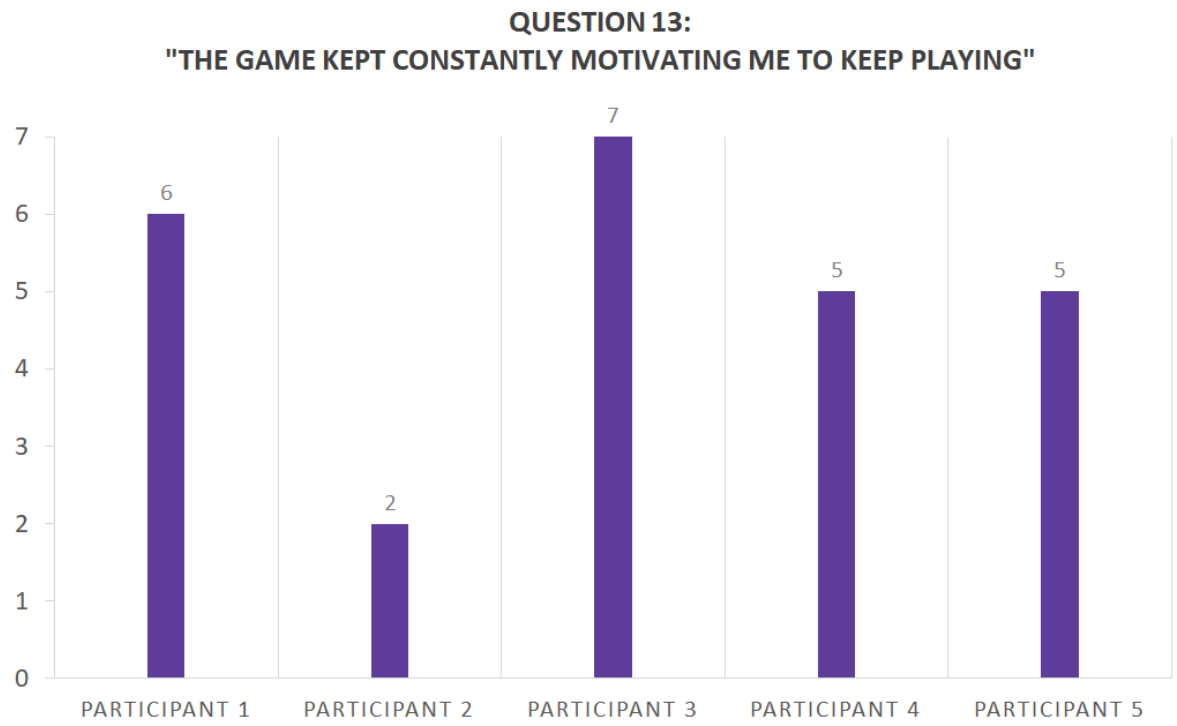


Figure 7.7: Results from Question 13.

Figure 7.7 displays answers from the question, “The game kept constantly motivating me to keep playing.”. From the results, we establish there are some varied answers with four out of five participants agreeing on different levels and Participant 2 disagreeing. Participant 2 had a comment on this answer as well: “This is a good basis for a game like this, but with the game at this stage, it did not motivate me.”

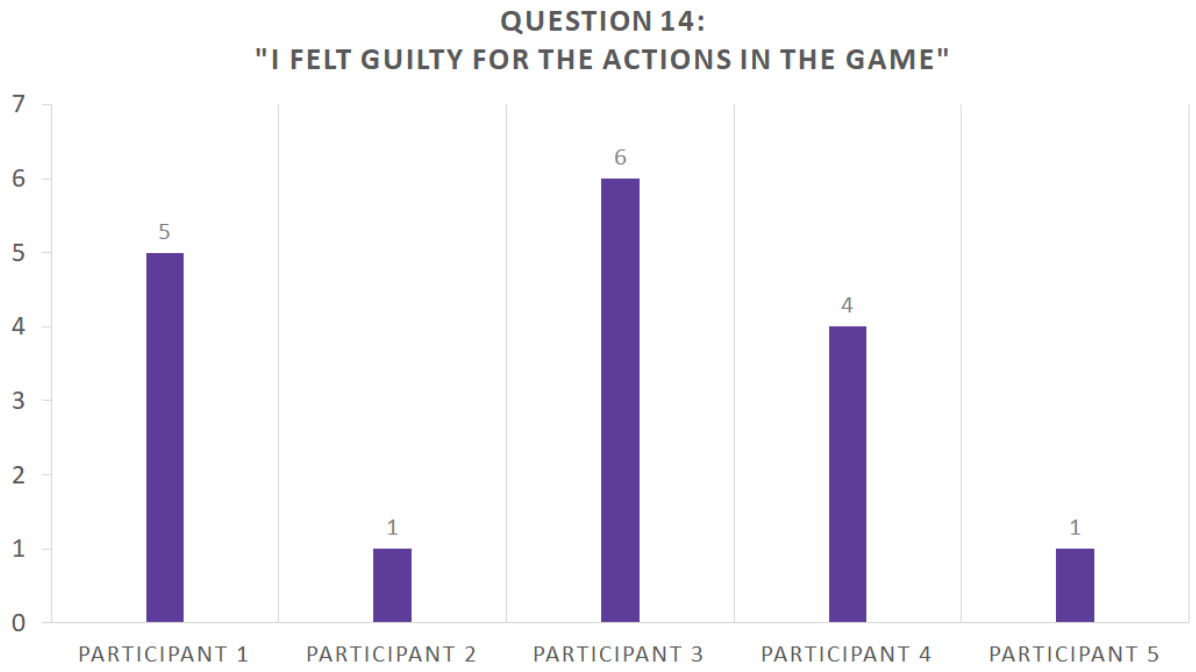


Figure 7.8: Results from Question 14.

Question 14 states the following: “I felt guilty for the actions in the game.”. The results are displayed in Figure 7.8 above. Participants 2 and 5 stated that they strongly disagreed with this. Participants 1, 3, and 4 all agreed on different levels.

7.3 Qualitative feedback

In addition to a quantitative method, the group had a qualitative question, allowing the participants to add their own thoughts. This involved both an input field at the end of the questionnaires, as well as making conversation with participants after the playthrough of VMM. The qualitative feedback from the participants varied with some providing more comprehensive answers than others.

We orally asked the following questions:

“In addition to the motivational and gaming experience questionnaires you have now conducted, do you want to add anything else?”

Participant 1:

> "I think that this idea could work as a good addition to the curriculum of medication management, or even replace the traditional learning method used today. For me it was both fun and motivating. I see this as a relevant method for learning and a method that can motivate students more towards learning about medication. Being able to practically practice with a tool like this, the students could feel more comfortable and experienced before conducting it in real life. With the implementation of sound effects, being able to communicate with doctors, patients, and maybe even other players, I believe this learning tool would suit a simulation of a real-life hospital. The players should also experience some type of stress as it is often a stressful feeling in many hospitals. The only real problem I see with a learning tool like this is the equipment as this is something the school would have to provide to each student."

Participant 2:

"The 'real-life experience' is not quite there, although it is a good basis. It could be implemented into the curriculum, but it would require some work before I would consider it a functional learning tool."

Participant 3:

> "I actually have a family member that is responsible for real-life simulators similar to this learning tool. Simulators in general are a great tool, and it always motivates me. Physical simulators are something we nursing students have been using a lot. I think visual simulators have great potential as well, and VMM could be a good basis for such a tool."

Participant 4:

"This is very cool and fun! I did not even think technology had come this far. Other nursing students and I have been requesting technology to be adapted into our learning methods, so seeing this puts a smile on my face."

Participant 5:

> "I find this prototype interesting. I think the concept is good, and can be built upon. I had a great time testing it. My concern is the financial challenge with using VR for learning. If VR were to be used, I would strongly prefer each student to have their own set of VR equipment for it to be efficient. This equipment would have to be paid for by the univercity, which would be expensive. Having just one VR headset shared with all other students would not be ideal."

8. Discussion

8.1 Increased motivation for learning medication management

The VMM learning tool was developed as a proof-of-concept prototype, which has been tested with test users. In this chapter, we discuss the results regarding the impact of VR (as utilized in the VMM prototype) on medication learning. This has been split in two parts, with the results from the motivation questionnaire discussed first, and secondly the results from the game experience questionnaire.

8.1.1 The motivation questionnaire

We earlier examined the answers from the participants on the motivation questionnaire with results from both before and after the playthrough (Table 7.1). Our participants had an overall high score on many questions before the playthrough, but there are also some changes. In general, the changes are mostly positive, except for Participant 2. There are some interesting findings from the selected questions. The question that states, "I enjoy learning medication management" seen in Figure 7.1, had three out of five participants leaning more toward agreement. This may mean that they enjoyed learning about medication management through VMM, indicating that they would enjoy further learning in such a way. Although Participant 3 did not change their answer, they stated that "...technology has great potential to motivate more nursing students," which indicates that this participant was positive to technology in general being more adapted into the curriculum.

Question 16, seen in Figure 7.2, states, "I believe I can earn a grade of 'A' in medication management." Participant 5 made us aware that students needed a 100% score to pass the medication management test. Participant 5 was also the only one that changed their answer

after the playthrough, which may suggest that they felt more comfortable in their ability to score 100% after trying VMM. There was also another interesting observation regarding Participant 5. The group noticed that they did not want to stop playing before they had administered medication to each patient. Participant 5 might have felt that it was more important to achieve a good score when they could see patients visually. It can therefore be assumed that participant 5 got the feeling of an "intrinsic" responsibility, which can be seen as an internal factor and thus may have influenced the intrinsic motivation. Participant 5 also changed the answer to the question, "Scoring high on medication tests is important to me" from "agree" to "completely agree", which may also support this assumption (Figure 7.3). Lastly, the results on Question 3, “Learning about medication management is interesting” are illustrated in Figure 7.4. We only observed one change, of Participant 4, going from “agree” to “strongly agree.” Ideally, we would have liked to see more changes in a positive manner, but then again all participants had a strong interest toward learning medication management to begin with, which does not leave much room for their opinion to change. With a larger sample size for this project, a larger variety of opinions could be expected, which could have led to other findings.

8.1.2 The game experience questionnaire

In Table 7.2, we examined answers from the game experience (CEGEQ) questionnaire. There are mostly positive answers, but also some disagreements.

The selected questions from the game experience questionnaire also have some interesting findings. Question 2 in Figure 7.5 states, “I was frustrated whilst playing the game.” Four participants answered “disagree,” while Participant 2 agreed. Participant 2 ran into a bug that made it impossible for them to administer medication to one of the patients. This might explain why Participant 2 felt frustrated. In Figure 7.6, we find results from the question “I would play this game again.” Three participants strongly agreed to this statement, Participant 5 agreed, while Participant 2 somewhat disagreed. This might also have been linked with the frustration Participant 2 felt when experiencing the bug. Furthermore, the comment on missing sound effects might have something to do with Participant 2’s answer.

Examining Question 13 in Figure 7.7, we find results from the statement ”The game kept constantly motivating me to keep playing.” All participants answered that they agree on different levels, while Participant 2 answered that they disagreed. The opinion stated by Participant 2 may be linked with their comment above, with them experiencing a bug, as well as the lack of sound effects. Based on the answers from Participant 2, they do not seem to have been immersed during the playthrough of VMM. Lastly, Question 14 found in Figure 7.8 states, “I felt guilt for the actions in the game.” Participants 2 and 5 strongly disagreed with this statement, Participant 1 somewhat agreed, Participant 4 had no opinion, and Participant 3 agreed. Participant 3 happened to administer less medication than prescribed to one of the patients during their playthrough. Participant 3 was not observant enough and did not realize until told in the game’s feedback stage. Participant 3 reacted with slight embarrassment. With this in mind, we might understand why Participant 3 felt more guilty for the actions in the game than others. This can be assumed as extrinsic motivation, because Participant 3 didn't want to look bad in front of the fellow students who were present. Therefore, one may assume that they had motivation based on extrinsic factors.

8.2 VMM user-experience in relation to age

It was originally planned to have a selection of participants that varied more in terms of age. However, there were no older nursing students that could or wanted to participate in this user test. It was intended to test whether age differences could result in a varying outcome in terms of the gaming experience as well as motivation for learning. With this, the group intended to find out if the younger students had an easier time using VR and whether the older students had a different experience - and to see if this had any affect on the test users' motivation. Although the group was not able to recruit older nursing students, VMM was, as mentioned, pretested on two nursing lecturers as mentioned earlier. These lecturers were in the age group of 45–64 years. The lecturers asked the group to perform a playthrough of VMM before conducting the main user test. By observing them under the playthrough, the group could see that they had difficulty both understanding how the controllers worked, and that they experienced cybersickness to a large extent. In both cases, the test had to stop earlier than planned as these lecturers felt uncomfortable using VR. Although there were some difficulties, the lecturers were positive about further development of such a concept.

8.3 Cybersickness

During development and early tests, the group had experienced some effects of cybersickness after replacing the teleportation methode with a continuous movement method. The feeling of walking in the virtual world while standing still in the real world was strange. This feeling was also described by some of the participants during both the pre and main user testing. Even though some cybersickness may be experienced with the movement method (that replaced the original teleportation method), the group believes that it is important to maintain this form of movement to meet this user requirement.

8.4 Limitations

8.4.1 Methods used

Using the DRSM in the project has been beneficial. Following the steps on conducting semi- and unstructured interviews, having workshops and developing a low-fidelity prototype has made the high-fidelity prototype (VMM) full-fledged. The method of using a quantitative motivation questionnaire during user testing of the prototype has given us a general understanding of the test users' motivation towards medication management. Along with the game experience questionnaire, we understood what aspects of the prototype fulfill the users needs, as well as which aspects need additional work to further meet the user needs.

The methods used do not allow to clarify some limitations of understanding nursing students' motivation on an intrinsic / extrinsic level. Looking back at the research from Niemiec and Ryan stated in the theory chapter, intrinsic motivation is important for gaining knowledge through education (Niemiec and Ryan, 2009, p. 136). The methods used do not expose which specific types of motivation the students have to learn about medication management.

8.4.2 Students accessibility and COVID-19

As mentioned earlier, nursing students were recruited through a nursing lecturer, posting information about the project on the University's learning management system "Canvas". Due to first and second year students having internships, and third year students writing their bachelor thesis, their accessibility was limited. Affected also by contact restrictions due to the ongoing COVID-19 pandemic, the recruiting of test users for this project turned out to be

impossible in the intended extent. As mentioned, this project did not have any test users in the target group 34-45, nor 45–64 years for the main test. Based on how the situation was, the group was fortunate to involve five test participants for the project.

9. Conclusion

9.1 Outcome

This research sought to understand how a virtual reality learning tool affects nursing students' motivation in relation to learning medication management. Based on an analysis of the challenges of medication management education, a “Virtual Medication Management” (VMM) tool has been designed, to create a learning scenario that is as realistic as possible for the students, with the support of virtual reality (VR) technology. The observation of nursing students during playthrough of the VMM training scenario has revealed how virtual reality, as implemented in the VMM, has affected nursing students' intrinsic and extrinsic motivation in relation to learning medication management. Most participants were observed having fun while conducting the playthrough of VMM, which can lead to improved learning motivation. Results from questionnaires also indicate an increased motivation towards learning. All participants stated that they would like to see a learning tool like the proposed and tested VMM to be implemented as an additional learning method in their curriculum.

The main contribution of this work is the gain of understanding of how VR can be beneficial in an educational setting that has the potential to reduce medication errors and thus save lives. For that, this project has contributed a VR tool that can enable healthcare professionals to train for stressful and demanding situations in a controlled, safe and emulated environment, that may feel immersive and real - such as what we saw an indication for with Participant 3 - is merely intriguing. Technological advances such as these allow for realistic learning that would otherwise be time-consuming due to the human planning aspect in the real world. Furthermore, we presume that this project could work as a foundation for further research on the relationship between medication management learning and VR. As stated in the introduction, medication errors occur in Norway, and much work still remains to prevent such errors from happening in the future. What we hope this project contributes to is a step in the right direction towards a more motivating learning method for nursing students. This learning

method might better equip nurses in the future with the right tools and knowledge to reduce the chance of medication errors from occuring.

9.2 Future work

Considering that the sample for this project only had five participants, it is difficult to draw a statistically-relevant conclusion. Ideally, this project would have recruited about twenty test users in different age groups. In a future evaluation of VMM, a purely quantitative method shall be used to map nursing students' intrinsic / extrinsic motivation to learn medication management. Conducting this before and after using the VMM tool to measure specifically a possible change in motivation, will provide for additional relevant findings.

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Appendix A Motivation Questionnaire

Hello! Thank you for taking a couple of minutes to help us test our virtual reality application/game by doing these tasks and answering our questionnaire.

The data collected will be used for a Masters project in MM-506-G Master Thesis. The data collected will be deleted right after the project deadline (10.06.2021)

Estimated time for this test and survey is approximately 10 minutes. Thank you in advance!

Sincerely,
Joachim H. Eriksen and Bjørn André F. Hjelle

1. Learning about medication management is relevant to my life.

Strongly disagree	Disagree	Somewhat disagree	No opinion	Somewhat agree	Agree	Strongly agree
(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑	(6) ❑	(7) ❑

2. I like to do better than other students on medication management tests.

Strongly disagree	Disagree	Somewhat disagree	No opinion	Somewhat agree	Agree	Strongly agree
(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑	(6) ❑	(7) ❑

3. Learning about medication management is interesting.

Strongly disagree	Disagree	Somewhat disagree	No opinion	Somewhat agree	Agree	Strongly agree
(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑	(6) ❑	(7) ❑

4. Getting a good medication management grade is important to me.

Strongly disagree	Disagree	Somewhat disagree	No opinion	Somewhat agree	Agree	Strongly agree
(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑	(6) ❑	(7) ❑

5. I put enough effort into learning medication management.

Strongly disagree	Disagree	Somewhat disagree	No opinion	Somewhat agree	Agree	Strongly agree
(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑	(6) ❑	(7) ❑

6. I use strategies to learn medication management well.

Strongly disagree	Disagree	Somewhat disagree	No opinion	Somewhat agree	Agree	Strongly agree
(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑	(6) ❑	(7) ❑

7. It is important that I get an "A" in medication management.

Strongly disagree	Disagree	Somewhat disagree	No opinion	Somewhat agree	Agree	Strongly agree

(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑	(6) ❑	(7) ❑

8. I am confident I will do well on medication management tests.

Strongly disagree	Disagree	Somewhat disagree	No opinion	Somewhat agree	Agree	Strongly agree
(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑	(6) ❑	(7) ❑

9. Knowing medication management will give me a career advantage.

Strongly disagree	Disagree	Somewhat disagree	No opinion	Somewhat agree	Agree	Strongly agree
(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑	(6) ❑	(7) ❑

10. I spend a lot of time learning about medication management.

Strongly disagree	Disagree	Somewhat disagree	No opinion	Somewhat agree	Agree	Strongly agree
(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑	(6) ❑	(7) ❑

11. Learning medication management makes my life more meaningful.

Strongly disagree	Disagree	Somewhat disagree	No opinion	Somewhat agree	Agree	Strongly agree
(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑	(6) ❑	(7) ❑

12. Understanding medication management will benefit me in my career.

Strongly disagree	Disagree	Somewhat disagree	No opinion	Somewhat agree	Agree	Strongly agree
(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑	(6) ❑	(7) ❑

13. I am confident I will do well on medication management projects.

Strongly disagree	Disagree	Somewhat disagree	No opinion	Somewhat agree	Agree	Strongly agree
(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑	(6) ❑	(7) ❑

14. I prepare well for medication management tests.

Strongly disagree	Disagree	Somewhat disagree	No opinion	Somewhat agree	Agree	Strongly agree
(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑	(6) ❑	(7) ❑

15. I am curious about discoveries in medication management.

Strongly disagree	Disagree	Somewhat disagree	No opinion	Somewhat agree	Agree	Strongly agree
(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑	(6) ❑	(7) ❑

16. I believe I can earn a grade of "A" in medication management.

Strongly disagree	Disagree	Somewhat disagree	No opinion	Somewhat agree	Agree	Strongly agree
(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑	(6) ❑	(7) ❑

17. I enjoy learning medication management.

Strongly disagree	Disagree	Somewhat disagree	No opinion	Somewhat agree	Agree	Strongly agree
(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑	(6) ❑	(7) ❑

18. I think about the grade I will get in medication management.

Strongly disagree	Disagree	Somewhat disagree	No opinion	Somewhat agree	Agree	Strongly agree
(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑	(6) ❑	(7) ❑

19. I am sure I can understand medication management.

Strongly disagree	Disagree	Somewhat disagree	No opinion	Somewhat agree	Agree	Strongly agree
(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑	(6) ❑	(7) ❑

20. I study hard to learn medication management.

Strongly disagree	Disagree	Somewhat disagree	No opinion	Somewhat agree	Agree	Strongly agree

(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑	(6) ❑	(7) ❑

21. My career will involve medication management.

Strongly disagree	Disagree	Somewhat disagree	No opinion	Somewhat agree	Agree	Strongly agree
(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑	(6) ❑	(7) ❑

22. Scoring high on medication management tests matters to me.

Strongly disagree	Disagree	Somewhat disagree	No opinion	Somewhat agree	Agree	Strongly agree
(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑	(6) ❑	(7) ❑

23. I will use medication management problem-solving skills in my career.

Strongly disagree	Disagree	Somewhat disagree	No opinion	Somewhat agree	Agree	Strongly agree
(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑	(6) ❑	(7) ❑

Do you have any additional comments?

_____
_____
_____
_____
_____
_____

Thank you for participating in our survey!

Appendix B Game Experience Questionnaire

Hello! Thank you for taking a couple of minutes to help us test our virtual reality application/game by doing these tasks and answering our questionnaire.

The data collected will be used for a Masters project in MM-506-G Master Thesis. The data collected will be deleted right after the project deadline (10.06.2021)

Estimated time for this test and survey is approximately 10 minutes. Thank you in advance!

Sincerely,
Joachim H. Eriksen and Bjørn André F. Hjelle

1. I enjoyed playing the game

Strongly disagree	Disagree	Somewhat disagree	No opinion	Somewhat agree	Agree	Strongly agree
(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑	(6) ❑	(7) ❑

2. I was frustrated whilst playing the game

Strongly disagree	Disagree	Somewhat disagree	No opinion	Somewhat agree	Agree	Strongly agree
(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑	(6) ❑	(7) ❑

3. I liked the game

Strongly disagree	Disagree	Somewhat disagree	No opinion	Somewhat agree	Agree	Strongly agree

(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑	(6) ❑	(7) ❑

4. I would play this game again

Strongly disagree	Disagree	Somewhat disagree	No opinion	Somewhat agree	Agree	Strongly agree
(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑	(6) ❑	(7) ❑

5. I was in control of the game

Strongly disagree	Disagree	Somewhat disagree	No opinion	Somewhat agree	Agree	Strongly agree
(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑	(6) ❑	(7) ❑

6. I remember the actions the controllers performed

Strongly disagree	Disagree	Somewhat disagree	No opinion	Somewhat agree	Agree	Strongly agree
(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑	(6) ❑	(7) ❑

7. I was able to see on the screen everything I needed during the game

Strongly disagree	Disagree	Somewhat disagree	No opinion	Somewhat agree	Agree	Strongly agree
(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑	(6) ❑	(7) ❑

8. I knew what I was supposed to do to win the game

Strongly disagree	Disagree	Somewhat disagree	No opinion	Somewhat agree	Agree	Strongly agree
(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑	(6) ❑	(7) ❑

9. I liked the way the game looked

Strongly disagree	Disagree	Somewhat disagree	No opinion	Somewhat agree	Agree	Strongly agree
(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑	(6) ❑	(7) ❑

10. I like to spend a lot of time playing this game

Strongly disagree	Disagree	Somewhat disagree	No opinion	Somewhat agree	Agree	Strongly agree
(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑	(6) ❑	(7) ❑

11. I got bored playing this time

Strongly disagree	Disagree	Somewhat disagree	No opinion	Somewhat agree	Agree	Strongly agree
(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑	(6) ❑	(7) ❑

12. I did not have a strategy to win the game

Strongly disagree	Disagree	Somewhat disagree	No opinion	Somewhat agree	Agree	Strongly agree

(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑	(6) ❑	(7) ❑

13. The game kept constantly motivating me to keep playing

Strongly disagree	Disagree	Somewhat disagree	No opinion	Somewhat agree	Agree	Strongly agree
(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑	(6) ❑	(7) ❑

14. I felt guilty for the actions in the game

Strongly disagree	Disagree	Somewhat disagree	No opinion	Somewhat agree	Agree	Strongly agree
(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑	(6) ❑	(7) ❑

15. The sound effects of the game were appropriate

Strongly disagree	Disagree	Somewhat disagree	No opinion	Somewhat agree	Agree	Strongly agree
(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑	(6) ❑	(7) ❑

16. I understood the rules of the game

Strongly disagree	Disagree	Somewhat disagree	No opinion	Somewhat agree	Agree	Strongly agree
(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑	(6) ❑	(7) ❑

17. The game was challenging

Strongly disagree	Disagree	Somewhat disagree	No opinion	Somewhat agree	Agree	Strongly agree
(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑	(6) ❑	(7) ❑

18. The scenario of the game was interesting

Strongly disagree	Disagree	Somewhat disagree	No opinion	Somewhat agree	Agree	Strongly agree
(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑	(6) ❑	(7) ❑

19. I did not like the scenario of the game

Strongly disagree	Disagree	Somewhat disagree	No opinion	Somewhat agree	Agree	Strongly agree
(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑	(6) ❑	(7) ❑

20. I knew all the actions that could be performed in the game

Strongly disagree	Disagree	Somewhat disagree	No opinion	Somewhat agree	Agree	Strongly agree
(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑	(6) ❑	(7) ❑

Do you have any additional comments?

_____

_____

_____

_____

_____

_____

Thank you for participating in our survey!

Appendix C Consent Form

Do you want to participate in the research project VR Sykepleier?

You are asked to participate in a research project where the purpose is to investigate the motivation behind the learning tool virtual reality for nursing students. In this consent form, we give you information about the purpose of this project and what participating in this project involves.

Purpose

This is a research project related to a master's thesis for Multimedia and Educational Technology at the University of Agder.

Our purpose with this thesis is to investigate the motivation associated with medication management for nursing students. We want to investigate whether VR can help increase motivation to learn more about medication management.

Virtual reality is a technology that simulates a virtual world. A set of goggles are used to experience virtual reality. Virtual reality is not real, and does not have real life consequences. Virtual reality can be used for both entertainment and education.

Who is responsible for the research project?

The University of Agder is responsible for the project.

Why are you asked to participate?

Since you are a nursing student, we would very much like to have you as a participant in this research project.

What does it mean for you to participate?

If you choose to participate in the project, it involves filling out a questionnaire. It will take you approx. 10 minutes to complete this. After the questionnaire, you will play through the Virtual Learning Sykepleier learning tool and then complete the questionnaire again. The questionnaire contains questions regarding your motivation in medication management. Your answers from the questionnaire will be registered electronically. The questionnaire will contain questions regarding your motivation regarding medication management. In the start of the interview, we will ask you your age and gender. We will also have audio recordings and notes from the interview.

It is voluntary to participate

It is voluntary to participate in the project. If you choose to participate, you can withdraw your consent at any time without giving any reason. All your personal information will then be deleted. It will not have any negative consequences for you if you do not want to participate or later choose to withdraw.

Your privacy - how we store and use your information

We will only use the information about you for the purposes we have described in this article. We treat the information confidentially and in accordance with the privacy regulations.

- People that have access to information gathered around your participation are the students belonging to this project; Bjørn André F. Hjelle and Joachim H. Eriksen. Supervisors for this project will also have access to this; Martin W. Gerdes and Santiago G. Martinez.

- All data collected will be done through the data collection tool SurveyXact. This means that data is stored remotely on their servers. SurveyXact has a collaboration with the University of Agder.

Description of the participants will not be recognizable in the publication of this research project. Only information about gender and age will be included in a publication.

What happens to your information when we end the research project?

The information is anonymised when the project is completed / the assignment is approved, which according to the plan is 10.06.2021.

Your rights

As long as you can be identified in the data material, you have the right to:

- access to which personal information is registered about you, and to receive a copy of the information,

- to have personal information about you corrected,

- to have personal information about you deleted, and

- to send a complaint to the Data Inspectorate about the processing of your personal data.

What entitles us to process personal information about you?

We process information about you based on your consent.
On behalf of the University of Agder, NSD - Norwegian Center for Research Data AS has assessed that the processing of personal data in this project is in accordance with the privacy regulations.

Where can I find out more?

If you have questions about the study, or want to use your rights, please contact:

- University of Agder by Bjørn André F. Hjelle.

Telephone: 46806994
E-mail: bahjelle@gmail.com

- University of Agder by Joachim H. Eriksen.
Telephone: 95169327
E-mail: joaeriks96@hotmail.com

- University of Agder by Martin W. Gerdes.
Telephone: 90798973
E-mail: martin.gerdes@uia.no

- University of Agder by Santiago G. Martinez.
Telephone: 37233472
E-mail: santiago.martinez@uia.no

- Our privacy representative: Bjørn André F. Hjelle.
Telephone: 46806994
E-mail: bahjelle@gmail.com

If you have questions related to NSD's assessment of the project, you can contact:

- NSD - Norwegian Center for Research Data AS by e-mail (personverntjenester@nsd.no) or by phone: 55 58 21 17.

With best regards

Project Manager Supervisors

Bjørn André F. Hjelle Martin W. Gerdes Joachim H. Eriksen Santiago G. Martinez

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Declaration of consent

I have received and understood information about the project VR Sykepleier, and have had the opportunity to ask questions. I agree to:

- to participate in the questionnaire
- to participate in user testing of application

I agree that my information will be processed until the project is completed

--- --- ------------

(Signed by project participant, date)

Appendix D Functional Requirements

Requirement: #1	**Type:** 9	**Use Case:** 4
Description: The user should be able to move within the environment.		
Rationale: Must be implemented for the user to be able to conduct user tasks.		
Source: Bjørn André Fauske Hjelle		
Fit Criterion: The user is able to use controllers to move within the learning tool.		
Customer Satisfaction: 5		**Customer Dissatisfaction:** 5
Priority: 1		**Conflicts:** 0
Supporting Materials:		
History: Created October 2, 2020		

Requirement: #2	**Type:** 9	**Use Case:** 1
Description: The user should be able to grab and drop pills.		
Rationale: Must be implemented for the user to be able to give pills to patients		
Source: Bjørn André Fauske Hjelle		
Fit Criterion: The user is able to grab a pill using a button.		
Customer Satisfaction: 5		**Customer Dissatisfaction:** 5
Priority: 1		**Conflicts:** 0
Supporting Materials: Figure 4.8		
History: Created October 2, 2020		

Requirement: #3	**Type:** 9	**Use Case:** 0
Description: The user should be able to open and close doors.		
Rationale: Should be implemented for a real-life effect.		
Source: Bjørn André Fauske Hjelle		
Fit Criterion: The user is able to open and close doors.		
Customer Satisfaction: 3		**Customer Dissatisfaction:** 3
Priority: 2		**Conflicts:** 0
Supporting Materials:		
History: Created October 2, 2020		

Requirement: #4	**Type:** 9	**Use Case:** 1
Description: Pills spawn upon interacting with the appropriate pill container.		
Rationale: Must be implemented for the user to be able to give pills to patients		
Source: Bjørn André Fauske Hjelle		
Fit Criterion: The appropriate pill spawns when their pill container is clicked.		
Customer Satisfaction: 5		**Customer Dissatisfaction:** 5
Priority: 1		**Conflicts:** 1
Supporting Materials:		
History: Created October 2, 2020		

Requirement: #5	**Type:** 9	**Use Case:** 0
Description: The user should be able to carry multiple pills at a time.		
Rationale: Should be implemented to increase usability and real-life effect.		
Source: Bjørn André Fauske Hjelle		
Fit Criterion: The user is able to carry multiple pills in some way.		
Customer Satisfaction: 5		**Customer Dissatisfaction:** 4
Priority: 2		**Conflicts:** 0
Supporting Materials:		
History: Created October 2, 2020		

Appendix E Non-Functional Requirements

Requirement: #6	**Type:** 11	**Use Case:** 0
Description: The environment should look familiar to a real-life hospital		
Rationale: Should be included to experience more immersion.		
Source: Joachim H. Eriksen		
Fit Criterion: The test users can recognize it as a virtual hospital.		
Customer Satisfaction: 5		**Customer Dissatisfaction:** 5
Priority: 1		**Conflicts:** 0
Supporting Materials: Figures 6.1, 6.2, 6.3, 6.6, 6.7, 6.8, 6.9, and 6.10		
History: Created November 10, 2020		

Requirement: #7	**Type:** 11	**Use Case:** 0
Description: User movement should feel natural.		
Rationale: Should be implemented to increase immersion.		
Source: Joachim H. Eriksen		
Fit Criterion: The user thinks the movement feels natural.		
Customer Satisfaction: 3		**Customer Dissatisfaction:** 5
Priority: 3		**Conflicts:** 0
Supporting Materials:		
History: Created October 2, 2020		

Requirement: #8	**Type:** 26	**Use Case:** 0

Description: The learning tool should have appropriate sound effects

Rationale: Should be included to experience more immersion.

Source: Joachim H. Eriksen

Fit Criterion: Objects has appropriate sound effects

Customer Satisfaction:	**Customer Dissatisfaction:**
3	2
Priority: 3	**Conflicts:** 0

Supporting Materials:

History: Created November 15, 2020

Requirement: #9	**Type:** 11	**Use Case:** 0

Description: The learning tool should present instructions on how to play

Rationale: Must be presented so user knows what to do

Source: Joachim H. Eriksen

Fit Criterion: The user understands how to use the learning tool.

Customer Satisfaction:	**Customer Dissatisfaction:**
5	5
Priority: 1	**Conflicts:** 0

Supporting Materials:

History: Created November 20, 2020

Requirement: #10	**Type:** 13	**Use Case:** 0

Description: The learning tool should not require too much real life space to use

Rationale: Should be limited to increase accessibility in smaller environmental spaces.	
Source: Bjørn André Fauske Hjelle	
Fit Criterion: The user is able to use the learning tool within a set area.	
Customer Satisfaction: 2	**Customer Dissatisfaction:** 2
Priority: 3	**Conflicts:** 0
Supporting Materials:	
History: Created January 5, 2021	

Requirement: #2	**Type:** 11	**Use Case:** 0
Description: The user should be given feedback on their tasks		
Rationale: Should be included for learning outcome.		
Source: Joachim H. Eriksen		
Fit Criterion: The test user gets appropriate feedback upon finishing the playthrough.		
Customer Satisfaction: 5		**Customer Dissatisfaction:** 5
Priority: 1		**Conflicts:** 0
Supporting Materials: [insert figure number]		
History: Created November 10, 2020		