Master's thesis

NTNU
Norwegian University of Science and Technology
Faculty of Architecture and Design
Department of Design

HENRIK MARTIN KRISTIANSEN

Virtual reality for nursing education

Optimising, exploring, and imagining the use of virtual reality in education of procedures for nurses

Master's thesis in Industrial Design Engineering
Supervisor: Ashis Jalote Parmar
Co-supervisor: Aslak Steinsbekk

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Preface and acknowledgements

Preface

This thesis constitutes the master's thesis as defined by the subject TPD4900. The thesis was written during the fall semester of 2021 by Master's student Henrik Martin Kristiansen, Faculty of Architecture and Design.

This thesis is written as a collaboration between the author and the ongoing research project "VirSam" (Virtuell Samhandling) led by Aslak Steinsbekk at the Department of Public Health and Nursing at NTNU. The goal has been to present insights, concepts and results about how virtual reality (VR) can be used in the education of nurses in the near future, as well as an understanding of how design and science research can co-exist when creating end-user-centric solutions in the health domain.

Acknowlegements

Firstly, I would like to offer my thanks to my supervisors: Ashis and Aslak. Thank you for keeping up with my ideas and mindset for this project. Secondly, a special thanks to Eivind and the administrative staff at Øya Helsehus, as well as my flatmates Jostein and Einar. Thirdly, a thanks to all students and contributors who attended my interviews. Last but certainly not least, I would like to thank my partner Caroline for keeping up with me and offering me her help this fall. It is hard to imagine if any of this would be possible without her.

Note to the reader

The findings in this thesis are intended for future designers, researchers and medical professionals who are considering using VR for educating medical professionals and want to look at the problem from a different perspective. The results are vague and aim to be a source of inspiration for further research and development in the domain.

The content of this thesis is inspired by, but not strictly following, a traditional research structure. My process has adapted and evolved as new insights and findings of the user group, VR and context have been uncovered. Additionally, I am coming from a point of view that has yet to be included in the development of this research project. Even though some hypotheses about the current state of the problem were made before I started the project, it is not in a designer's nature to take on trust results without first investigating the origin of the problem. The following quote from Jerald's The VR Book (2015) describes the process well:

"A human-centred design principle, like lean methods, is to avoid completely defining the problem at the start and to iterate upon repeated approximations and modifications through rapid tests of ideas with real users"

Abstract

This thesis explores and imagines how educational virtual reality (VR) software can be designed to be usable, desirable and engaging for nursing students at NTNU, Trondheim. An existing solution from the research project “VirSam” the Department of Public Health and Nursing is used as a platform for testing and a springboard for new ideas.

Through interviews, observations and user tests the master’s student has found that nursing students experience a feeling of unrealised potential in their education with regards to simulation training, and the possibility for including VR software in the study program is very much welcomed by both students and educators. VirSam’s VR-application application for clinical procedure training represents a good start, however, the application is experienced as too limited regarding functionality and scope to be thought of as a long-term solution for procedure training.

VR in nursing education is first explored through an objective literature study of relevant topics. Subsequently, a process of exploration and insight gathering creates an understanding of the current solution and context of use. The findings are then analysed and concretised to actionable ideas. The ideas focus on meeting the student’s need for scalability and feedback, receiving good feedback by students, educators and other relevant contributors. Additionally, the thesis discovers that using pairs of students, where one is inside VR and the other is observing and subsequently giving feedback, can be of great educational and motivational effect.

Still, the master student’s research suggests that there are unrealised needs in nursing education perceived by the students, which are not met by the new VR solutions alone. The thesis reflects upon the role of VR in nursing education, discussing that it should be based on the inherent strengths and weaknesses of VR, as well as be evaluated against what the students feel is lacking in the education. The master’s student concludes by suggesting and illustrating how VR should be used to simulate more challenging, complex and stressful scenarios than what is presented in VirSam’s solution, exemplified through a future concept.

Further exploration into the presented solution’s end-user effects is needed in order to draw more concrete conclusions on possible next steps. More experimentation on how to integrate VR in nursing education is needed to understand the technology’s role in the context.

Sammendrag

Denne masteroppgaven utforsker og illustrerer hvordan pedagogiske “virtual reality” (VR) programmer kan bli designet for å være mer brukbar og engasjerende for sykepleierstudenter ved NTNU, Trondheim. En eksisterende løsning fra forskningsprosjektet “VirSam” ved Institutt for samfunnsmedisin og sykepleie er brukt som en plattform for testing og springbrett for nye ideer.

Gjennom intervjuer, observasjoner og brukertester har masterstudenten funnet at sykepleierstudenter kjenner et urealisert potensiale for mer simulasjonstrening i utdannelsen, og muligheten for bruk av VR er ønsket av både elever og lærere. VR-programmet for klinisk prosedyretrening laget av VirSam representerer en god start, men programmet oppleves som for begrenset med tanke på funksjonalitet og omfang for å være en langsiktig løsning for mangelen på prosedyretrening.

VR i sykepleieutdanning er først utforsket gjennom en objektiv litteraturstudie av relevante tema. Deretter følger en prosess med utforsking og samling av innsikt fra brukskonteksten. Funn er så analysert og konkretisert til håndfaste tiltak brukes til videre ideutvikling. Ideene har fokus på å møte individuelle studentenes behov for skalerbarhet og tilbakemelding, og har fått god tilbakemelding fra studentene, lærere og andre medvirkende. Det blir også gjort eksperimenter hvor to-og-to studenter, der en er i VR og gjennomfører oppgaver, og en utenfor og observerer og deretter gir tilbakemelding, som ga indikasjon for å kunne gi gode lærings- og motivasjonseffekter.

Masterstudentens undersøkelser indikerer at det er uløste utfordringer opplevd av studenter ved utdanningen som ikke kan bli møtt løst med VR alene. Denne oppgaven reflekterer omkring VR sin rolle i sykepleieutdanning, og diskuterer at bruk inkludering av teknologien burde ta høyde for VR sine iboende styrker og svakheter, samt evaluere det opp mot hva som oppleves som mangler av studentene. Masterstudenten konkludere med og illustrerer at VR burde brukes til å simulere mer utfordrende, komplekse og samarbeidende opplevelser, eksemplifisert av et fremtidig konsept.

Videre utforskning av det presenterte konseptets sluttbrukereffekter må gjennomføres for å kunne trekke tydeligere konklusjoner. Mer utforsking omkring inkludering av VR i sykepleierutdanning for å bedre forstå teknologiens fremtidige rolle i brukskonteksten.

About the project

This master's thesis is an exploratory design project focusing on the usage and possibilities for nursing education in virtual reality.

The master's contract has been created to have as much room for exploration and design research as possible, and still be tied to and relevant for the domain and similar research. Having the project be of the exploratory variety leaves room for experimentation and tangents on the expense of depth. The project goal has been to present a broad view on the problem, and use the findings to create possible future solutions for the problem space.

The project has been defined and written by own initiative, and should not be considered a part of the ongoing research project VirSam. VirSam's research and results are to be considered a case in this project, and the results of this project have no guarantee to be implemented in further research.

NTNU
Fakultet for arkitektur og design
Institutt for design

Masteroppgave for student Henrik Martin Kristiansen

Optimalisere brukerreisen av VR-basert simulatortrening for utdanning av helsepersonell

Optimizing the user journey of VR-based simulation training for education of health professionals

Helsepersonell er trent i en rekke forskjellige teknikker, metoder og kommunikasjonsferdigheter for å evaluere og behandle pasienter. Fordi yrket ofte er et resultat av utdanningstilbud fra institusjoner, individuelle utdanningsforløp og subjektive læringsprosesser, er det utfordrende å sørge for at alle opplever den samme kvaliteten i utdanning og opplæring.
Virsam, et pågående prosjekt ved NTNU, utvikler VR (viritual reality)-baserte simulasjoner for utdanning og trening av helsepersonell. Simulasjonene er basert på eksisterende metoder brukt i både trening og utførelse av flere oppgaver. VR-teknologi har potensiale for å gjøre metodebasert utdanning mer tilgjengelig for både kommende og eksisterende helsepersonell, men dersom teknologien ikke møter brukerens kompetansenivå, behov eller interesser vil løsningene ikke være mer enn gimmicks.

Denne oppgaven vil basere seg på metoden/applikasjonen «ABCDE» med den hensikt å oppdage, identifisere og definere tydelige strategier for bedre introduksjon, utførelse og fortsettelse av VR-applikasjonen. Målet er å gi Virsam tydelige strategier, idéer og/eller funksjonalitet som vil bidra til å gjøre produkttilbudene i VR mer effektive som pedagogiske fartøy for målgruppen.

Oppgavens gjøremål:

- Litteraturstudie omkring temaene VR-teknologi, VR-designparadigmer, VR-simulasjon, utdanning av helsepersonell, oppgave- og informasjonsvisualisering.
- Planlegge, gjennomføre og evaluere intervjuer med helsepersonell, studenter og lærere.
- Idégenerere, prototype og utvikle brukerreiser, bruksflyter og funksjonalitet som bidrar til introduksjon, brukbarhet og læringseffekt.
- Testing, evaluering og iterasjon sammen med helsepersonell.

Oppgaven utføres etter «Retningslinjer for masteroppgaver i Industriell design»
Ansvarlig faglærer (hovedveileder ID): Ashis Jalote Parmar
Biveileder (ISM): Aslak Steinsbekk

Utleveringsdato: 26.08.21
Innleveringsfrist: 19.01~~.22~~

Trondheim, NTNU, 26.08.21

Ashis Jalote Parmar (ID)
Ansvarlig faglærer

Sara Brinch
Instituttleder

Dictionary

VR Virtual reality, all-encompassing immersive digital environments. Often experienced through HMD's

AR Augmented reality, digital overlay over the real world where digital elements are augmented

MR Mixed reality, merge between VR and AR where digital worlds can react to real environments and objects

XR Extended reality, collective term for VR, AR and MR

HMD Head mounted display

Quest 2 HMD from Meta (formerly Oculus / Facebook)

VirSam "Virituell Samhandling", ongoing research project at NTNU

Øya Helsehus Campus for nursing education in Trondheim

ABCDE Clinical procedure, see page 81

NEWS Clinical procedure, see page 82

ISBAR Clinical procedure, see page 83

Clinical procedure Described workflow of steps to be performed to solve a task

Clinical Observation and treatment of actual patients rather than theoretical or laboratory studies

Stakeholder Interested party that can influence the concept or product

Contributor Someone who has influenced the decision-making and process

Target user The intended demographic for the solution

Table of contents

17 **01 Introduction**
18 Motivation and importance of topic
18 Purpose and research questions
20 Contribution
21 Scope
23 Goal
24 Target users
25 Contributors
26 Process and Gantt

29 **02 Methodology**
30 Scientific research and design
32 Design theory
40 Research methods

51 **03 Literature**
52 Introduction
53 VR Technology
60 Pedagogial methods
62 VR in education
65 Disucssions and predictions for the future
66 Relevant examples of VR

75 **04 Exploration & Insights**
76 Introduction
76 Research Questions
77 Methods
80 Evaluation of VirSam's VR-application
98 Exploring the nursing education
119 Closing thoughts

121 **05 Analysis**
122 Introduction
123 Research Questions
124 Establishing the target users
130 Student's model of the education
134 VR in relation to the skill education
138 Defining the focus areas
148 Establishing a vision for future work
149 Closing thoughts

151 **06 Experimentation**
152 Introduction
152 Research Questions
153 Methods
154 Concept 1: laptop prototype
172 Concept 2: VR prototype
190 Side-experiment: Peer-to-Peer feedback
198 Discussion
201 Closing thoughts

203 **07 Imagining**
204 Introduction
205 End-user effects
210 "Game" mechanics of the concept
213 Ideation
214 Elements
216 Concept presentation
222 Evaluating the concept

227 **08 Discussion**
237 **09 Conclusion**
242 **References**
254 **Appendix**

01
INTRODUCTION

This chapter will introduce the topic and research questions of this thesis, as well as an introduction to the target users and contributors.

17 **01 Introduction**
18 Motivation and importance of topic
18 Purpose and research questions
20 Contribution
21 Scope
23 Goal
24 Target users
25 Contributors
26 Process and Gantt

Motivation and importance of topic

Virtual Reality (VR) technology has the potential to both digitise current practises and offer new ways of educating nurses, as well as make knowledge more accessible and standardised for students across institutions. The immersive effect that VR has upon its users has proven to be effective for education (Schmidt, 2014; Kavanagh et al., 2017; Jerald, 2016), especially in the medical field (Gutierrez, Pierce, Vegara, Coulter & Saland, 2007; Fominykh et al., 2018; Berg & Steinsbekk, 2020; Gåsbakk et al. 2017; Wan & Lam, 2019). However, there are several limitations with the technology, among them the core design of the applications and interfaces (Stauffert et al., 2020; Lackner, 2014; Kavanagh et al., 2017; Jerald, 2016). Design represents an important translational layer between human users and solutions, however it is a perspective that is having problems integrating into research and practice (Zimmerman et al., 2007; Kavanagh et al., 2017; Jerald, 2016). Therefore, I see it apt to explore how we can make sure that needs of the end-user, the student, are met when faced with new technologies such as VR.

Nursing is a socially critical occupation, and ensuring that all graduating students have experienced the same level of quality in their education is an ongoing process. In 2019 the Department of Education in the Norwegian Government presented their regulations on national guidelines for nursing education, valid from 1st of July 2020 (Kunnskapsdepartementet, 2019), with varying degree of successful implementation of the guidelines (Amundsen, M., Rasmussen, I. & Sverdrup, S. 2021). There seems to be room for new solutions regarding nursing education that are yet to be fulfilled.

Purpose and research questions

The purpose of this thesis is to contribute towards understanding and conceptualising how VR can be used for the education of health professionals in general and nurses specifically.

The basis of this thesis has been built upon, but is not limited to, VirSam's developed application for training on the ABCDE procedure. ABCDE is a clinical survey tool for evaluating the patient's condition.

RQ1: How is procedure training in VR currently experienced by target users, and what can we learn from it to construct future concepts?

First, I evaluate the ABCDE application using design heuristics. Through user-testing with the target demographic and subsequent semi-structured interviews, I obtain an understanding of the purpose and usability of the application.

RQ2: How is the study program for nursing education in Trondheim experienced by its students?

Second, I ask the student how they feel about the study programme, and what they would like to see be improved. This is acquired through interviews and observations.

RQ3: "In what context of nursing education might VR be used to best meet the student's educational goals and requirements?"

Third, I investigate the context in which VR is intended to be used. Through interviews with the students, educators and other contributors, I will obtain a designers perspective of how the study is currently planned and structured, and construct an opinion of where VR can be best used.

RQ4: How can we best meet the student's requirements using VR as an educational tool?

Last, I develop my concepts based on the insights from the former research questions. Rather than focusing on the requirements of the institute and study, this chapter focuses on the individual student's requirements and needs.

Contribution

As mentioned in the *Note to Reader* section, I am entering this project from a perspective that is heuristic. Meaning: not fully developed and with elements that need to be explored further. Arguably, this is also the most valuable contribution from this thesis. Research conducted for this thesis about education in VR indicates that one of the biggest hurdles is, in fact, the design of the program. This is true not only of the user interface but of the value proposition and utility of VR in the defined context.

Creating products and solutions is a balancing act of resources and knowledge. The user's wants, needs and expectations change continuously, and knowing how to adapt and change the solutions to better fit the needs is a domain of its own. The current suite of VR solutions by VirSam has, arguably, been mainly driven by the domain of science and technology. It is where science and technology interact with human users that we find design.

When looking at a problem with a designer's mindset, you are looking at the users in conjunction with the solution. Designers continuously alternate between "solving the right problem" and "solving the problem in the right way", and they are not afraid of deviating from the planned route. Designers are not driven by science or technology per se. Instead, we apply scientific methods to find the problems and use new technology to solve them. At the end of the day, designers are driven by the end-users and their requirements. The presentation and execution of this mindset applied to the research questions is what the reader will find in this thesis.

This thesis has used the *reframing method*, an alternative design methodology, in conjunction with human-centred design and design-based research to answer the research questions. The result is a new take on how to look at procedure training for nurses in VR. The thesis is structured in three main chapters, all looking at the problem at different levels.

Scope

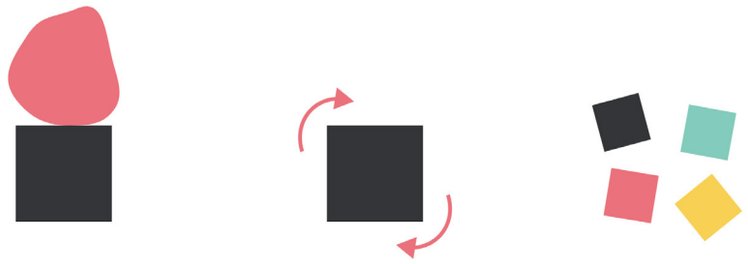
As stated, this thesis uses learnings and solutions from the ongoing research project called VirSam. Using an already established foundation has been valuable for this thesis' progression, but also means that the results of this thesis will naturally be viewed in the context of the work done by VirSam. In order to differentiate this thesis' contributions the scope needed to be clearly defined.

In the early stages of the thesis, it was decided that there were three ways to advance the project:

1. Build on the solutions already made by VirSam to target certain user groups (for example professional novice users) more specifically.

2. Iterate on the ABCDE-application to include more of simulation training as it is today (for example, including soft-skills like empathy).

3. Take a step back and evaluate, speculate, and ideate what role VR could have in skill-based education.



From the outside perspective it is arguably clear that the usage of VR technology in the education of health professionals is in its early days (Fominykh et al., 2018; Berg & Steinsbekk, 2020; Gåsbakk et al. 2017). Going into this project I personally was a sceptic of the utility value of VR – it's just a gimmick, right? These prejudices might seem like I've made a terrible mistake choosing this project, but I would argue against it. Having someone who is not smitten by the promise of VR to design the experience might be more effective in the long run. I'm entering with an eagerness to explore how this technology can be used to aid in the education of the people who are going to take care of me when I'm sick.

Therefore, I chose outcome number 3, and for some specific reasons:

- VR has specific strengths and weaknesses tied to soft- and hardware that are still undiscovered and developing
- Learning a skill is an educational journey that takes time, and some parts of this journey might be better suited for VR than others
- Re-thinking how applications could and should be developed to best meet the end-user's requirements might result in new and interesting ideas
- There is room and need for conceptual innovation, rather focusing on incremental iteration of VirSam's applications

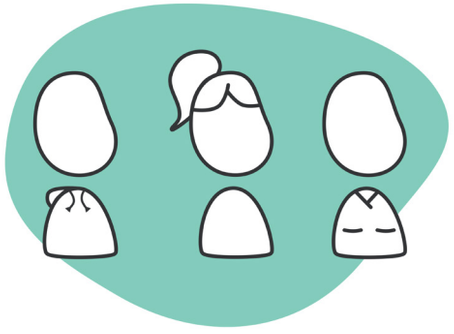
Goal

The goal is to create clear strategies, guidelines, user journeys and design concepts for VirSam (and other recipients in the medical educational field) to help them create better product offerings in VR for nursing students.

Target users

The target users are the pool of students who have been interviewed and used for testing VirSam's application and later concepts. They were at several occasions throughout the fall between August and November, and were found through personal acquaintances and recruitment posters at the campus (see Appendix C for the poster).

In total, 10 individual target users were recruited for the studies. The target users included 1st grade (n = 5), 2nd grade (n = 1), 3rd grade nursing students (n = 1) and professional nurses with almost a year of working experience (n = 3) (the latter are also referred to as students in the thesis). Their ages ranged from 18 to 27 years old. In order to have as good of a representation of the end-user base as possible, it was preferred they had little experience in VR. The group were asked to participate in an interview or a test a total of three times, and varied in size from 3 to 10 participants.

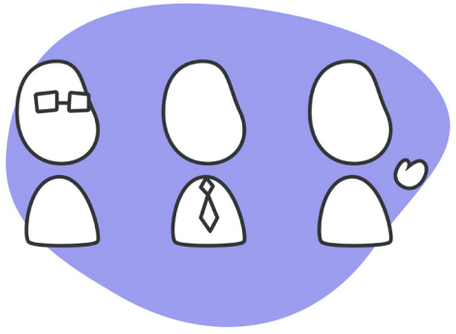


Contributors

The contributors are people who have been interviewed for this project about their expertise and/or experience, and asked to evaluate and offer opinions regarding the topic and final concepts. The contributors were recruited as seen necessary throughout the semester, and were found through personal acquaintances and searching online. They were selected based on the relevance to the project topics. Each contributor was interviewed once during the semester.

The group is made up of 9 contributors from different companies and organisations. These included the study program coordinator and educators from Øya at NTNU, professor at NTNY, former nursing education students, design science researcher from Sintef, mentor at Trams, curriculum manager at MedEasy and product developers at Laerdal Medical.

Complete list of contributors are found in *Refrences*.



Process timeline

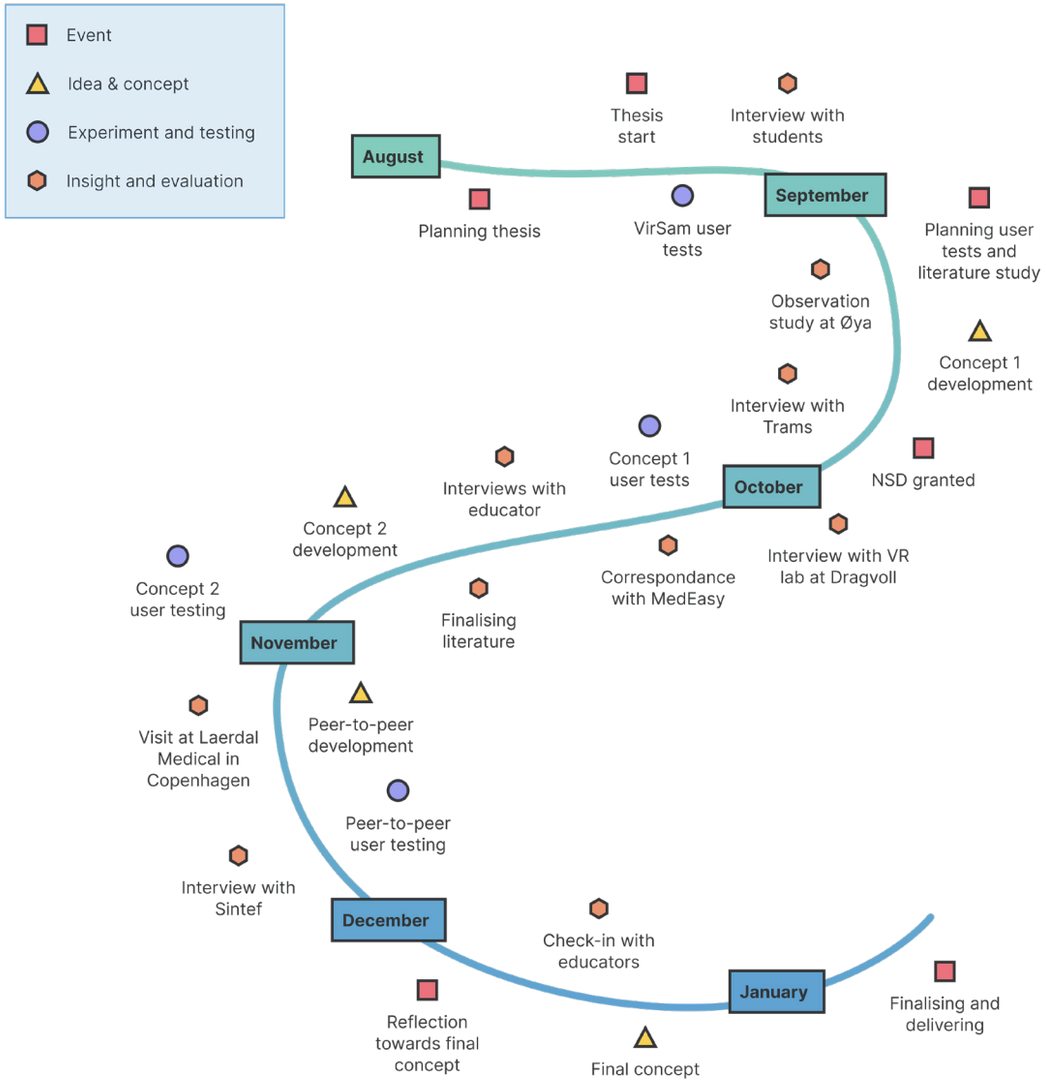


Figure 01-01: Process timeline

Gantt Diagram

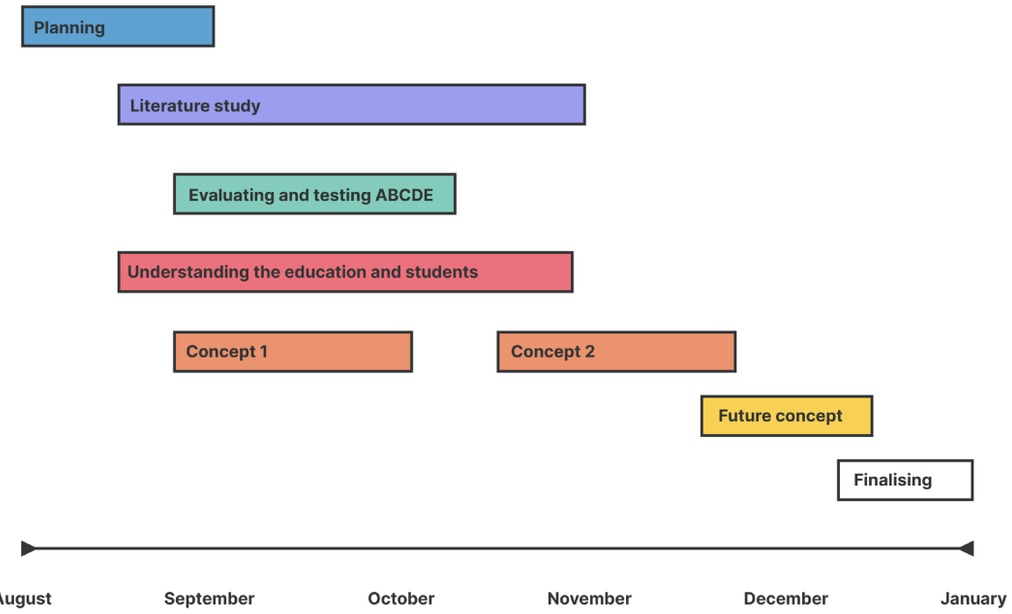


Figure 01-02: Gantt diagram of the project

02 METHODOLOGY

This chapter will present the methodologies that have been used to conduct the research, evaluate the findings and present the results.

29 **02 Methodology**
30 Scientific research and design
32 Design theory
40 Research methods

Scientific research and design

Design-based research

Design-based research (DBR) is a relatively “new” research method that has arisen alongside the focus on design as a profession over the last couple of decades (Anderson & Shattuck, 2012). Most frequently used as a development methodology in education, DBR benefits from being a more practical research methodology that bridges the difference between research and practice in formal education. DBR as a methodology is designed by and for educators that want to improve the impact, transfer and translation of educational research into measurable improved practice (Joseph, 2004; Anderson & Shattuck, 2012). The methodology has been known through other aliases, such as “design-research” (Oh & Reeves, 2010) and “development research” (Conceição, Sherry, & Gibson, 2004; Oh & Reeves, 2010), but has converged towards “design-based research”. DBR approaches research, in education, by using intervention to gain insight into learning in realistic in-world contexts (Joseph, 2004), and can be defined by the following (Anderson & Shattuck, 2012): “Being situated in a real-world educational context”.

Design versus science research

The medical field has intrinsically been based on science and research. Jerald (2016) describes the scientific method as an approach where observations lead to hypotheses, which are then tested in carefully controlled and replicable environments using pre-made protocols. To ensure the validity of the tests’ results, the results should be replicated several times. Through analysis, conclusions are drawn from the results. It is a tried and true methodology, and in most research projects considered a “best practice”. However, Jerald (2016) also says:

> *“Best practises are not the ‘truth’ but have been found to be useful in the way we think about design and interaction. Studying theory can be useful, but VR development should always follow pragmatism over theory.”*

When using a scientific approach, the intention is to build upon previous knowledge to do experiments, document the results and lay the foundation for others to either replicate or build upon. In comparison, the intention of using a design-based approach is not necessary to document everything with the goal of having others replicate the result - the goal is the result itself (Zimmerman et al., 2007) (IDEO). Of course, it is beneficial for many reasons to have proper documentation of the process, but this should not come at the expense of designing the solution. Arguably, whereas the scientific approach prides itself by creating set plans and following them, the design-based approach is not afraid of, but in fact encourages, rapid evaluation and changing of plans and protocols based on new insights.

Design Theory

It is a common misconception that designers focus solely on the visual and aesthetics of computer software and physical hardware (Zimmerman et al., 2007). This is not surprising, as even practising designers are having problems with defining the idea - there is no single definition (IDEO). Some describe it as “the discovery of mental models”, “a discipline focused on the whole instead of the parts” and “a desire to understand users” (Zimmerman et al., 2007). This subchapter is not trying to define design, but rather present design in the context of this thesis.

Design thinking

Design thinking is a well-known concept at this point, both within the design community and beyond. Tim Brown, the executive chair of IDEO, defines it as (IDEO):

> *“... a human-centred approach to innovation that draws from the designer’s toolkit to integrate the needs of people, the possibilities of technology, and the requirements for business success”*

Design thinking is a viewpoint, mindset, and philosophy. It is a way of thinking about the world – how humans interact with each other, physical products, and digital technology (Norman, 2013; IDEO). Design thinking is found in the intersection between desirability, viability and feasibility of a solution (IDEO), and designers always consider the most minute detail in every decision, and how all these minute details add up to an experience (Razzouk & Shute, 2012). The user and the context of use is always in the centre of design thinking, and every small interaction, graphical element, snippet of audio and line of text is supposed to be evaluated by the end user – not the designer or developer (Norman, 2013).

The designer has a difficult role in all of this. We are trusted with crafting these complex experiences, all within set timelines and budgets. We make sense of ideas, make things look pretty and aid in usability and understanding. Designers with experience have a built-in gut feeling telling them what works and what does not, but these are still only gut feelings. Decisions need to be evaluated by the users, making designers simply messengers for end-users more than anything else (Norman, 2013)(Jerald, 2016).

Human-centred design

Human-centred design is a cyclical process that has its origin in the end-users’ needs and requirements. Figure 02-01 shows a standardised version of the HCD process, ISO9241 (ISO, 2019).

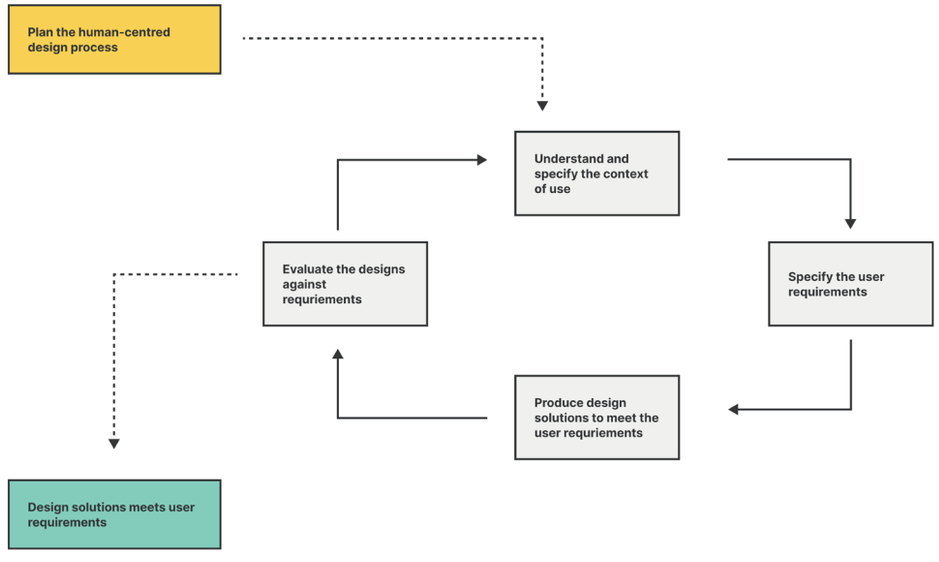


Figure 02-01: Simplified illustration of the HCDE process (ISO)

Double Diamond

Throughout the steps of the HCD process, a designer typically varies between looking broadly at the problem, and focusing on smaller parts of it. This process of diverging and converging is a fundamental design process called the Double Diamond (DD) of decision making, seen in *Figure 02-02*. DD is about considering several options, and can be used at every step in the HCD process. By asking if we are considering the right problem and the right outcome at each step, no problem is left unexplored and no solution is left unconsidered (IDEO)(Norman, 2013).

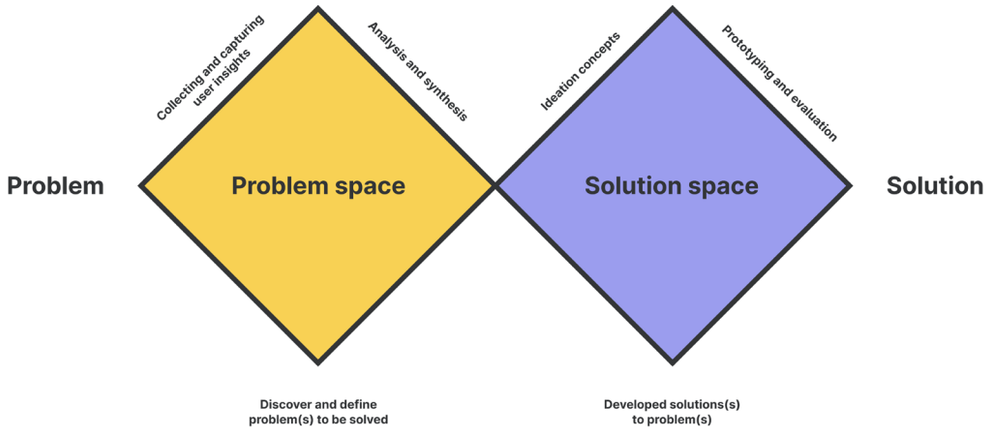


Figure 02-02: Illustration of the “double diamond“ process (Norman, 2013)

In this thesis, both design thinking, human centred design and double diamond have been used as decision-making frameworks for evaluating insights, ideas and concepts.

Reframing method

The reframing method is a central influence for this thesis. It tints and affects every step in the process; from creating research questions and goals, to deciding how to conduct insights and evaluate findings. In short, the reframing method is apt for creating products and services that last, both now and in the future (Hekkert & Van Dijk, 2011).

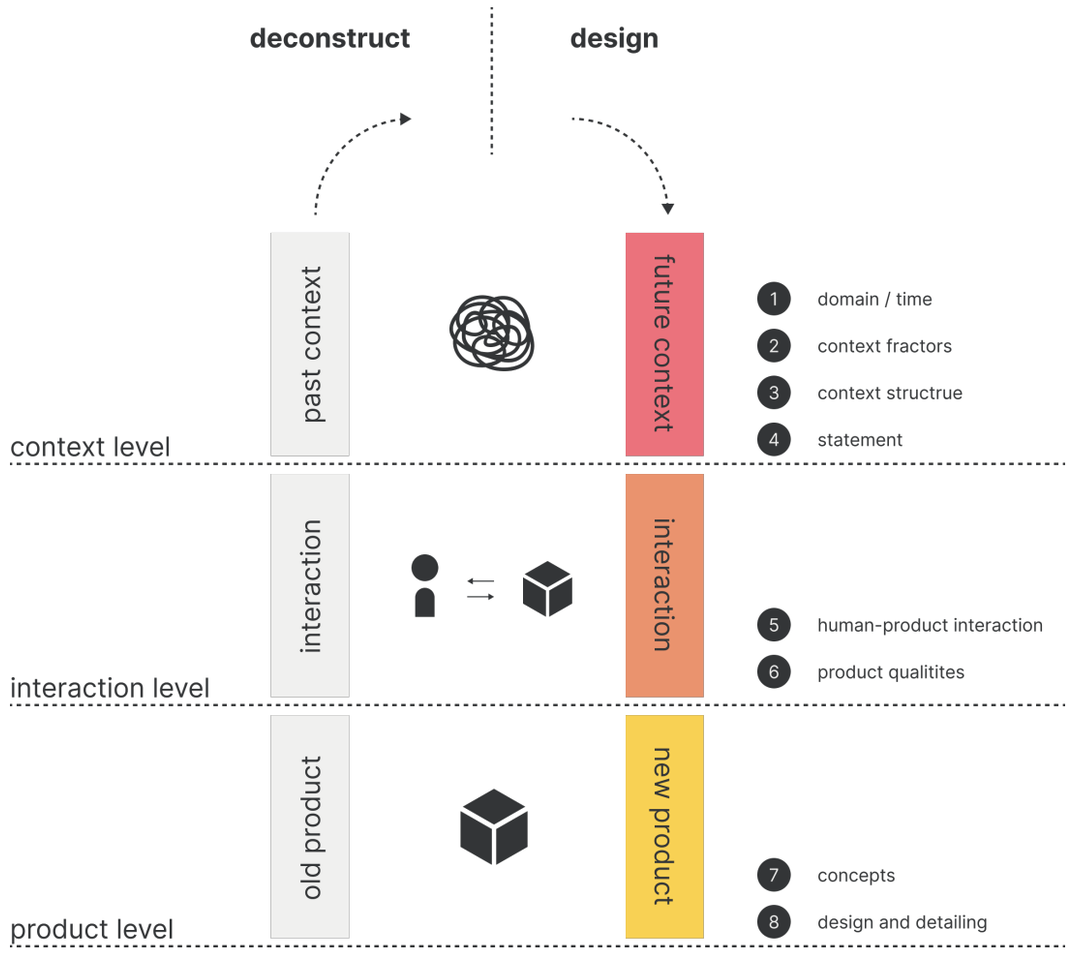


Figure 02-03: Reframing method (Hekkert & Van Dijk, 2011)

Defining the interpretation of the reframing method

The reframing method consists of three layers and two phases, shown in *Figure 02-03*. Even though the reframing method is a defined framework, it is open for interpretation. Here is how I have interpreted it for my thesis:

The reframing method is based on an already existing product. In this thesis, we will define a product as a “tool used in a context” (Osterwalder, Pigneur, Bernarda & Smith, 2014)(Hekkert & Van Dijk, 2011). When using the reframing method, one deconstructs the product into these two parts: the tool itself and the context of which the tool is supposed to be used. These two parts are then evaluated and understood in isolation from each other. The tool is evaluated from an objective and opportunistic point of view - what is seemingly good and bad about the tool? The context is all about understanding where, how and who is going to use it. After evaluating and understanding the tool and the context separately, the two parts are then put back together to create either a new perception, aim, strategy, or even an entirely new product for the future (Hekkert & Van Dijk, 2011).

The reframing method differs from the human-centred design process in how designs are evaluated. HCD arguably evaluates designs more binary - did this design meet the specified requirements - yes or no, and why? (Norman, 2013). The reframing method makes use of a different way of evaluating designs, namely end-user effects. These end-user effects are more abstract than specified requirements, but also might lead to more possibilities when it comes to the final designs. The end-user effects are the parameters to evaluate the product against as the tool and context is put back together. In order to more easily communicate the constructed end-user effects, visions are used to make them more grounded and relatable. To be clear, the reframing method does not replace human-centred design, rather, it complements and expands upon it.

Why have I used the reframing method?

If I were to test, redesign and iterate on VirSam’s VR-application, I would get a great understanding of how this specific application was put together, its strengths and its weaknesses. However, I would know nothing about the decisions made to create it, the original scope, the original problem or the vision that has led to it all. I would only solve the problems created within the space of ABCDE, not knowing if they were mere symptoms of a larger issue. With the reframing method, I am taking the entire product apart, taking three steps upstream and finding out where the problems and needs really come from. Through deconstruction I will get a greater understanding of the construction itself. I might even realise there are other ways to put it together again than I expect.

How have I used the reframing method?

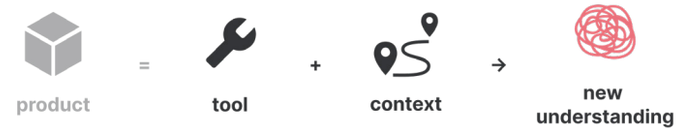
The reframing method is used inherently throughout the thesis and can be viewed in the structure itself.

03 Literature is dedicated to understanding the tool that is virtual reality technology. A tool is created for a specific purpose, and the purpose in this case is education. The context of which this is used is clinical procedure training of nursing students.

In *04 Exploration and Insights* we evaluate the tool from a heuristic point of view. The aim is to uncover the do's and don'ts of the tool, VR, by evaluating a current implementation, VirSam. By doing this, a greater understanding of the usability of the tool is obtained and can be used to better utilise the inherent strengths and weaknesses.

In *04 Exploration and Insights* we also move our attention towards the context - where is the tool supposedly being used, who is going to use it, how are they using it, and why are they using it? The chapter concludes with key findings that are brought into the next chapter.

05 Analysis acts as the turning point in the reframing method. This is where everything that has been taken apart is put back together. The chapter starts by taking the key findings from the previous chapter and uses them to construct the aforementioned end-user effects and subsequent focus areas.



After that, *06 Experimentation* presents tangible concepts to be evaluated against the end-user effects.

The last chapter, *07 Imagining*, uses the learnings from all the chapters and envisions future usage of the product, completing the reframing method.

Research methods

The concepts presented in the Design Theory chapter acts as mindsets that have tinted the entire process. In addition to these mindsets we have the more tangible methods. In this chapter we are going to take a look at several established-, experimental- and something in-between frameworks for researching, defining, developing, user-testing and delivering results in this thesis.

This chapter will present the general idea and structure surrounding the methods. The methods are not presented in any particular order, and later chapters will refer to the methods when they are applied.

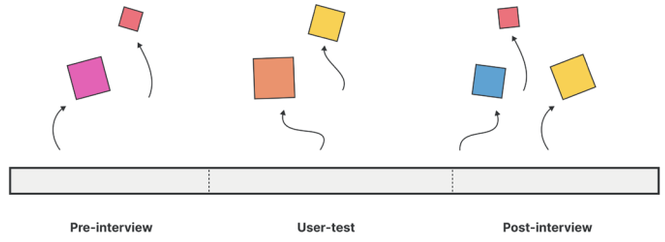
Data collection

As discussed in the scope, the contribution from this project is more holistic than narrow. My main goal was to obtain an understanding of the problem space that spanned multiple levels from multiple angles. The insights from this thesis has come from three main sources: background study, target users and contributors, as presented earlier.

This project has used a wide variety of methods for collecting insights: Parallel insight gathering, interviews, prototyping, observation and user testing.

Parallell insight gathering

The insights gathered for this project has been unconventional, but effective. Insights and research might normally be done sequentially - one phase followed by another phase. This thesis has adopted a more parallel approach to insight-gathering. For instance, the recruited students have in some cases been interviewed about their needs as well as performed user tests of the developed solution (Martin & Hanington, 2012).

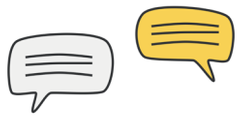


Interviews

Interviews are a method for collecting firsthand personal accounts of experience, opinions, attitudes and perceptions (Martin & Hanington, 2012). Considered one of two methods of survey research, questionnaires being the other, interviews come in several degrees of structure. Structured interviews follow a set script and are considered more controllable in terms of time-keeping and analysis, but may in turn be experienced as formal and impersonal (Martin & Hanington, 2012). Unstructured interviews also have conversational topics and are in turn less strict and harder to analyse, but allow for conversational tangents and be more comfortable for participants (Martin & Hanington, 2012)

This project has opted in using the version in-between structured and unstructured: semi-structured. The questions have been open-ended, allowing the participant to more freely talk about their opinions regarding the topic (Goodwin, 2011) and go on relevant tangents (Portigal, 2013). Though being an effective conversational strategy, semi-constructed interviews are prone to bias from the interviewer. Interviews are also somewhat unfitting for predicting future needs and wants (Portigal, 2013) because people most often imagine the future based on their current situation and intentions (Poon, Koehler, & Buehler, 2014; Kvam et al., 2021).

The topics of interest have been ever evolving throughout the thesis. What started as exploratory questions to better understand the problems, got more specific into the defined areas of issues.



Observation

Observation can be described as “attentive looking and systematic recording of phenomena” (Martin & Hanington, 2012). It is a passive way of gathering insights by witnessing what is being said and done. The method can be used discreetly (unobtrusive), participatory (in conjunction with f.ex. an interview) or guided (user testing) (Hanington & Martin, 2012).

This project has used observation alone and in conjunction with usability testing. When observing how skill education and training is done today at campus, a “fly-on-the-wall” approach was used in order not to impact the results. When observing the usability testing, remarks were noted and used as part of the subsequent interview.

Something to keep in mind whilst doing and evaluating observations is the Hawthrone effect, a non-specific effect where the one being observed changes their behaviour due to the fact that they are being observed (Sedgwick & Greenwood, 2015).

Prototyping

“Prototyping” is a very broad and vague term used to describe functional experiments. A prototype is an unfinished experience created to evaluate if a design meets the set requirements. “The primary purpose of a prototype is to tackle one or more product risks (user value, usability, feasibility, or viability)” (Cagan, 2017). These requirements can be either defined by users, stakeholders, aesthetics, functions, or a combination of all of them. The prototype itself can be of varying fidelity according to what is being tested (Hanington & Martin, 2012).

This project has opted for prototypes of different fidelities from low to high to target decided end-user effects. Low-fidelity prototypes are commonly used throughout the design process, often as concept sketches or storyboards etc. (Martin & Hanington, 2012). High-fidelity prototypes in turn are more refined, and tend to generate more detailed feedback (Martin & Hanington, 2012). These might more closely resemble the final product. Using non-VR prototypes to test something that would otherwise be in VR would exclude the immersive effect of VR through HMD’s, making the experience too dissimilar to draw meaningful conclusions (Jerald, 2016; Kvam et al., 2021). Therefore, there is a need for high-fidelity prototypes for testing the effects of VR.

The high-fidelity prototypes for this thesis have been created in Unity, with assets created in Blender and Figma. Limits of my own technical capabilities and knowledge impacted the prototypes, limiting the possibilities, but also catalysed creative and cheap alternative solutions.

The first concept in chapter *06 Experimentation* opted to use a method of prototyping called Wizard-of-Oz. Through Wizard-of-Oz, a simple non-interactive prototype is created, and the interactions are instead performed manually by an invisible participant, a wizard (Norman, 2013; Jerald, 2016).

Usability testing

> *“The ultimate user experience is improved much more by 3 studies with 5 users each than by a single monster study with 15 users.” — (Nielsen, 2000)*

Usability testing is an evaluation method that focuses on people and their given tasks and looks for evidence of how to improve the usability of a solution (Martin & Hanington, 2012). The point is to seek out, identify and target the friction points of what is being tested with the intention of fixing them to the benefit of the interaction between the user and solution (Cagan, 2017). The tests are designed around tasks and scenarios that represent typical end-user goals (Martin & Hanington, 2012). Participants in usability testing are asked to “think-aloud”, helping the observator to uncover specific mental models of what is being tested (Martin & Hanington, 2012). Also, it is important that the participant is aware of the fact that it is the solution that is being tested, and not their subjective performance (Norman, 2013).

This method goes hand in hand with the previous method, prototyping. Usability testing is best used when the solution is malleable early in the project to uncover issues before it is too late (Cagan, 2017).

Data evaluation

To evaluate the data gathered from the aforementioned methods, methods for data evaluation have been chosen to best extract the gathered insights: Heuristic evaluation, user journey mapping, affinity diagramming, the elito method, visions and analogies. The methods are chosen based on their capabilities to extract qualitative insights from the collected data.

Heuristic evaluation

Heuristic Evaluation is an evaluation of a given system or design. In heuristic evaluation, an expert, for example a designer, not working on the project gives their professional opinion on the current solution based on set usability parameters. This is normally done before the design is tested on end-users (Hanington & Martin, 2012).

The parameters can be whatever the designer want them to be, but a good basis is to look at Nielsens’ heuristics (1994):

1	**Visibility of application status**	6	**Recognition rather than recall**
2	**Match between app and real world**	7	**Flexibility and efficiency of use**
3	**User control and freedom**	8	**Aesthetics and minimalist design**
4	**Error prevention**	9	**Help users recognize, diagnose and recover from errors**
5	**Consistency and standards**	10	**Help and documentation**

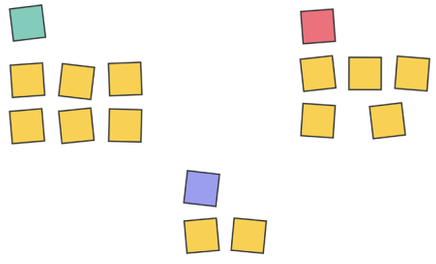
Figure 02-03: Heuristics (Nielsen, 1994)

User Journey Mapping

A user journey map is a visual representation of the experiences people have in the context of interacting with a product or service (Martin & Hanington, 2012). The map can tell a story of how an individual's actions, feelings, desires, and interactions with other people and systems evolves throughout a specified scenario. User journey maps are therefore often made in close collaboration with personas and user scenarios. By creating a map of the user journey, we get a frame of reference for understanding what happens before, during and after an experience (Stickdorn, Hormess, Lawrence & Schneider, 2018). This project has used user journey mapping, as well as personas and scenarios, both for designing abstract concepts and detailed concrete solutions.

Affinity Diagramming

Affinity diagramming is a visual method for organising specific insight into topical clusters. Clusters are made to visualise general categories of the problems and areas of interest, each cluster with a headline and space for sorting insights (Hanington & Martin, 2012). The method is considered an inductive exercise, where findings have first been recorded, and then sorted into clusters.The method has been used for both gathering insights regarding the research topics, contextual inquiry, and prioritising findings from usability testing.



Elito Method

The Elito method is a tool for evaluating findings. It is used to create grounded design arguments that ties into research observations and interviews. It is often related to business strategies, but is used in this thesis to create a connection between insights and solutions (Hanington & Martin, 2012).

The findings from the affinity diagram are used actively in creating the Elito table. The method is used as a way of structuring findings, as well as brainstorming and coming up with solutions to pain points. Each column in the table represents a point of view, moving from fuzzy user insights to actionable solutions (Martin & Hanington, 2012). The columns are sorted from left to right: observation, judgement, value, concept/sketch, key metaphor.

Visions and Analogies

"A vision is a view on something to come" - Hekkert & Van Dijk (2011).

To better understand for what purpose this project is creating solutions, visions and analogies have been created. They both describe the desired end-user effects, and help create concepts and questions for interviews and user testing. Visions in design are constructed and used in a way that allow the designer to explore possibilities that may not solve any problem, but fulfil unarticulated needs (Hekkert & Van Dijk, 2011).

Visions are sentral in the reframing method, as the method does not view end-users' needs as requirements, rather possibilities for improvement using a product in a context. Requirements are, in many ways, constraints and should therefore have as small an effect on the concept generation as possible. They can be viewed as constraints of what the final outcome can be by introducing factors that are considered fixed and inevitable. However, in order to make the product fit the context optimally, detailed requirements should be taken into account as late as possible, leaving room for the vision to drive the development (Hekkert & Van Dijk, 2011).

"The benefit of visions is not restricted to their function as models or to the description of aims alone. Visions help to allocate resources, they condense information, they can easily jump across the boundaries of segmented scientific disciplines, and they can be used for an early assessment of technology." (Tepper, 1996)

Analogies, on the other hand, are seemingly unrelated anecdotes that help explain which end-user affects the vision is striving to achieve. The analogy can be compared to the user's experience using completely different points for references. For example, saying that an event was a rollercoaster of emotions is explaining to the recipient that the sender's emotions were fluctuating.

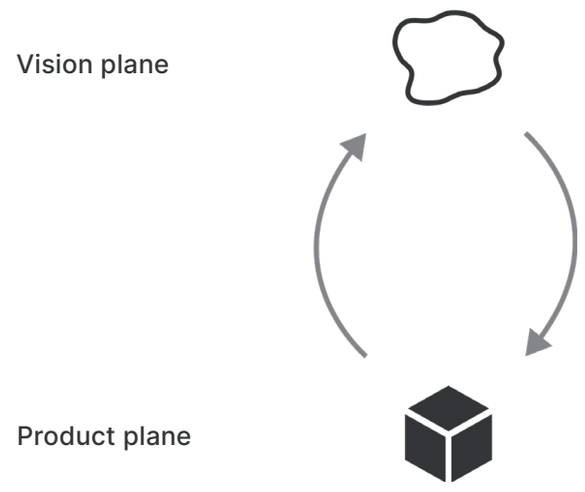
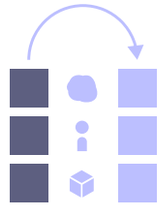


Figure 02-04: Vision- and product plane



03 Literature

This chapter will provide a theoretical foundation for reading this thesis, and contribute in placing my own research in the context of others.

51 **03 Literature**
52 Introduction
53 VR Technology
60 Pedagogial methods
62 VR in education
65 Disucssions and predictions for the future
66 Relevant examples of VR

Introduction

Methods

Looking for relevant sources in a rapidly evolving field is challenging regardless of the topic. The research was conducted through several literature searches using relevant keywords. The references have mainly been scientific papers and books, although some websites and interviews have been used. The article "The Effectiveness of Virtual Reality-Based Simulation in Health Professions Education Relating to Mental Illness: A Literature Review" by Wai Hin Wan and Angie Ho Yan Lam (2019) acted as a springboard to other articles on the same topics.

The current incarnation of VR can be traced all the way back to the 1950's, when Moroton Heiling first envisioned Sensorama - the cinema of the future using something that resembles today's head-mounted displays. Fast forward to 2022, VR has evolved to become both accessible and cheap enough for mass usage (Gilbert, 2021). Due to the rapid development of VR technology, finding articles that are not outdated has been challenging. In some cases, the article was using hardware and/or software that is now obsolete, and in other cases the demographic subjects are not matching the ones I'm tackling. Nevertheless, with time several relevant articles have been found.

Research questions

The themes, namely virtual reality, educational practises and the health sector, are drawn from the title: Optimising, exploring, and imagining the use of virtual reality in the education of nurses. The themes were then reframed as questions, with follow-up questions:

What is VR, and how do we deconstruct its effect on the users?

What pedagogical theories would be beneficial to use with VR?

How is VR currently used in education?

Defining "users"

In the design of products, services and experiences, the term "user" and "end-user" is thrown around quite a lot, especially in this thesis. The definition of users vary in terms of how they are perceived in the context of the solution (Keitsch, 2014). When talking about users in the context of a product, one might use "customer" or "consumer", whereas in the process designing a solution one might use "person" or "participant" (Kvam, Larssen & Wulvik, 2021; Sanders & Stappers, 2013).

In this thesis we are considering "users" and "end-users" the same, and to be the people who are intended to use the solutions.

VR technology

This subchapter will define VR and the VR experience, as well as look broadly at the state of VR in 2021, identifying paradigms and predicting what it might look like in the future.

Defining VR

Defining a technology that is under constant change seems impossible. VR will always be defined by whatever is the most advanced or the most accessible technology at the time. Nevertheless, viewing VR as a concept rather than a technology might bring some clarity to the topics of this thesis. I will therefore present several definitions of VR offered by authors that have written literature on the topic.

Decomposing the words "virtual" and "reality" might aid in understanding the origins of the concept. In their book Understanding Virtual Reality, Sherman and Craig (2003) point out that a late 1980's dictionary defines virtual as "being in essence or effect, but not fact", and reality as "the state of quality of being real. (...) Something that constitutes a real or actual thing as distinguished from something that is merely apparent".

In his most recent book on VR, The VR Book, Jerald (2016) brings forth a more updated definition that considers the concept as a single entity rather than as two separate words: "Virtual reality is defined to be a computer-generated digital environment that can be experienced and interacted with as if that environment were real." Merriam-Webster (2021) defines "virtual reality" as "an artificial environment which is experienced through sensory stimuli (as sights and sounds) provided by a computer and in which one's actions partially determine what happens in the environment".

Macpherson and Keppell (1998) draws inspiration from several definitions to create their own definition: "Virtual reality is a state produced in a person's mind that can, to varying degrees, occupy the person's awareness in a way similar to that of real environments." Wan and Lam (2019) builds upon this definition to further describe the VR environment as a three-dimensional imagining that could be either real-world based or an abstract world. They classified the VR-environments as immersive- and non-immersive, depending on the level of movement-mapping (Wan & Lam, 2019). For example, using a head-mounted display offered a more immersive experience than using a computer-mouse (Wan & Lam, 2019).

For this project we are going to use Jerald's (2016) definition, as it offers a relevant and clear description which includes much of what the other definitions:

Virtual reality is defined to be a computer-generated digital environment that can be experienced and interacted with as if that environment were real.

Effects of VR

Building on the chosen definition of VR, one could say that virtual reality can be described as being psychologically in a different place than where one is physically. To fully utilise the effect of VR, we need to understand how and why users should feel like they are somewhere else. Using themes from Jerald's book (2016) I attempt to dissect how an experience in VR is constructed.

Immersion

Jerald (2016) explains immersion as the degree of which a VR system creates stimuli for the user. An experience is immersive when the surroundings are spatial, vivid and interactive, when the system can register a range of inputs which mimics the user's actions and when the experience matches the behaviour of the world (Jerald, 2016). Even though the description introduces immersiveness as objective, how the individual user perceives the experience is entirely subjective. The degree of immersiveness can only direct the user's mind, but it cannot control it (Jerald, 2016).

Presence

Where we can say that immersion is describing the characteristics of the technology, presence can be described as the "psychological and physiological state of the user" (Jerald, 2016). When present, the user forgets about the technology altogether and instead focuses on the environment, objects, story, and other characters. This way we can say presence is a function of immersion and the user, both dependent on and limited by each other. The greater the system/application can make us immersed, the better the effect of presence will be and vice versa (Jerald, 2016).

A tool for understanding

Compared to the other mentioned technologies, VR is tapping into a number of sensory capabilities and motor skills, making the experience more engaging (Jerald, 2016). Actively utilising more of the human senses has proven to be an effective way to increase understanding and learning for some time (Dale, 1969). This can be explained by the fact that making use of more senses fills the sensory bandwidth of the recipient, thereby drawing more attention towards what is being presented (Dale, 1969; Jerald,2016), as shown in *Figure 03-01*.

The more senses that are being used, the clearer the message is being communicated to the recipient (Jerald, 2016). By inviting the users to construct their own experience through interaction, the user also might be able to construct their own understanding of what is being conveyed.

Reality and its trade-offs

Jerald (2016) points to an unresolved discussion around the topic of reality – is reality the goal of VR, or is it something to surpass? He argues that the goal of virtual reality is not always to replicate it. On the contrary, described by Jerald (2016):

> *"... presence does not require photorealism and there are more important presence-inducing cues such as responsiveness of the system, character motion and depth cues".*

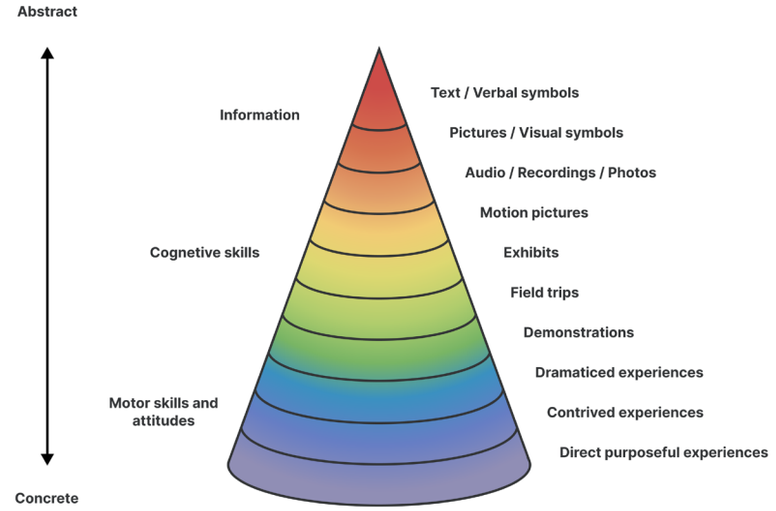


Figure 03-01: The Cone of Experience. VR uses many levels of abstraction (Jerald, 2016)

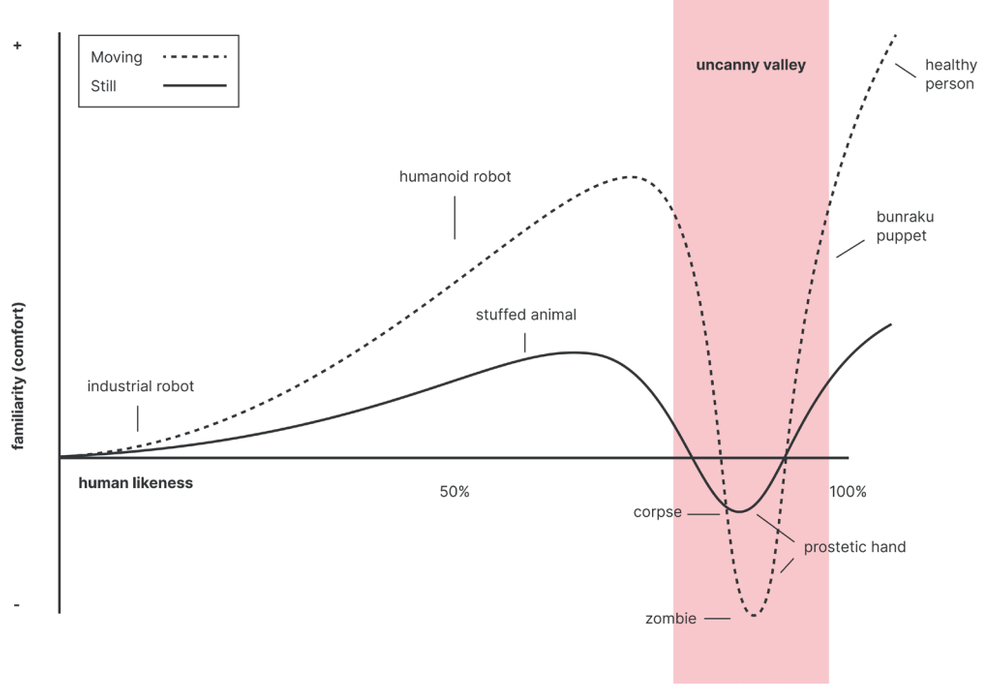


Figure 03-02: Uncanney Valley (Jerald, 2016)

Therefore, avoiding reality by creating more abstract and unrealistic environments can be more valuable (Jerald, 2016).

In fact, replicating reality close to perfection can be experienced as uncomfortable and creepy, a phenomenon described as “the Uncanny Valley” (Jerald, 2016; Henze, 2018). First coined by Mashairo Mori in 1970, “The Uncanny Valley” refers to the shift in a viewer's inner emotions from empathy to disgust as computer-graphics inches towards “reality perfection”. The user’s comfort and ease increase as the observed character becomes more human-like up until a certain point as the character is so close to a human. At this point a feeling of discomfort takes over (Jerald, 2016), see *Figure 03-02*. Some experiences avoid this by changing the humanoid characters to instead resemble cartoon characters (Henze, 2018).

Health effects

The previous subchapter discussed technical limitations hindering the users of becoming completely immersed and comfortable in VR, namely “The Uncanny Valley”. This might be described as a more “virtuous” limitation compared to the topic ahead. In this subchapter I am going to present the effect VR can have on health, and discuss how this can be avoided through design.

Motion sickness

Motion sickness is a complicated syndrome that occurs when the user is exposed to an apparent motion, either in real life or in the digital reality (Lackner, 2014). Motion sickness is the most common negative side effect of using VR, and can cause symptoms such as general discomfort, dizziness, disorientation, nausea and headaches, among others (Jerald, 2016; Lewis-Evans, 2015; Lackner, 2014; Johnson, 2005). There are several theories as to why humans experience motion sickness. Lackner (2014) explains that some people experience the effect immediately, others might get some symptoms after an extended period of time. Also, users can experience sensitivity towards completely different motions (Jerald, 2016). Several factors can lead to the feeling of motion sickness, such as the user’s prior health history, their gender and their sense of balance (Jerald, 2016).

In essence, Jerald (2016) concludes that motion sickness in essence occurs when there is a mismatch between what the users’ expect of the program - their mental model - and what the external program presents to the user. Mental models are quite subjective and vague by definition – every person has their own mental model of what happens in the world around them. Through iteration and testing it is possible to identify many of the mismatches between how the program presents the world and the user’s mental model, resulting in a program which hopefully minimises motion sickness (Jerald, 2016; Johnson, 2005).

Jerald (2016) also points out factors from the system and application design that can lead to discomfort, such as latency, refresh rate, field of view, duration and luminance. These technical factors can contribute in influencing the users beyond a state of motion sickness, leading to a feeling called cybersickness (Stauffert, Niebling & Latoschik, 2020). Cybersickness is a kind of motion sickness which is induced by subconscious and perceivably “invisible” technical factors, combined with the user’s individual factors mentioned above. Minimising cybersickness requires advancement in technology, and more extensive research and testing than what has already been done (Stauffert et al., 2020).

The current state of VR technology

Attention to VR

Although VR has been regarded as one of the most futuristic technologies for a long time, it was not until 2014 when Facebook (now Meta) bought Oculus that low-cost consumer VR technology caught on to professional VR systems. At that time, Samsung released their Gear VR headset, a head-mount that utilised their own phone’s screen, accelerometer, and processing power to create low-cost immersive experiences for consumers. Today, Oculus Quest 2 is estimated at almost 8 million devices world-wide, gaining 75% of the market-share for consumer VR-headsets (Gilbert, 2021).

Every year the technology research company Gartner publishes a report on the top trends in the “Gartner Hype Cycle of Emerging Technologies”, containing the technologies that are highlighted as promising and exciting (Blosch & Fenn, 2018), see *Figure 03-03*. These technologies are ranked on a scale from being new and compelling (“Peak of Inflated Expectations”) to being a relatively established technology (“Plateau of Productivity”). AR was introduced to Gartner’s predictions in 2004, and VR in 2013. However, both of the technologies were removed from the list by 2018. At first glance this looks bad, right? Does this mean that no one believes in technology anymore? Not quite.

The fact that VR and AR are removed from the list simply testify that they are not viewed as buzzwords anymore. The technologies are believed to have moved beyond the “Plateau of Productivity”, and at this stage we are beginning to see the fruits of all the attention (Pelletier, 2021; Blosch & Fenn, 2018).

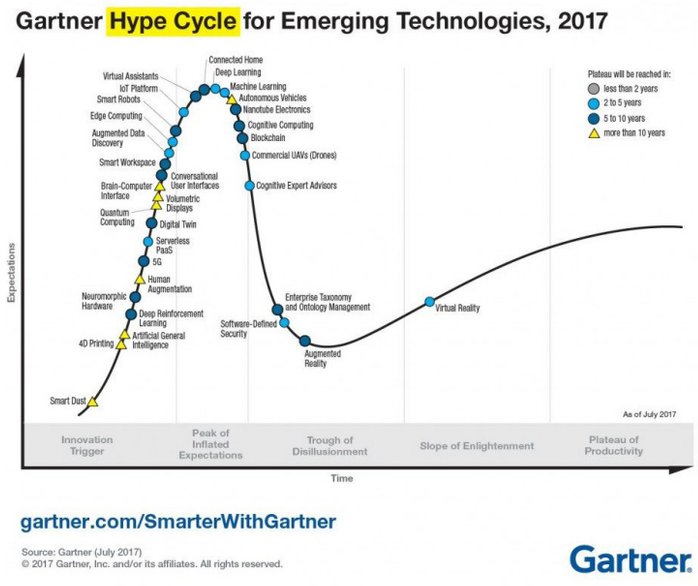


Figure 03-03: Gartner hype cycle of emerging technologies 2017 (Gartner)

Tools for creating VR applications

The main engines for building VR experiences are Unity Technologies (Unity, 2021) and Epic Games' Unreal Engine (Epic Games, 2021). Notably, Unity is currently at the forefront of creating new libraries and tools for developing VR experiences (Unity, 2021). Recently Unity released a toolkit for creating universal applications that adapts to the user's headset, removing the need for tailor-made applications to each headset. The toolkit, aptly named XR toolkit, is a huge step in the direction of making VR experiences more accessible (Unity, 2019).

Similarly, the possibility of making VR content in the web browser using the open-source JavaScript-library "Three.js", is on its way to make VR more accessible.. Three.js uses the JavaScrip API WebGL to create objects and viewport, and any Three.js scene can be experienced in VR by simply adding an "Open in VR" button to the project (Threejs, 2021).

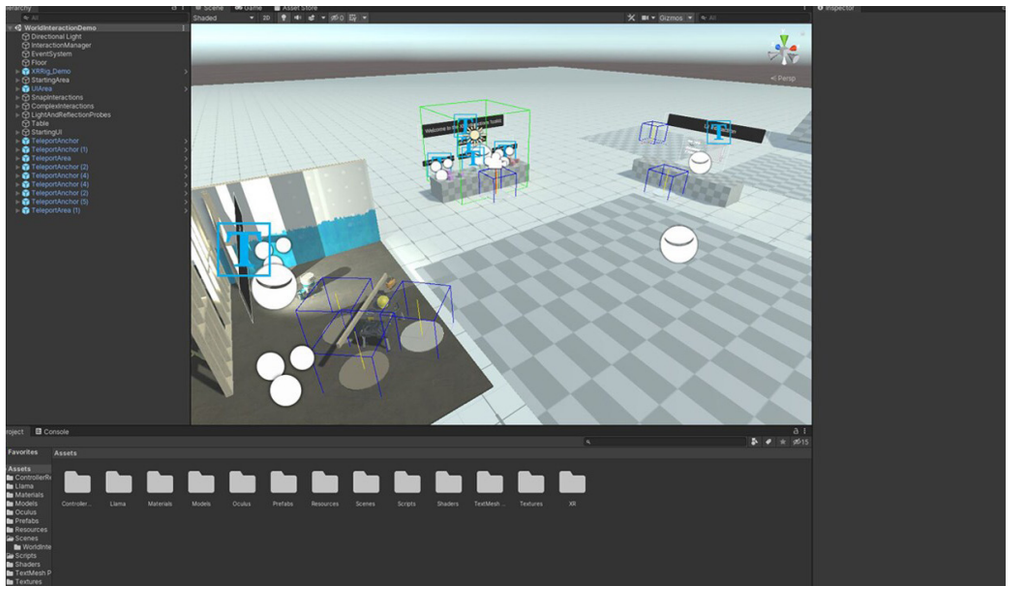


Figure 03-04: Unity development platform

Designing VR

Virtual reality is, in essence, another tool for designers and developers to convey a message. In this section we are looking at what should be kept in mind when designing VR experiences.

Designing with users

A common mistake made by VR creators, especially programmers, is that when creating VR experiences, it is easy to think that whatever works for you works for everyone else (Jerald, 2016; Norman, 2013). This is not always the case. As we will see in the following chapters of this thesis, several factors need to be evaluated against users' experience, most notably usability and educational gain. The best way to understand if something works, is to test it in the relevant context and with the target user group (Norman, 2013).

However, the degree to which the users are involved in the design is for the team to decide. By being aware of the user's role in the design of the solution, one is able to better decide and select what methods for data gathering, expected outcomes and data evaluation (Keitsch, 2014). A suggested figure is presented by Keitsch (2014):

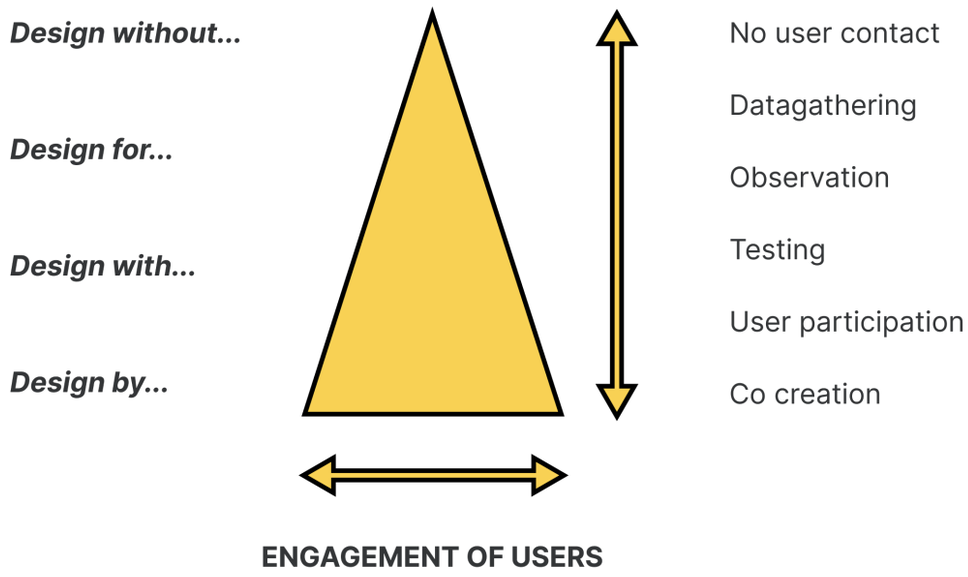


Figure 03-05: User engagement by participation

Designing novel technologies

When met with technology they haven't seen before, users bring the knowledge they have already obtained from familiar technologies (Norman, 2013). To properly meet the user's mental models, designers and developers need to adapt the system to better meet the user's needs (Norman, 2013). This means that, due to the low exposure of VR, one must suspect that all users are novice users and design the experiences accordingly (Schmidt, 2014). There are relatively few "established" ways of designing VR experiences compared to designing for flat screens, keyboard, mouse, and touch interfaces, which poses a challenge when designing for VR (Jerald, 2016; Kavanagh et al., 2017). Still, one can expect that the technical know-how surrounding VR will increase as exposure to the technology becomes more common (Kavanagh et al., 2017; Gilbert, 2021).

The future of VR

Timoni West, head of augmented and virtual reality at Unity Technology, was recently interviewed by WIRED magazine about the current state of VR (West, 2021).

Similar to Jerald (2016), West states that good VR does not equal high fidelity. There is no way to bridge the gap of the Uncanny Valley, and VR experiences are most uncomfortable when trying to replicate the outside world. She encourages nurturing the strengths of VR, namely removing it from the real-world constraints, using fun mechanics and exploiting VR's wow-factor (West, 2021).

To achieve this, people need to be educated about the capabilities and opportunities in VR. She points to the example from "Second Life", a once popular life simulation game for desktop computers. Creator of Second Life, Philip Rosedale, noticed that even though the users could do anything in Second Life, they still built grounded concepts, often their own homes. Still, over time the users could be observed to become comfortable with the medium, expanding the possibilities of what is possible within the platform (West, 2021).

Looking forward, West believes that VR headsets will become incredibly common in households, although not as common and versatile as smartphones - at least not yet (West, 2021).

Pedagogial methods

The use of digital tools in education is relatively new in education when compared to the use of traditional tools. However, who is saying that digital education should play by the same rules as traditional education? When imagining digital education, we should also be considering new ways of learning, and video games could be an inspiration.

Mastery learning

Mastery in learning is a pedagogical method focused on giving the student control of their own learning process, and providing targeted and individual feedback. The concept of mastery traces back to the 1960's and the work of Benjamin Bloom. Bloom thought that, when given the correct educational tools, nearly all students could excel academically. He observed that teachers usually organised their curriculum in traditional units and then evaluated the students' progress at the end of the unit, which is often today's practice as well. Instead, he proposed that the teachers would observe the students' difficulties and progress, and based on this suggest specific activities and adapted learning conditions for helping them (Bloom, 1971). He called this strategy "Mastery learning" (Bloom, 1971; Guskey, 2021).

His strategy was proven right in numerous studies comparing students in traditional classes and mastery learning classes. In the latter, students consistently reached higher levels of achievement and greater confidence in their own learning abilities (Anderson S. A., 1994; Guskey & Pigott, 1988; Kulik, Kulik, & Bangert-Drowns, 1990). As mastery learning has grown more mature in educational sciences, more and more researchers are looking for ways to accomplish even more gains in the students' learning process by looking at more innovative strategies (Fominykh et al., 2018; Schmidt, 2014; Wang, 2020). This brings us neatly into the next topic of this section: Game design.

Learning from game design

Games, more specifically video games, are interactive and fictional experiences. A game can be described as a "structured form of play" often used for entertainment (Schell, 2008). Game design pioneered with the cyclical and iterative loop of trial and error called "gameplay" (Schell, 2008). To excel in a game, the player must practice. Some games are easy and do not require a lot of practice, while other games are designed for absolute gameplay perfection (Gee, 2007). The game is providing consistent and sustained feedback, endorsing the player to do frequent risk analysis and evaluations (Ryan & Deci, 2000). As shown in *Figure 03-06*, playing a game is a cyclical process where the player hypotheses, probes the world, gets a reaction, reflects on the results and issues a reprobe (Gee, 2007).

The success of video games as a medium has sparked an interest in using the same principles in other

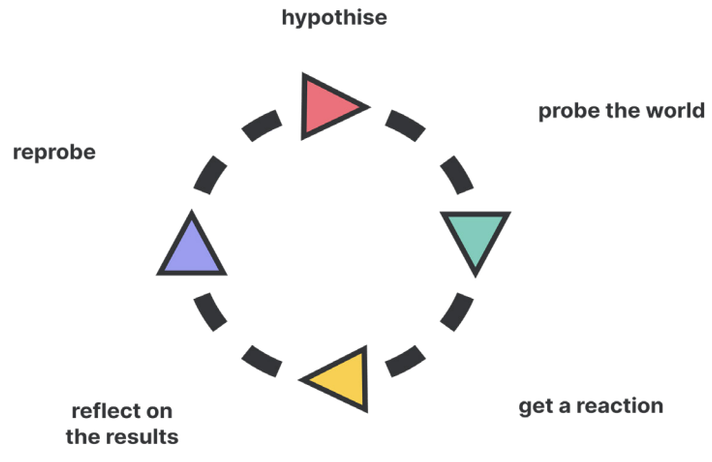


Figure 03-06. Analytical thinking cycle (Gee, 2007)

areas, for example in educational contexts. Here we have seen a popularisation of adding elements like “high-scores” and “achievements” that is meant to target the user’s intrinsic motivation (Ryan & Deci, 2000; Goethe, 2020). The inclusion of these elements have been aptly called “gamification”, and can be described as when non-gaming contexts implement game mechanics with the intention of more usage (Dahlstrøm, 2017).

However, this technique has proven to trigger so-called “dark patterns” (Goethe, 2020). Instead, rapid replayability and overall progress is the key to more “healthy” gamified applications. Using gamification as a sprinkle on top of the design of an application is the epitome of bad gamification (Goethe, 2020). By properly incorporating play and restricting play with rules and goals from the beginning, the user will experience a more intrinsic pull for more usage rather than being pushed by external motivations (Kristiansen, 2020).

Mastery learning and game design

Games are an interactive art form that utilise the best of what mastery learning has to offer. Rapid development of digital educational platforms is laying the groundwork for incorporating mastery learning in curriculums (Kavanagh et al., 2017). These digital platforms allow tracking individual student's progress and provide immediate feedback. In regular study environments, students often finish a test or assignment, wait and then find out whether he/she passed. In video games, and more importantly, a mastery-based classroom, students can be assessed in just about real-time. If students fail an objective, they are immediately told which steps led them there, hopefully they learn how to avoid it, and most likely they get the chance to do it again until they obtain the objective (Guskey, 2021).

VR in education

Using VR for education is nothing new. The first recorded usage of digital VR was by the American Air Force for pilot training in 1966 (Kavanagh, Luxton-Reilly, Wuensche & Plimmer, 2017). As mentioned, VR’s ability to immerse it’s users contribute in increasing the learning outcome (Dale, 1969; Jerald, 2016). Still, VR does not seem to have properly gained traction in education. This might be due to a myriad of reasons, with cost, development and logistics being in the most obvious ones. In this subchapter we are going to look at some of the main reasons for using, and not using, VR as an educational tool, as well as looking at recent examples of using VR for educational purposes. The article “A systematic review of Virtual Reality in education” by Kavanagh et al. (2017) will act as the source of inspiration for this subchapter.

Who is using VR for education?

According to Kavanagh’s et al. (2017) systematic review looking at the academic papers written about using VR in education, 35% of the applications is related to health, followed by general education (28%), engineering (19%), science (16%) and other domains (27%). 51% of the target demographic for these VR applications are found in higher education (Kavanagh et al., 2017). These numbers are from 2017, but because VR has been relatively slow-growing both prior and post the study, there is reason to think that today’s situation in the academical field is not far off when interpolating.

Looking at the health domain, the application has been centred around “general medicine” and “surgical education”, with some minor interest in “physical education”, “nursing education”, “rehabilitation” and “nutrition”.

Why use VR in education?

To understand the benefits of using VR in education, one should understand why educators would like to use it in the first place. To answer this, the aforementioned article looks at in what situations educators apply VR and how VR could motivate learning (Kavanagh et al., 2017).

Applications

Kavanagh et al. (2017) highlight four situations for applying VR in education:

- Simulation
- Training
- Access to limited resources
- Distance learning

Even though we are defining categories, it does not mean that a VR-application is defined to any single one.

Simulation

VR makes participating in lifelike simulations possible. It can be scenarios that are too dangerous to explore in real life, or other limiting reasons. This application is targeted towards exploring and experiencing different places or points of view.

Training

Training could be described as experiences where the goal is to facilitate the transfer of practical skills. There is a close relationship between simulation and training, but they can be differentiated by the fact that in training the user is asked to act upon the experience.

Access to limited resources

While the two previous categories are focusing on knowledge, this category is focusing more on access to resources otherwise scarce and hard to come by on demand. For medical students practising on living patients is rare, but in VR it can be instantiated endlessly.

Distanced learning

VR has the potential for students to communicate and collaborate across the world, making the physical location irrelevant. Distance learning can make it possible to get access to tools, expertise and colleagues from wherever (Fominykh et al., 2018).

Motivation

Kavanagh et al. (2017) point out several ways VR can be motivational in education, dividing it into pedagogical and intrinsic factors. Again, even though we are defining categories, it does not mean that a VR-application is defined to any single one.

Pedagogical motivations

Huang et. al (2010) argues that “... all worthwhile educational innovation must begin with a strong pedagogy”, and VR is no different. Luckily, there are strong indications that VR solutions are showing effect in learning and

engagement. Active encouragement is preferable compared to passive learning, and immersive 3D environments with interactable objects are great for this. Furthermore, the ability to explore virtual environments with fellow students or teachers has been recognised as a motivating factor.

Intrinsic factors

Intrinsic factors are influences that are targeting subjective aims and goals of the learner (Sizer, P et. al, 2008). Compared to extrinsic factors, the intrinsic factors are less visible and often yield a subsequent effect of the factor (Ryan & Deci, 2000). VR is appealing for educators who want to impact, or even improve, the students' motivation. The simple fact that VR has a novelty around it has been described by several papers to improve motivation. VR's ability to provide a sense of presence, contributes to this effect and increases the student's enjoyment. The possibility for personalised learning through VR allows the students to explore, learn and understand at their own pace, which is appealing for both educators and students.

Why not use VR in education?

Despite the various applications for VR in education and the way it motivates learning, there are some unsolved and inevitable problems with using VR for education. Kavanagh et. al (2017) points out problems connected to efforts, to the input and output that VR allows, and to the overall usefulness.

Applications

Naturally, training the educators on helping the students with potential issues takes time and effort. A long standing factor in computers and education is that each student and educator are different, and require unique amounts of time and assistance to be comfortable with the tools (Kavanagh et al., 2017).

Input problems

Previously, VR has been famous for deploying proprietary solutions for input mechanisms for their headsets. This has been somewhat standardised with the release, support and standardisation of OpenXR-support for game engines such as Unity and Unreal. Still, there are some issues with using keyboard, mouse and hand gestures, and with the lack of feedback and tactility. I will not explore this further in the thesis, as this is controlled by manufacturers and development tools available.

Output problems

The output refers to what is displayed by the headset, and is connected to the usability of the software.

Insufficient realism

Depending on the use and context, there may be a need to create VR experiences that accurately represent the "real" reality. For example, failing to provide a realistic experience in surgical simulations might both lessen the learning experience, and decrease the enjoyment for the students. The problem of insufficient realism is caused by the quality of the display used and the development of the software.

Software usability

Software usability is by far the most common identifiable problem in VR for education (Kavanagh et al., 2017). The issues range from bad interface design and low interaction quality, to poor readability. While some issues are tied to the technology and the headsets themselves, most are just results of poor software design. There are cases where difficulty in understanding and navigating the system interfaces is hindering the students in using the experience.

Lack of engagement

30% of the cases of using VR in education reported a lack of engagement, or "boredom", expressed by the student. While the novelty-factor plays an important role for initial excitement of the system it can not be relied on as the sole means of facilitating engagement. Even when using VR, poor educational design can and will still result in a lack of engagement (Kavanagh et al., 2017).

Discussion and predictions for the future

The examples in the report by Kavanagh et al. (2017) are heavily skewed towards VR software created with academic origin, mostly found in the medical domain with simulation and training as the key applications. We have seen, and will likely continue to see, that the investment model around VR will become more targeted towards wider, consumer-based audiences. The chances are, devices and software intended for a bigger audience will mitigate many of the issues discussed in this chapter, especially the issues connected to usability. A system which is designed with consumer usability in mind will most likely also be easier for training students and educators. As with other technologies, the novelty around using and experiencing VR will likely diminish, making more people mature to the technology in the process (Kavanagh et al., 2017)(Jerald, 2016).

There are other approaches to interact with head mounted displays that should be explored and exploited. Including keyboard- and mouse support, handwritten notes and 360-degree video would make the VR experiences more nuanced and accessible for people who are having issues with using hand-controllers and gestures (Kavanagh et al., 2017).

The lack of realism is a pressing issue in the entire field of VR, and will most likely not be solved for while. It takes computation power and time to create photo-realistic experiences, and for many educators and developers it is simply not worth the investment. Because of this, it would be wise to reconsider the experiences, and focus less on creating perfectly realistic experiences and more on making it enjoyable, following the ideas of Jerald (2016) and West (2021).

Relevant examples of VR

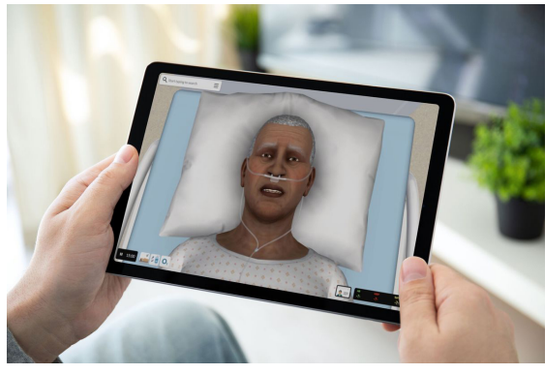
Using what we have learned about VR, education and VR in education, let's take a look at some examples.

SimCapture by Laerdal Medical

This is an example that is not currently using head mounted displays, but is still creating a digital world of simulation and training. Laerdal Medical is a Norwegian company most known for creating simulation dolls for training doctors and nurses. Furthermore, with SimCapture they have created a set of software-tools for monitoring the dolls, controlling the dolls, capturing the student's performance and creating results based on this performance. It is not strictly VR, but they are crafting a digital reality around physical dolls and nursing procedures, which makes it a relevant example for this thesis (Laerdal Medical, 2021).

vSim by Laerdal Medical and Wolters Kluwer

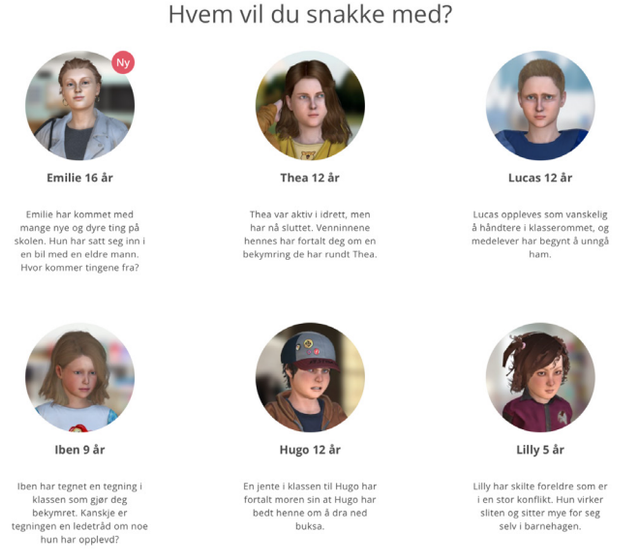
vSim was just updated in January 2022, and is a collaboration with aforementioned Laerdal Medical and software developer Wolter Kluwer. vSim is a digital 2D platform aimed at teaching the student clinical judgement, competence and confidence. The students are immersed in a safe, dynamic environment with diverse 3D patients that is mirroring clinical practice. The goal is for the student to analyse cues and recognize symptoms, and subsequently teach the student how to perform the "new situation, background, assessment and recommendation (SBAR)" that produces an SBAR-score based on the students' report (Wolters Kluwer, 2022).



Attensi

Attensi is a company that uses gamified learning to create simulation training in 3D environments. They are creating training material for a variety of different areas, healthcare being the biggest. So far, the main vessels for these training materials are laptops and mobile phones. In an especially interesting project the Norwegian Postal Service (Posten) are using Attensi's software to train clerks on how to handle and confront challenging customers (Attensi, 2021).

Another interesting case created by Attensi is called "Snakke med barn" (Talking to Children), which is an open online tool created for training on conversations with kids about complex issues (Attensi, 2021).



Stavanger Sykehys & Bouvet

The technology consultant company Bouvet has created a medical training program in VR for Stavanger Hospital where patient diagnosing is the focus of the experience. The program revolves around being inside a patient's room together with the patient, and asking questions, using instruments and reading the patient's medical history in order to come create a diagnosis (Bouvet & Stavanger Sykehus, 2021).

Høgskolen i Innlandet

Innlandet College (Høgskolen i Innlandet) has contributed in creating a VR application for VID scientific college in Bergen for teaching nursing students how to handle medical drugs. The student is placed in a medical room and given tasks to solve. The goal is to help students improve their skills regarding understanding, selecting and dispatching medicine (Fynd Reality & Høgskolen Innlandet, 2019).

Other examples of interest

Video games have been and will most likely continue to be pushing the current envelope of what is possible to do in VR (Jerald, 2016). Therefore, it would be a huge omission not to include some relevant examples of how a subset of VR-games behave. The category of games we are looking at are scenario-based puzzle games. This is because they are the ones that most closely resemble the interactions of a procedure training in VR.

I Expect You To Die

I Expect You to Die (IEYTD) is a single-player spy-simulation VR game series that puts you in the role of a spy that needs to perform tasks in set environments (Schell Games, 2021). The game is meant to be played sitting down, and uses realistic hand-controllers for interacting with the environment.

The Introduction

At the start of the game you are put in an environment with a lot of interactable objects. A god-like voice is greeting you, asks you to select a mission and presents the goal you are supposed to achieve. It is up to the player to understand how to select a mission.

The Gameplay

Being a puzzle-game, the goal is to perform tasks in a specific way to achieve the desired result. If you fail to complete the subtasks in time or in the correct order, you lose and have to start over. Many of the tasks in the game require the player to scavenge the environment for clues and information, often in the form of books, notes or posters. All the objects are fully interactable, meaning the player can grab them, turn them around, burn them, toss them and even lose them.

Takeaways

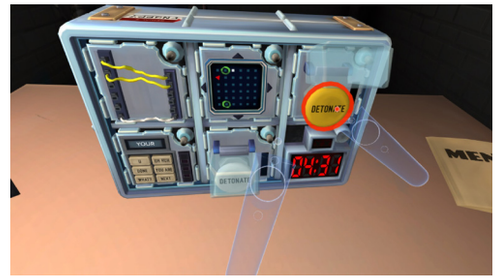
There are some qualities we can take from this game.In the introduction, by allowing the player to get a feel for the mechanics of the game, you are preparing them for what is to come at no expense of the immersion of the game. Having this separate, but connected environment encourages trial and error of the controllers, head movement, physics and more. This is important, especially in VR (Jerald, 2016). The repetitive nature of the missions encourages the player to try out many different solutions until one is correct. Learning the sequences in a puzzle game is not too dissimilar to learning a clinical procedure, and is something that should be explored.

Keep Talking and Nobody Explodes

Keep Talking and Nobody Explodes is a cooperative VR party-game (Steel Crate Games, 2018). The game is about defusing a bomb, but only the person wearing the VR headset sees the bomb, and only the people outside VR have the manual to defuse it.

The introduction

Similar to the introduction to I Expect You to Die, the introduction in this game is an environment where the player is encouraged to get familiar with the controls. The player is presented with a book that represents all the levels that can be selected.

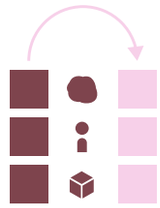


The gameplay

After selecting a level, the player is put in a room with a cubic bomb. The bomb has several puzzles, all of which need to be solved to defuse the bomb. The only way to defuse the bomb is using the manual that is outside of the VR headset. The key to success is communication and collaboration between people in the virtual and real world.

Takeaways

The interesting thing about this game in particular is how it mixes VR and the real world at no expense of the immersive feel of the game. By removing some of the information that might have been in VR, the game is able to extend the experience to more people.



04 EXPLORATION & INSIGHTS

This chapter will present the result of insights that have been gathered to understand the current solution and context.

75 **04 Exploration & Insights**
76 Introduction
76 Research Questions
77 Methods
80 Evaluation of VirSam's VR-application
98 Exploring the nursing education
119 Closing thoughts

Introduction

VR is a tool for delivering information and facilitating learning, just like a laptop, a smartphone, a lecturer, a colleague, a video or a book. VR needs to prove itself that it too can have a place in the ecosystem of educational tools. It needs to do selected functions better than other tools, but at the same time be aware of its weaknesses.

This thesis has its roots in the ABCDE VR-application developed for VirSam. Early in the process it was decided that my thesis would not be about re-designing the application, but rather explore and evaluate how it can be used in education more broadly. The findings in this chapter is a result of conducting user interviews and tests on the developed solution throughout the semester. Additionally, this chapter is exploring how using VR as a tool for educating health professionals might fit along-side all the other tools they have at their disposal, how VR might replace some parts of the education, and where it might need to accept defeat. When exploring this, we also need to learn about how the nursing students experience their education.

Research questions

This chapter is trying to answer two research-questions.

RQ1: How is procedure training in VR currently experienced by target users, and what can we learn from it to construct future concepts?

This will be researched through user testing and a heuristic evaluation of VirSam's VR-application.

RQ2: How is the study program for nursing education in Trondheim experienced by its students?

This will be research through understanding the education from the student's perspective, including what the student is expected to learn, how the study is structured, what educational tools and more.

Methods

Topical inquiry

To get a higher level understanding of how the education is structured, a topical inquiry was conducted on websites and articles.

User testing

User testing acts as the backbone for the heuristic evaluation and catalyst for interviews.

Heuristic evaluation

The current user journey has been evaluated using a form of heuristic evaluation, where some of the defined heuristics have been excluded and/or swapped for for relevancy.

The current solution was evaluated on a collected number of 10 individual students through 2 rounds of testing. Some feature changes, namely updates on summary screens and removing unnecessary aids were changed between the tests.

Observation of current practises

To understand how simulation training is performed today, an early observational study was done at Øya Helsehus at NTNU. The goal was to understand the inherent qualities of doing physical, real-world, simulations from the educator and student perspective.

In order to comply with privacy consent and avoid an eventual change in behaviour due to the students being observed, Hawthorne effect, the observations were done from the control-room of the simulation centre. I had access to the video- and audio feed of the simulation, and was only allowed to take hand-written notes while the simulation was ongoing.

Interviews

To answer the research questions, in-depth semi-structured interviews and discussions with the target users and contributors were carried out. Topics have been discovered and defined through background studies and interviews with the target users, and evaluated and discussed with the contributors.

The main topics with the target users included: simulation training in school, feeling of mastery in the education, education at school versus education in supervised clinical practice and education of hard skills versus soft skill.

The main discussion topics with the contributors included: study progression, procedure training and supervised practice at NTNU, as well as creating products for educational purposes.

The complete interview protocol for target users and contributors can be found in Appendix H-J. Interviews with contributors were more tailored to the induvidual's background and expertise. The next section addresses the results from these interviews and discussions.

The following sections will present the fidings from the collection of insights.

Evaluation of VirSam's VR-application

This subchapter will explore and evaluate how VirSam's VR application is performing in terms of usability.

Clinical procedues - ABCDE, NEWS and ISBAR

To understand the VR application, we need to understand the theory behind the clinical procedures they are trying to emulate. Clinical procedures are the established practises that are taught to medical- and nursing students. They act as the theory behind the workflow practised by students. There are numerous different procedures for different scenarios and use-cases, but in this thesis we are only focusing on the three used in VirSam's VR-application.

ABCDE

ABCDE, also called "primary examination", is a survey-, action- and reporting order. It is designed so that the most critical patient is taken care of first. In acute medicine it is necessary to conduct a quick and systematic survey of the patient to uncover possible life threatening conditions or failure of vital functions. Therefore, this procedure is the backbone of any medical examination used for both acute scenarios and long-term monitoring. ABCDE is an an abbreviation (Johansen, Blinkenberg, Arentz-Hansen & Moen, 2021):

- A - Airways - luftveier
- B - Breathing - respirasjon
- C - Circulation - sirkulasjon
- D - Disability - bevissthet, nevrologi
- E - Exposure / environment - omgivelser / kroppsundersøkelse

It is important to follow this order when examining the patient and take action accordingly. For example: if you find the airways to be blocked in A, it must be corrected before proceeding to B.

NEWS

NEWS, National Early Warning Score, is an aggregate scoring system in which a score is given to physiological measurements, already recorded in routine practice (Royal College of Physicians, 2017). The scoring system is based on data from the following physiological parameters:

- Respiration rate
- Oxygen saturation
- Systolic blood pressure
- Pulse rate
- Level of consciousness
- Temperature

The score is given to each parameter as they are measured, where the magnitude of the score reflects how far the parameter deviates from the normal. Normal is a score of 0, and the deviations score up to 3. The scores of each parameter are then tallied up and the overall condition is evaluated against a table for indicative medical response (Royal College of Physicians, 2017). A total score of 0 indicates a surveillance frequency of at least once every 12 hours, and a score of 7 or more indicates continuous surveillance of vital functions.

Although NEWS is supposed to help simplify the process of prioritising patients, nurses have very different experiences with the tool and practice it differently (Kjøl, Melbye & Mundal, 2020).

ISBAR

ISBAR is a structure of communication which offers simplified, effective, structured and predictable conversations between health professionals (Moi, Söderhamn, Marthinsen & Flateland, 2019). ISBAR was first used in the American health care service in 2003, and has been used in Norway since 2017 (Moi et al., 2019). ISBAR is an abbriviation and stands for:

- I - Identification - identifikasjon
- S - Situation - situasjon
- B - Background - bakgrunn
- A - Analysis - analyse
- R - Recommendation - råd

It is currently being implemented in the education of nurses in the master's program in specialist nursing (Moi et al., 2019).

See *Appendix A & B* for the tables used in the field to describe the procedures.

Early discussion about the project

To better understand where the VirSam-project has come from, the early insights and talks students and project owner were synthesised into the map on the next page. It acted as a basis for understanding the scope and how to evolve the project.

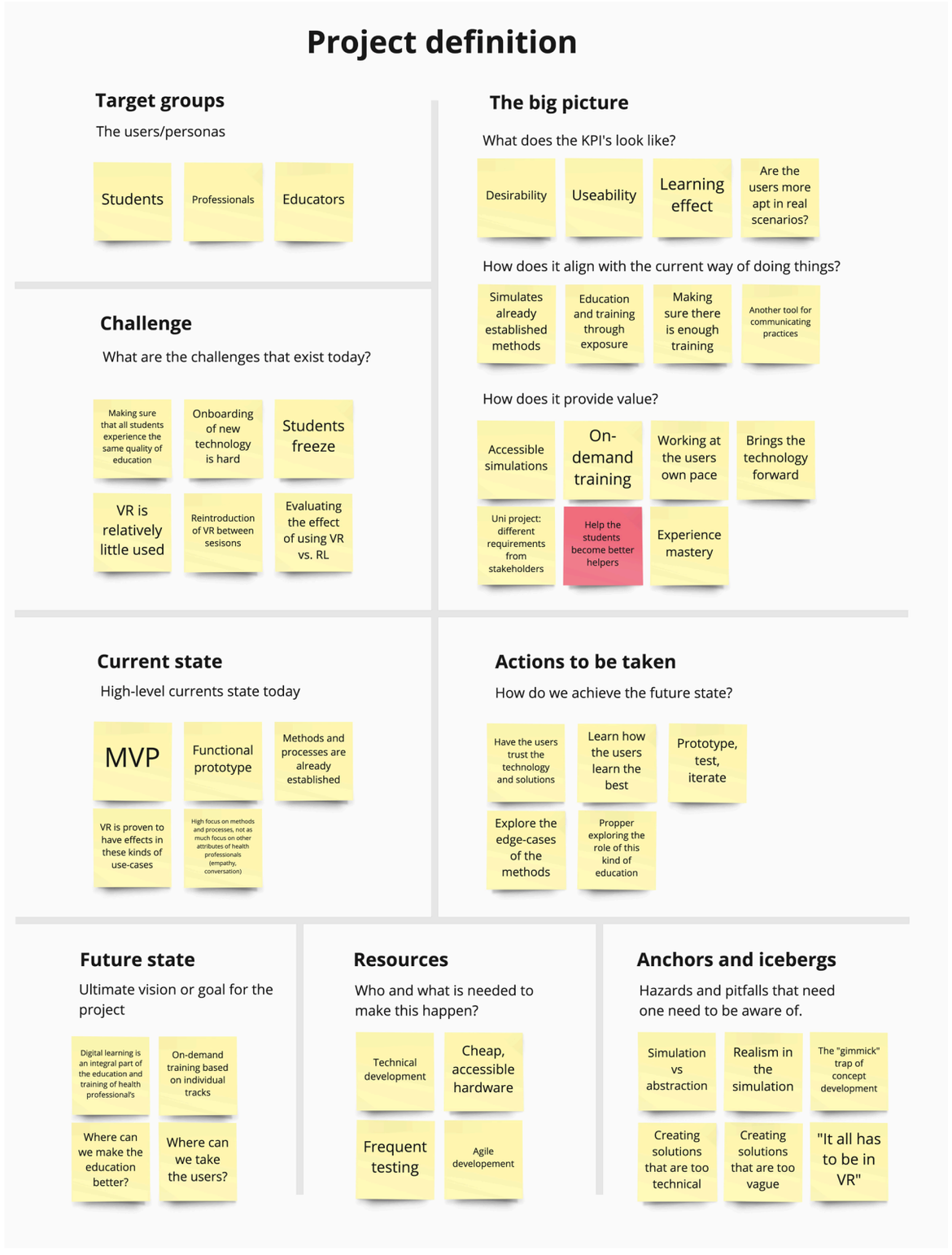


Figure 04-01. Project definition map.

Presenting the current application

VirSam's ABCDE-application has been developed to teach the students in what order an examination of a patient should take place, how to perform the tasks and what equipment to use. The purpose of the application is to let the students practice the procedure to such a degree that the steps are automated (VirSam, 2021).

An explanation from VirSam themselves can be read on the following website: virsam.no/projects/abcde

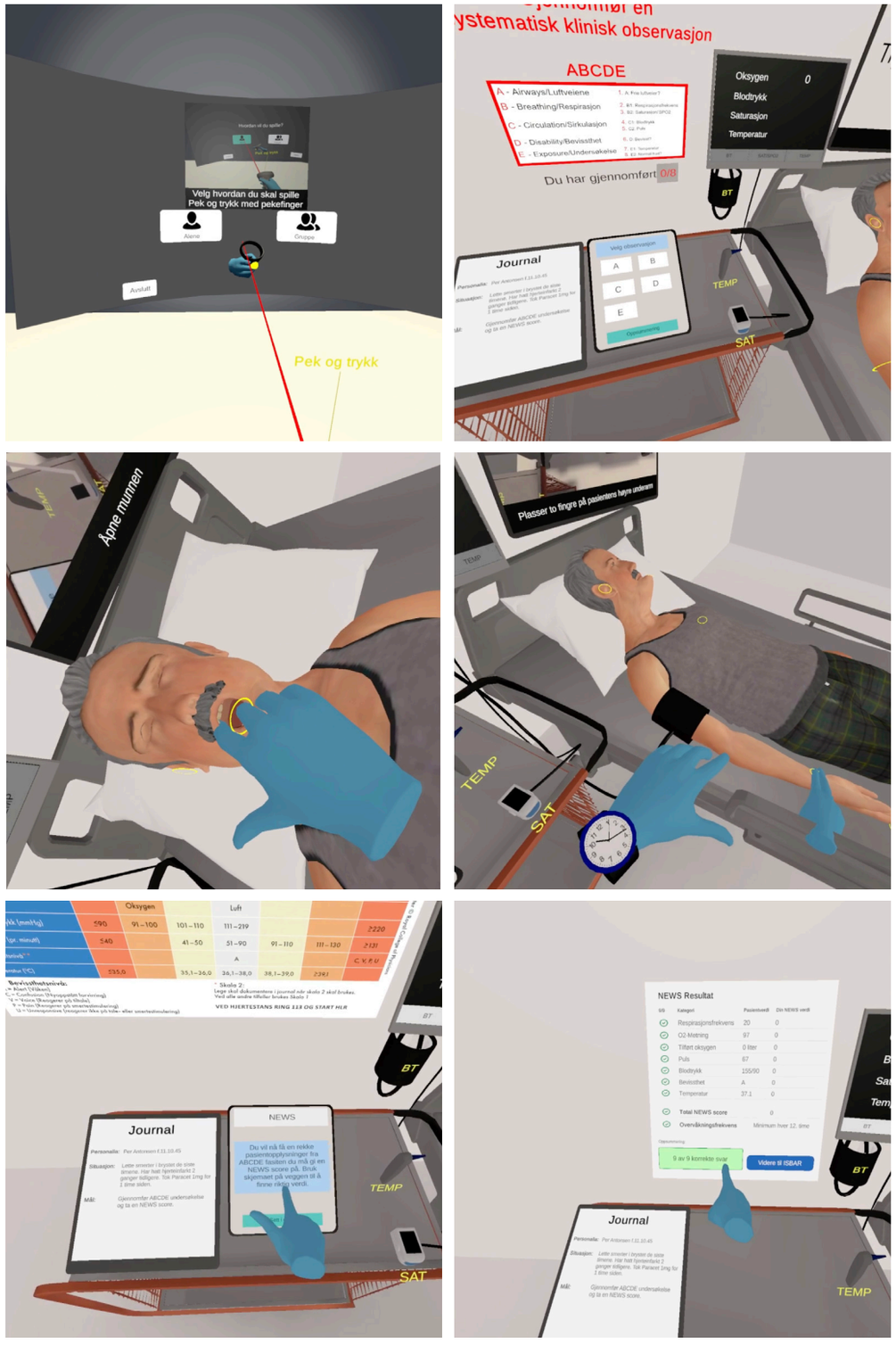


Figure 04-02. Screenshots from VirSam VR-application

User journey map VirSam's ABCDE

Original

Added after my start in the project

Touchpoints

Before ABCDE → Starting the program → Introduction screen → Selecting playmode → Onboarding sequence → ABCDE → Results from ABCDE → NEWS → Results from NEWS → ISBAR → Results from ISBAR → End summary → Quit the program

Subtasks

- Putting on the gear
- Familiarise with controls
- Selecting difficulty
- Interaction with objects
- Interaction with input mechanisms
- Onboarding task
- Performing tasks based on procedure
- Tasks are presented and recorded on tablet
- Performing intermitten quizzes
- Read summary of performance
- Answer quiz based on hyptheses and table on the wall
- Tasks are presented and recorded on a tablet
- Answer quiz based on hyptheses and table on the wall
- Tasks are presented and recorded on tablet

Value proposition

- Be able to try different versions of the experince
- Separate onboarding for helping the user get familiar with controls
- Onboarding task is relevant and accopanied with instructional video
- The tasks are performed in an isolated environment with no distrubences
- The user is given scores based on their performance.
- NEWS is important to be put into the context of ABCDE
- The player gets an overview of what is done right and wrong
- ISBAR is important to be put into the context of ABCDE
- The player gets an overview of what is done right and wrong

Known issues

- The VR equpitment is not readily available for everyone to use.
- Controllers are not known to many users
- The playmodes are not transparent
- The onboarding is unskippable
- The tablet is finiky and slow to use
- The quizzes are drawing too much attention and obscures the patient.
- The results are displaoed at multiple locations in the room
- The scores are through abstract stars, not providing any real value.
- The values from ABCDE is reset.
- The focus is switched from the patient, to the tablet
- Not using the values from ABCDE.
- The focus is switched from the patient, to the tablet

Observed feelings

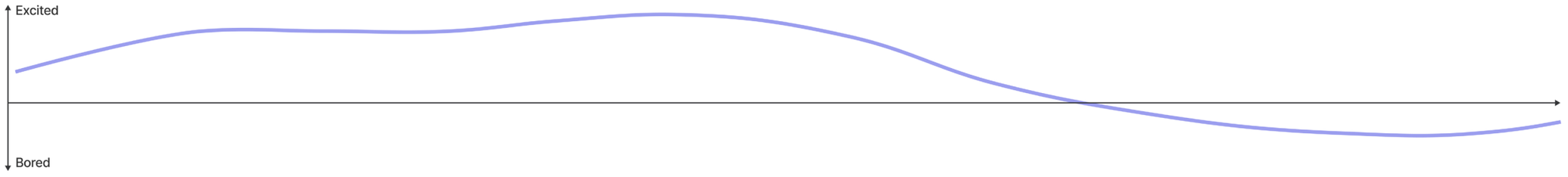


Figure 04-03. VirSam VR-application constructed user journey

Heuristic Evaluation

To find ways to improve upon the VR-application, a heuristic evaluation was performed. As described in Methods, heuristic evaluation is an objective evaluation of an existing system or application based on predefined heuristics. As discovered in chapter *03 Literature*, software usability is by far the most pressing issue in VR in education (Kavanagh et al., 2017: Jerald, 2016), and should therefore be high on the priority-list whilst creating and iterating the applications.

Choosing our huristics

Heuristic evaluation is an objective evaluation based on a set of usability practises that are meant to uncover and discover usability problems. Normally, this is done by an expert before the design is tested by real users, but in this thesis there is some overlap. Some heuristics are evaluated only within the context of the program, and some have been evaluated through observing users.

In the Methodology chapter we find the suggested heuristics presented by Nielsen (1994). These are very much relevant for our case, but I want to expand upon and add an eleventh and final heuristic:

11 **Utilisation of VR**

The reason for this is that VR can be considered an entirely different medium of interaction, and the application should be taking this into account.

Evaluating based on heuristics

The ABCDE applicatiom is a program with lots of cogs and interacting parts. For this thesis we are focusing the following components (in no particular order):

- **Flow between tasks (ABCDE → NEWS → ISBAR)**
- **Tablet (how the user is inputting values)**
- **Assistance in procedures**
- **Interaction with the tools**
- **Feedback and progression**

In this thesis we will go through each component and evaluate it based on selected heuristics. Not every heuristic will be discussed in each component, as some might be irrelevant for the context. The heuristics evaluated are based on usability and user experience alone. If something is made for an educational reason, that is not commented on.

Note: the purpose of using heuristics here is to identify areas of improvement in the ABCDE-application. This means that while it seems overly negative, there are a lot of good aspects to the application. However, as the intention of heuristic evaluation is to bring forth and discuss what may cause / has caused usability issues, this is what is being put into focus.

Flow between tasks

The application is made to demonstrate how the selected procedures are performed. However, through interviews with students, teachers and professionals, this flow between ABCDE to NEWS, and NEWS to ISBAR is artificial and disingenuous to how it is being performed in the real world.

Tablet

The tablet is the input mechanism through which the user enters the surveyed information about the patient. Compared to how the tasks are performed in real life, a tablet is not something that is being used by nurses in that context. The interface of the tablet changes completely between stages, and there are little to no hierarchical indicators, back-buttons or interaction-state indicators. Lastly, using a tablet as a tool for data input is effective, but having to use large hand movements to point and click for inputting values is slow and not precise.

Assistance in procedures

To aid the student in performing the tasks given, the application has put in place several visual and auditory aids. Videos explaining how to perform the tasks, posters with tables and explanations and tooltips are examples of this. The vidoes put in place are looping continuously, and there is no way for the student to intuitively know the start and finish of the videos. The posters are not of the same visual design as the ones used in the field, and they are rarely hung around the patient. Additionally, the help is the same regardless of the level of the student. Lastly, making the student stand still and watch a video about how to perform a task is not the best utilisation of VR as a 3D environment.

Interaction with the tools

The tools are what the user is using to take blood saturation, blood pressure, temperature and gather other values. They also include the screen where values are displayed. Some of the tools used have dissimilar functionality in the program compared to the real world (e. g. blood saturation instruments can also take the pulse). There are only predefined areas to place the tools, and tools do not adhere to gravity, breaking the feeling of immersion.

Feedback and progression

Feedback on the user's performance is generated by the application, and are displayed in tables of what the user did right and what they did wrong. Currently, there is no way of scaling progression other than selecting difficulty, which in turn is not transparent in terms of what is changed. There is no way of comparing results from previous sessions, and there is no way to immediately try again. Lastly, the feedback in the application is mostly binary, whereas in real life it is more nuanced.

Deconstructing the application

The reframing method uses visions as the source for motivation and intent. By understanding the connection between the institute's vision for nursing education, and the solution that is VirSam's ABCDE, we might get a better understanding of how the solution is made and why the solution is what it is today.

Figure 04-03 one the right illustrates how a project might move from the high-level, abstract visions, through several decisions and questions, and ends up in a concrete solution. The presented vision is taken from the institute's Unit of Health Professional Simulation, and the steps and questions are extrapolated from talks with contributors and from findings on VirSam's website (VirSam, 2021).

The takeaway from this figure is not the content itself, but how a designer using human-centred design and the reframing method thinks about solutions. For every intersection there are endless answers and decisions. By being aware of what decisions are made at what intersections, back-tracing and changing the solution based on new insights and testing can be more easily achieved.

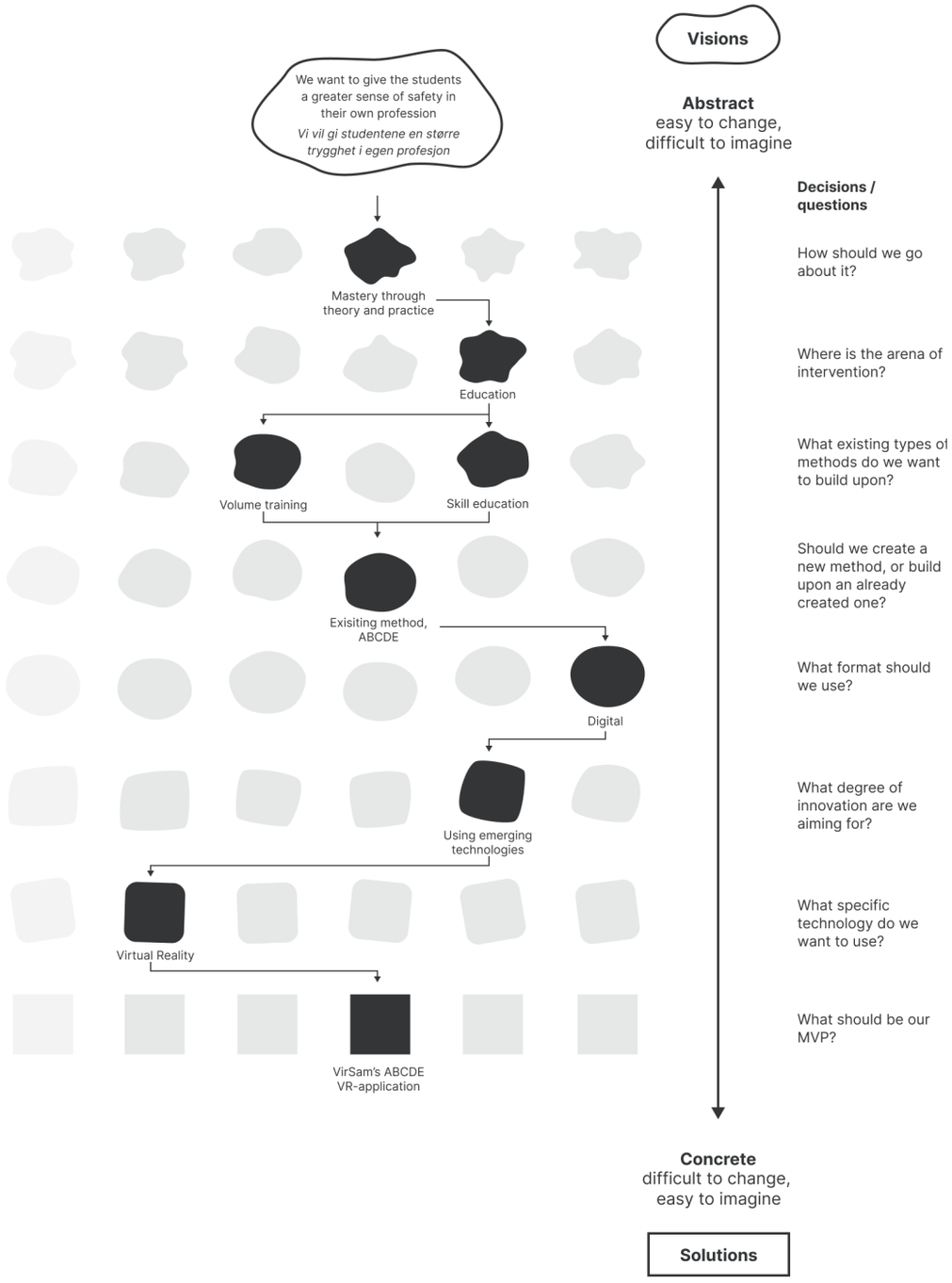


Figure 04-03. Deconstructed concept journey from start to finish. Made to illustrate how decisions include and explude possibilities

Key takeaways from heuristic evaluation

The current ABCDE experience is treating the procedure training as a test: The student is asked to do a task, the student tries to find the answer using the tools at their disposal, the answer is recorded and the student gets the result back. It is essentially a quiz, and quizzes can also be done without VR.

The best experiences are the ones that are focused on specific aspects, and the current VR experience is off to a good start by having the student learn and practice the ABCDE-procedure in an isolated environment. When the procedures NEWS and ISBAR is included, this experience gets cluttered and unfocused for a couple of reasons:

- When NEWS is introduced, the experience moves from being a nurse-patient simulation, to a theoretical test. The values recorded by the nurse in ABCDE are reset, and the tasks presented by the tablet are to be evaluated using a poster with fixed values.

- Going from an experience where the user is physically interacting with the environment, to where the user is asked to only pay attention to on a tablet is poor usage of the time in VR.

This is not to say that NEWS and ISBAR should be excluded from the ABCDE-application. On the contrary, both NEWS and ISBAR are very important skills to learn and use in the context of the ABCDE-procedure. However, there are other, more interactive, ways of including training of these procedures that are not the same as doing it on for example a laptop.

Exploring the nursing education

This subchapter will explore how the nursing education is experienced by the students.

Nursing education

This thesis is focusing on the education given to nurses studying at the Department of Public Health and Nursing at NTNU in Trondheim. In this subchapter I will present how NTNU prepares their students towards becoming nurses, as well as dive deeper into some of the specific educational methods.

The point of me listing up these regulations is to ensure that solutions proposed in this thesis do not mismatch with what is both recommended and obliged by law. The regulations are, in their own right, stakeholders in this thesis - they are to be considered when suggesting new solutions.

National regulations

Nurses are, alongside other occupations such as police, doctors and firefighters, considered socially critical for society (Regjeringen, 2021). This means that, if the country does not have enough qualified nurses, the welfare state would suffer. Hence, the Norwegian Government and the Department of Education have set regulations on what is expected of nurses when they graduate with a bachelor's degree (Kunnskapsdepartementet, 2019). These regulations are both communicated as criterias and guidelines, some more specific than others. What sets these regulations apart from other studies (for example Industrial Design at NTNU), is that the universities and institutions are obliged by law to follow them. There is a lot to unpack in the regulations, and this thesis will only highlight the most relevant topics. The information was retrieved from Lovdata's website (Kunnskapsdepartementet, 2019) in late November / early December 2021.

According to the regulations issues by the Norwegian Government and the Department of education, nursing students should gain competence within the following areas:

- Health, illness and nursing
- The nursing profession, ethics, communication and teamwork
- Science theory and research methods
- Professional management, quality and patient safety
- Service development and innovation
- Technology and digital competence

A central topic in this particular education is the acquisition of skills and how to use them. Two areas especially focus on practical skills. The area “Health, illness and nursing” highlights the importance of not only having the ability to apply the knowledge, but to be able to adjust and tailor the skills when necessary. The area “Nursing as a profession, ethics, communication and teamwork ”highlights the importance of having compassion whilst performing skills, requiring that the candidate “can apply relation-, communications- and guidance competence when interacting with users, patients and relatives.” (Kunnskapsdepartementet, 2019).

According to the regulations, the natural progression of the bachelor’s degree also needs to be taken into consideration. The structure of the study is expected to make sure there is integration between theory and practice in such a way that substantiates the learning outcome descriptions. Each year should have both theory and supervised clinical practice, and the curriculum should evolve from the fundamental topics to the advanced and compounded.

Through the regulations, the Government and Department of Education argue that no bachelors is complete without supervised clinical practice. How this builds upon and expands the education given by the institutions is crucial for the overall quality of the education. The students should go through at minimum periods of at least 7 weeks during their studies, visiting both municipal health care services and special health services. The shifts should be varied throughout the hours of the day. Like the education at school, there are a set of topics that should be included in the supervised practice:

- General medicine
- General surgery
- Mental health and psychiatry
- Elderly care and geriatrics
- Pregnancy and maternity care
- Primary school care and paediatric nursing
- Home care

Evaluation of the national regulations

An independent report on the implementation of the national guidelines ordered by the Norwegian Nurses Organisation (Norsk sykepleierforbund, NSF) was done by Vista Analyse AS (2021), highlighting the implementation of the regulations. In short, they conclude that differences in graduating competence between the 13 institutions are inevitable, and the education given by the institutions will always have variable factors, making the regulations mere “good intentions” rather than a long-term solution (Amundsen, M., Rasmussen, I. & Sverdrup, S. 2021).

The report highlights that the regulations leave room for interpretation and opportunities for local solutions. The different emphasis by individual institutions on the topic is believed to create various degrees of competencies (Amundsen et al., 2021). The report also highlights the irregular interpretation of the EU directive’s demand for the amount and type of supervised clinical practice, and that all supervised practice should be patient-centred. There are, for example, not enough internships for maternity, paediatrics, and a surplus of internships in elderly care. It is argued that the knowledge gained by supervised clinical practice is of the utmost importance, and that most institutes have capability to simulate some of these scenarios, although to a limited degree. (Amundsen et al., 2021).

Physical simulation training

To better understand what VR might be compared with in education, an observational study was conducted at Øya Helsehus.

The main aim was to get insights in how physical simulation training is planned, set up and performed today, and what learning VR could take from it. The hypothesis was that physical simulation training had inherent qualities, or deficiencies, that would be beneficial to include in VR.
A breakdown of the observation can be read in *Figure 04.03* on the next page (in Norwegian).

Takeways from the observation:

The simulations are very much adapted to the skill level / competence of the students before they arrive

The facilitators and operators are putting the notion of it being a safe experience above almost everything else

Having the students reflect upon their experience in the simulation is the most important learning outcome

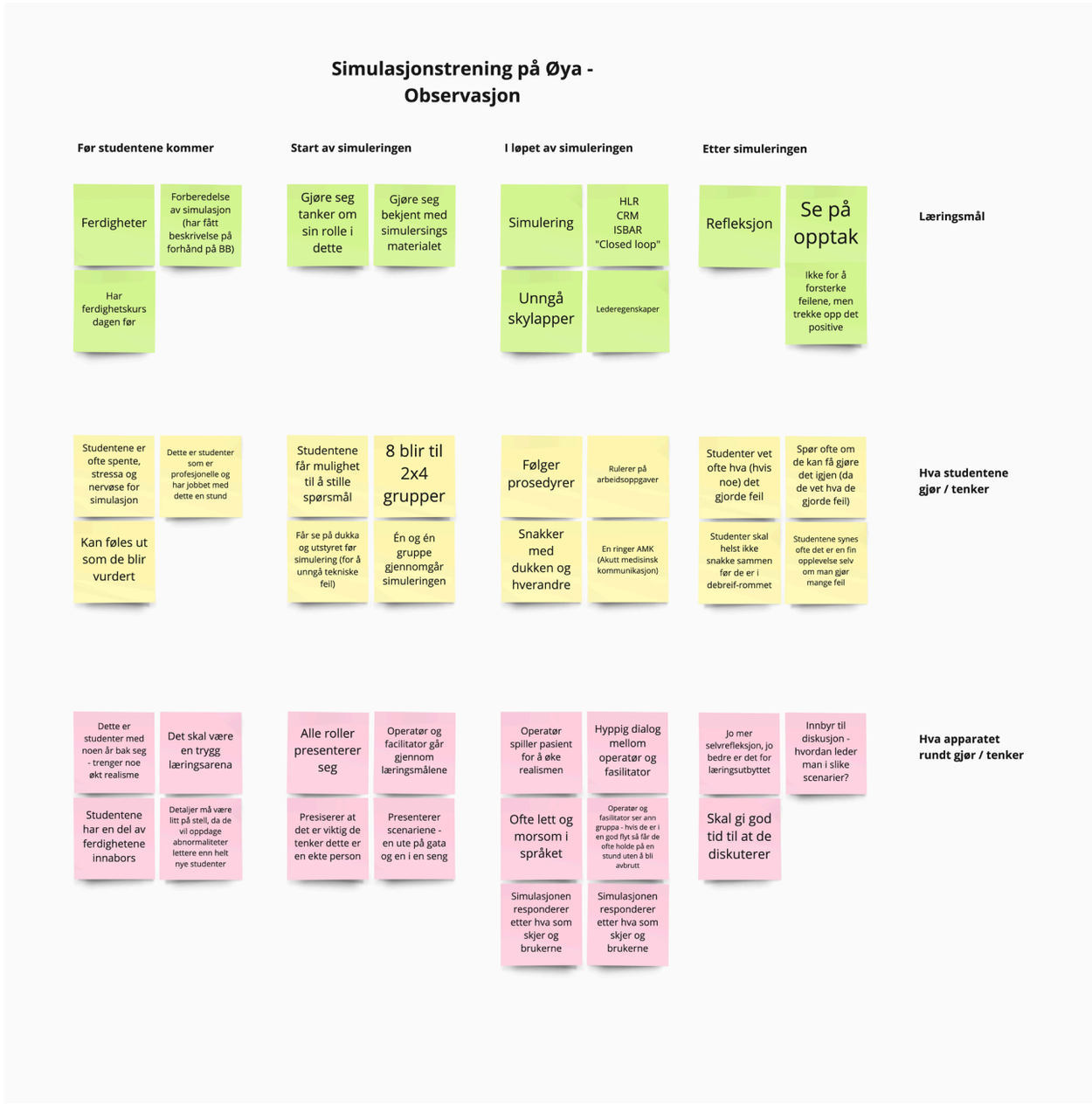


Figure 04-03. Topcial description of the simulation.

Interviewing students about simulation in their study

When interviewing nursing students at NTNU about their experience of learning practical skills and procedures, they are describing a study where it is expected they should know a little bit about everything. Additionally, the simulation training is few and far between. Described earlier, the simulation training is often in groups of several students, making individual follow-up and feedback almost impossible.

The students in the first years, who are entering the education with nervousness of what is to come, explain this as a bit of a let-down. They feel unprepared and nervous about going out into supervised clinical practice because of this.

The students who are halfway through the education are more relaxed about the situation because they have understood that they cannot learn everything at school, although they also think that they don't have enough simulation training. They understand that learning a skill means using them in practice, and there is a time and place for that. However, they would like to exercise more granular procedures that are a bit more technical than ABCDE, for example SKUV.

The students in the latter years have a more nuanced understanding of the possibilities and limitations of the study. They have learned that education is best taught through practice, but are still looking for arenas for trial and error.

However, the more they have learnt, the more they know that they don't know - making going into a full-time job as nurses a scary thought. Not to mention the nonlinear structure of the study, the students might have vastly different experiences even though they are from the same class. Having access to some kind of introduction or exposure to the experience they "missed" is sought for.

Although these were a lot of negative points, it does not mean that everything about the study is bad. This section has only highlighted the actionable feedback taken directly from the students.

"The way the school uses the simulation equiptment is frankly shameful"

- graduated student

"You are somewhat left to yourself to practice"

- 1st grade student

"There is a impression of 'you should already know this' from the teachers"

- 3rd grade student

"You do not feel ready until you graduate, and not even then do you feel close to competent enough"

- graduated student

Same study program - different education

Even though the students are admitted into a planned and structured university programme, the nurses that graduate have experienced very different educations. Due to how the study program is structured with school and supervised practice, almost no two students are alike.

Before admission

The educational journey might even start before being admitted. Some students have taken health sciences in high school, some have been medic in the army, and some do not have any relevant experience. The student brings their own prerequisite into the study, and that is to be considered part of their education.

Supervised clinical practice

Around 50% of the study is based on supervised clinical practice. The students most often first encounter this in the latter half of the first year of bachelors. The county has a set number of positions for practice, both in and outside Trondheim. Who gets to go where is decided randomly, meaning that two students from the same class might have practised- and learned vastly different skills throughout their supervised practice.

Extra activities

Some students might have paid or voluntary roles in other organisations besides school, such as Leger Uten Grenser, Trams, Røde Kors or other. This too shapes the student's experience and interest, and can be considered a very important part of the education.

The individual educational journey

To sum up, what makes up a student's individual educational journey is a calculation with many variables. Of course, there are some fixed variables in the equation, among them the national requirements and planned courses created by the university. Having said that, what makes up a given student's arsenal of skills and knowledge is, arguably, decided by their exposure and experiences outside the study hall.

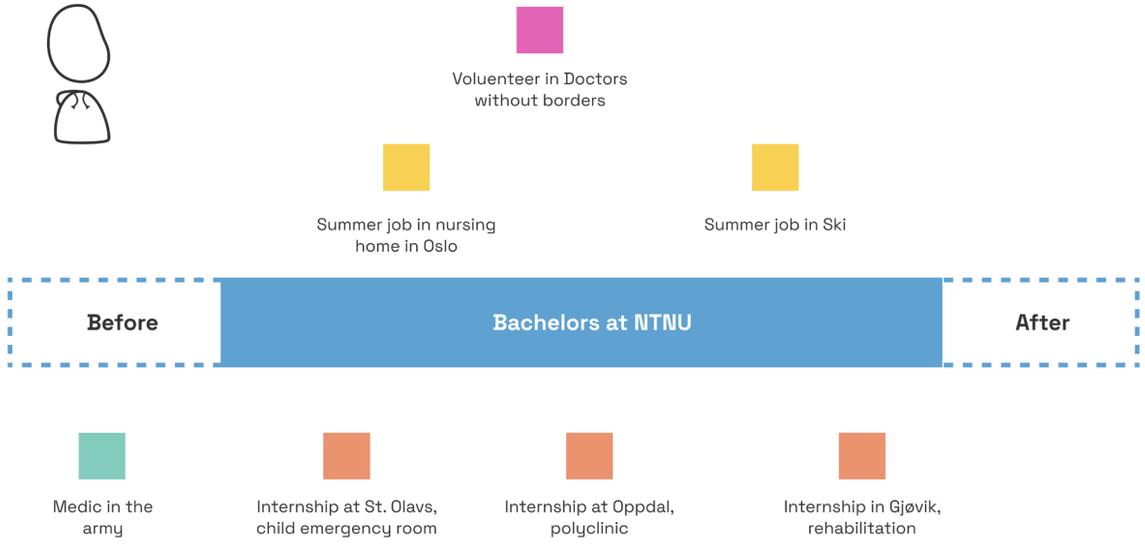


Figure 04-04. Generalised illustraion of where practical knowlege is aquired.

The educator's perspective

Even though this thesis is mainly focusing on the end-user for nursing education in VR, the students, it is important to keep in mind some of the other stakeholders. Part of the insights have come from the contributors of this project, some of which are the educators themselves at NTNU, namely the ones who create the curriculum and the ones who educate based on it.

The educators have their own needs, ideas and visions for how the education can and should be. Most of the educators have been, and are, practising nurses themselves, and therefore have valuable perspectives from they were students themselves.

Talking with the educators have rendered some interesting findings about the current state of the education and how they think VR can be beneficial.

> "The education is highly influenced by the individual educators and professionals"

One of the biggest strengths, and sometimes the biggest weaknesses, is how the educational offer is delivered by individual educators. The educators are free to use tools they find personally beneficial and interesting, for example VR. Having access to more educational tools is great for choice, however, the educator needs to feel comfortable in using and providing guidance in the tool themselves.

> "Becoming part of a university programme has taken away some freedom"

When NTNU expanded to include Gjøvik and Ålesund in 2016, larger parts of the nursing education in Trondheim was put under the academic umbrella of NTNU. This meant some of the curriculum needed to make room for other courses, such as ExPhil, removing some of the freedom the study program previously had. Arguably, nursing education has different needs and requirements than other study programs offered by NTNU, and this relationship is still a work in progress.

> "Providing the right motivation and feeling of mastery is central throughout the education"

One of the requirements of the study program is to help the students feel motivated and achieve a feeling of mastery while progressing throughout the study. Educators at Øya want to create a system where they can help the students find their own way of learning the curriculum.

They want to teach the students to acknowledge when, how and why they did something right, through providing feedback and praise. The goal is to provide feedback on what is done right and what can be improved.

The educators understand that the student wants more freedom of choice in how they learn. Subsequently, there is relatively little research on the effects of the current methods, especially in skill- and procedure training. The pedagogical tools are very static, and there is reason to believe that VR can make some parts of the education of procedures more dynamic.

”It needs to work”

The tools the educators choose simply need to work. Even though the educators are somewhat free to select the tools they want, they often select the ones they know works.

Up until now, there are some indications from educators and other researchers that VR has positive results in education (Steinsbekk & Berg, 2020). However, educators are more sceptical towards the longevity of the current solutions (in this case, VirSam’s ABCDE). They find VR to be good for demonstrations and for providing positive effects on the students through the novelty factor, but are still technically unoptimised.

The toolbox

In this section we are going to highlight and understand the various tools and methods that are being used in education today. Some of the tools are created by and the university and incorporated into the study program, meaning the student is required by the school to go through the scheme. These are hereafter categorised as “Internal” tools. Other tools are created by external actors and are sometimes used by students at their own initiative. These are hereafter categorised as “External” tools.

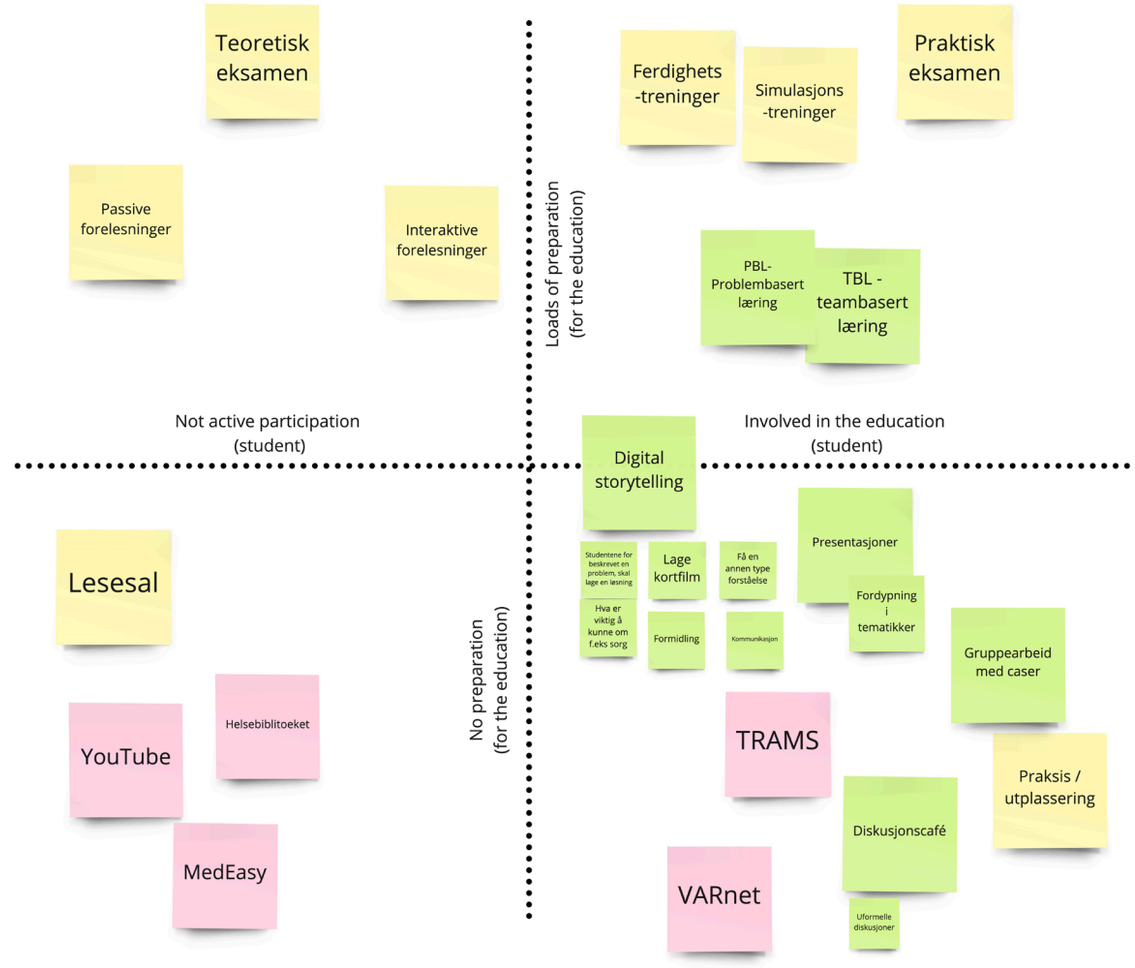


Figure 04-05. Matric of many of the tools used in the edcuation. Horisontal axis describes the activity level of the student, and vertical describes the amount of preperation for the educators.

Internal tools

In-house educational tools are the ones created and run by the university. These tools are part of the larger study plan, and leave little room for individual students to deviate outside the set path.

Lectures

The most basic form of knowledge-sharing: the humble lecture. As with all other lines of study, lectures are used by one person to convey knowledge to many people. The lectures vary by interactivity and content, but most lectures are of the form that includes a presentation of a given topic, often of the theoretical variety.

Skill training

A nurse's toolbox is filled to the brim with both theoretical knowledge and manual skills. A nurse is supposed to know various communication methods, practical procedures, how to use certain instruments and basic medicine. The skills training might come in several forms, but the most common is courses made by lecturers where the students have the opportunity to ask questions.

Simulation training

To put the skill training to the test, part of the education is arranged in so-called "simulation training". The simulation training are staged scenarios utilising dolls or human markers where teams of nurses are collaborating to treat the patient. These simulations are often along-side a skill training course, but during the simulations the students are not supposed to ask for help or guidance. After the simulation, there are often debrief sessions where the students are given feedback by the observatory and asked questions created to invoke self-evaluation in the students.

Supervised clinical practice

Every year, students are placed at hospitals, nursing homes or municipalities to work as nurses. The different in-field practises should align to what the institutional and national learning objectives are expecting of the students. The periods of in-field practises does not always align with the theory and simulation training that the students performed prior to being placed, and sometimes refreshing courses or e-learning material is needed for the students to feel ready before going to work.

Practical exams

To evaluate the student's performance on skills and teamwork, practical exams are arranged. One example of practical exams is when the student moves from room to room and performs selected situational and clinical tasks.

Theoretical exams

Part of the expected knowledge is theoretical and that too needs to be evaluated. Theoretical exams evaluate the student's knowledge through standardised written tests, quizzes and written exams.

External tools

Leardal Medical SimCapture

Laerdal's SimCapture is a suite of software programs that connects to their own physical hardware of simulation dolls, sensors, cameras and more. The software is not something that is directly interacted with by the students, but is something that educators use to observe, monitor and construct feedback to the students.

TRAMS

Trams is a student initiative by medicine students at St. Olavs. Their main purpose is to make scenario-based training more accessible for all medical students. Trams is a volunteer-based organisation that arranges various courses for groups of students, focusing on acute scenarios and clinical practises. The courses are scalable according to what grade the attending students are in, and has achieved great success by offering exposure that is not covered by the study programs today. The exposure for acute scenarios is only part of the learning outcome, as Trans also focuses heavily on being a unifying place for students across medical fields and educational progression to share and inhale experiences. Part of the success of Trams is arguably because they are serving a demand. When there is a lack of something in the education, one gets automatically engaged and interested to fulfil that demand.

MedEasy

Most health professional nurses are, to this date, using external, digital tools to help them be better in more theory-heavy subjects like anatomy, EKG, microbiology etc. The most common one, MedEasy, is designed and developed by and for medical professionals, helping them to better understand and contextualise all the curriculum.

MedEasy is a different kind of educational vessel that wants to help medical students do be better at their exams by making the curriculum more easily digestible and accessible.

MedEasy is a scandinavian platform for e-learning and education of medicine- and nursing students. The platform has a high focus on letting the individual users consume the content at their own pace, helping them take better notes of the lectures and small, but frequent tests. The aesthetic expression is light, clean and playful, and these characteristics are hallmarks in many of the lectures as well. The lectures are light-hearted, funny and well designed with custom motion graphics and well structured content.

I asked them why they have chosen to use specific approaches to their education. Their response was that they view the light-hearted approach as a key to helping the students understand and staying motivated. When challenged with new concepts and theory, students are at their most vulnerable, and sometimes at the edge of frustration. By channelling the complex information through a filter of playfulness, MedEasy have realised that it is just as much about how you deliver the education as what you are delivering.

YouTube

You can find anything on YouTube, including videos on skills and training for nursing. YouTube is a global platform where all users can upload and share videos. The platform is used by both students, for finding explanations and examples, and teachers, for posting and finding said examples.

Loooking at an exisiting framework

One of the most used educational frameworks in the education of nurses is the Circle of Learning, created by the company Laerdal Medical. Of course, Laerdal Medical being an external company, this framework is tightly connected to the products they make. What is good about the Circle of Learning is how it understands and illustrates the different stages of learning a skill in the medical and nursing field. As shown in *Figure 04-06*, learning a skill is a cyclical process, moving between stages of knowledge as the student progresses.

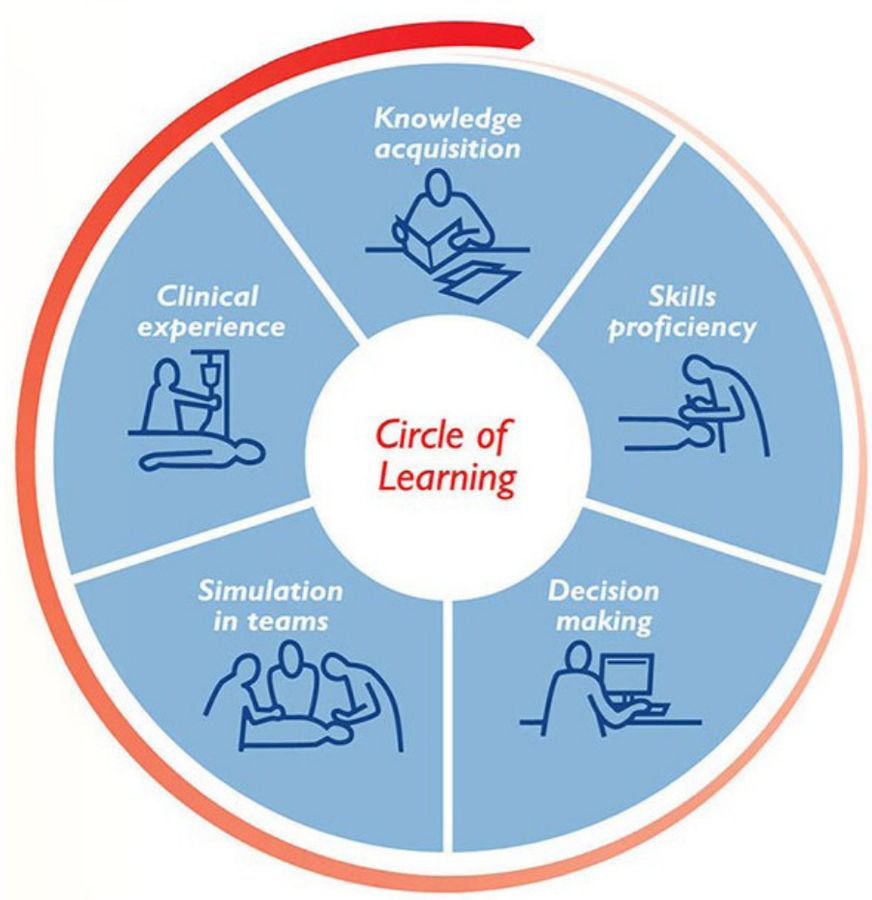


Figure 04-06. Leardal Medical's "Circle of Learning"

Key findings from the nursing education

To sum up, through interviews with the target users and input from the contributors, here are some of the key findings from the results.

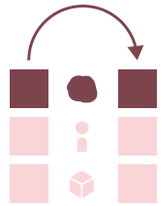
- NTNU's goal is to create safe learning environments where the students are given room for trial and error. However, procedure training is described by students to be scarce and much sought after
- The educators are often free to decide what pedagogical tools they want to use as long as the learning objectives are met
- The courses might use several different pedagogical tools in line with what gives the most effect
- Students at different stages in their education have different goals and needs for training
- More actionable and personalised feedback is wanted by both the students and the institution, but it is difficult due to lack of resources
- There is sometimes a thematic mismatch between what the student learns in theory and what they are asked to do during practice
- Graduates often have vastly different training experiences and exposure to the field due to how the supervised clinical practice is set up

All these findings can be described as symptoms to a larger issue: Some students feel they do not master some procedures due to insufficient training and feedback, giving them a sense of vulnerability going into the real world.

Closing thoughts

Following the reframing method this chapter, alongside the *03 Literature*, has provided a good foundation for understanding the tool we are dealing with. The interviews have given me knowledge and understanding on how a VR application for nurses should and should not be designed. Furthermore, having access to a developed experience and working closely with the developers of VirSam's ABCDE VR-application has made it easier for me to prototype my own concepts and communicate with the developers.

Through interviews and discussions with nursing students and other contributors I have gained an understanding of the student's needs, how they experience the study program, which tools they use and how they learn new skills. In the next chapter, these findings will be used to explore whether VR can assist in improving nursing education.



05 ANALYSIS

This chapter presents processed understanding of the current solution and context, and suggests areas of focus for further experimentation.

121 **05 Analysis**
122 Introduction
123 Research Questions
124 Establishing the target users
130 Student's model of the education
134 VR in relation to the skill education
138 Defining the focus areas
148 Establishing a vision for future work
149 Closing thoughts

Introduction

This chapter aims to further concretise the findings from chapter *04 Exploration & Insights* into actionable findings. The goal is to take the qualitative insights and use established design visualisations to better understand the findings. Additionally, I check in with the contributors to gain their opinion about the selected areas of focus.

Research question

This chapter is trying to answer two research-questions.

RQ3: “In what context of nursing education might VR be used to best meet the student’s educational goals and requirements?”

This will be explored and defined through design visualisation such as personas, stakeholder mapping, user journeys, focus areas and a future vision.

Establising the target users

There are several components to any education: the teachers, the knowledge, the delivery mechanisms, the evaluation and much more, but they are all means to an end - educating the student to become professional students.

By looking at the student's current situation, understanding what they are struggling with and using that as the driving force and foundation for developing solutions, we are exercising design thinking through the human-centred design methodology. However, it is also important to consider the reframing methodology, which puts the users wants and needs in a larger context and also consider and speculate the future needs.

Personas

It is easy to think that all students could be placed in the same bucket of users, all with the same needs, wants and proficiency. That is not the case, and the product should know how to respond to different user's needs.

By breaking up by "stages of education", we are able to both follow the natural progression and acknowledge that different users have different needs. Because of how the study program in Trondheim is structured in periods of theory and periods of in-field practice, it is difficult to simply divide the groups based on grades - 1st grade, 2nd grade, 3rd grade, graduate. Rather, the groups should be divided based on the student's level of skill regarding theories and practises - beginner, intermediate and advanced skill level. Each user group is presented as a "persona", which is used to generalise the groups' needs, wants and opinions.

The stages are not definitive and set in stone, but acts as a guide to understand the different needs and expectations when going into procedure training.

Beginner

Description

- Most often students in the 1st to 2nd grade.
- Knows fundamental theories and has practised some of the procedures.
- Needs to be reminded of the steps in procedures.
- Feedback should be straight to the point and binary.
- No VR experience.

Needs

- Have a good overview of what is expected to be known
- Clear connections between theory, practice and procedures
- An overview of where to go to know more about the subjects
- Feedback on what it takes to be pass
- An arena to try and fail

Focus and goal

- Passing exams

Intermediate

Description

- Most often students in 2nd to 3rd grade. Knows how to use most procedures
- Might need some refreshers, but gets back quickly.
- Feedback should be performance based and shaping good habits.
- No VR experience.

Needs

- On demand refreshing of procedures Feedback on what it takes to be good
- An arena to try and fail

Focus and goal

- Get relevant experience

Advanced

Description

- Most often 3rd grade to graduate students.
- Instinctively uses procedures to the point where they know where to take shortcuts.
- No need for refreshing the theories and steps in the procedures.
- Feedback is purely performance based and should correct any habitable flaws.
- No VR experience.

Needs

- On demand refreshing of procedures
- Challenging cases
- Feedback on what it takes to be great
- An arena to try and fail

Focus and goal

- Be prepared for working professionally

Stakeholders

From the previous chapter, key stakeholders and constituents that are impacting the student's experience while getting their education have been identified and mapped out. One important note is that the stakeholder map is from the point of view of the student, including who and what they consider the closest to their educational experience. Initially, this map focused on the first and second year students, but the contents have relevance for higher levels as well.

The radiant layers illustrate the distance between the student and the stakeholder in question. In the centre of the map we find the student, followed by their fellow students in close proximity. After that we find what students consider the core part of their education. Next, other external tools and arenas for supervised practice are placed. Lastly, the highest-level organisations that manage and oversee the education and occupation. The stakeholders include not only other people, but sources of information, contributors and sources of information that impacts the student's, not only education, but day-to-day life as a nursing student.

What is important to note here, is how this map might change as the student progresses in their studies. Fellow-students after a while become colleagues, the core parts of the education become more arranged and planned by the workplace, and the arenas that once were part of their education become their workplace.

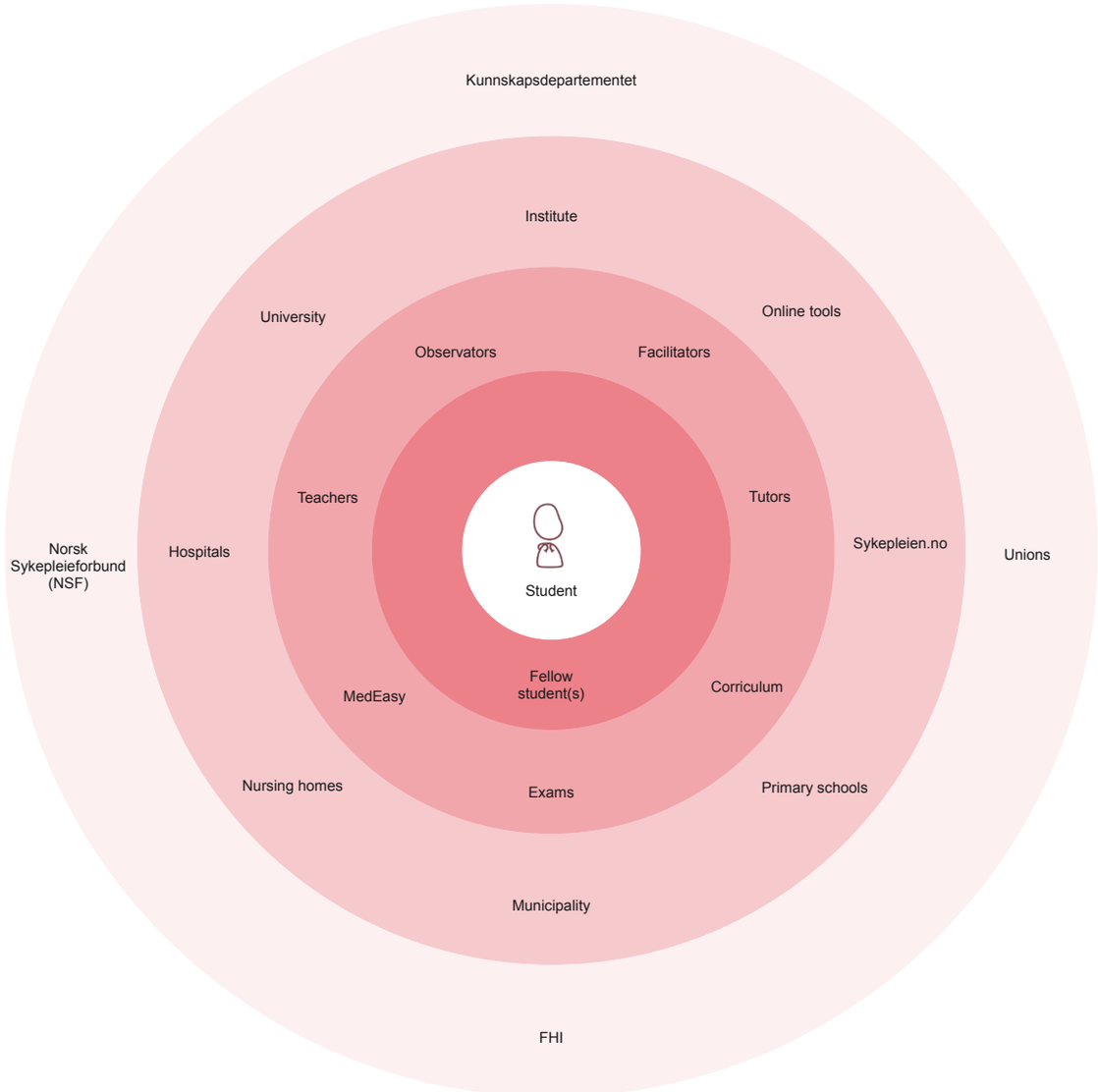


Figure 05-01. Stakeholder mapping illustrating the people and educational elements surrounding the student.

Student's model of the education

This subchapter discusses how students think about and describes the education, constructed using insights from the previous chapter. The following subsections will shed light on the most basic building blocks of education, how the students interact with other stakeholders, how their educational journey is crafted throughout the study, the educational tools that are being used and what learning processes they are going through.

Building blocks

Health and medical professionals go through education to learn various techniques, advanced theory, communication and collaboration skills and how to handle complex situations. Within this we find numerous tools and educational strategies, all created to best educate the students and help them to become the best version of themselves.

To better understand how VR is to be considered, treated and used to aid in the education of health professionals, we need to know what the most fundamental and high-level learning objectives are.

Through interviews with students, these categories are created to illustrate how the student's experience and think of the education. There are natural overlaps with how the education is imagined by the student, and how it is planned by the school.

Theoretical knowledge

Theoretical knowledge is the learning objective that includes all fact-based and intellectual knowledge. All questions here have a (more or less) fixed and binary answer, and include the knowledge students simply need to study and read in order to understand.

Technical skills

The technical skills are not limited to knowing how to operate a digital interface or software, but rather how to apply clinical procedures and techniques in order to get a job done. Here we find the connections between theoretical knowledge, physical/digital tools and situational tasks.

Situation management and teamwork

Nurses rarely work alone, and knowing how to work with colleagues for optimal team performance is key to a well-functioning system. These are the kinds of know-how that rely on everyone having a common understanding of theoretical knowledge and technical skills, as well as exposure for leadership and communication practises. This building block is heavily tied into the next block when it comes to areas such as patient communication.

Compassion, empathy and consideration

Nursing is one of the most humanitarian professions there is, and as part of the education students are trained, tuned and exposed for situations where being a fellow human is the best, and sometimes only, tool to solve the task. This building block is more latent than the other blocks. It is engraved in every step, intent and procedure to varying degrees. Of course, there are set techniques for how to behave around patients, but those are covered in the previous building block. Here we are talking about the empathy and emotional bond that is driving all the aforementioned blocks.

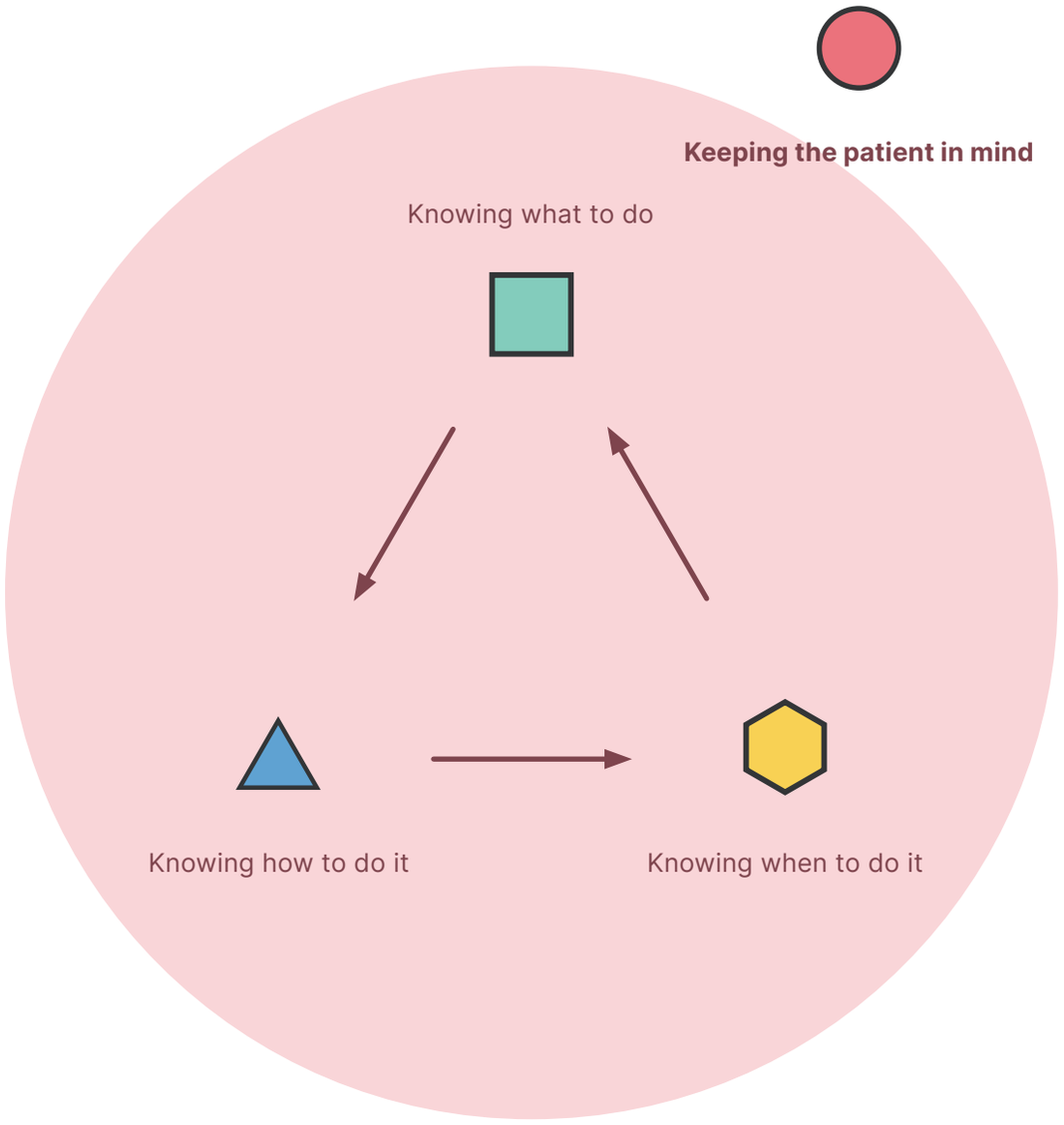


Figure 05-03. Illustration of how the bulding blocks interact to create mental connections.

The mental model serves as an important illustration for later, as this can be used to pinpoint where VR might be best placed.

The education journey

As learned in the previous chapter, no two graduating students are alike.

If we comapre the educational progression of hands-on practice of three students, we see three seemingly similar students end up with very different portfolios of experience.

Figure 05-04. Comparing the student's portfolio of experience.

The question going forward is not necessarily how do we "avoid" or "fix" this - it is in the nature of the study programme. Rather, future experimentation should be aware and put the difference in experience to good use.

VR in relation to the skill education

This subchapter tries to explain how VR can be considered part of the education of skills in nursing education.

Let's look back on some findings on VR in education: Kavanaugh et al. (2017) describes situations in education where VR has been applied: simulation, training, access to limited resources and distance learning. Furthermore, VR can motivate learning through collaboration, gamification, immersion, enjoyment and personalization (Kavanaugh et al., 2017). VR is tapping into a number of sensory capabilities and motor skills, making the experience more engaging, potentially strengthening the learning effect (Dale, 1969; Jerald, 2016). Like digital tools in general, VR can contribute to mastery learning by tracking performances and providing immediate feedback. Additionally, VR equipment is portable and accessible. However, the learning outcome and engagement can be weakened by problems concerning input and output, motion sickness, and poor educational design within the VR system.

Defining VR's contribution

With this in mind, how can VR assist in improving nursing education? In the context of education, VR can be viewed as simply another tool for conveying knowledge. For VR to add value, it needs to do one or more of these things:

1. Solve a problem better compared to the solutions that are already there

2. Solve a problem that does not yet have a solution

3. Create new opportunities, moving beyond existing problems

These thoughts will be kept in mind moving forward.

Considering VR in the skill-based learning journey

Based on the Circle of Learning and findings from the students, now we are going to look at where VR might be best used in learning a skill.

Learning a skill is a journey on its own. Let's consider a skill most of us know - riding a bike. I would guess that most readers of this thesis consider riding a bike as trivial. But it has not always been that way. As a kid you were introduced to the concept of a bike, and how it might be useful for you as a means for transportation. Then you needed to know how the steering and pedals worked. After that your parents may have cycled while you were watching, not really thinking about what you were passively learning. Then it was your turn to do it, but one step at the time. Your bicycle had small training wheels on the side, helping you focus on pedalling and steering before tackling the issue of balance. Suddenly the training wheels were off, but you still felt a bit unsure, so your parents were behind you to catch you if you fell. And you would fall – a lot. After a while you practised on your own, but in safe areas. Maybe in the yard, maybe on the sidewalk in front of your house. Suddenly you felt proficient enough to use the bike to get to school, but you still had both your hands on the wheel and still reminded yourself about leaning into the corners and distributing the braking between the front and back wheels.

After years of practice you don't even think that cycling is such a complex composition of hand-eye coordination, awareness and years of practice.

This breakdown of how many of us were taught to ride a bike is an analogy of how one might learn all different types of skills – the educational journey of any given skill. I've broken them down into sections:

- **Introduction** – your first encounter with the skill
- **Theory** – the theoretical facts you need to know about the skill
- **Observation** – looking at someone with the skill perform the skill
- **Isolated skill training** – skills are often compositions of smaller skills, here you pause some smaller skills to devote more attention to others
- **Simulation training** – putting the skill into a safe context
- **Practice** – using the skill in the real world with some supervision
- **Perform** – using the skill as part of your routine
- **Automate** – not even thinking about that it was something you had to learn

Figure 05-05. The educational journey of a given skill.

These sections can vary in duration and complexity, and some even overlap each other. The point is that skills can be broken down to create a visual journey that the users are going through when learning said skills.

Chapters *03 Literature* and *04 Exploration & Insight* have taught us where current- and near future VR have its strengths and weaknesses. Coupling this with what the students feel like is missing in procedure training, we can speculate where VR is placed in the skill-based learning journey.

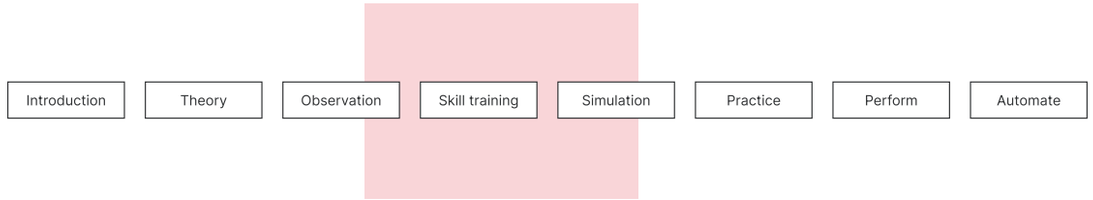


Figure 05-06. Placing VR in the educational journey.

Focusing the VR experiences to be about the specific step skill training, I believe we might be able to fill a demand that is currently lacking.

Consequently, there are other parts of learning a procedure that is not being taken into consideration. This goes to show that VR does not have to be the tool for every step of a given procedure. VR can provide only a part of the education. Still, if the VR simulation is to be the best version of itself, it needs to be aware of the other steps in the learning journey, and the student needs to know where to obtain the other parts.

Defining the focus areas

This subchapter will further define in what way VR can assist in the nursing education in Trondheim.

To answer this, focus areas are defined that will act as a basis for the next chapters. This part is twofold: First, a specification of the arguments used to decide upon focus areas, based on insights from the previous chapters. Second, a presentation of the focus areas themselves.

Deciding the focus areas

Deciding on a focus area involves making choices on several levels:

How do we create solutions that best make use of VR?

As discussed in earlier chapters, VR offers a lot of opportunities, but also limitations. Evaluating which problems to solve in this thesis is therefore affected by what opportunities VR offers and, whenever possible, what limitations can be challenged. For example, improving the students' expected curriculum can not be solved by using VR, and is therefore not relevant for this thesis.

Where do we see a lack of solutions and experimentation?

Through learning about VR for education, looking at previous and current examples, and evaluating the current solution of ABCDE by VirSam, one can say that several areas of focus have been left in the dark in terms of design to the benefit of others. This is not to say that all solutions should be innovative and unique - the best solutions are often the ones that build upon a tested foundation. However, there might be reason to think that some solutions are built upon the wrong foundation, and this can be verified by building a new foundation and comparing.

What would have the greatest impact?

By interviewing students and stakeholders we have gathered insight into what problems they would like to have solved. A part of human-centred design is listening to all of these problems, filtering out the ones that can be described as "symptoms", and evaluating the solving of the given problem that has the best positive impact on the users and stakeholders.

Identifying key metaphors

The findings from the interviews and observations from the previous chapters have been summarised and sorted using affinity diagramming, as well as used to construct the user-personas. The results from the affinity diagramming were then used to create an *Elito table*. The Elito table played the role as a source of inspiration for creating the proposed solutions.

Observation "What did you see, read or hear?"	**Judgement** "What is your opinion about the observation?"	(spine-column)	**Value** "What values are ultimately at work?"	**Concept / sketch** "What can the design team do to solve this problem?"	**Key metaphor** "What is the hook for this story?"
VR is expected to be fun.	VR is novel for many demographics, and one of the best showcases for VR is games. Because of this, it is expected that VR should adapt some of the same attributes as games.		Enjoyment	Create a playground that acts as part of the experience	Configurable VR experiences
You never learn as fast as when you are just thrown into it.	Many nursing students have only completed basic training before going to supervised practice.		Nervousness	Help the student to learn how to "take a break" and evaluate the scenario.	
The students feel ill prepared for all the various scenarios they might encounter in their job	The more they know, the more they feel they don't know. There are so many different scenarios they can encounter in their job, and the university can hardly account for them all.		Nervousness	Have lots of different cases that the student can go through according to their own progression.	
The teachers and tutors have a lot of independence to choose how the subjects are taught	There is a feeling of trust among the teachers. It is expected that the teachers choose an educational tool that best suit their needs and they deem fit to communicate what the students want to learn.		Flexibility	Toolbox where the teacher can select tools based on their own criteria	
There are not a lot of companies that create technology solutions for education of nurses	There are some companies (Laerdal) that have in many ways a Monopoly on the equipment and services.		Lock-in	Create in-house alternatives	
There is lack of individual follow-up in feedback.	The schools only have a set amount of resources to follow up the students		Frustration Helplessness	Have the VR system tell the student what they did good / what they need to work more on.	Peer-to-peer
There are too few teachers to give each student the attention they need	The schools only have a set amount of resources to follow up the students		Frustration Helplessness	A system where teachers can give feedback to students based on their procedure training	
Supervised clinical practice is a hallmark in the education	The education at school is not enough to become a nurse.		Variation Exposure	Use experiences from the practice in the solution	
Students often shares experiences with each other	The eagerness to share experiences is something I would say is a very important characteristic of the profession.		Sense of community	A space where sharing experiences is the, either, sole purpose or hidden purpose.	
Feeling that you master something is a result of experience and feedback.	Getting recognition that you are doing something right is how the brain creates connections.		Mastery	Give the student the top 3 things they did right, and the top 3 things they need to do next time.	Targeted feedback
Students are often evaluated in groups	Many of the educational programs place students in groups, both because it is efficient for the teacher, and because working in teams is important for the education.		Unity Frustration	Give each member in the group "time to shine"	
Progression is key to knowing where you are and where you are going.	Nursing education is a broad field of both theoretical knowledge and hands-on skills. Knowing what you have mastered and what you need to work more on is a source of mastery.		Safety	Timeline Visualising progression	Overview over progression
National regulations are put in place to ensure the quality of the profession	Due to the education being of outmost social importance, the Norwegian Government has put in place national regulations. Which is good.		Security	Communicate to the student what is national, and what is local (is that something they want?)	
The education is made of a collection of theory, skills, communication and empathy	There is a lot to learn.		Vastness	Help the student to create an overview of what they are expected to know, and when they are expected to know it.	

Figure 05-07. Elito method of insights gathered from the students.

Looking at the far right of the table, some clear metaphors, or topics, have been identified. Among them we find:

- Configurable experiences
- Peer to peer collaboration and communication
- Targeted feedback
- Overview over progression / knowing what needs more practice

What do I find interesting?

Even design students, who are supposed to be the more objective and selfless of students, have subjective opinions and interests. This means that even though the selection of topics are based on arguments, how these arguments are weighted differ from person to person. My own interest is a factor of what is chosen as the area of focus, knowingly that some problems are left unsolved.

The focus areas

The focus areas are chosen based on (as mentioned above) the potential for creating solutions that make good use of VR, that have not yet been done, that have a big impact on the students and that I simply find important.

Note: The focus areas have evolved and changed over time alongside my own understanding of the field as I have been testing concepts with the end-users. Following the traditional double-diamond methodology, the focus areas which started as a narrow thought or a hunch were later expanded, explored and then further defined. What you see in this thesis is mostly the tail-end of this process.

1. How can we create VR experiences that scale with the individual student's needs and goals?

This first topic is a reaction to the fact that the educational VR experience in ABCDE is built as a "single use" experience, at least in theory. Educational software should be built with scalability in mind, even for newer technologies like VR.

Nursing students are at different stages in their studies, have different experiences and have different requirements regarding help and support. A good educational tool should evolve with the student by making it progressive and motivating. I believe that the need for tailored learning materials and scaled experiences adapted to the student's individual level can be offered through VR.

2. How can we make VR create and facilitate better constructive feedback?

A big portion of education, learning and pedagogy is about giving feedback on what the student is doing right, and what could be better. This is already central in the education of nurses today: The students have supervised internships every year, and at school they are divided into groups for simulation- and skill-training.

Looking at the current state of feedback given in VR in VirSam, it is clear that providing feedback is somewhat sidelined, as exemplified earlier in this chapter. Furthermore, most of the educational feedback given in VR training software (or even digital training software) is often "incorrectly" gamified, sometimes to the point where the user is collecting stickers, not constructive knowledge. This is something I want to challenge.

External verification the focus areas

Even though the focus of this chapter is directed towards the students, it is worth getting feedback from contributors as well. As mentioned previously, contributors include educators, former students, researchers and product developers in the medical field. The feedback form the contributors have been gathered through one-on-one interviews and workshops. They were asked to give their first impressions and opinions regarding the domain, education of procedures in VR for nurses, followed by me presenting the chosen focus areas and sketches for the concepts shown in the next chapter. Then, an active discussion took place, which was later transcribed and categorised. The following sections show the contributors' feedback, structured around different perspectives.

From the educational perspective

From the educators' perspective, including VR as part of the educational offering is very welcome at NTNU (as expected). As we learned in the previous chapter, nursing education, especially at Øya, is often a result of the individual educators' interests and pedagogy. VR could be something the educators choose to include in the study program.

Knowing how to give good and constructive feedback is of high priority for the institute. In the previous chapter we learned that providing a safe and motivating learning arena is a continuous goal at Øya. The way this chapter has handled the different permutations of feedback has been received with great interest. The educators have observed that binary feedback such as "approved / not approved" are less useful and effective compared to feedback that targets performance and execution. Additionally, the way feedback is treated by some of the current tools, such as Laerdals RQI-simulators, are experienced more as certifications rather than constructive feedback by the students. By highlighting what went well, and what the students need to do to improve, the contributors believe the program provides the right value to the student.

In terms of scalable applications, the contributors at NTNU agreed with this focus area. Because VR is digital and "infinitely scalable", it should be obvious that the program is not locked to be one single experience. If VR is to be included in a blended learning strategy, it needs to be included at several levels throughout the education. However, one concern uttered by the contributors at NTNU is making the VR-experience too single-player focused. Hallmarks of nursing are collaboration with colleagues and communication with patients, and having the programs be individually scaleable and the feedback be personal might work against this. This inspired the idea of testing a peer-to-peer experiment in the next chapter.

Additionally, a concern uttered by a former student at NTNU is the introduction of VR in general. It is not that VR itself will not provide any additional value, but rather how the institute is treating the educational tools. The equipment that is currently used for simulation purposes is rarely used, which is described as "frankly shameful". The former student thinks that the institute is not using the technology that is already available the correct way. Rather than thinking of simulation-training with dolls as a "one-time experience", the school and educators should rather think of them as tools and not be afraid to wear them down.

From the possibility perspective

Sintef and Trams are interesting contributors, because their perspective on VR lies somewhat in the middle of the educational, and the product perspective. They are eager to fill the gaps in the education and help the students to become better nurses, but not strictly for profit.

Trams is a student initiative, created by and for students. As mentioned earlier, they mainly arrange workshops for nursing- and medical students to exercise teamwork and procedures in acute scenarios. Because they work with larger groups of students, the individual feedback and scaling is not the main priority, but they do take the end-user effect into consideration. Also, being a voluntary initiative, scalability and personalisation are focus areas they agree with.

Sintef Digital is coming from another, but similar angle. They are balancing between understanding today's problems spaces, and experimenting with current and future technologies that might fit into these spaces. The contributors for this thesis come from a more possibility-driven design mind-set, where the needs and requirements are not deemed as problems, but rather possibilities for technology to provide value. This was well-aligned with the focus areas of the concepts and the thesis in general.

From the product perspective

As previously introduced, Laerdal Medical is one of the leading companies in creating simulation tools for the education of health professionals. They too want to help students become confident and better nurses, but they also want to make money. The representatives from Laerdal were eager to distinguish between these two points of views.

From an educational perspective, Laerdal has experimented with using XR (extended reality, a term encompassing virtual reality, augmented reality and mixed reality) for medical training, and believes it to be a natural extension of their current digital product offerings. However, from a business perspective, Laerdal wants to meet the needs of their customers who are, in this case, the university hospitals and medical institutes. Creating products the customers want is easy business, but retaining the customers after they have made the purchase is the difficult part. Laerdal started with making simulation dolls, which are physical products with a one-time price tag. As digital technology has developed, the move towards creating upgradeable digital solutions has gained traction. A current example of this from Laerdals product portfolio is the aforementioned SimCapture, a tool for monitoring student's performance during simulation training.

Building on top of the business perspective, owning more of the student's educational journey is part of Laerdal's key objectives. By creating products that include more of the student's learning objectives and curriculum, they are able to meet the needs of the customers more frequently. Making the programs scaleable and fit for more students, and providing value through better feedback is part of this vision, and Laerdal found these focus areas to be very important for future XR experiences.

However, replicating the text-book explanation of procedures is not how Laerdal invisions the future use of XR for education. Rather, they imagine XR (and by extension, VR) to be more experiential and edge-case focused. They state that placing students in scenarios where they are challenged with tackling difficult scenarios and making rapid choices could be a way to go.

MedEasy should also be mentioned here. Even though they are not publicly advertising any VR solutions, they do have provided their opinion on how scalability and feedback is handled. MedEasy has a clear focus on progression in their solutions. By using friendly graphics and a user interface centred around individual choice and progression, MedEasy is currently the most student-centric external product that nursing and medicine students are using, thus becoming (by my impression) the most popular. Their strategy is to help the students set goals and monitor progression, which is well-aligned with the focus areas of these chapters.

Establishing a vision for future work

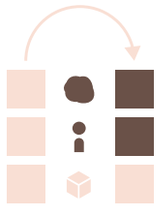
As presented in chapter *02 Methodology*, visions and analogies are central to concept development using the reframing method. To better understand what role VR, the product, should have in the education of nursing students, the context, this project has created a vision to better predict this future human-product relationship. This vision has been crafted through interviews with students and contributors, and acts as the contour for the new product to come.

For the coming chapters, the vision we are operating with is the following:

We want students to experience mastery when training to become nurses.

Closing thoughts

Through various visualisations and thought experiments, the findings from the previous chapter have been analysed and concretised. VR as an educational tool has several positive effects on learning and motivation, and I have found that it can be especially powerful as a tool for learning and applying a skill. Additionally, due to the students' different goals, experiences and needs, it is clear that tailored learning environments and constructive feedback is important for shaping the nurses of tomorrow. These requirements have been defined as focus areas, which will be the basis for further experimentation in the next chapter. Furthermore, VR will be considered as a vessel for fulfilling these focus areas.



06 EXPERIMENTATION

In this chapter we will dive deeper into some of the findings from the previous chapters, and look into how VR can be designed to meet the requirements.

151 **06 Experimentation**
152 Introduction
152 Research Questions
153 Methods
154 Concept 1: laptop prototype
172 Concept 2: VR prototype
190 Side-experiment: Peer-to-Peer feedback
198 Discussion
201 Closing thoughts

Introduction

The insights from chapters *03 Literature, 04 Exploration & Insights* and *05 Analysis* have helped create an understanding of what VR is, how VR can be used in education in general, and what we need to keep in mind when creating educational tools for nursing education. Even though students are to follow the set curriculum and national guidelines, it is safe to assume that they have preferences, requirements and wishes for how the education can and should be in the future. Of course, the requirements of the student need to be evaluated against requirements from other stakeholders, but there is an argument to be made about whether the student's requirements should have more weight. After all, they are the ones who are supposed to use it.

Research questions

The research question for this chapter is as follows:

RQ4: How can we best meet the student's requirements using VR as an educational tool?

The contributions of this section is to - more nuanced - identify the potential for improvement and making a difference for the students using VR. These contributions are exemplified by concrete experiments and user testing of concepts. Additionally, the chapter concludes with suggested recommendations based on findings from the experiments about what can and should be included into future VR solutions to better meet the students needs and wants.

To repeat the focus areas from last chapter:

- How can we create VR experiences that scale with the individual student's needs and goals?
- How can we make VR create and facilitate better constructive feedback?

Methods

Prototyping

Based on the focus areas from chapter *05 Analysis*, the suggested functionality and effects were validated through rounds of prototyping. The prototype moved from low-fidelity and based on wizard-of-oz in concept 1, to more high-fidelity in concept 2. The side-experiment was based on a simple paper-prototype of a future concept.

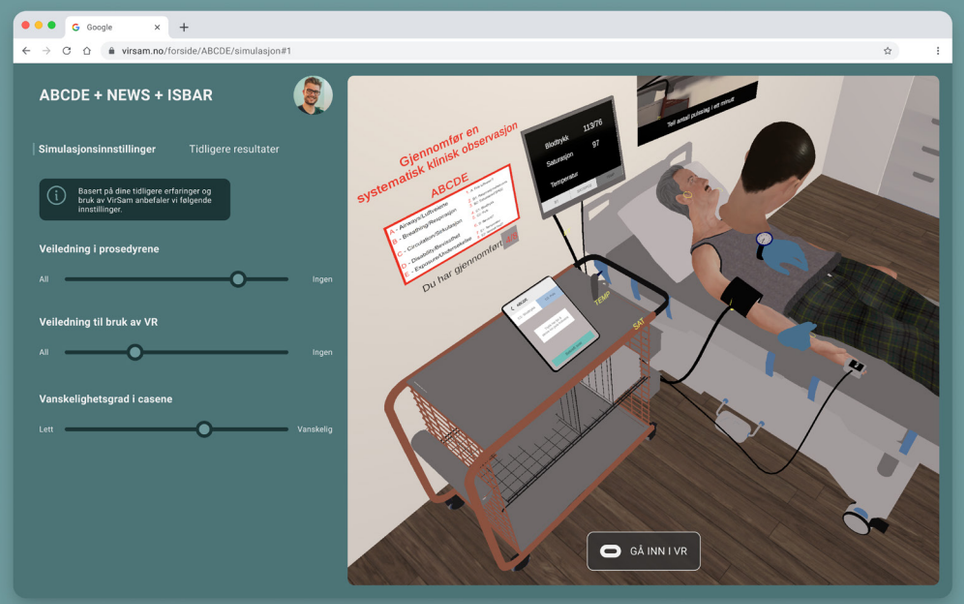
User testing

User testing was performed in phases according to the concepts. The tests themselves were introduced and followed up by interviews. The complete testing protocol is found in the Appendix H-J.

Observation

Whilst the students were using the prototypes, notes about what was said, done and reacted to was structured into topics.

Concept 1:
Laptop prototype



Introducing the concept

In order to test whether the chosen focus areas would lead to desired effects, a low-fidelity concept prototype was made in the wireframing tool Figma.

This first prototype was made outside VR for two specific reasons:

Firstly, to be able to test the selected focus areas more rapidly.
Secondly,to explore whether it was possible / desirable to extend the VR application outside VR.

However, making the first prototype outside VR has some implications that should be kept in mind. The experience might lead to confusion due to the fact that the users are switching between something happening on a laptop and something else happening in a VR headset. Also, most users in the demographic sample have used a laptop and know its interaction conventions, but comparably not as many are familiar with VR.

Ideation

The ideation stage is focused on discussing how the focus areas should be addressed. Through initial interviews with students and observations of how simulations currently are being done at the start of the project, some hypotheses were made. These hypotheses have been conceptualised and refined into the following topics:

Personal tool for education

We learned in the chapter on mastery learning that in order to create better educational experiences you need to take personal needs and progress into consideration by monitoring, evaluating and suggesting actions. Even though students are placed into groups and classes, each educational journey is individual.

By imagining a tool that could for example recognize the individual students by name, track the progress and present suggestions, the tool would be able to get closer to being a “personal tool” for their own education.

Scalability at the core

Every student brings their own knowledge, experience and goals when learning something new. There are differences in how individual students learn most effectively (Whiting et al., 1995; Bloom 1971). When learning a skill, my studies suggest some students want to practice over and over until they get it right, while others want to practice briefly and then stop to reflect. By keeping this in mind as a core functionality of the system, we inch closer towards creating educational software that can resemble a mastery-based learning system.

Configurable scenarios

A key issue with today’s solution is that they are “one-off” scenarios, built as one-time experiences. However, creating several configurations of a scenario can contribute to meet the needs of more studentsThrough interviews with but students, lecturers and facilitators, we found that the experience can be configured by including:

- Various degrees of assistance in understanding VR
- An introduction and guidance during the procedure
- Various degrees of difficulty in cases

Designing for impactful feedback

After observing the traditional simulation training and talking to teachers and students, the importance of good feedback throughout the education cannot be understated. The students have two goals throughout their studies: Passing exams and becoming the best version of a nurse they could possibly be. Regardless of where they are in their education, the need for good, consistent, and apt feedback is high on the priority list for all the students.

Data-generated feedback

Findings from testing the existing ABCDE-application showed that only giving feedback on what was correct or incorrect is not optimal for learning how to perform procedures, even though the feedback is technically precise. When observing the physical simulation training, the feedback given to the students from the supervisor mainly centred around two things:

- Self reflection
- Performance outside the specific procedure and theoretical knowledge

It is difficult to perfectly replicate the kind of feedback that is generated by humans. Nevertheless, providing any kind of feedback besides the factual “you did 7/9 tasks right” will likely enrich the experience. The question is what non-factual feedback should be given to the students, and how could this be generated?

What kind of feedback do students want?

These educational goals of the student demand different educational feedback. To pass the exams, students need feedback based on facts, such as whether they are doing tasks in the wrong established order or providing the wrong dosage of medicine. The other goal is more subjective and variable, and therefore difficult to measure and evaluate:

To become a good nurse, he or she must be able to adapt according to the specific patient and setting, such as talking to the patient, giving the right amount of attention, and adjusting procedures and practises according to the patient’s needs. This is often “experience based” knowledge, acquired through trial, error and feedback.

The ideal kind of feedback is a combination of these two: An overview of what you did factually right or wrong, and comments on how one could perform the procedure more in-line with “best practises”.

Evaluating performance

When understanding what makes a nurse’s performance good or bad, it is of course possible to look to the textbooks and experts. However, all patients are different, which makes it difficult to define a correct or incorrect action for every scenario. Therefore, it is helpful to look at a few examples:

Patients with Alezheimers disease might not always be okay having someone put their hand on their chests to measure their respiratory rate. In these cases, nurses act as if they are taking the patient’s pulse by holding their wrists, while actually counting their breaths. This example highlights the importance of knowing how to adapt clinical procedures to individual patients. By getting to know the patient through their journal, procedures can be adapted to increase the comfort level of the patent.

Gathering the data

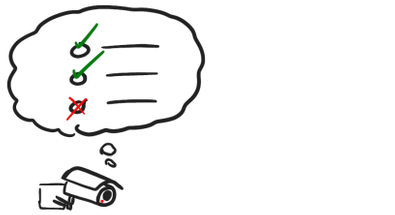
The next step is to figure out how the system can collect the data in order to properly draw a conclusion on the nurse’s performance. In the case of the patient with Alzheimer's disease, the simulation could register whether the student is putting his/her hand on the patient's chest to take the respiratory rate. This makes it a binary case of “did the student know that he/she should not put his/her hand on the patient’s chest? yes/no”, which is possible for the program to respond to.

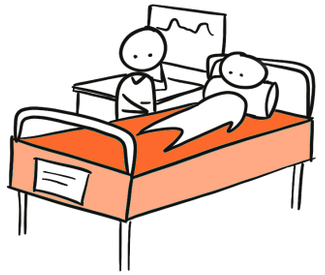
How to present the feedback

After gathering all this data, the system needs to present it somehow. Even though the system evaluates the student asking binary questions, it is not that valuable for the student to know that “Alzheimer’s + hand on chest = false”. The feedback needs to be wrapped up and presented in the right way.

I was inspired by a strategy used by teacher students. When providing feedback to their pupils one method is to start with highlighting two positives, followed by pointing out one thing that could be improved. By highlighting the good parts, the student will be confident about their performance, making the critique less devastating. Following this, the feedback in this concept will be framed in three categories:

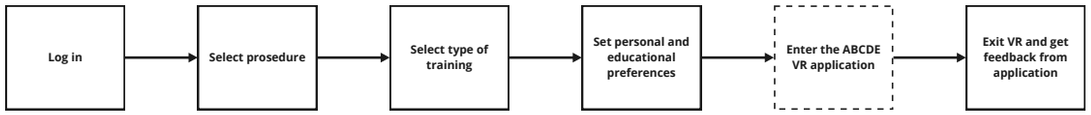
- What you did great
- What you did pretty good
- What you can work on until next time



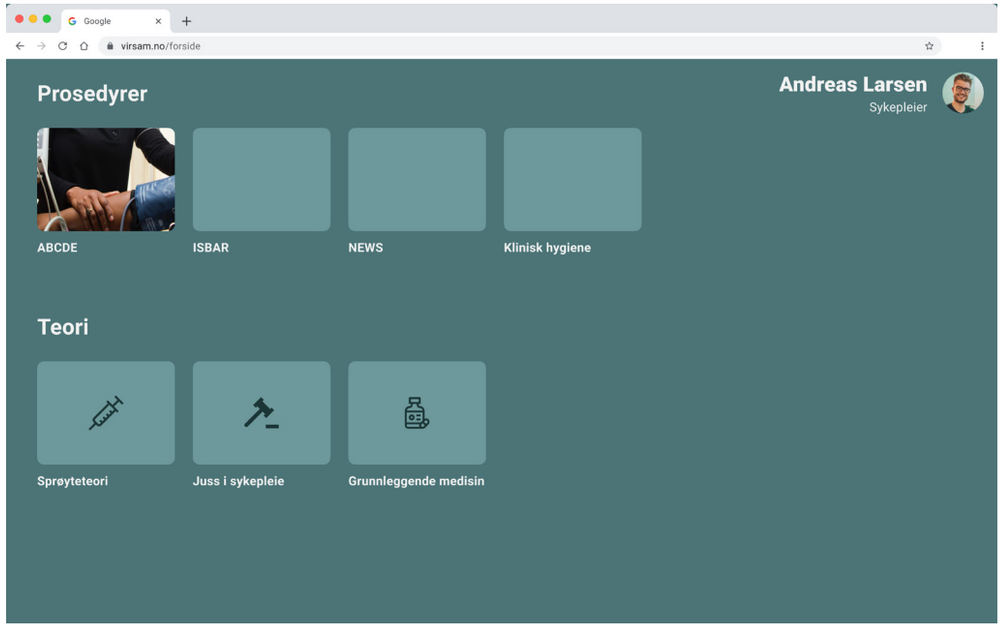


Prototyping

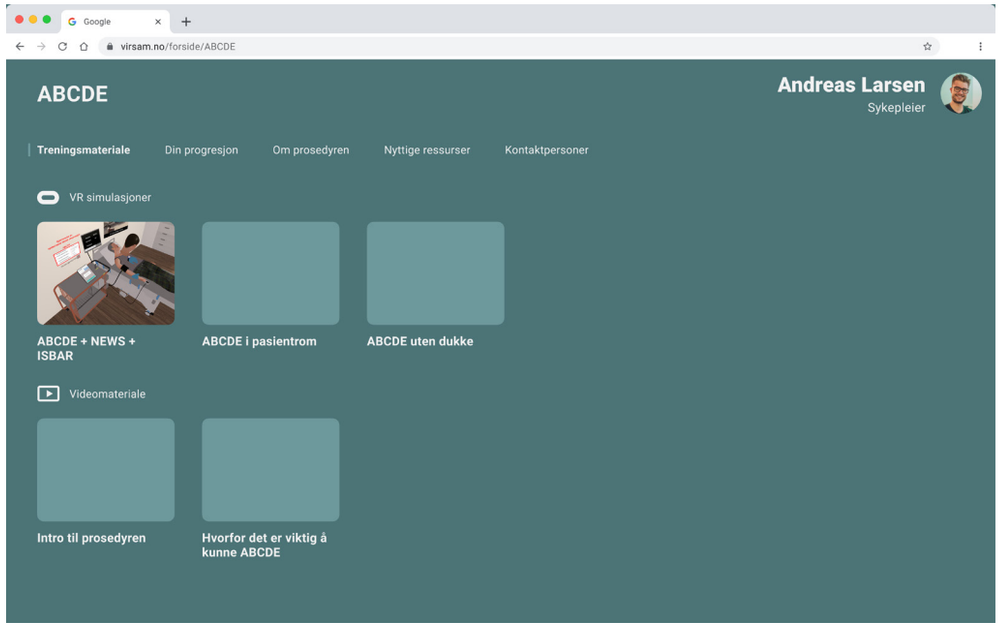
The prototype for this concept was created and tested in the graphics tool Figma.
Before creating the tool itself, a rough outline of the steps in the user journey was created



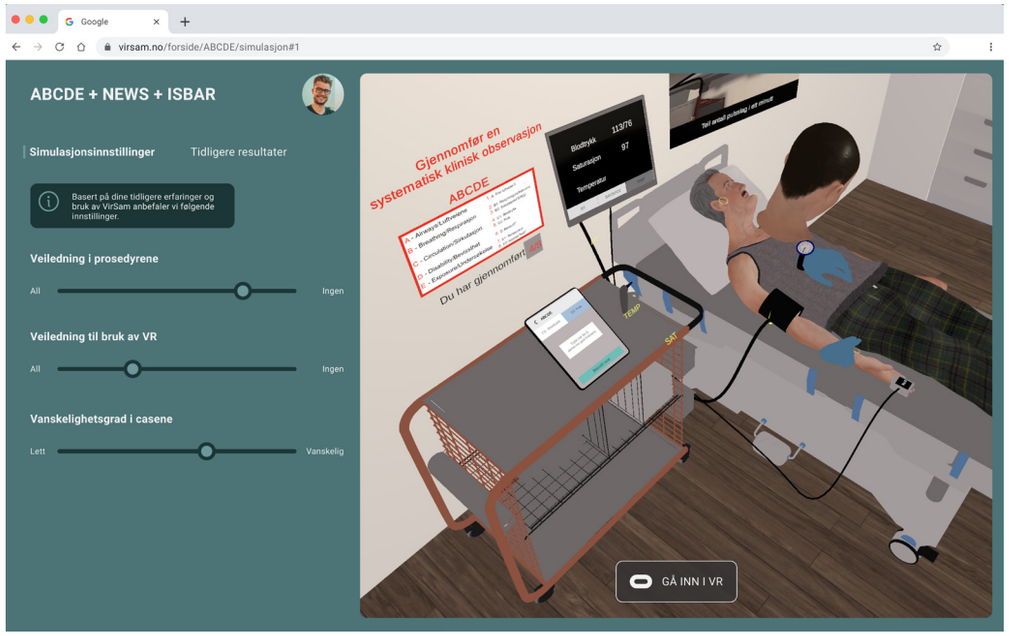
The steps were created to evaluat specific aspects of the prototype. To better understand what information and interactions needed to be tested, each step was accompanied by hypotheses. These hypotheses were made to further concretize what user requirements were included, and what part of the journey they relate to.



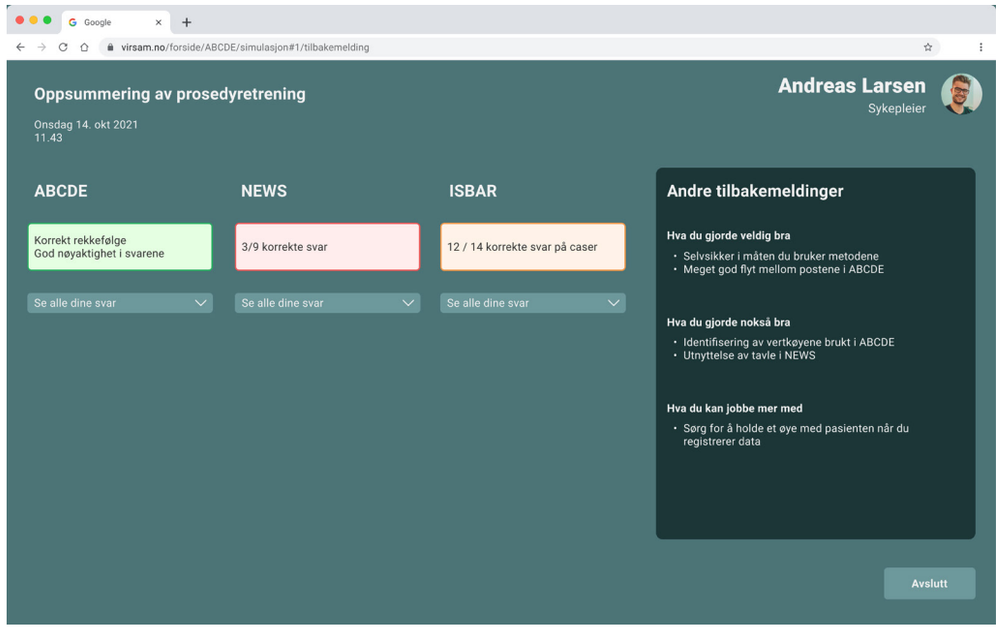
The frist page presents the student with an overview of possible learning material, sorted by prosedures and theory.



When selecting ABCDE, the student moves into that perticular topic where they find spesific matieral for the selected topic.



Selecting the VR procedure renders this page, where they can see a snippet of what is to come, as well configure the simulatiuon to their liking.



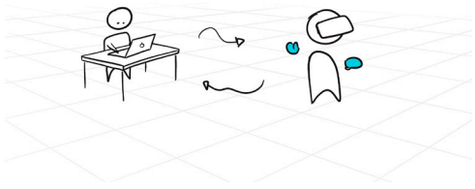
After having done VirSam's VR-application, the student takes of the headset and is greeted with this page that presents a summary of their performance.

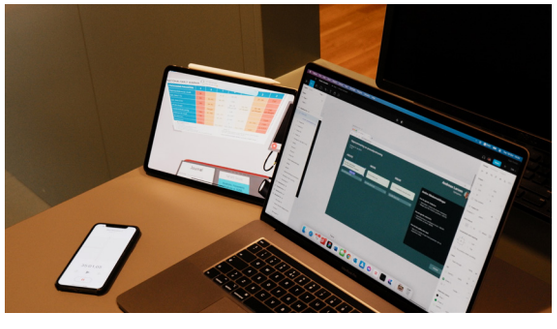
Testing

The testing of the prototype was done in controlled environments in the VR-lab at Øya Helsehus with 7 students from the target user group. The user test followed a semi-structured protocol (see Appendix H). Audio recordings taken done for later recollection and evaluation.

An important note is that this round of testing focused on understanding what the users think about the defined areas of focus, not as much about the layout, aestheticihs and such.

All the tests were performed of the same format. First, the student was asked to perform the given tasks on a laptop prototype outside of VR. Second, the student was asked to put on the headset and perform VirSam's ABCDE VR-application. While the student was wearing the headset and performed the tasks, the observer (me) was looking for remarks to comment on. These remarks were typed into the laptop prototype in a wizard-of-oz style of prototyping. Third, when the student had completed the tasks in the application, they were asked to take off the headset and complete the prototype on the laptop.





Findings from testing

The user-test was immediately followed by an individual debrief, where findings were summed up as single quotes and remarks using post-it's. The post-it's were later sorted into topics of interest using the Affinity Diagramming method. Here we will look at the major topics and their results.

> "More opportunities to practice is always good"

As we have learned in the previous chapter, the education of nurses is made up of many different educational tools, methods and approaches. The students who tested this all felt that there are too few opportunities on campus to simply practice on skills and knowledge. Because of this, they found that being offered a new platform for practising was very valuable for the educational choice in the study program.

However, some concern about how the content is presented was addressed. The students in the later years of the education showed some concern for the platform being controlled and developed by the university, as they have had good experiences with external tools like MedEasy and YouTube.

”I like that I’m able to select and adjust the program to fit me. It makes me feel included”

As the students progress in their studies, their expectations change accordingly. The first year students are aiming to be better at the knowledge and skills that will help them pass the exams. Therefore, a sense of progression and knowing specifically what to work on to pass the exam is key. However, the students in the later years are more aware of the knowledge and training they don’t yet have. Their goals are therefore more targeted towards feeling they know enough to be useful when working in the field. Being able to adjust the level of difficulty has been received by all students with a mixture of interest and excitement. For the younger (in terms of years as a student) students, it meant they could “grow” into the application and see how they were progressing. For the older students, this gave them the opportunity to tailor the training to what they felt they needed, not what was expected of them.

However, the majority of the students felt that more transparency in what specifically is changed when altering for example the difficulty was needed to be useful.

“How you get feedback means as much as what you get feedback on”

An opinion shared across all the students is that they have too little simulation and procedure training, and when they do get feedback it is often aimed at larger groups of students. “You all did well” is a common one.

All the students show positive interest towards getting more detailed feedback on how they performed. The first year students in particular liked the mixture of binary and non-binary feedback because it gave them a safe estimate they could use to practice towards their exams. The later years students were particularly fond of the more “humane” feedback that was structured in sentences. The content of the sentences were experienced as relevant, well structured and motivational. One of the first year students summed it up nicely by saying “This kind of feedback makes me aware of the things I didn’t know I was supposed to know.”

“I would love to have something like this today”

Overall, the concept received a lot of positive feedback, but that should be taken with a grain of salt. When doing qualitative evaluations of design, one should always keep in mind that there are social reasons to why a design would do better in testing than in real life. More on this in the next section.

Evaluation of the prototype

This first prototype proved to be a very useful way of trying out ideas and testing the reactions.

Not using VR for initial testing

To be honest, at first I thought not going directly into VR might have negatively impacted the results of the user test. In hindsight, I think it might have greatly benefited it. As mentioned several times in this report, there is a general awe and excitement around VR as a tool, and if I were to go straight into VR, some of the honest expectations, opinions and feedback regarding the areas of interest might have been overshadowed. By testing the areas of interest in isolation, we can say with confidence that the end-user effects were achieved regardless of the involvement of VR.

Reflecting upon the findings

As mentioned in the last paragraph in the previous section, the prototype received overall really good feedback. The students thought the prototype looked nice, had a logical layout and was easy to use. The content felt appropriate, and the subsequent feedback was useful and motivated them to try again.That is a lot of positive feedback, and when a design gets overly positive feedback, it might be beneficial to ask “why?”.

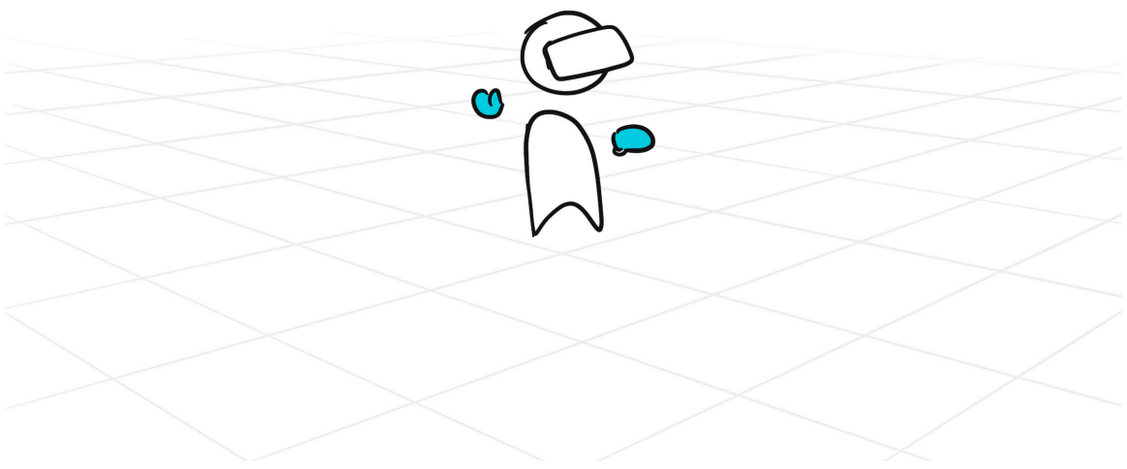
There are a couple of bias-factors that should be addressed first. Being put in a situation where you are asked face-to-face about your opinion might lead you to be more positive to please the recipient (in this case me). Another point is the setting of it all: (Most of) the users are about to try VR for the first time, and VR is exciting. Just the thought of doing something new and cool might tint the answers towards one side or the other.

Regardless of how the design might have been interpreted, it is my job to dissect their answers and extract what is useful for the next iteration. Due to these bias-factors I acknowledge that although the feedback is generally positive, I must stay critical when moving on to the next concept.

Moving towards 3D and VR

This being a project about education in VR, it is clear that some of the learnings should be tested in VR. Through the findings from chapter *04 Exploration & Insights* we know how the students experience the current solution, and based on what we have constructed in chapter *05 Analysis,* we can conclude that there is room for playing around with how procedure training is presented.

Concept 2:
VR prototype



Introducing the concept

Concept 2 is a continuation of the functionality and ideas from concept 1, wrapped in a new suit. Whereas concept 1 acted as an external tool for selecting and configuring VR experience, concept 2 puts all this functionality inside the goggles.

“But if concept 1 was somewhat successful, why put it in VR?” you might ask. There are several reasons for this, but the one I will use is the mindset that is “possibility driven design”. We don’t know what is suitable in VR if we don’t try. I might find that concept 1 was the best solution all along, but what is “best” is not possible to know without knowing what to compare it against.

Ideation

Compared to the previous section, this ideation-phase is targeted towards finding more tangible solutions to the focus areas based on the foundation made in concept 1. The ideation-section in the previous concept, focusing on ideating within the conceptual realm, still applies here, but now we are looking more on the interaction itself between VR and the user.

Using the act of play as an end-user effect

One of the major challenges in any design is making sure the user is comfortable in navigating and using the solution, especially when using technology and interfaces that are totally dissimilar from everything else.

The act of play is a powerful and intuitive way for sentient beings (such as humans) to explore, ask questions, try and fail at understanding the world around you. By fooling around with ideas, objects and environments humans get a better understanding of how things are put together, and we can use this understanding to create new connections or experiments (Kristiansen, 2020).

There is a difference between “to play a game” (nor: å spille et spill) and “to play” (nor: å leke). What differentiates “the act of play” from a game is that play does not have a goal except play itself (Gingold, 2016). When play is restricted with elements such as rules, stories, goals and achievements, the result is a game (Kristiansen, 2020; Gingold, 2016). As mentioned, play is a way to be exposed to and understand the world around you, but put in a safe environment. The act of play should be without consequence, without inhibitions and without rules.

The act of play is incorporated into this concept in several ways, all presented in the Prototyping section of this chapter.

Making the students comfortable in VR

As discussed in chapter *03 Literature*, VR is (still) a very new experience for many in the target demographic. The VR experience should therefore consider all users new users, and at the same time keep in mind users who have already used it before. By making a fully fledged environment for selecting and preferencing the VR experience that lives beside all procedure training, the student is able to safely try out and get a grasp of how the controls and mechanics work - all in their own time.

Student- and progression centric

“Personalising” is a word that has come up several times in this thesis, and this is where we take action upon this vision. Remember, we are using mastery learning as a core part of the solution, and because of this the student should be met as an individual person, not as just another user. This can be achieved in several ways, but the main strategy is to link the application to the individual user and their past experiences. By showing the student that the application knows what he/she has experienced and provide the main topics for improvement, the application is able to get closer to providing a personalised learning experience for the students.

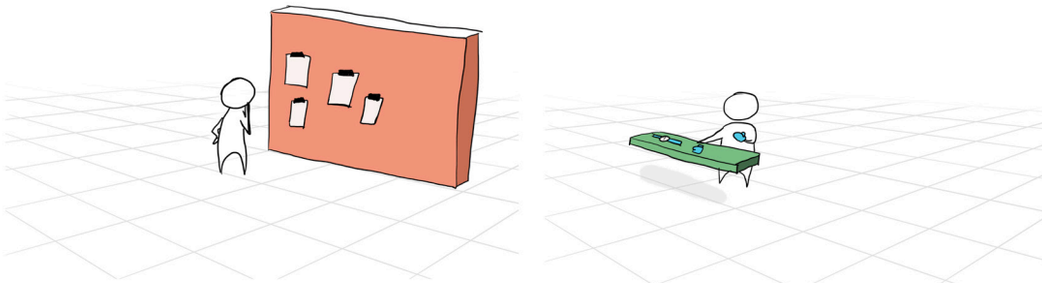
Additionally, the possibility to configure and customise the experience is making the experience more student-centric. Simple customizations such as having the students pick on what wrist they want their wristwatch to be placed might seem small in the grand scheme of things, but might impact greatly in how the student feels about the application. (Note: we have uncovered that using a wristwatch is not practised by nurses due to hygienic reasons. This is only an example, and the point still stands).

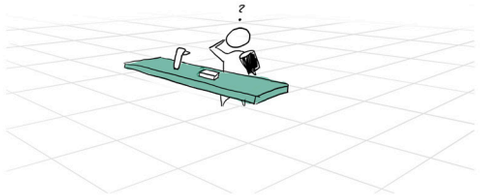
Grounded in reality

The promise of virtual reality is that we can create any reality we want. However, even though we can, it does not mean we should (West, 2021; Jerald, 2016). This being an educational software for nursing education, the concept needs to be somewhat grounded - no flashy, futuristic, neon interfaces, or floating screens and ray-casting interactions. By making the look and feel as tangible as possible, the student is better prepared for how to interact with the procedure training that is coming. Subsequently, by using movement and interactions with objects we are utilising the potential VR has to create digital environments.

Prototyping

The prototype for concept 2 is both a continuation and evolution of the laptop-prototype in concept 1. The prototype is an introductory environment that is balancing the notion of play and being an interface. However, this should neither be in the way of or weaken the experience.

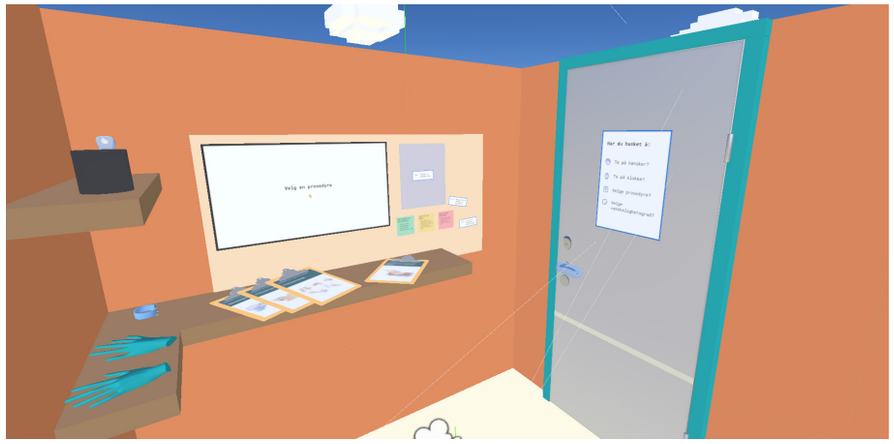




The environment

The environment facilitates two main functions: To be able to learn the mechanics and be able to select and configure a selected training. The interface is object-based, meaning physical objects are to be used to trigger desired functions and navigations.

Besides that, the choice of colours and ambience was selected to avoid a dull and boring environment, encouraging interaction and creating a light-hearted tone.



Clipboards

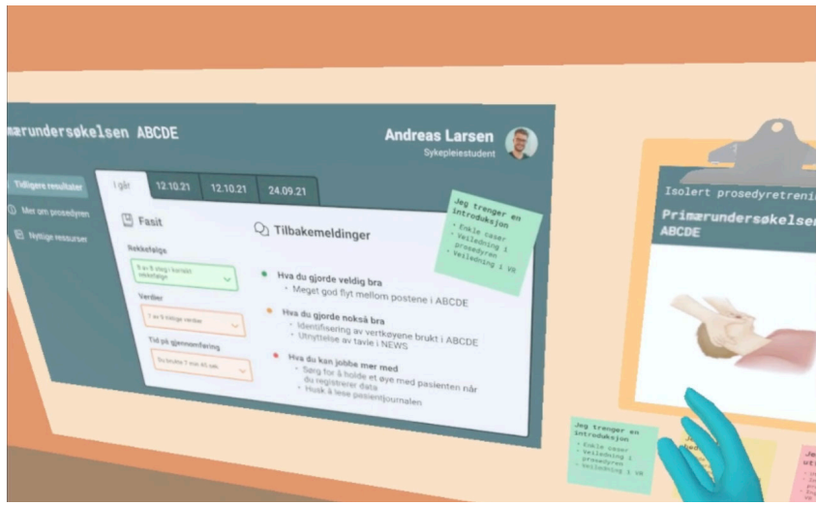
The clipboards are the “buttons” of this interface. This is how the users select the procedure they want to practise on. The content of the clipboard has been through some iterations already, going from a quite information-dense expression, to being more minimal and focused.
The intention of having the selection of procedure being a physical clipboard is to give the user some exposure to what is coming in the procedure training. Also, why not?

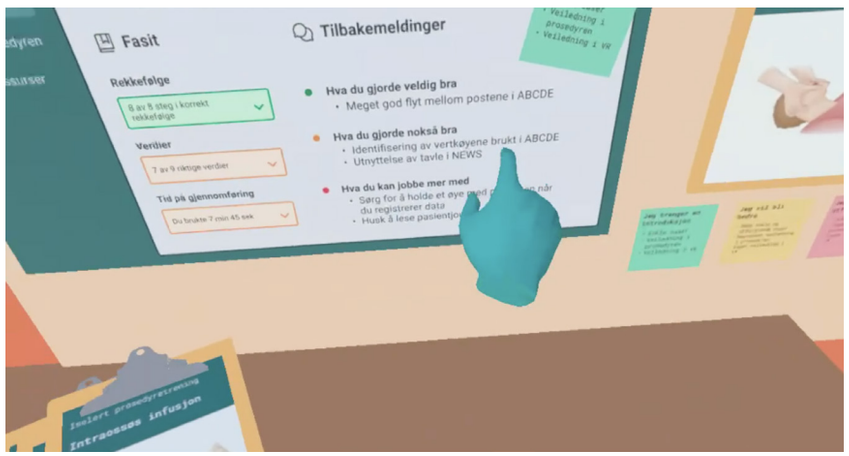
Post-its

The post-its are how the user configures the procedure training. Each post-its represent a level of difficulty, as well as saying what is configured when using that specific post-it.

The wall

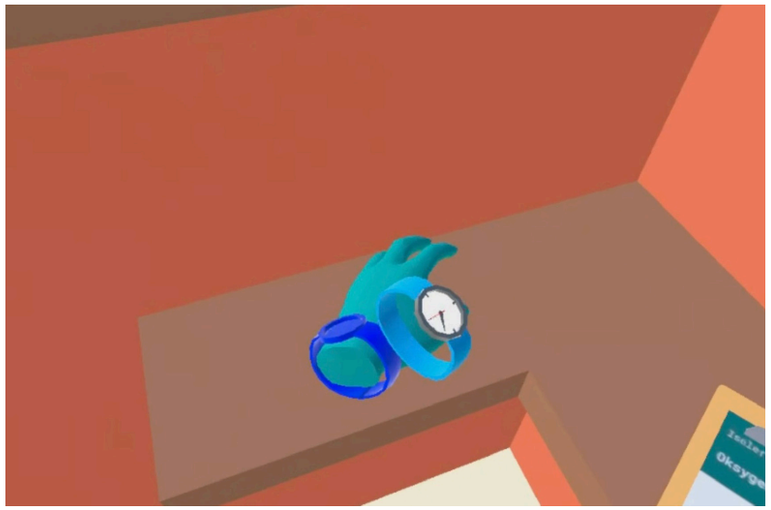
The wall is probably the least “realistic” of this entire prototype. The wall responds to which clipboard is hung on the wall, changing content based on the selected procedure. The wall “extends and expands” the content behind the clipboard - revealing the student’s past experiences, the most recent result and feedback, and what configuration the student chose the last time.
It is the graphical user interface of the clipboard.

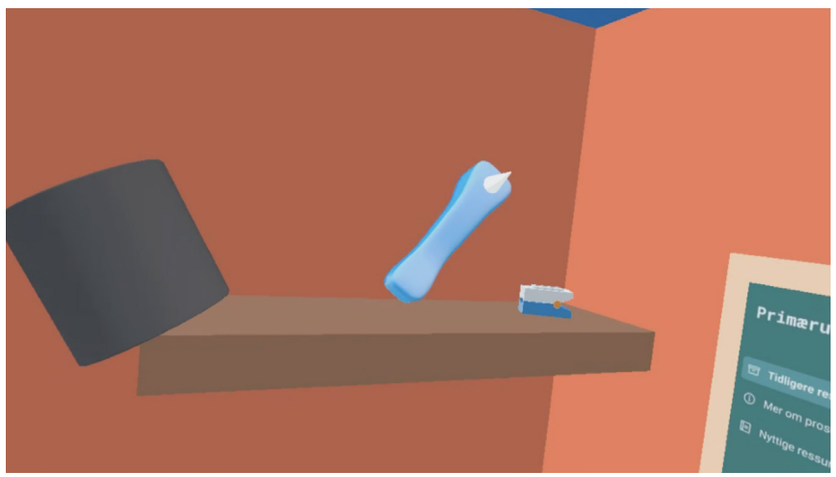




The objects

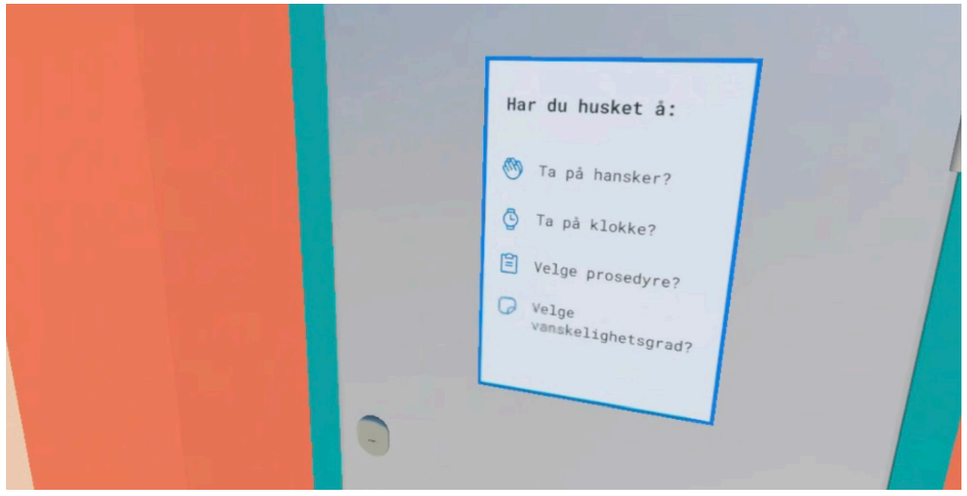
On the same table as the clipboards, the student finds a set of gloves and a watch. The watch can be picked up and put on whatever hand the student wants to put it. On the shelf above, there are some relevant objects that the user can pick up and look at. There is no other use for the objects, only to be familiar with the control and physics.

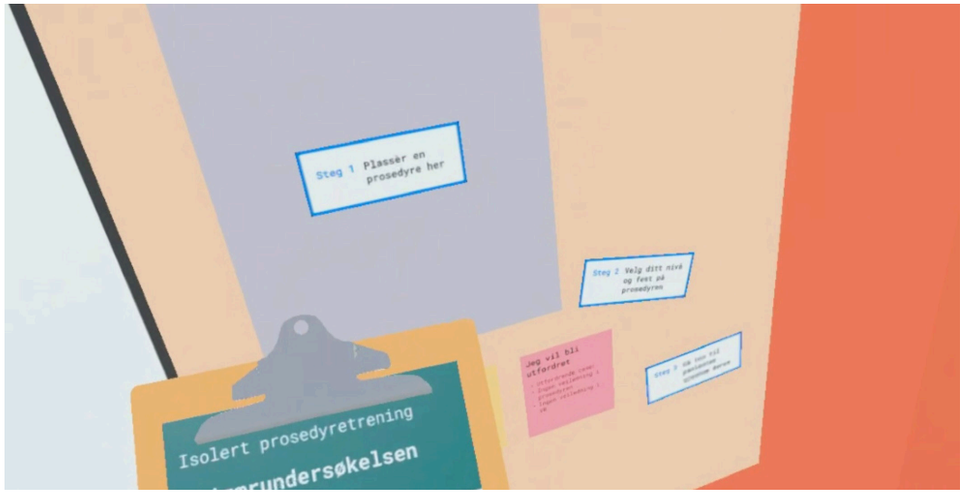





Velg en prosedyre


Isolert prosedyretrening
Krikotyreotomi
Isolert prosedyretrening
Intraossøs infusjon


Har du husket å:
Ta på hansker?
Ta på klokke?
Velge prosedyre?
Velge vanskelighetsgrad?


Steg 1 Plasser en prosedyre her
Steg 2 Velg ditt nivå og fest på prosedyren
Jeg vil bli utfordret
Isolert prosedyretrening


Jeg trenger en introduksjon
• Enkle caser
• Veiledning i prosedyren
• Veiledning i VR
ABCDE
Steg 2 Velg ditt nivå og fest på prosedyren

Testing

The VR prototype was tested on 5 students from the target user group. The tests were conducted in the same environment as the previous concept, in the VR-lab at Øya Helsehus. Part of the requirement for concept 2 was to test on students who already had tried the first concept and VirSam's ABCDE. More on this in "Evaluating the Prototype" later.

The testing protocol is more thoroughly explained in Appendix I, but here are some of the research questions:

- What are the expectations from last time?
- What is the student's reaction to an open environment?
- How are the selection of training and configuration experienced?

Before putting on the headset, the users were told that they were about to try a separate, but connecting experience tying into the procedure training they had tried earlier.

Findings from testing

”This was very confusing”

The first impression from almost all users was a feeling of overwhelming and chaos. Most users took some time to become oriented and understand the environment.

”Wow, fun!”

After the initial confusion and disorientation, all students began to familiarise themselves with the environment and controls. The clipboards were considered as intuitive and fun “buttons” by all students. “I can imagine just a bunch of these clipboards hanging on the wall for me to pick and choose”. The same sentiment went for the post-it notes. Although confusing at first, using the post-its to “build” your own experience was described as fun and engaging.

> “Should I bring all this with me?”

Something that objectively did not work well is having a number of objects lying around the environment. 3 out of 5 students thought they should bring it into the room with the patient, and all students did not understand why the objects were there.

> “It is difficult to read the text”

There is a lot of text in this experience, and that was not the easiest vessel for information to use in VR. The text was somewhat small and often in inconvenient placements, which led to a lot of crouching and squinting. Most of this was alleviated by the fact that clipboards and post-its were grabbable objects that could be moved around to better read the text.

> “It makes sense to have a room before you walk in to the patient”

Having a preliminary environment for getting ready was well received by most students. The students in the higher levels of education were generally more eager to spend time in the introductory environment than the fresh students.

Evaluation of the prototype

Not testing on new students

A prerequisite of testing concept 2 was to use some of the same students who had tried the first concept. This made it easier to recruit and put the concept into the context of how and where it was being used along-side the ABCDE VR-application. However, this removed an important and current limitation of any design (especially VR): The first impression. The excitement around VR means that most experiences are new and exciting, and this can be “exploited” to increase interest in the application.

Testing the experience isolated from the procedure training

Pulling apart and testing steps of a user journey in isolation can increase the effectiveness of user testing, but might leave out some findings in the transitions between the steps (Martin & Hanington, 2012). Concept 2 is designed as a separate experience, and was thought to be a “hub world” where students are before “entering” the selected procedure and after completing it. Leaving the procedure training out of the prototype might have made the testing more focused, but makes it impossible to say how it works in the collected user journey. The previous concept, Concept 1, was comparably a more complete test of the user journey, and findings from there can be considered applicable for this concept as well.

Fighting the urge to comment on efficiency and speed

Common metrics to evaluate design against are how efficient and fast the user performs the task. This was not the case for this concept. When using the reframing methodology we are looking for other end-user effects that are less quantifiable such as emotional response, subsequent comments and long-term effects. In my case, the end-user effect I am aiming for is the feeling of mastery through scalability and feedback. This concept is not for finding out how efficiently the students can familiarise themselves and select a procedure training, but rather to broaden the horizon of what is possible and beneficial to include in an educational tool for nursing students.

Text

The VR head-mounted display used in testing for this thesis is far from perfect, and a drawback that stands out is the portraying of text. Text needs to be readable to have any value, and this prototype featured a lot of it. However, due to the resolution and how the headset and VR-program, by default, emulates focal distances, text is only easily readable from a set distance from the head. This was not taken into account when creating the prototype, and many users struggled with reading text, especially the post-its.

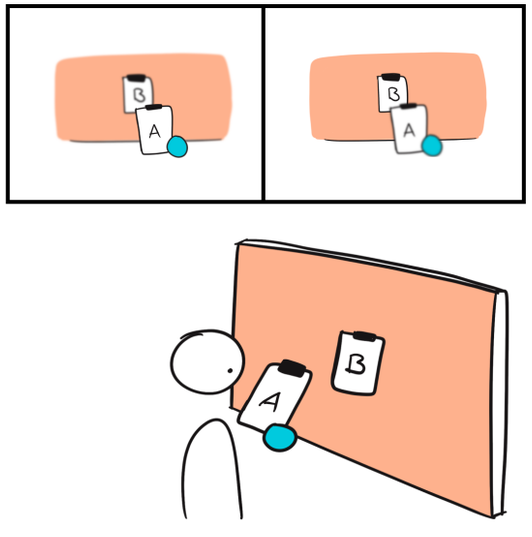


Figure 06-01. Describing the experienced problem of focus in VR headsets.

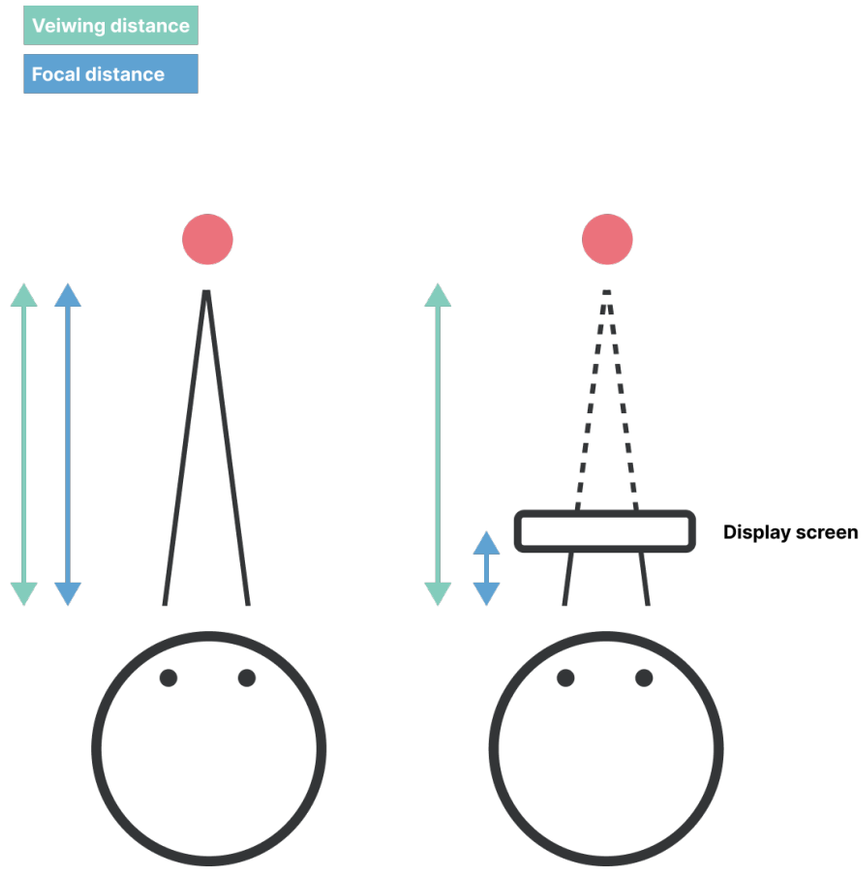
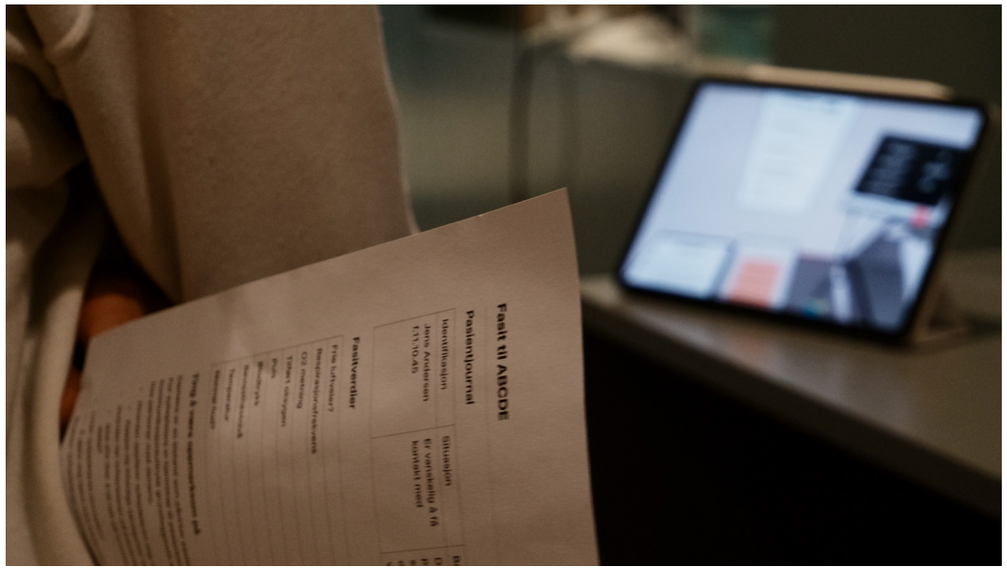


Figure 06-02. Focal and veiwing distances in VR and AR headsets (Gabbard, Mehara & Swan, 2019)

Side-experiment: Peer-to-Peer feedback

As a part of the iteration from concept 1, an alternative way of providing feedback was considered, namely peer-to-peer, or student-to-student, feedback.



Ideation

As we learned in chapters *03 Literature* and *04 Exploration & Insights*, nursing education is heavily reliant on skill- and simulation training to learn what is expected of them in the job. The way they receive feedback on performance in these trainings are most often from the observers and facilitators who have arranged the training, and the feedback is often given to groups - not to individual students.

Remembering the idea of mastery learning, it is evident that it is beneficial to direct the feedback more directly towards the recipient, rather than offering general feedback (Guskey, 2021). In spite of the reported effects of mastery learning , it is way too costly to be practical. There are simply not enough teachers and hours in the day to make sure that each student gets the appropriate amount of feedback. However, there is one available resource, and that is the students themselves.

Using fellow students might have several positive effects on the learning outcome:

- Having another student give you feedback might be experienced as less artificial than a computer giving you the same feedback
- Receiving feedback from someone at our own level might feel less like an “evaluation”

However, there might be some less positive effects to be aware of:

- When practising by themselves, interviewed students have reported that it is easy to lose focus when not in the presence of an educator
- Making sure that the feedback given by a fellow student is the “correct” feedback is difficult to control

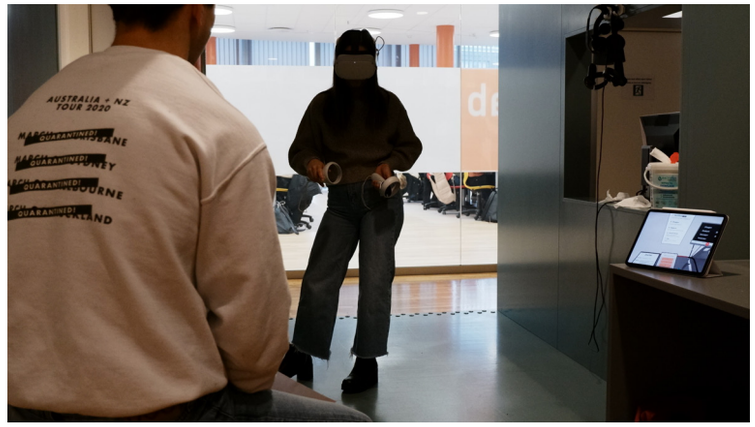
Prototype

This test used a slightly modified version of VirSam's ABCDE application, and a printout of the patient's records alongside some useful hints. The hypothesis was that getting feedback from a fellow student would be considered as preferred compared to getting it from a teacher or a computer program.

Testing

The idea was tested in three groups of two, where the two students were from the same class. Group 1 was in the first grade, group 2 was in 2nd grade, and group 3 had just finished their bachelors. The tests were done in the same location as the tests of the previous concepts, at the VR lab at Øya Helsehus.

Before starting, each student was briefed of each other's roles, where one student was asked to go through VirSam's ABCDE application, while the other student was observing. The observant was able to see what the student in VR saw using Oculus Quest's casting function to a nearby Apple iPad. After the procedure, the student who was observing was then instructed to give feedback based on his/hers observations.



Findings from testing

First off, this might be some of the most interesting findings in this project. From my observational standpoint, the level of engagement from both users in the test was unexpected. Not only did the users fall easily into their role, but the communication and collaboration was very interesting.

As we learned in chapter *05 Analysis*, students at different educational levels have different requirements and goals. Some of the findings are more or less exclusive to the educational level of the user-group, which I will deliberate on in the discussion.

> “It feels safer to get feedback from a student compared to a teacher”

All the user groups reported that getting feedback from a fellow student was both enjoyable and useful. A first year student uttered the impression that “... at school, teachers think about all sorts of stuff. We are only thinking about learning”, and that might impact the feedback given. The teachers often give feedback to groups, and if a student has a question it is asked in a group setting, which can be difficult. Having a one-on-one chat with someone at your own level might alleviate some of these issues, and might be considered preferred by some students.

Group 2 mentioned that “... getting feedback from a teacher sometimes feels like an exam, and that you are being constantly evaluated”, which is not particularly ideal in scenarios where trial and error is highly encouraged. In addition to that, they raised some concern that using VR “... makes you very exposed, and you can’t see who is observing you.”, but knowing that a fellow student was the one observing you would relieve the concern.

> “You become an active participant, even though you are not the one doing the procedure”

Group 3 highlighted the benefit of not only getting feedback, but being the one that is giving it. By giving one student the task of observing, the test was able to actively engage both participants through one prototype. The observing student (who had tried the ABCDE application themselves) observed and took mental notes of what the fellow student was doing for self comparison and for later feedback. An observing student in group 3 said that “when I did the procedure I did not notice the details you did. Now I have learned that as well.”, exemplifying that the observer does not necessarily need to use the program to learn from it.

> “Having a solution-sheet is a very good conversation starter”

A known concern going into the test was that when asking two students at the same educational level to converse, there might not be a natural flow to the conversation. Additionally, a student in group 1 mentioned that “I don’t want [my fellow student]’s learning outcomes to be affected by me knowing or not knowing the subject”. Having a printed-out “solution-sheet” proved to be overall well-accepted and used by the observant. The content of the sheet was considered useful, but the students in Group 3 were unsure of what content was more relevant than others.

> “This seems wrong. Is this wrong?”

VirSam’s ABCDE is knowingly not a complete and accurate simulation. There are several decisions made for practical and education reasons, which in turn became a discussion topic in the groups. Pointing out what is missing or wrong often leads to discussions back and forth to why the VR simulation was seemingly wrong.

Whereas group 1 compared the VR simulation to the doll-simulations arranged at the school and what they had read in textbooks, group 2 and group 3 were mostly comparing the VR simulation to how the procedures are used in practice on real patients.

An example is how the students in group 2 and group 3 wanted to enact measures if they found something to be wrong with the patient. “A patient with a blood staturaturation of 93% is not normal and should be treated”. Comparing this behaviour to group 1, who were more interested in doing the presented tasks right and not asking follow-up questions. Additionally, the groups reacted differently to the inclusion of ISBAR and NEWS in the VR application. The students in group 1 had little to no knowledge in the procedures, and used the VR application to learn about them. Group 2 and 3 on the other hand were more sceptical in the inclusion of this, as they found the perceived usage disingenuous from how it is used in practice.

> “Have you done this on a real patient before?”

An unintended consequence of having two students at the same educational level discussing how to do procedures was that they began sharing knowledge they had obtained from practising the procedures in real life, challenges they had met and how they solved them.
All students were keen to share and discuss how they would go about it if that scenario were to happen again. Even though the members of the group were from the same class, due to the nature of the nursing education they had very different experiences to share. Some had worked at the emergency room, some had worked in domestic care, and they were all eager to share their perspective regarding similar scenarios.

Evaluation of the experiment

Involving more people in testing

As we have learned, involving more students in the VR experience, even though they are not in VR themselves, has proven to be an effective way to increase engagement in all parties. Additionally, having the outside student being the person who is observing the performing student has proven to be enjoyable and comfortable for both. However, involving more students increased the complexity of the testing. Whereas the previous tests were with one student, this test needed to plan for, include and evaluate two students’ opinions and conversations.

The answer-sheet

This answer-sheet proved to be an effective conversation-starter and a help for the observer to know what to look for. Additionally, the answer-sheet can too act like a “test” for the observer, challenging them to know what to look for. However, the sheet itself can use some work. The look and hierarchy are mere sketches, the content is not proof-read by professionals and the amount of content needs to be adjusted. Nevertheless, the inclusion of such an answer-sheet should be included in similar future solutions.

Discussion

Evaluating the design

Creating designs for education is a long term project. We can't really know how the solutions perform unless it has been used for a while. When evaluating educational software, we need to also evaluate the educational and end-user effects of the design. This is not something one can evaluate over one session, but rather be evaluated over time by looking at the individual and overall progress of the students. This is not possible to achieve in a single thesis. What we can do is create isolated tests and perform isolated usability evaluations and this way get first impressions of the design. That has been the approach in this project.

Luckily, the team at VirSam has conducted studies comparing some of the educational effects of training in VR compared to traditional methods and found VR to be non-inferior (Berg & Steinsbekk, 2020). However, even though the immediate reactions of the immersive training simulations were positive, it does not say anything about the long-term effects of using VR as part of the educational curriculum. After interviewing one of the students who were present in the mentioned study, the student could say that even though the application they used was interesting and managed to complete the tasks, the overall setting and experience was kind of weird and laughable. Although impressive and novel at first, the novelty factor has later worn off and the students are left with their long-term impression.

Hence, even though the first impressions are positive, simulation training in VR needs a combination of evaluations to become the best for its users.

Validation of findings

Validating the findings is important in science and research. Without validation, the findings might be coincidences, flukes or fabricated. Validation in design is just as important, especially testing on end-users. The effect a design inflicts on a user might be a compound of more than the design they are testing. The context of which the design is supposedly used, the users past experiences and expectations, the presentation of the design, eventual bias and even the time of day impacts how users experience a solution. In contrast to how science strives for eliminating these variables to ensure the best possible chance for validation, design embraces the variables and includes them as part of the result.

There are different ways of validating designs, most of them fall into two categories: Quantitative and qualitative. Whereas quantitative validation is more binary and focuses less on the human behind the results, qualitative validation uses what is being said and done by the users to extract findings. Throughout the thesis qualitative methods are used to validate the designs. Arguably, this is what makes design validation more difficult. By embracing the real world limitations in the testing, we are making it inherently more difficult to replicate the findings. Testing over longer periods of time might gradually uncover the flaws and potential of improvement and use this to further develop the solution using the build-measure-learn method.

When evaluating designs in the context of use, there is a degree of caution that needs to be taken into account regarding correlation and causality. Being that testing is performed in set scenarios, it is difficult to determine whether the results of testing the result of the solution being tested (correlation), or if the result was impacted by something else than the solution, and just happened to occur in the context of the solution (causality). As mentioned, this project is embracing the real world in the testing, and is therefore considering the results to be correlated. However, it is worth mentioning that the result might be casualty by unremarked influences.

As mentioned in the previous point, in order to truly understand the impact of experiences like the ones presented in this thesis, the product needs to be tested over longer periods of time.

Comparing the concepts

This chapter has presented two concepts and a side experiment. The concepts are, even though presented separately, targeting many of the same end-user effects. Concept 2 was in many ways a continuation of concept 1 put into VR. However, even though they were quite similar in functionality, testing the ideas of scaling the procedure training and getting feedback outside helped focusing those effects in ways that would otherwise be drowned if put into VR straight away.

The side experiment is where I believe future concepts should find inspiration. By engaging more students using the tool, some truly interesting and useful conversions were sparked between the students. Seeing as the student's educational experience is often diverse, having a common platform for conversation might be just what the study program needs.

About using play and playfulness

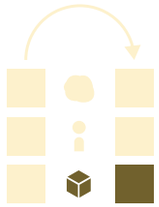
Personally, I am interested in the effect of play and playfulness in digital solutions. I find the effect of having users play in order to familiarise themselves deeply interesting. However, play is something that should be used with intention, and should not dominate the entire experience. In concept 2 it did dominate the experience, but arguably not to a detrimental degree. The created environment was a separate experience from the procedure training, and therefore did not have to be as linear and effective. Instead the user could use the space to familiarise themselves with the controls and also figure out what they wanted to select, killing two birds with one stone. Playful mechanics should be included in future versions of nursing education in VR, although not maybe as dominant as concept 2.

Closing thoughts

In this chapter we have taken a journey from using the knowledge acquired from *03 Literature, 04 Exploration & Insights* and *05 Analysis* to create actionable end-user effects and areas of focus. We have then created several concepts to experiment on how to achieve these end-users effects, as well as receiving feedback and inspiration from contributors.

In conclusion, the results have been overall good. By testing a lower-fidelity outside-VR prototype early on, we learned that there was merit to the chosen areas of focus. These were then reimplemented into VR, along-side an objective to make the experience more playful and utilising the VR-medium differently compared to other solutions.

The most surprising result was how successful the experiment involving two students were. Having one student as the trainee in VR and the other as the observant proved to spark interesting conversations and motivate learning, and should be included in future concepts.



07 IMAGINING

This chapter will present a future concept that puts together most of the findings from previous chapters. The concept is not developed or tested as a whole, but represents a synthesis of the insights, learnings, experimentation and visions for how VR can contribute in the education of nurses.

203 **07 Imagining**
204 Introduction
205 End-user effects
210 "Game" mechanics of the concept
213 Ideation
214 Elements
216 Concept presentation
222 Evaluating the concept

Introduction

This chapter will first present the effects the concept is striving towards achieving. Second, it will present an overview of the mechanics introduced in the concept. Third, the concept is realised in sketches and storyboards. Finally, the chapter concludes with reflections about the concept and how it corresponds with the insights and experimentation from previous chapters.

End-user effects

Before diving into the concept, let us first look at the reasons why the concept exists. The sole reason for this concept to exist is to answer to the findings of what the students feel a lack of and need in their education. Therefore, we are primarily looking at the end-user effects.

Acquiring vs. applying knowledge

As discussed in Exploration, VR applications should be focused and tailored according to their strengths and weaknesses. Skill-based education is all about gathering knowledge and insights about a skill, and then applying it. These steps, knowledge acquisition and knowledge application (*Figure 07-01*), can be viewed as a concentrated version of the skill-based education journey presented earlier in chapter *05 Analysis*. The point of distinguishing between these two steps is to highlight that these in fact are two different mind-sets. Knowledge acquisition is about learning, knowledge application is about using what you have learned (Perez-Lopez & Contero, 2013).

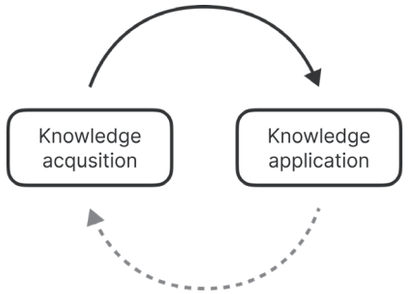


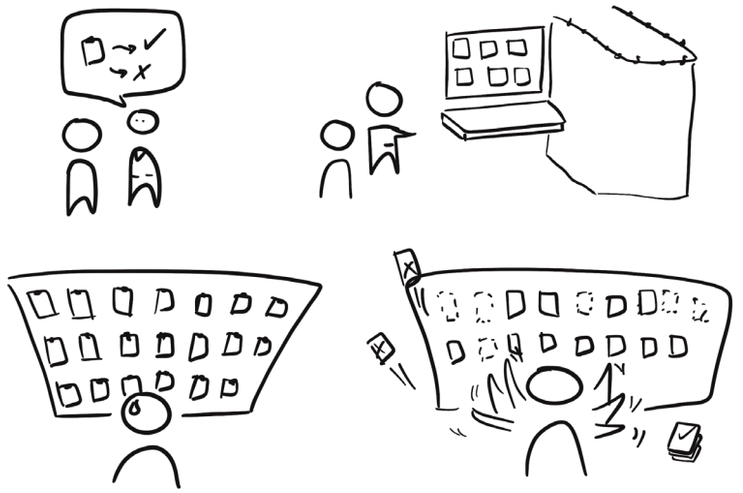
Figure 07-01: Knowledge aqusition to knowledge applciation

It is important to distinguish between these because it might set a precedence to what is the expected outcome of an educational VR application. VR is neither better nor more effective than real life at displaying text or video, both demanding passive engagement from the user. What VR is good at is action-based learning, such as moving objects and interacting with the environment. Based on this, I believe that VR is better at the latter mind-set, namely for applying knowledge, rather than acquiring knowledge.

Feeling stress and chaos

As mentioned in the previous section, VR could be a tool for exploring edge-cases and pushing skills to the limit. Learning the ABCDE-procedure isolated is useful, but knowing how to apply it when you have numerous other inputs is even more important.

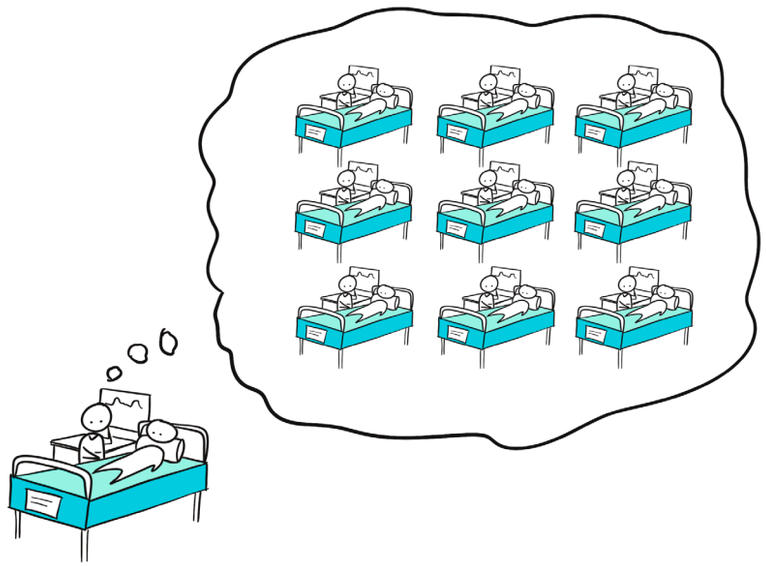
Creating simulations in the real world is time consuming and requires a lot of preparation and people. The simulations are often staged with dolls and in simulation-labs at school, and even then, the experience itself is rather limited and artificial. If we could go beyond this and create a VR experience which puts the nurse in a high-speed environment and asks the student to make the right priorities, decisions and judgements, we would have a tool that truly would be something that is highly relevant, and almost impossible to truly replicate in the real world.



This does not mean the experience should actively scare the student away, but rather the opposite. By having the experience pushed right up to the limit of what seems possible, the experience might speak to the intrinsic motivation of completing the presented tasks.

Applying prioritisation & clinical judgement

As a nurse, you are rarely working on one single patient during a shift. Depending on where nurses are working (nursing home, hospital, emergency room etc.), they need to prioritise based on the patient's needs. Sometimes this process is automatic and stress free, but sometimes other inputs and needs compete with the attention and may impact the nurse's performance. In such cases the nurse needs to prioritise the patients based on their clinical judgement.



Learning new procedures in practice

NEWS and ISBAR are relatively unknown procedures for many practising and studying nurses. The current version of VirSam's VR-application has, to a degree, integrated the recording of NEWS and ISBAR, but not the practice of it. By using the parts of the procedures as core mechanics of the experience, the student might get a better understanding of the value of the procedure, not only the theory behind it.

Collaborating with peers

One of the most surprising findings from the experimentation was how two and two students interacted with each other in the context of using VirSam's VR experience. This effect is also to be included here, and maybe in a different way. The game Keep Talking and Nobody Explodes introduced the mechanic of outsourcing half of the game outside of the VR experience, making it essential for the person in VR to communicate and collaborate with the person(s) outside. This effect can be introduced in the concept in various ways.

”Game” mechanics of the concept

As we are constructing a digital experience that has no repercussions to what happens in the real world, it is useful to think of it as a game. Game mechanics are the rules that govern and guide the players actions and the games response to said action (Schell, 2008).

Scaleable difficulty, time and aids

Different students want different things, and to ensure longevity and relevancy for the experience, the concepts adjust difficulty, time in room and accessibility aids to as many students as possible.

Different scenes

As we have learned, almost all nurses graduate with different educations due to the fact that they have had different hands-on experiences. The concept will be able to take in students input about where they have had supervised clinical practice and/or other experiences, and present them with environments they previously have not been experienced.

Too much to do, too little time

One of the effects we are striving towards is simulating stress and chaos, and, arguably, the best way to do that is introducing too much to do and too little time. The concept will be task- and time-based, both forcing the student to complete the tasks and encouraging them to complete before the time runs out.

Prioritise, judge and take action

The student is asked to base prioritisations on clinical judgement. In this concept, the clinical judgement will be based on patients journals and their last recorded NEWS-score. Some patients have more urgent NEWS scores than others, and some have not been checked out for some time. It is up to the student to select and prioritise the patients that need attending to first.

Only a certain number of journals are visible at the time. To make room for more journals, the least pressing patients can be “snoozed” and come back later.

Survey and progress

After selecting a journal, the patient appears. Now the student needs to perform the ABCDE-procedure using the available tools, and use the data to establish a new NEWS-score. When the NEWS-score is recorded and the patient is okay, the task is complete and the student moves on to the next patient.

If the patient seems to have symptoms or conditions that need specialist care, the student can call additional personnel and refer the patient.

Press pause

Being in the simulation can become overwhelming, and that is the point. However, if a game was unnecessarily overwhelming the player might exit the simulation altogether. To combat this, the concept also includes a “pause mode” where the student can collect themselves and assess the situation in a calmer environment. This aid can be configured to whatever level the student feels comfortable in performing or be challenged.

Collaborate and use outside help

The concept is a single-player experience inside the VR headset, but is thought to be a collaborative experience as a whole. This means including eventual peers outside the headset.

To make the experience engaging for both, it is thought that the person outside can play one or several roles.

The first role is, similar to Keep Talking and Nobody Explodes, to have the peer sit with information that is crucial for completing the tasks. In this case, all the tables and information regarding ABCDE, NEWS and ISBAR. The goal is then for the student in and outside VR to communicate effectively.

The second role could be one of a moderator. The student outside could either help their peer by organising the incoming journals or add additional information about the patient. Similarly, this can be turned on its head and let the student outside of VR sabotage their peer by introducing other stressful elements like sirens or a talkative colleague.

Feedback and progression

After completing the “shift”, the student is presented with a summary of his/hers performance. The feedback is a combination of facts and figures, as well as remarks on habits and things to keep in mind for the next session.

Ideation

To get an overview over what the future concept could look like, a VR Game Canvas was used. The structure of the canvas is made by Fridheim and Støen (2021), and is a combination of related and accessible examples.

VR game canvas

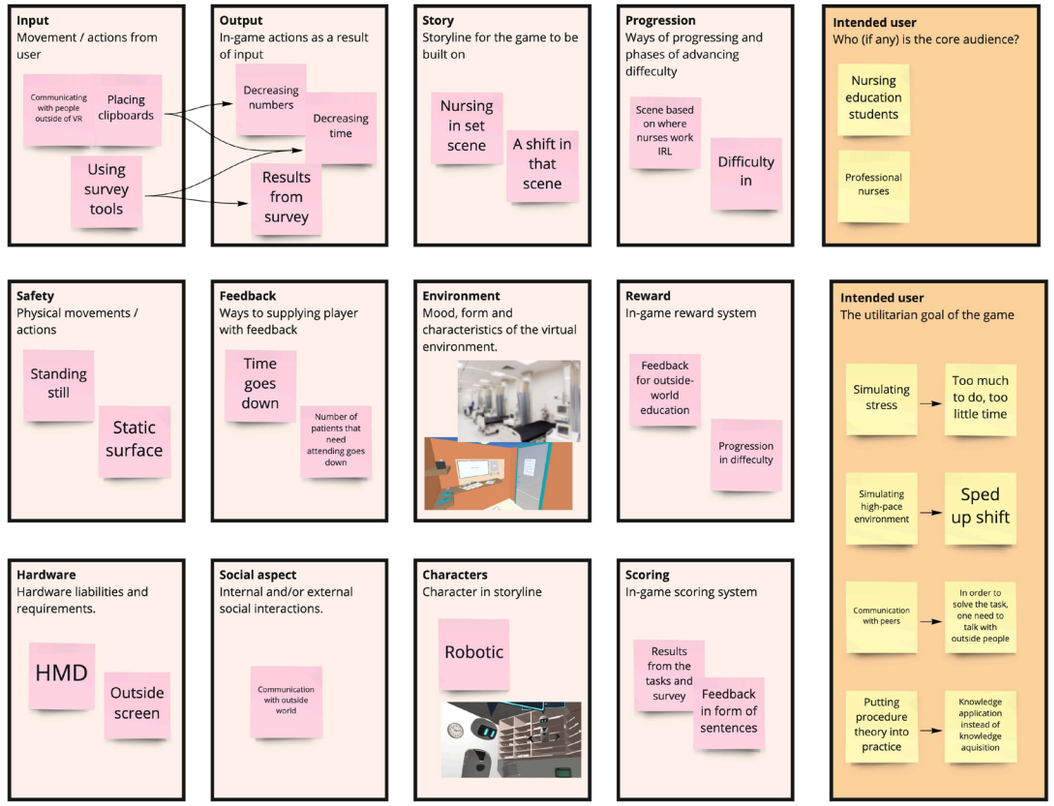


Figure 07-02. VR game canvas of the suggested concept.

Elements

The environment

The concept is to take place in an open room. A table is in front of you, and a board hangs above the table. On one side of the table there is a curtain obscuring a patient

Journals

The journals are in the shape of clipboards, and act like the primary “buttons” of the system. The current patient is selected by placing a clipboard on a designated area on the table.

The journal itself presents a patient with their condition, last NEWS score and timestamp when last seen to.

Input mechanisms

Similar to VirSam’s VR-application, the input mechanism is the shape of an in-game tablet. This is where the student inputs relevant data. However, the student is not asked to input the patient data, as with VirSam’s application. This tablet is solely for inputting the final NEWS-score, as well as look up information about procedures (if playing alone).

Curtain

The curtain is there to rapidly show and hide patients. When selecting a journal, the curtain opens and a patient is revealed. When the journal is removed, the curtain closes.

Slots for snoozing, completing and referring journal

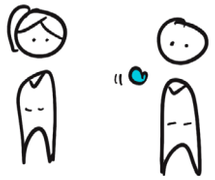
Slots in the wall are made to have the student take action upon the journals. There are three kinds of actions:

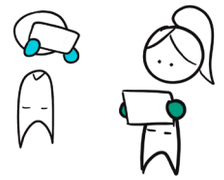
- Completing the journal. After the journal has been updated through a clinical survey, it can be marked as done.
- Snoozing the journal. If the patient has just been tended to, the journal can be snoozed and brought back later.
- Referring the patient. If the patient has symptoms or conditions that need attention by someone else, the patient can be referred.

Clock and counter

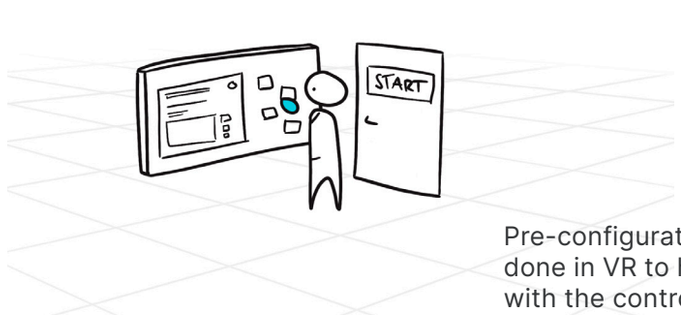
Over the board there are two digital displays. One displays the total number of journals left, and the other displays the time left of the session. The session is meant to be a sped up version of a shift. The number of journals left can fluctuate throughout the day based on the scene the student is playing.

Concept presentation

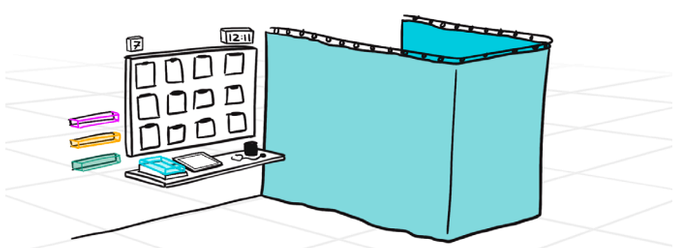




A collaborative experience. One student in VR, one outside with a digital device with selected information.



Pre-configuration of the simulation is done in VR to help the user get familiar with the controls and mechanics.



After configuration, the student in VR is met with a wall of patient journals and a closed curtain.

Figure 07-03. Concept journey.

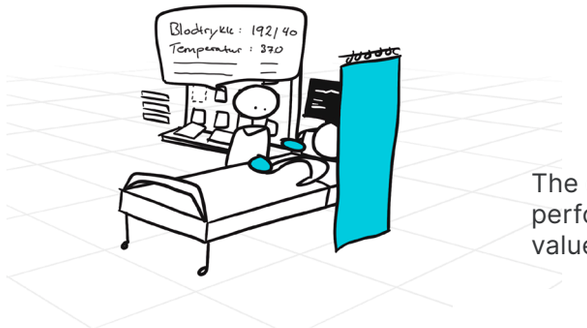
In VR, the student looks at the walls and picks a journal to be surveyed.

The student says out loud the last NEWS-score and timecode.

The student outside decides if the patient should be checked, snoozed or referred.

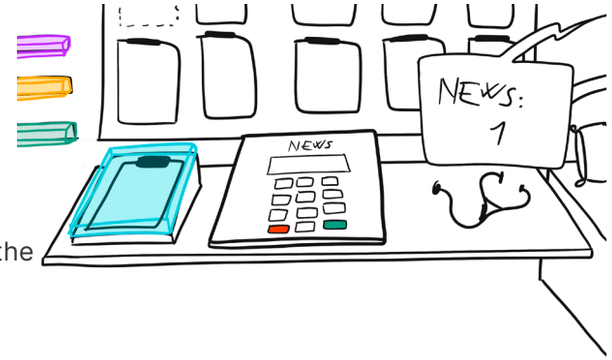
The journal they decide to check is placed on the designated area on the table, and the curtain opens to reveal the patient.

The student prepares to perform a clinical survey.

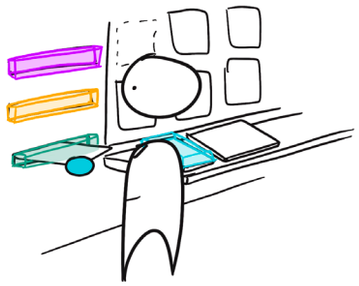


The clincial survey is performed, and the values are said aloud.

The outside student uses the values to create a new NEWS score.

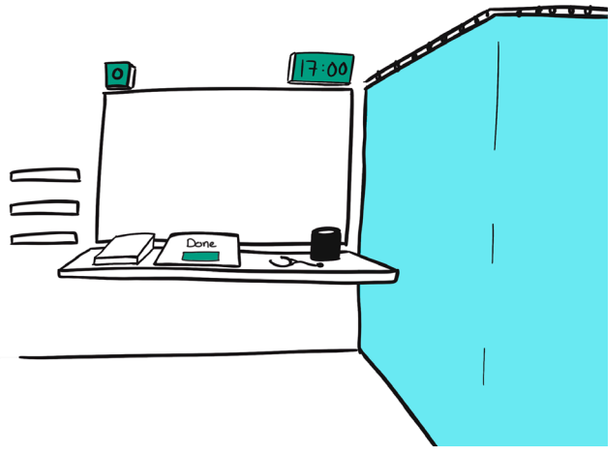


The new NEWS score is recorded on the journal on the tablet by the student in VR.

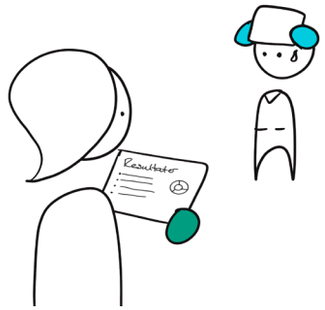


The updated journal is put through the "Completed" slot.

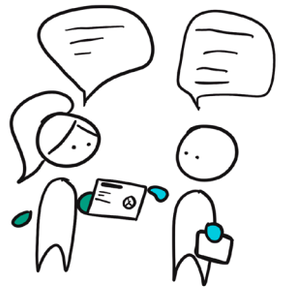
Time is ticking, and all the patients needs to be checked or referred before the time runs out. The curtain opens and closes as new journals are placed.



When the cue is empty or the simulated shift is done, the simulation ends.



As the simualtion ends, the student outside recieves the result from the similation.



The outside student provide the feedback, and the students discuss the results.

Evaluating the concept

Learning outcome

The desired learning outcome of this concept is deeply tied into the desired end-user effects presented earlier.

- Put the student at the edge of what is possible to do in a timeframe
- Prioritise and judge tasks
- Use and adapt procedures in practice
- Collaborate with peers

This kind of scenario teaches the student that clinical procedures rarely are done in isolation, and needs to be adapted to a workflow. The concept is meant to render different arenas based on where nursing is practised, meaning the student will have different kinds of patients to evaluate and survey, further adapting the procedures.

Through the simulation explained above, the student is taught how to apply their knowledge in a stressful, but safe environment. They are asked to assess, prioritise and judge the scenario based on facts, visual and auditory clues. Moreover, the patient's diagnosis and the number of distractions at the hospital can be adjusted in order to adapt to the different users' levels.

Validation of the concept

The presented concept is untested on users. However, most of the components, elements and mechanics have already been explored throughout this thesis. Each part has been validated separately, but that does not mean this concept will float. Future validation is needed to figure out if the concept as a whole is doable, feasible and desirable.

Including the outside world

When considering the target users for this thesis, the closest "stakeholder" to the individual student is the fellow student. To not include the fellow student into the concept would be an omission, and the question is how they could be included.

As discovered in Exploration, the inclusion of peers in the sphere around using VR rendered good results, and analysing games like Keep Talking and Nobody Explodes strengthens that notion. As learned in chapter *03 Literature*, VR has the possibility to transport the user to whole new worlds where anything is possible. However, even though we can, does not mean we automatically should. VirSam has already created some applications where several students and teachers are together in VR, so that could be a possibility. In chapter *06 Experimentation*, we learned that putting a peer outside of VR and having them be part of the experience made for "double learning" to a degree, and the student in VR felt more comfortable having a peer observing and providing feedback.

By removing some of the information from the VR-part of the application, the two students become dependent on each other to solve the scenario.

Is it real enough?

In Exploration I found that some students commented on the fact that NEWS and ISBAR is disingenuously represented in VirSam's VR-application, explaining that NEWS especially is a tool used in certain scenarios and use-cases.

In that regard, how will this concept fare under similar comparisons? The concept would most likely undergo several evaluations, among them if the renditions of the procedures are accurate. That being said, the intention of this concept is not to emulate the textbook practice of either ABCDE, NEWS or ISBAR. Rather, the methods are instead used as mechanics to achieve the end-user effects and subsequent learning outcomes. A discussion needs to be had regarding what should be accurate and real, and what can be loosely based in reality is a trade-off to simulate the experience.

Going beyond what can be done in the real world

In chapter *05 Analysis* it was mentioned that for VR to contribute to nursing education, it needed to either solve a problem better than the solutions that are already there, solve a problem that does not yet have a solution or create new opportunities.

The presented concept fulfils all three requirements to varying degrees. First, the concept suggests putting students in a high-paced environment where moving from patient to patient might prepare students for similar situations in real life. This effect is something the students experience when in supervised clinical practice, only this concept implements it in the education.

Second, the concept suggests implementing the clinical procedures ABCDE, NEWS and ISBAR in a different and more "gamified way". By considering some of the steps like catalysts for interaction mechanics, the concept is able to engage both students inside and outside the VR solution.

Third, the concept opens up for several ways of expansion and customization for different students' needs. By digitising the simulation of procedure practice, the concept opens of for individual follow-up of students to help them become better nurses.

08

Discussion

This chapter reflects and discusses opon some of the findings and decisions made in the previous chapters, as well as contemplates using VR for nursing education.

Science project versus consumer product

Explained in the Design Theory part of this thesis, we are using the reframing method of thinking about problems. This means thinking of solutions as products, or tools in a context. Hence, in this thesis we are looking at VR for education as a consumer product, and not a science project. In this case, “consumer” does not refer to the user's buying power or eventual marketing that might be needed down the road, but rather the association the user has to the product.

Science projects and their reports are immensely valuable for gathering, crunching, and presenting large amounts of complex and important information. However, they are poorly fitted to build delightful, usable, and desirable products. Arguably, VirSam needs both, which is why I would call the VirSam project a “science product” – a consumer product derived from and backed up by scientific research and methods. This kind of product is not afraid to experiment with less tangible metrics for evaluating whether an experience is meeting requirements or not. Products do not exist in a vacuum; consumers are continuously evaluating products against each other to find the one that fits their need the best.

That being said, in the education of medical professionals there is not a surplus of solutions, making it even more important that the end-users' needs and requirements are met. Even though a given solution is the only solution available to the user, it does not give it the right to be a bad solution.

Defining the problem

Going into this project, there was a notion that the problem was known and well defined, and using VR might solve that problem. Skill- and procedure training are fundamental parts of the education of nurses, and is not something you can get enough of. VR has the potential to focus the training on specific fields based on personal requirements. However, by zooming out and looking at nursing education from more angles, we also get a greater understanding of the problem space.

There are numerous solutions to any given problem, and creating solutions is just as much about defining the problem as it is solving it. By continuously asking if we are solving the right problem, we get closer to the right solution. This thesis has both been about delivering understanding about the problem area and presenting experiments and concepts. Designers alternate between “solving the problem right” and “solving the right problem”, and by doing experiments we inch closer towards understanding the problem that we want to solve. The experiments in this thesis have been largely focusing on the students, and switching focus to other stakeholders might render entirely different understandings of the problem and context.

Rethinking realism

VR is a complex equation of resources. It takes time to create something digital, especially in a non-mature field such as VR. Some aspects of the experience should understandably be realistic, but others must not. When creating educational software for nursing, some things need to be more realistic than others in order to create the level of immersion that is necessary for both comfort and learning effect.

Looking back at the findings from *03 Literature* and *04 Exploration & Insights*, we learned that good VR does not equal high fidelity. It is more important that the experience feels right than it looks photorealistic (Jerald, 2016; Kavanagh et al., 2017; West, 2021). Fidelity might benefit from being played down and kept simple for the benefit of avoiding "uncanny valley" (Kavanagh et al., 2017; West, 2021). Furthermore, the real world constraints don't need to follow into the VR world, you can rather create new ones (West, 2021). The overall goal of the experience should be to achieve an end-user effect. Although it might be the case that certain end-user effects are achieved by improving the visual fidelity, it should never come at the cost of other qualities of the VR experience (West, 2021).

Considering these points, it is natural that the act of learning and practising procedures in VR is the focus for this thesis, rather than purely the usage of VR. It should be said that the degree of fidelity has an impact on immersion (Jerald, 2016; Gutierrez et al., 2007), but if the core mechanics do not feel good, making it look real or pretty will not mend it.

Considering simulation versus emulation

Understanding what are the possible outcomes of using virtual reality technology is important to understand how we can design a system that best meets the established needs of the students and their education. Part of this understanding is how, in more abstract terms, VR can be valueable for the context. In computer science and software developers, the words simulation and emulation is often used when describing the recreation of functionality. There are numerous explorations, comparisons and concepts surrounding this topic, none of actually which compare simulation and emulation. However, I find the thought of differentiating between simulation and emulation interesting and important for the creation of VR experiences for education.

The online dictionary Merriam-Webster (2021) defines a simulation as "the imitative representation of the functioning of one system or process by means of the functioning of another", and emulation as a synonym of imitation and "ambition or endeavour to equal or excel others (as in achievement)".

I offer this explanation: Emulation is a reproduction or duplication of the functions of another device or system, amining to be as close to reality as possible. Simulation is "giving the appearance", an imitation, of the functions of another system at a more abstract and less precise level.

By choosing to simulate something in VR, we are setting the expectations of what could and should be represented. Simulation can deliberately include and exclude certain functions from what it is trying to simulate, and cultivate certain qualities at will. Emulation, on the other hand, is comparing its results directly to what is being emulated, and could possibly replace it.

This is important to keep in mind, because recreating (emulating) certain practises or parts of nursing education in VR is nearly impossible. However, by using the medium for what it is good for, we can create a simulation that encourages certain effects that the real world might only scratch the surface of.

Re-evaluating how to use VR in education of nurses

Through this thesis, we have gotten a pretty good understanding of the problem space through the eyes of students and stakeholders. We have found that although procedure training in VR sounds simple, when seen in the context of the entire education it becomes much more complex.

What problems remain unsolved in nursing education?

A part of this thesis has been about the context in which VR is supposed to be used. That has meant hours of interviews and reading about how nursing education is structured. There are some unsolved issues in education that need to be considered when placing new tools and technologies into the mix and looking beyond procedure training.

First of all, someone will always think that there are deficiencies in the study program. There will be opinions from students, educators and stakeholders saying there is too much or too little of something. Right now, the students experience a lack of skill and simulation training, and VR might be a solution to that. But will including VR in the study program alleviate some of the deficiencies, or will it create new ones?

Secondly, current and past students have a general feeling that the development of the study program is not structured by actual nurses. Although this might not be the case (and in fact, my research suggests that some courses are closely developed with practising nurses), they still experience that the curriculum is not necessarily preparing them to become professional nurses. This is exemplified by the fact that the simulation lab at the students' campus is (knowingly by the educators) rarely used, and mostly for research purposes. There is great potential in using the simulation lab for more extensive simulation training on a bigger scale.

Thirdly, there are great differences between graduated nurses. This is not necessarily a problem - diversity is a great asset in teams. However, there is an ongoing nation-wide process trying to make the study program more standardised (Kunnskapsdepartementet, 2019) with varying degrees of success (Amundsen et al., 2021). On a local level, the differences in education become a problem when students return to school after attending supervised clinical practice. In these cases they might have vastly different experiences and foundations to build more knowledge on top of. Because of this, some students feel less prepared for what is to come as professional nurses compared to others.

VR should aim higher

The current ABCDE VR-application is a digital textbook. You are going from page to page on a linear experience, and in the end you are presented with green check-marks and stars. Even though it is an interactive and novel experience, it quickly becomes old. You are learning how to perform tasks in the correct order in a 3D-environment, which already offers more compared to a textbook or YouTube video could, but not much more compared to a physical doll-simulation.

The whole point of VR is to be placed into new environments that can be whatever we want, not simply replicating a lesser version of the ones we already have (Jerald, 2016). Students should have all their “bad” experiences in safe environments. These “bad” scenarios should be the goal of which to model the VR experience. It should explore edge-cases and push skills to the limit, only for the student to fail and try again.

Re-evaluating the use of VR for procedure training

Even though I claimed that VR should aim higher, there is value in using it for isolated procedure training such as in the case of VirSam's ABCDE. Many of the target users have said they wanted to be able to train on selected procedures in larger quantities, and the ABCDE-application is great for that (although it can be improved on some aspects, as mentioned in *04 Exploration and Insights*). This kind of application is perfect for students to learn the mechanics and controls of VR and to exercise a certain procedure. My opinion is that having isolated procedure training be a part of a larger system of applications in VR is definitely the way to go.

Future VR technologies

Closing this chapter, there is one opportunity that I think deserves more attention, namely the possibility of running VR in a web browser. Running VR through a web browser might sound trivial, but I believe it opens up a whole new way of thinking about VR applications. Mentioned in chapter *03 Literature*, theThree.js Javascript-framework more easily enables the creation of 3D environments on the web. This framework has a VR-component, enabling websites to be rendered in supported head-mounted displays with ease.

There are of course advantages and disadvantages with this approach. On one hand, the end-users do not have to bother with installing, updating or maintaining any VR software. They simply need to plug in the headset and go. Also, the fact that the VR experience is accessed through a website means it can more easily integrate with other web-based platforms and behave as a component in a system, instead of a separate experience. On the other hand, a web browser would not have access to the same rendering pipeline as a program made in Unity, and is therefore somewhat limited in terms of technical and visual performance.

Arguably, I would say the advantages far outweigh the disadvantages, and therefore I believe that this approach should be considered and utilised in future prototypes. Furthermore, VR being an increasingly popular medium, one might imagine that frameworks for including VR in web browsers will advance and increase in numbers.

09

Conclusion

This concluding chapter rounds of the thesis by reflecting upon the process itself, as well as presenting some thoughts on the designer's role in a project like this.

Project pivot

This thesis is an exploration of how newer technology can be used to improve the current and future of nursing education. When first starting to work on this project, the initial scope was to “build upon the existing VR-application ABCDE” with the intention of making it a better educational vessel for the target demographic. In spite of that, early secondary and primary insights suggested that the existing solution was lacking both functional and conceptual elements, which a design perspective would consider fundamental. On account of this, the scope pivoted towards experimenting more broadly on how VR could be used in the chosen domain, hence the inclusion of the reframing method.

Reflecting upon the process

The reframing method has been central in this thesis, as the project uses an already established solution, domain and target demographic. The process has centred around using the target demographic as an important source of insight and evaluator of how VR can be used to better the education of nurses. Additionally, external contributors with insights in VR, health education and concept development have been used to further reflect upon insights.

What makes the reframing method a valuable asset in the process is how it encourages the deconstruction of an existing product in an existing domain, looking at these with individual mindsets, for them to be put together to craft new understanding and ideas. The product and domain has been deconstructed in *03 Literature* and *04 Exploration and Insights*, reconstructed in *05 Analysis* and *06 Experimentation*.

Central to the reframing method is the synthesis, construction and usage of measurable end-user effects to design and evaluate solutions. The concept presented in *07 Imagining* presents a different way of using procedures for pedagogical gain by challenging the perception of how VR can be used in the education of nurses, guided by the desired end-user effect.

Thesis contributions

As discovered in *03 Literature* and through my own research, a big challenge for VirSam and other research projects using VR is the lack of focus on end-user centric design, both in terms of usability and the concepts. Even if a solution is made for research purposes only there should be someone on the team who understands the relationship between technology and humans, both theoretically and empirically. This is especially important if the research depends on the usability and comprehension of the solution, as with the case of VirSam. Bringing this perspective to the table is the most important contribution of this thesis. Solutions could be viewed and filtered through numerous different perspectives, and with each perspective new value and knowledge is added to the result. Human-centred design is yet another perspective to add to the mix of researchers, developers, technologists, educators, investors, governing bodies and other stakeholders. Regardless, if the solution is intended to be used by people, design should be a fundamental inclusion.

Final thoughts

The idea of virtual reality has almost endless possibilities, grounded in the digital tools that allow these ideas to exist. It is when the tools meet the intended target users that the ideas are put to the test. Numerous criteria need have to be met, conditions need to be understood, and needs to be considered in order to pair the idea with the tool. VR can be ever so cool, but if it does not meet current or future needs of the people who are supposed to use it, the ideas will remain just that - ideas.

References

Contributors

Ekaterina Prasolova-Førland	NTNU, Leader of Innovative Immersive Technologies for Learning
Eivind Kværnø	NTNU, Chief Engineer & Nurse, Unit for health professional simulation, ISM
Marit Mauset	NTNU, Head of course development, ISM
Sara Sundqvist	NTNU, University lecturer in Commercialising of Technology, former nursing student
Eirik Unneland	TRAMS Former leader
Nils Karlsen	MedEasy Course responsible and physician
Valeria Gaitan	SINTEF Design Health Researcher
Simon Hartmann	Laerdal Medical Senior Digital Learning Specialist
Kjetil Nilsen	Laerdal Medical Senior Lead Designer

Sources

Anderson, S. A. (1994). Synthesis of research on mastery learning.

Anderson, T., & Shattuck, J. (2012). Design-Based Research: A Decade of Progress in Education Research *Educational Researcher,Vol. 41, No. 1, pp. 16–25 DOI: 10.3102/0013189X11428813*

Amundsen, M., Rasmussen, I. & Sverdrup S (2021). Lik sluttkompetanse – visjon eller virkelighet? *Vista Analyse AS. 978-82-8126-505-9*

Attensi (2021). Various solutions. *Retrieved from: https://attensi.com*

Berg, H. & Steinsbekk, A. (2020). The effect of self-practicing systematic clinical observations in a multiplayer, immersive, interactive virtual reality application versus physical equipment: a randomized controlled trial. *Advances in Health Sciences Education (2021) 26:667–682*

Berg, H., & Steinsbekk, A. (2020). Is individual practice in an immersive and interactive virtual reality application non- inferior to practicing with traditional equipment in learning systematic clinical observation? A randomized controlled trial. *BMC Medical Education (2020) 20:123*

Bloom, B. S. (1971). Mastery learning. *Mastery learning: Theory and practice, 47-63*.

Blosch, B. & Fenn, J. (2018). Understanding Gartner's Hype Cycles *Retrieved from https:// www.gartner.com/en/documents/3887767*

Bouvet & Stavanger Sykehus (2021) Leger i utdanning skal diagnostisere sjeldne og akutte sykdommer med VR. *Retrieved from: https:// www.bouvet.no/prosjekter/medical-trainer*

Brown, T. (2021) Definition of Design Thinking. *Retrieved from https:// designthinking.ideo.com/*

Cagan, M. (2017). Inspired: How to create tech products customers love: *John Wiley & Sons*.

Costello, B., & Edmonds, E. (2007). A study in play, pleasure and interaction design. *In Designing Pleasurable Products And Interfaces (pp. 76- 91): ACM.*

Dale, E. (1969). Audio-Visual Methods in Teaching. (3rd ed.). *The Dryden Press*

Dahlstrøm, C. (2017). Impacts of gamification on intrinsic motivation. *NTNU Universitetsforlag*.

Epic Games (2021). Unreal Engine. *Retrieved from https://www.unrealengine.com/ en-US/solutions/simulation*

Fridheim, M. L. & Støen, A. B. (2021) VRehab: Designing for VR-based serious games in neurorehabilitation. *NTNU Universitetsforlag*.

Prasolova-Frøland, E., Steinsbekk, A., Fominykh, M. & Lindseth, F. (2018). Practicing Interprofessional Team Communication and Collaboration in Smart Virtual University Hospital. *Smart Universities: Concepts, Systems and Technologies. Chapter 7.*

Fynd Reality & Høgskolen Innlandet (2019) Virtual Reality som et treningsverktøy for å forebygge feilmedisinering. *Collected source, retrieved from: https://www.fyndreality.com/nb/virtuelt-medisinrom/ - https://www.nrk.no/innlandet/vr-briller-skal-forhindre-feilmedisinering-1.14755605 - https://www.altomdinhelse.no/mannens-helse/virtual-reality-sykepleie-sant/#*

Gabbard, J. L., Mehra, D. G. and Swan, J. E. (2019) Effects of AR Display Context Switching and Focal Distance Switching on Human Performance. I*EEE Transactions on Visualization and Computer Graphics, vol. 25, no. 6, pp. 2228-2241, 1 June 2019, doi: 10.1109/TVCG.2018.2832633.*

Gee, J. (2007). What Video Games Have to Teach Us about Learning and Literacy. Second Edition: Revised and Updated Edition. *Palgrave Macmillan*.

Gilbert, N. (2021). 74 Virtual Reality Statistics You Must Know in 2021/2022: Adoption, Usage & Market Share . *Retrieved from Finances Online: https:// financesonline.com/virtual-reality-statistics/*

Gingold, C. O. (2016). Play Design. *In: eScholarship, University of California*.

Goethe, O. (2020) Gamification for good: addressing dark patterns in gamified UX design. *CRC PRess*

Gutierrez, F., Pierce, J., Vergara, V., Coulter, R., & Saland, L. (2007). The effect of degree of immersion upon learning performance in virtual reality simulations for medical education. *InMedicine Meets Virtual Reality, 15, 155*.

Guskey, T. R., & Pigott, T. D. (1988). Research on group-based mastery learning programs: A meta-analysis. *Journal of Educational Research, 81, 197-216*.

Guskey, T. R. (2021, October 9). Lessons of Mastery Learning. *Retrieved from ASCD: https://www. ascd.org/el/articles/lessons-of-mastery-learning*

Goodwin, K. (2011). Designing for the digital age: How to create human-centered products and services. *John Wiley & Sons*.

Snarby, H., Gåsbakk, T., Prasolova-Førland, E., Steinsbekk, A. & Lindseth, F. (2017). Procedural Medical Training in VR in a Smart Virtual University Hospital

Hall, R. F. (2013). Mixed Methods: In search of a paradigm

Hekkert, P. & Van Dijk, M. (2011) Visions in Design: A Guidebook for Innovators. *Laurence King Publishing*

Hekkert, P. & Van Dijk, M. (2011) Reframing Method. *Retrieved from https://www. reframingstudio.com/reframing-method*

Schwind, V., Wolf, K. & Henze, N. (2018). Avoiding the uncanny valley in virtual character design. *Article in interactions August 2018, DOI: 10.1145/3236673*

IDEO (2021). Design Thinking Defined. *Retrieved from https:// designthinking.ideo.com/*

ISO (2019). ISO 9241-210:2019 Ergonomics of human-system interaction — Part 210: Human-centred design for interactive systems. *Retrieved from https://www.iso.org/standard/77520.html*

Jerald, J. (2016). The VR Book: Human-Centered Design for Virtual Reality. *ACM Books*.

Johansen, I. H., Blinkenberg, J., Arentz-Hansen, C. & Moen, K (2021). Primærundersøkelsen - ABCDE. Legevakthåndboken. *Retrieved from: https://lvh.no/naar_det_haster/ abcde__primaer-_og_sekundaerundersoekelsen/ primaerundersoekelsen__abcde*

Johnson, D. M. (2005). Simulation Sickness Summary. *U.S. Army Research Institute for Behavioral and Social Science*.

Joseph, D. (2004). The Practice of Design-Based Research: Uncovering the Interplay Between Design, Research, and the Real-World Context . *Educational Psychologist, 235-242*.

Kavanagh, S., Luxton-Reilly, A., Wuensche, B., Plimmer, B. (2017). A Systematic Review of Virtual Reality in Education. *Themes in Science & Technology Education, 10(2), 85-119, 2017*

Kavanagh, S., Luxton-Reilly, A., Wuensche, B., Plimmer, B. (2017). Intrinsic and Extrinsic Factors Important to Manual Therapy Competency Development: A Delphi Investigation

Keitsch, M. M. (2014). Integrating different user involvement methods in design curriculum. *International conference on engineering and product design education, 4 & 5 September 2014, University of Twente, The Netherlands*.

Kjøl, J., Melbye, L. & Mundal, I. P., 2020. NEWS-målinger trygger sykepleiere i den tverrprofesjonelle kommunikasjonen. Sykepleien 2020;108(83082):(e-83082) *Retrieved from: https://sykepleien.no/fag/2020/12/news-malinger-trygger-sykepleiere-i-den-tverrprofesjonelle-kommunikasjonen 01.01.22*

Kvam, S., Larssen, A. O., & Wulvik, T. (2021). Creating a sense of togetherness in remote Virtual Reality workshops. *NTNU Universitetsforlag*.

Kunnskapsdepartementet (2019). Forskrift om nasjonal retningslinje for sykepleierutdanning. *Retrieved from Lovdata: https://lovdata.no/dokument/LTI/forskrift/2019-03-15-412*

Kulik, C. C., Kulik, J. A., & Bangert-Drowns, R. L. (1990). Effectiveness of mastery learning programs: A meta-analysis. *Review of Educational Research, 60, 265-299*.

Kristiansen, H. M. (2020). Considering play and playfulness in the design of digital experiences.

Lackner, J. R. (2014). Motion sickness: more than nausea and vomiting. *Exp Brain Res (2014) 232:2493–2510*.

Laerdal Medical (2021). SimCapture - En styringsløsning for simuleringstrening innen helsevesen og utdanning *Retrieved from: https://laerdal.com/dk/products/simulation-training/manage-assess-debrief/simcapture/*

Lewis-Evans, B. (2015). Designing to Minimize Simulation Sickness in VR Games. *Retrieved from https://www.youtube.com/watch?v=2UF-7BVf1zs*

Macpherson, C., & Keppell, M. (1998). Virtual reality: What is the state of play in education? *Australian Journal of Educational Technology, 60-74*.

Martin, B. & Hanington, B. (2012). Universal methods of design expanded and revised: 125 Ways to research complex problems, develop innovative ideas, and design effective solutions. *Rockport Publishers. 978-1-59253-756-3*

Merriam-Webster. (2021, September 10). *Retrieved from Merriam-Webster: https://www.merriam-webster.com/dictionary/virtual%20reality*

Moi, E. B., Söderhamn, U., Marthinsen, G. N. & Flateland, S. M. (2019). Verktøyet ISBAR fører til bevisst og strukturert kommunikasjon for helsepersonell. *Sykepleien Forskning 2019 14 (74699) (e-74699) DOI: 10.4220/Sykepleienf.2019.74699*

Nielsen, J. (1994). Enhancing the explanatory power of usability heuristics. *Paper presented at the Proceedings of the SIGCHI conference on Human Factors in Computing Systems*.

Nielsen, J. (2000). Why You Only Need to Test with 5 Users. *Retrieved from https://www.nngroup.com/articles/why-you-only- need-to-test-with-5-users/*

Norman, D. A. (2013). The design of everyday things (Rev. and exp. ed. ed.). *New York: Basic Books*.

NTNU, Bachelorprogram, 3-årig - Gjøvik, Trondheim og Ålesund Sykepleie (2021). *Retrieved from: https://www.ntnu.no/studier/bspl*

Oh, E., & Reeves, T. C. (2010, December). The implications of the differences between design research and instructional systems design for educational technology researchers and practitioners. *Educational Media National, 265-275*.

Pelletier, K. E. (2021). 2021 EDUCAUSE Horizon Report, Teaching and Learning Edition. *Boulder, CO: EDUCAUSE*.

Perez-Lopez, D. & Contero, M. (2013). Delivering Educational Multimedia Contents through an Augmented Reality Application: A Case Study on Its Impact on Knowledge Acquisition and Retention. *Turkish Online Journal of Educational Technology - TOJET, v12 n4 p19-28 Oct 2013*

Poon, C. S., Koehler, D. J., & Buehler, R. (2014). On the psychology of self-prediction: Consideration of situational barriers to intended actions. *Judgment & Decision Making, 9(3)*.

Portigal, S. (2013). Interviewing users: how to uncover compelling insights. *Rosenfeld Media*.

Razzouk, R., & Shute, V. (2012). What Is Design Thinking and Why Is It Important? *Review of Educational Research, 82(3), 330-348. doi:10.3102/0034654312457429*

Reeves, T. C. (2000). Enhancing the Worth of Instructional Technology Research through “Design Experiments” and Other Development Research Strategies. *International Perspectives on Instructional Technology Research for the 21st Century,*

Regjeringen (2021) Liste over kritiske samfunnsfunksjoner *Retrieved from: https://www.regjeringen.no/no/tema/samfunnssikkerhet-og-beredskap/innsikt/liste-over-kritiske-samfunnsfunksjoner/id2695609/*

Royal College of Physicians (2017). National Early Warning Score (NEWS) 2: Standardising the assessment of acute-illness severity in the NHS. *Updated report of a working party. London: RCP.*

Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *Am Psychol, 55(1), 68-78. doi:10.1037//0003-066X.55.1.68*

Sanders, E.B., & Stappers, P.J. (2013). Convivial Toolbox: Generative Research for the Front End of Design.

Schell, J.. (2008). The art of game design : a book of lenses. *Amsterdam ; Boston :Elsevier/Morgan Kaufmann,*

Schell Games (2021). I Expect You to Die 2. *Retrieved from: https://iexpectyoutodie.schellgames.com/sequel*

Schmidt, M. M. (2014) Designing for Learning in a Three-Dimensional Virtual Learning Environment: A Design-Based Research Approach. *JSET 2014 Volume 29, Number 4*

Sedgwick, P & Greenwood, N. (2015) Understanding the Hawthrone effect. BMJ 2015;351:h4672

Sherman, W. R., & Craig, A. B. (2003). Understanding Virtual Reality: Interface, Application and Design.University of California, Berkley: Morgan Kayfmann Publishers.

Steel Crate Games (2018). Keep Talking and Nobody Explodes. *Retrieved from: https://keeptalkinggame.com*

Sizer, P., Sawyer, S., Felstehausen, V., Couch, S., Dornier, L., & Cook, C. (2008). Intrinsic and extrinsic factors important to manual therapy competency development: a delphi investigation. *The Journal of manual & manipulative therapy, 16(1)*

Stickdorn, M., Hormess, M. E., Lawrence, A., & Schneider, J. (2018). This is service design doing: applying service design thinking in the real world. *O'Reilly Media, Inc.*

Stauffert, J.-P., Niebling, F., & Latoschik, M. E. (2020). Latency and Cybersickness. Impact, Causes and Measures. A Review. *Frontiers in Virtual Reality*.

Tepper, A. (1996) Controlling technology by shaping visions. *Policy Sci 29, 29–44. https://doi.org/10.1007/BF00141478*

Three.js (2021). Three.js. *Retrieved from https://threejs.org*

Unity Technologies (2019). XR interaction toolkit. *Retrieved from https://docs.unity3d.com/Packages/com.unity.xr.interaction.toolkit@2.0/manual/index.html*

Unity Technologies (2021). Unity VR. *Retrieved from https://unity.com/unity/features/vr*

Usability.gov. (2021). Personas. *Retrieved from https://www.usability.gov/how-to-and-tools/ methods/personas.html*

Wang, Y. H. (2020) Design-based research on integrating learning technology tools into higher education classes to achieve active learning. *Computers & Education Volume 156, October 2020, 103935*

Wan, W. H., & Lam, A. H. (2019). The Effectiveness of Virtual Reality-Based Simulation in Health Professions Education Relating to Mental Illness: *A Literature Review. Health, 646-660.*

West, T (2021). Unity's Head of VR Offers a Much-Needed Reality Check. *Retrieved from https://www.wired.com/story/timoni-west-unity-vr-ar-interview/*

Whiting, B., Van Burgh, J. W., & Render, G. F. (1995). Mastery learning in the classroom.

Wolters Kluwer (2022). Help Students Be Practice-Ready with The Next Generation of vSim for Nursing. *Retrieved from: https://www.wolterskluwer.com/en/solutions/lippincott-nursing-faculty/vsim-for-nursing/vsim-2*

Zimmerman, J., Forlizzi, J., & Evenson, S. (2007). Research Through Design as a Method for Interaction Design Research in HCI. *CHI 2007 978-1-59593-593-9/07/0004*

Appendix

A ABCDE & ISBAR tables

B NEWS tables

C Recruitment poster

D Consent form, contributors

E Consent form, taget user

F "Answer sheet", peer-to-peer experiment

G Early feedback to VirSam regarding the application

H Protocol, concept 1

I Protocol, concept 2

J Protocol, concept peer-to-peer

K Master's protocol for NSD

L NSD application

A ABCDE & ISBAR tables

ABCDE – OBSERVASJON OG TILTAK	
A	**AIRWAYS** / Luftveier Sørg for frie luftveier ▶ Hakeløft/kjevetak, sideleie, fjerne fremmedlegme
B	**BREATHING** / Respirasjon Pustebesvær/taledyspne, respirasjonsfrekvens, respirasjons-lyder, rytme/dybde, hjelpemuskulatur, cyanose, SpO_2 ▶ Kroppsleie, berolige, pusteveiledning, oksygen
C	**CIRCULATION** / Sirkulasjon Hud (farge/temp, kald/klam), kapillær fyllingstid, puls (rytme/fylde), BT ▶ Perifer venekanyle (PVK), evt. væske, heve bena
D	**DISABILITY** / Bevissthet Bevissthetsnivå (ACVPU), tegn på hjerneslag (PSL/andre sympt.) sjekk pupiller og evt. blodsukker ▶ Frie luftveier, evt. sideleie, regulere blodsukker
E	**EXPOSURE** / Kroppsundersøkelse / Omgivelser Hudforandringer (utslett, sår ol.), kateter/dren, temperatur, feilstilling/brudd, smerter etc. Endring i hjemmeforhold? ▶ Tiltak avhenger av funn

MISTANKE OM SEPSIS:

quick SOFA (qSOFA)

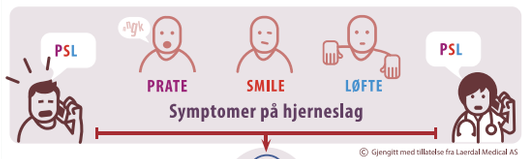
- Respirasjonsfrekvens ≥ 22 ☐
- Endret mental status ☐
- Systolisk BT ≤ 100 mm Hg ☐

NEWS ≥5

MISTANKE OM KLINISK INFEKSJON OG MINST TO AV KRITERIENE TIL VENSTRE, OG/ELLER NEWS ≥5:

Varsle lege og/eller ring113

TEGN PÅ HJERNESLAG?



Andre symptomer

- Akutt oppstått ensidig koordinasjonssvikt (akutte gangvansker)
- Halvsidig synsfeltutfall
- Hyperakutt hodepine
- Nedsatt sensibilitet

AMK

113

ISBAR – KOMMUNIKASJON	
I	**IDENTIFIKASJON** Ditt navn, funksjon og arbeidssted Pasientens navn, fødselsnummer og adresse
S	**SITUASJONEN** Hva er det akutte problemet / årsaken til kontakt? "Jeg ringer fordi...."
B	**BAKGRUNN** Kortfattet og relevant sykehistorie Aktuell diagnose og/eller tidligere diagnoser Evt. smitte / allergier og behandlingsreservasjoner
A	**AKTUELL TILSTAND** Aktuelle målinger etter ABCDE observasjoner, evt. NEWS skår "Jeg er bekymret fordi ..." "Jeg tror årsaken er ..."
R	**RÅD/RESPONS** "Hva synes du jeg skal gjøre?" "Da gjør jeg følgende ..." "Når vil du at jeg skal ta kontakt igjen?" Bli enige om felles plan for videre oppfølging

NB! Dette kortet kan desinfiseres med sprit

Tidlig oppdagelse av forverret helsetilstand

Kommunehelsetjenesten

Utviklingssenter for sykehjem og hjemmetjenester

KlinObsKommune - v. 2.8 - 2020

B NEWS tables

NATIONAL EARLY WARNING SCORE (NEWS2)

FYSIOLOGISKE PARAMETERE	3	2	1	0	1	2	3
Respirasjonsfrekvens (pr. minutt)	≤8		9–11	12–20		21–24	≥25
SpO_2 Skala 1 (%)	≤91	92–93	94–95	≥96			
SpO_2 Skala 2 (%)*	≤83	84–85	86–87	88–92 ≥93 på luft	93–94 på oksygen	95–96 på oksygen	≥97 på oksygen
Luft eller oksygen		Oksygen		Luft			
Systolisk blodtrykk (mmHg)	≤90	91–100	101–110	111–219			≥220
Pulsfrekvens (pr. minutt)	≤40		41–50	51–90	91–110	111–130	≥131
Bevissthetsnivå**				A			C, V, P, U
Temperatur (°C)	≤35,0		35,1–36,0	36,1–38,0	38,1–39,0	≥39,1	

** **Bevissthetsnivå:**
A = Alert (Våken)
C = Confusion (Nyoppstått forvirring)
V = Voice (Reagerer på tiltale)
P = Pain (Reagerer på smertestimulering)
U = Unresponsive (reagerer ikke på tale- eller smertestimulering)

* Skala 2:
Lege skal dokumentere i journal når skala 2 skal brukes.
Ved alle andre tilfeller brukes Skala 1

VED HJERTESTANS RING 113 OG START HLR

TILTAK ETTER NEWS-SKÅR – Lav poengsum utelukker IKKE alvorlig sykdom

NEWS SKÅR	OVERVÅKNINGSFREKVENS	KLINISK RESPONS*	FARE FOR MORTALITET
0	Minimum hver 12. time	• Følg rutinene for NEWS2 overvåkning ved ditt arbeidssted	Lav
Totalt 1-4	Minimum hver 4.–6. time	• Informer ansvarlig sykepleier/helsepersonell på vakt om NEWS2 skår • Ansvarlig sykepleier/helsepersonell tar stilling til økt overvåknings-frekvens, behov for kliniske tiltak og/eller legevurdering	Lav
Skår 3 i ett parameter	Minst én gang per time	• Ansvarlig sykepleier/helsepersonell skal kontakte lege umiddelbart for vurdering • Vurdere behov for tettere overvåkning eller høyere behandlingsnivå	Lav-Middels
Totalt 5 eller høyere Grenseverdi for rask respons	Minimum 1 gang i timen	• Ansvarlig sykepleier/helsepersonell skal umiddelbart kontakte lege • Lege vurderer behov for overflytting til høyere behandlingsnivå	Middels
Totalt 7 eller høyere Øyeblikkelig respons	Kontinuerlig overvåkning av vitale funksjoner	• Ansvarlig sykepleier/helsepersonell skal umiddelbart kontakte ansvarlig lege, legevakt og/eller113 • Videre behandling på riktig behandlingsnivå med kontinuerlig overvåkning vurderes. Dette må vurderes opp mot behandlings-begrensede hensyn.	Høy

NEWS2 er et supplerende hjelpemiddel for å bedømme vitale funksjoner hos voksne og må alltid brukes i kombinasjon med helsepersonellets kompetanse og kliniske skjønn.
*Kolonnen KLINISK RESPONS er tilpasset kommunehelsetjenesten gjennom utvikling av dette lommekortet.

KlinObsKommune - v.2.8 - 2020

C Recruitment poster

Har du lyst til å prøve prosedyretrening i VR?

Dersom du er sykepleiestudent, uansett når i studiet, kan du du delta på en observasjonsstudie om bruk av VR i prosedyretrening. Du vil få prøve en VR applikasjon og bli intervjuet om opplevelsen.

Hvor: **Øya Helsehus**

Varighet: **60ish minutter**

Når: **Oktober - November 2021**

Ta kontakt via mail, SMS eller svar på kontaktskjemaet bak QR koden dersom du ønsker å delta ☺️

Henrik Kristiansen
Masterstudent, Institutt for Design

henrkri@stud.ntnu.no
+47 41758288

D Consent form, contributors

Informasjon om og samtykke til deltagelse i masteroppgaven:

Optimalisere, utforske og forestille bruk av VR i prosedyretrening av sykepleiere

Bakgrunn og formål
Masteroppgaven skrives av Henrik Martin Kristiansen ved Institutt for Design i samarbeid med VirSam ved Institutt for Samfunnsmedisin og Sykepleie, NTNU. Hensikten med oppgaven er å gi Virsam tydelige strategier, idéer og/eller funksjonalitet som vil bidra til å gjøre løsningene i VR mer effektiv som pedagogiske fartøy for målgruppen. Dette utforskes gjennom intervjuer, observasjoner, prototyping og brukertesting med målgruppen.

Om intervjuet
For å samle innsikt ønsker jeg å utføre intervjuer med personer som kan ha relevant kunnskap eller erfaring innen utdanning av sykepleiere og/eller VR-teknologi. Data blir samlet via notater og bilder.

Om informasjon du gir fra deg
Innholdet fra intervjuet vil kunne publiseres i studentens masteroppgave. Ditt navn, din stilling og eventuelle bilder kan bli brukt til å henvise til intervjuet i masteroppgaven.

Frivillig deltagelse
Det er frivillig å delta, og du kan når som helst trekke ditt samtykke uten å oppgi grunn.

Kontaktinformasjon
Dersom du har spørsmål om oppgaven eller intervjuet, ha lav terskel for å ta kontakt med masterstudenten:
Henrik Martin Kristiansen – henrkri@stud.ntnu.no
Eller veilederne:
Ashis Jalote Parmar (ID) – ashis.jalote.parmar@ntnu.no
Aslak Steinsbekk (ISM) – aslak.steinsbekk@ntnu.no

Jeg har mottatt informasjon om intervjuet og samtykker å delta:

Dato/sted _____

Signatur _____

E Consent form, target user

Vil du delta i prosjektet
«Optimalisere brukerreisen for VR-basert simulatortrening for helsepersonell»?

Dette er et spørsmål til deg om å delta i et forskningsprosjekt hvor du spørres om å prøve ut en VR løsning

Formål

Prosjektet er en masteroppgave gjort ved Institutt for Design ved NTNU. Formålet er å utvikle løsninger som kan bidra til å gjøre bruken av VR applikasjoner enklere for personer med liten eller ingen erfaring med bruk av VR utstyr.

Hvem er ansvarlig for forskningsprosjektet?

Prosjektet gjennomføres av masterstudent:
Henrik Martin Kristiansen – henrkri@stud.ntnu.no.
Veileder er Ashis Jalote Parmar – ashis.jalote.parmar@ntnu.no
Biveileder erAslak Steinsbekk – aslak.steinsbekk@ntnu.no

Hva innebærer det for deg å delta?

Du vil bli spurt om å teste ut en VR-løsning hvor du vil ha på deg VR briller. Du vil få instruksjon om hva du skal gjøre. I tillegg vil du bli bedt om å fylle ut et spørreskjema og å bli intervjuet om hva du synes. Det vil bli gjort video og lydopptak for å kunne analysere dette i ettertid. Totalt vil dette ta ca. 45 til 60 minutter.

Det er frivillig å delta

Det er frivillig å delta i prosjektet. Hvis du velger å delta, kan du når som helst trekke samtykket tilbake uten å oppgi noen grunn. Alle dine personopplysninger vil da bli slettet. Det vil ikke ha noen negative konsekvenser for deg hvis du ikke vil delta eller senere velger å trekke deg.

Ditt personvern – hvordan vi oppbevarer og bruker dine opplysninger

Vi vil bare bruke opplysningene om deg til formålene vi har fortalt om i dette skrivet. Vi behandler opplysningene konfidensielt og i samsvar med personvernregelverket.

Kun medlemmer i prosjektet vil ha tilgang på opplysningene. Alle opplysninger og data vil bli lagret på lokalt på én datamaskin sikret med to-faktor innlogging.

Hva skjer med opplysningene dine når vi avslutter forskningsprosjektet?

Opplysningene anonymiseres når prosjektet avsluttes/oppgaven er godkjent, noe som etter planen er i februar 2022.

Hva gir oss rett til å behandle personopplysninger om deg?

Vi behandler opplysninger om deg basert på ditt samtykke.

Dine rettigheter

Så lenge du kan identifiseres i datamaterialet, har du rett til:

- innsyn i hvilke opplysninger vi behandler om deg, og å få utlevert en kopi av opplysningene
- å få rettet opplysninger om deg som er feil eller misvisende
- å få slettet personopplysninger om deg
- å sende klage til Datatilsynet om behandlingen av dine personopplysninger

Hvis du har spørsmål til studien, eller ønsker å vite mer om eller benytte deg av dine rettigheter, ta kontakt med:

- Henrik Martin Kristiansen (henrkri@stud.ntnu.no) ved Institutt for Design
- Ashis Jalote Parmar (ashis.jalote.parmar@ntnu.no) ved Institutt for Design
- Vårt personvernombud: John Herman Rismoen (jon.rismoen@ntnu.no) ved Institutt for Design

Hvis du har spørsmål knyttet til NSD sin vurdering av prosjektet, kan du ta kontakt med:

- NSD – Norsk senter for forskningsdata AS på epost (personverntjenester@nsd.no) eller på telefon: 55 58 21 17.

Med vennlig hilsen

Ashis Jalote Parmar
(Veileder)

Henrik Martin Kristiansen

Samtykkeerklæring

Jeg har mottatt og forstått informasjon om prosjektet *Optimalisere brukerreisen for VR-basert simulatortrening av helsepersonell*, og har fått anledning til å stille spørsmål.

Jeg samtykker til at mine opplysninger behandles frem til prosjektet er avsluttet

---
(Signert av prosjektdeltaker, dato)

F "Answer sheet", peer-to-peer experiment

Fasit til ABCDE

Pasientjournal

Identifikasjon	Situasjon	Bakgrunn	Aktuelt	Råd
Jens Andersen f.11.10.45	Er vanskelig å få kontakt med	Demens. Bruker psykofarmaka og sovemedisin. Får oxycontin 5 mg ved behov.	Fått Oxycotin 5 mg kapsel x 2 i natt	Gjennomfør ABCDE undersøkelse og ta en NEWS score

Fasitverdier

Frie luftveier?	Ja
Respirasjonsfrekvens	10
O2 metning	93%
Tilført oksygen	0
Puls	45
Blodtrykk	90/45
Bevissthetsnivå	Ubevisst
Temperatur	36.9
Normal hud?	Ja

Ting å være oppmerksom på

Demens er en tilstand som påvirker pasientens adferd.
For sykepleiere er kjennskap til pasienten, kunnskap om demens og forståelse for atferd som kommunikasjonsuttrykk grunnleggende elementer for å kunne tilpasse tilnærmingen til utfordrende atferd hos personer med demens.

- *Hvordan oppfører sykepleieren seg rundt pasienten?*
  - Kjappe og tilfeldige bevegelser er ikke å foretrekke rundt demenspasienter
- *Hvordan tar sykepleieren på pasienten?*
  - Ikke alle liker å bli tatt på brystet når man sjekker respirasjonsfrekvensen. Jobber studenter rundt dette?
- *Leser sykepleieren journalen?*
  - Å gjøre seg kjent med pasienten er en sentral rolle ved behandling av personer med demens
- *Snakker sykepleieren med pasienten?*

G Early feedback to VirSam regarding the application

Funksjonelle tilbakemeldinger etter test av ABCDE + NEWS + ISBAR

Onboarding

Introduksjonen med ballen og prøvedukka oppleves som noe uoversiktilg.
Videoen tar for seg informasjon som brude vært kommunisert før prøvedukka.

"Pek på B og C" er feil. Brukere peker på bokstavene, men er for langt unna. Burde byttes til "Trykk".

Andre forslag:

- Presenter noe informasjon om at dette er en introduksjon, og at den virkelige simulasjonen skjer etter.
  - Pluss mulighet for å hoppe over

ABCDE

Tabletten må visalusere informasjonshirearkiet.

Videoen er veldig lett å overse.

At man må trykke på en knapp på den svarte skjermen for å få opp verdier oppleves som forvirrende.

Andre forslag:

- Breadcrumbs som indikterer hvor man er
  - Hjem > A > Airways > Registrer resultat
- Skjul video under en "hjelp" knapp, og la den ta hele synsfeltet (som i onboardingen) ved behov
- Svart skjerm: gi tilbakemelding til brukeren at instrumentet er festet på riktig sted (kanskje en "-" strek der verdien skal komme).
  Gjør det tydeligere at verdien kommer når man trykker på knappene.
  - Knappene bruder forøverig redesignes til å lettere virke som knapper

NEWS

Å gå fra ABCDE til NEWS oppleves som rotete og forvirrende. Det er ingen audio- eller visuelle cues som indikerer at nå er det en ny oppgave som skjer.

Tabletten har spesielle utfordringer her. Når man blir servert en oppgave, så er det en del av brukerne som trykker seg inn på input-feltet, blir overrasket over at oppgaven blir bort og sliter med å komme seg tilbake for å lese oppgaven.

I tillegg brukes tabellen og tabletten om hverandre, og mange brukere lener seg mot tabellen for å lese det klarere. Flere har i trykket seg inn på input-feltet med et uhell og blit forvirret over hvor oppgaven har blitt av.

Andre forslag:

- Vibrasjon i kontroller ved knappetrykk

ISBAR

Samme problem som ved ABCDE til NEWS, det er få indikasjoner på at man jobber med en ny oppgave.

H Protocol, concept 1

Intervju- og brukertest

For-intervju

Fortell litt om deg

- Klasse, hvor du har vært på praksis, osv.

Om utdanningen (til nå)

- Hvordan opplever/ opplevde du utdanningen?
- Hvordan er/var balansen mellom teori og praktisk?
- Fortell om et emne du synes er veldig bra på studiet
- Hvordan føler du at du mestrer noe i studiet?

Simulasjonstrening på skolen

- Fortell om hvordan du har opplevd simulasjonstrening på skolen
- Hvordan gjennomføres det i dag?
- Hvor mye tid brukes på simulasjons/ferdighetstrening?

Om bruk av digitale verktøy på skolen

- Hva bruker dere av digitale verktøy på skolen i dag?
- Hva føler du om balansen mellom fysisk / digital (inkluder gjerne erfaringer fra korona-tiden)
- Kan du se for deg noen muligheter for digitalisering i utdanningen?

Fortell litt om hvordan du opplevde prosedyretrening i studiet

- Hvordan lærte dere f.eks. ABCDE?
- Hvordan trente / øvde dere på f.eks ABCDE?
- Kan du si noe om hvordan dere fikk tilbakemeldinger på hva dere kunne gjøre bedre?

Figma-test

Jeg har forberedt en liten prototype av en nettside som skal kunne brukes av studenter som både er i bachelor, men også dere som er ferdig med utdannelsen og har lyst til å terpe litt ekstra.

I første omgang skal vi se på den, og så skal vi gå videre til test av VR-applikasjonen.

I denne nettsiden heter du Anders Larsen, og du er ute etter å trene litt ekstra på en prosedyretrening med ABCDE + NEWS + ISBAR. Du har ikke prøvd VR før, men nettsiden vet at du har gjennomført studiet og vet hva metodene er.

- Log inn med feide
- Velg ABCDE i menyen med prosedyrer
- Velg ABCDE + NEWS + ISBAR i simulasjonsoversikten
- Inne på ABCDE + NEWS + ISBAR - siden
    - Hva ser du her?
    - Hva tenker du om informasjonsboksen du ser?
        - Er det andre ting du kunne tenke deg å justere på?
- Gå inn i VR

ABCDE test

- Kan du fortelle meg stegene i ABCDE?
- Gå inn programmet og bli kjent med hendene dine
- Les journalen til pasienten
- Kan du sjekke luftveiene til pasienten?
    - Registrer svaret
- Gjennomfør resten av ABCDE prosedyren

NEWS

- Alle svarene dine er nå satt til fasitsavar, gjennomfør NEWS

ISBAR

- Du vil nå bli presentert en rekke caser hvor du skal vurdere i hendhold til ISBAR-rammeverket hvor informasjonen passer inn
    - Gjennomfør oppgavene

Tilbake i Figma

- Hva ser du på skjermen nå?
- Hva tenker du om tilbakemeldingene du får her?

Etter test

Hva er dine førsteintrykk

Fortell om hvordan du opplevede oppgavene i VR.

- Logikk
- Flow

Fortell om hvordan det var å ta av og på headsettet (laptop - VR - laptop)

- Hvordan var opplevelsen av å bruke VR til prosedyretrening?
    - Hva funket bra, hva fungerte dårlig?

I Protocol for concept 2

Concept 2 - Onboarding, skalering og digital tilbakemelding

Hypoteser

- Studentene har et behov for et miljø hvor man kan bli komfortabel i VR mekanikker, grensesnitt og miljø
- Valg av scenarier, teori og prosedyrer er viktig for å lage en læringsarena som oppfattes som inkluderende og responsiv til induviduelle behov
- Å få mer konstruktive tilbakemeldinger er mer verdifult i en læringssammenheng sammenlignet med statistiske tilbakemeldinger
  - "Top 3 ting du kan gjøre bedre" vs. "65% riktig"

Observasjonspunkter

- Hvordan oppleves et miljø uten mye veiledning?
- Hvordan leker studenten med objektene i miljøet?
- Hvordan er opplevelsen omkring valg og tilpasning av programmer?

Protokoll

Introduksjon

- Hva forventer / håper du har endret seg siden sist?
- Fortell meg om hvordan du ser for deg et miljø hvor du kan velge prosedyrer og bli kjent med kontrollere

I Clipboard

- Førsteinntrykk: hva ser du her?
- Hva tror du at du kan gjøre her?
- Ta på hanskene
- Ta på klokken
- Bli kjent med utstyret på hylla.
- Bli kjent med hvilke programmer du kan velge
- Juster programmet etter hvordan du vil ha det
  - Hva tror du endrer seg i programmet?

Etter test

- Hva tenker du om det du fikk se her?
- Hvorfor tror du at du blir bedt om å ta på hansker?
- Hvordan opplevde du det å velge disse ulike treningene på denne måten?
- Hva skulle du ønske var annerledes?

J Protocol for peer-to-peer

Peer-to-peer feedback

Hypoteser

- Studenter som gir tilbakemelding til hverandre gir økt læringseffekt av flere faktorer
  - Studenten som spiller ekspert lærer av å lære bort
  - Studenten som gjennomfører prosedyren vil føle seg mindre iaktatt, overvåket og trygg
  - Å få tilbakemelding på "samme språk" vil oppleves som lettere å aksjonere på
- Å kunne adaptere en prosedyre til virkelige pasienter gir bedre uttelling og variasjon på utdannelsen

Observasjonspunkter

- Hvordan leser medstudenten fasiten?
- Hvordan ser medstudenten etter intersesseområdene i fasiten?
- Hvordan kommuniserer studentene sammen?

Protokoll

Introduksjon

- Har dere noen forventnigner til hva som skal skje
- Det vi skal teste i dag er samspill mellom studenter hvor én er i VR, og en er utenfor
  - Studenten i VR skal gjennomføre simulasjonen som vanlig
  - Studeten som ikke er i VR kommer til å få oppgave som observatør
  - Når prosedyren er ferdig, så skal studenten som ikke var i VR gi tilbakemeldinger til personen som var i VR.

Student i VR, medstudent utenfor

- Studenten i VR blir bedt om å følge ABCDE applikasjonen som vanlig
- Studenten utenfor VR vil bli gitt en oversikt over ting som er viktig at studenten i VR overholder.

Etter VR:

- Studenten som ikke var i VR blir bedt om å gi tilbakemelding til studenten i VR på bagrunn av pasientjournalen

Debreif:

- Hva tenker dere om opplevelsen?
- Til student i VR
  - Hvordan var det å få tilbakemeldinger fra en medstudent?
  - Kan du si noe om hvordan det føltes å gjøre VR og bli observert?
- Til student utenfor VR
  - Hvordan var det å være observatør?
  - Hva lærte du av å sitte på fasiten?

K Master's protocol for NSD

Master thesis protocol

Henrik Martin Kristiansen
Student number: 768249

Table of contents

Summary 3
Background 3
Aim 3
Method 3
Design 4
Participants 4
Recruitment procedures 4
Sample size 4
Data collection procedures 4
General insights 5
Concept development 5
Analysis 5
Data linkage, storage and confidentiality 6
Ethical issues 6
Timeline 6
Economics, personnel and equipment 6
Appendix 7
Participant information and consent form 8
Study 1: Observation 11
Study 2: Interviews, no VR 12
Study 3: Interviews, with VR 13
Study 4: Concept user testing 14
Study 5: Focus group. 15

Exploring the user journey of VR-based simulation training for health professionals.

Summary

This master's thesis will design user journeys and solutions for usage of VR-based simulation training for health professionals. The goal is to develop solutions that can contribute towards making the usage of VR applications easier for people with little to no experience with VR equipment. The project is based on VR applications developed in the VirSam project at NTNU (www.virsam.no). Health professionals and students will be recruited to test applications to study the usage. This will create a foundation for an iterative design process where new ideas are developed, tested and iterated.

Background

This thesis will explore, define and optimize user journeys and solutions for using VR-based simulation training for health professionals. The targeted user group is defined as health profession students and professionals. The main aim of the project is to learn how VR can be used as educational vessels for the target users, create concepts that aid in that aim and provide VirSam with clear strategies and features that might improve their simulation offerings.
The master's thesis is done by an interaction design student from the Institute of Design at NTNU and will therefore include methods and techniques that are drawn from the Human Centered Design (HCD) methodology.
The project is based on VR applications developed in the VirSam project at NTNU (www.virsam.no). Health professionals and students will be recruited to test applications to study the usage. This will create a foundation for an iterative design process where new ideas are developed, tested and iterated.

Aim

To develop solutions that can contribute towards making the usage of VR applications easier for people with little to no experience with VR equipment.

Method

The study will consist of two parts: general insights, concept development.

- General insights will consist of semi-structured interviews and passive observation of simulation training, as well testing of today's solution. The interviews and testing will be voice- and video recorded for later use during the design-phases in the study.

- Concept development will consist of testing solutions, followed by a simplified questioner and individual in-depth interview of the solution. Voice- and video recording will be used for recollection of answers. This will be done twice with the same and/or different participants.

Design

This is a qualitative study where the results will be used to develop solutions to further strengthen the experiences VirSam is developing for health professionals.
Data will be collected using semi-structured interviews, observations and usability- and user experience testing of the target end-users.

Gathering of user insights, concept development and user testing will follow the framework that is the HCD-model:
plan for the usage of HCD → specify the context of use → specify the user requirements → produce solutions → evaluate against target users → repeat if necessary.

Participants

The aim is to include persons 18 years or older that are studying or have finished their degree in as health care professionals, and that have no or little experience with VR. They also must sign a written informed consent to participate.

Requirement Procedures

Participants will be recruited through the networks of the research teams. Potential participants will be contacted and informed about the study. Then they will be given some time to consider participation if they want. Those wanting to take part, contact the master student who will repeat the main information about the study, collect the written consent and make an appointment

Sample size

As this is a design project, it is planned to include a total of up to 15 participants, 5 in the general insight and 2x5 in the concept phases.

Data collection procedures

In both the general insight phase and concept development, the participants will be asked to fill a consent form explaining the data collection procedures and how the data will be used to improve and optimize VirSam's offerings.

General insights:

The general insight phase will be conducted with the intent of uncovering needs and opportunities regarding usage of VR technology with the intent of optimizing VirSam's product offerings.

The data is collected by:

- Written notes
- Audio recording, in-depth interviews and user testing
- Video recording, in-program (no faces)

Voice recording will be conducted on a dedicated device and stored on an institute-issued computer.
Video recording will be conducted on-device of the VR-headset and exported to an institute-issued computer.

Concept development:

The concept development phases will utilize, and process insights gathered from the general insights phase to create new usage flows, features and capabilities.

The data is collected by:

- Written notes
- Audio recording, user testing and focus group
- Video recording, in-program (no faces)

The users will be asked if they want to participate in a focus group for later feedback.

Analysis

Data gathered will be processed using thematic analysis to turn qualitative data into actionable user insights. The procedure will be based on four steps:

1. Creating themes out of data: reading the transcribed material to get a general impression of the material and suggest themes.
2. Codifying the data based on the themes: using methods like *Affinity Diagramming,* mapping data to constructed themes.
3. Develop user requirements: using the codified data, user stories and user journeys will be constructed to aid in defining the context of the use, user needs and frustrations.
4. Suggest and sort actionable items: using the user requirements concepts that meet the specifications are created and tested.

No statistical comparisons will be conducted, as hypothesis testing is not a goal of this study. The video- and audio-recording will be transcribed and compared with field notes.

Data linkage, storage and confidentiality

Data will be stored locally on the student's personal computer, as well as on his digital storage on NTNU's server.
All recorded and transcribed material will be deleted one month after the planned delivery date.
Voice recording will be conducted on a dedicated device and stored on the master student's digital storage on NTNU's servers.
Video recording will be conducted on-device of the VR-headset and exported to master student's digital storage on NTNU's servers

Ethical issues

The participant will be presented with both oral and written information about the study and will be given the opportunity to ask questions before giving consent. All participants need to sign written consent before inclusion. Study participation is voluntary and anonymized and will not influence the participants' relation to work or study. Participants will be reminded that the study is about helping VirSam develop better solutions, and not their knowledge and/or skill. They will also be assured that the master student and project leaders are within duty pf confidentiality.

As we are not collecting any personal data, the project is not foreseeing any ethical issues with the study.

Time schedule

VirSam is an already ongoing project, and the master's thesis will start in early September, with insights planned to start in early October and go through the length of the thesis schedule, until February.

Economics, personnel and equipment

The master student does not generate any costs. The participants will not get a payment for participation.

Needed equipment is available free of charge.

Study 1: Observation of simulation training

Aim

The aim of the study is to observe users to identify interactions and details in how the simulated processes are being performed by health professional students on the VR system.

Method

Observations with follow an un-intrusive “fly on the wall” approach to observe the participants workflow, cooperation and communication with each-other. In case of simulation in VR, interaction with the application will also be considered.

User group / sample

(N=10-20 participants)
Health professional students and faculty members in a training environment from the health department, NTNU.

Procedure

Observations will be performed in the simulation-lab at Øya Helsehus, NTNU during work hours.

- Pre-observation: participants will be informed of the aim of the study existing simulation training, both physical and digital. Ethical compliance norms for the study and be made to sign the informed content. They will also be informed of the method data handling throughout the observation.
- During: The participants will be made to do specific tasks on in the simulations. In-program video recording of the VR simulation observations will be done - where the face of the user will not be identifiable. Along with it, paper and pen-based observations will be made.
- Post-observation: Post study brief up and unstructured interviews will be made to understand the participants experience of using the system with the participants.

Data handling – what we do with the data

The video recording will be anonymized and be saved on a secured server. Apart from this no other personal data of the participants will be taken

Informed consent

The participants will be signing an informed consent form.

Study 2: In-depth interview without VR simulation

Aim

The aim of the study is to gain insights into thoughts, opinions and experience regarding both physical and digital simulations of health profession procedures and education.

Method

Semi-structured interview.

User group / sample

(N=5 participants)
Health profession students and health professionals, accessed to through the institute.
Up to 5 participants in the 19-48 age range, gender and experience based on availability.

Procedure

In-depth interviews will be conducted one-to-one in a convenient location and considering COVID-restrictions. Interviews may be held digitally using Microsoft Teams.

- Pre-interview: participants will be informed of the aim of the study. Ethical compliance norms for the study and be made to sign the informed content. They will also be informed of the method data handling throughout the observation.
- During interview: warm-up, general questions about their day-to-day routines as a student/professional, experiences with simulations (both physical and digital), opinions/experiences regarding digital simulations, and thoughts about the technology can be used in the future
- Post-interview: the participant is asked whether he/she would like to participate in user test of a later concept(s), and again informed about his/hers right to withdraw from the study.

Data handling – what we do with the data

Audio-recording will be stored at the master student’s area on NTNU’s server.

Informed consent

The participants will be signing an informed consent form.

Study 3: In-depth interview with VR simulation

Aim

The aim of the study is to gain insights into thoughts, opinions and experience regarding both physical and digital simulations of health profession procedures and education.

Method

Semi-structured interview.

User group / sample

(N=5 participants)
Health profession students and health professionals, accessed to through the institute.
Up to 5 participants in the 19-48 age range, gender and experience based on availability.

Procedure

In-depth interviews will be conducted one-to-one in a convenient location and considering COVID-restrictions. Interviews will be held digitally using Microsoft Teams.

Participants are first asked to sign the consent form; only then can the interview proceed. If digitally, the participant will be asked to send a signed digital copy over email.

The interview is structured into relevant topics, namely:

- Pre-interview: participants will be informed of the aim of the. Ethical compliance norms for the study and be made to sign the informed content. They will also be informed of the method data handling throughout the observation.
- During: The participants will be asked questions about about their day-to-day routines as a student/professional, experiences with simulations, both physical and digital and opinions/experiences regarding digital simulations.
  After that the participants will be asked to do the “ABCDE” VR-application created by VirSam.
- Post-VR test: Post study brief up and semi-structured interview will be made to understand the participants experience of using the system.
- Post-interview participant is asked whether he/she would like to participate in user test of a later concept(s), and again informed about his/hers right to withdraw from the study.

Data handling – what we do with the data

Audio- and videorecording will be stored at the master student’s area on NTNU’s server.

Informed consent

The participants will be signing an informed consent form.

Study 4: User test of concept

Aim

The aim of the study is to validate if the designed concept meets the user’s requirements.

Method

Semi-structured interview and test of application.

User group / sample

(N=5 participants)
Health professional students and health professionals, accessed to through the institute.
Up to 5 participants in the 19-48 age range, gender and experience based on availability.

Procedure

User tests will be conducted one-to-one in a convenient location and considering COVID-restrictions. In case of digital, a simpler version of the test will be held using Microsoft Teams.

- Pre-observation: participants will be informed of the aim of the study. Ethical compliance norms for the study and be made to sign the informed content. They will also be informed of the method data handling throughout the observation.
- During: The participant will be presented the concept and asked for initial reactions. Specific tasks regarding the concept are given to the participants.
- Post-test: Post study brief up and semi-structured interviews will be made to understand the participants experience of using the concept.
- Post–interview: The participant is asked whether he/she would like to participate in a focus group with other people who experienced the same test, and again informed about his/hers right to withdraw from the study.

Data handling – what we do with the data

Audio- and videorecording will be stored at the master student’s area on NTNU’s server.

Informed consent

The participants will be signing an informed consent form.

L NSD application

NSD NORSK SENTER FOR FORSKNINGSDATA

Meldeskjema

Referansenummer

784019

Hvilke personopplysninger skal du behandle?

- Bilder eller videoopptak av personer
- Lydopptak av personer

Type opplysninger

Skal du behandle særlige kategorier personopplysninger eller personopplysninger om straffedommer eller lovovertredelser?

Nei

Prosjektinformasjon

Prosjekttittel

Utforsking av brukerreisen for VR-basert simulatortrening for helsepersonell

Prosjektbeskrivelse

Denne masteroppgaven skal utforske og designe løsninger for brukerreisen for helsepersonell og studenter som bruker VR til læring.

Dersom opplysningene skal behandles til andre formål enn behandlingen for dette prosjektet, beskriv hvilke

No.

Begrunn behovet for å behandle personopplysningene

Ingen persondata vil bli samlet.
Videoopptak vil på ingen måte kunne identifisere personen som blir filmet. Dette er bare gjort for å forstå hvordan brukerene bruker teknologien.

Ekstern finansiering

- Norges forskningsråd (NFR)

Behandling

Hvor behandles opplysningene?

- Maskinvare tilhørende behandlingsansvarlig institusjon

Hvem behandler/har tilgang til opplysningene?

- Prosjektansvarlig
- Student (studentprosjekt)

Tilgjengeliggjøres opplysningene utenfor EU/EØS til en tredjestat eller internasjonal organisasjon?

Nei

Sikkerhet

Oppbevares personopplysningene atskilt fra øvrige data (koblingsnøkkel)?

Nei

Begrunn hvorfor personopplysningene oppbevares sammen med de øvrige opplysningene

Det er ingen direkte identifiserbar data i prosjektet.

Hvilke tekniske og fysiske tiltak sikrer personopplysningene?

- Opplysningene anonymiseres fortløpende
- Adgangsbegrensning
- Flerfaktorautentisering

Varighet

Prosjektperiode

01.09.2021 - 28.02.2022

Skal data med personopplysninger oppbevares utover prosjektperioden?

Nei, alle data slettes innen prosjektslutt

Vil de registrerte kunne identifiseres (direkte eller indirekte) i oppgave/avhandling/øvrige publikasjoner fra prosjektet?

Nei

Tilleggsopplysninger

Deltakende observasjon

Grunnlag for å behandle alminnelige kategorier av personopplysninger

Samtykke (art. 6 nr. 1 bokstav a)

Gruppeintervju

Grunnlag for å behandle alminnelige kategorier av personopplysninger

Samtykke (art. 6 nr. 1 bokstav a)

Informasjon for utvalg 1

Informerer du utvalget om behandlingen av opplysningene?

Ja

Hvordan?

Skriftlig informasjon (papir eller elektronisk)

Tredjepersoner

Skal du behandle personopplysninger om tredjepersoner?

Nei

Dokumentasjon

Hvordan dokumenteres samtykkene?

- Elektronisk (e-post, e-skjema, digital signatur)

Hvordan kan samtykket trekkes tilbake?

Gjennom epost.

Hvordan kan de registrerte få innsyn, rettet eller slettet opplysninger om seg selv?

Gjennom epost kan de be oss og vi vil slette det fra den sikre databanken vår.

Totalt antall registrerte i prosjektet

1-99

Tillatelser

Skal du innhente følgende godkjenninger eller tillatelser for prosjektet?

Type prosjekt

Studentprosjekt, masterstudium

Kontaktinformasjon, student

Henrik Martin Kristiansen, henrkri@stud.ntnu.no, tlf: 41758288

Behandlingsansvar

Behandlingsansvarlig institusjon

Norges teknisk-naturvitenskapelige universitet / Fakultet for medisin og helsevitenskap (MH) / Institutt for samfunnsmedisin og sykepleie

Prosjektansvarlig (vitenskapelig ansatt/veileder eller stipendiat)

Aslak Steinsbekk, aslak.steinsbekk@ntnu.no, tlf: 41559076

Skal behandlingsansvaret deles med andre institusjoner (felles behandlingsansvarlige)?

Nei

Utvalg 1

Beskriv utvalget

Helsepersonell og studenter

Rekruttering eller trekking av utvalget

Helsepersonell og studenter fra Institutt for samfunnsmedisin og sykepleie.

Alder

19 - 45

Inngår det voksne (18 år +) i utvalget som ikke kan samtykke selv?

Nei

Personopplysninger for utvalg 1

- Bilder eller videoopptak av personer
- Lydopptak av personer

Hvordan samler du inn data fra utvalg 1?

Personlig intervju

Grunnlag for å behandle alminnelige kategorier av personopplysninger

Samtykke (art. 6 nr. 1 bokstav a)

HENRIK MARTIN KRISTIANSEN

Virtual reality for nursing education

NTNU
Norwegian University of
Science and Technology