Virtual humans in the Virtual Hospital

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Abstract

Described in this thesis are the details behind the implementation of virtual humans into NTNU's virtual university hospital in Second Life. These virtual humans played as patients, and it will be discussed how such virtual patients can contribute to the education of medical personnel. The work in this project build upon work done earlier on the virtual hospital by the students Kleven and Heintz. Virtual environments have been explored earlier by other projects as an alternative to traditional patient simulation and paper based education. These projects have been met with positive results, and this thesis was an attempt to implement virtual humans in a virtual hospital for purposes of patient simulation. The evaluation of the work took place in two stages. Firstly, a testing of the system by nurse students and teachers from Ålesund University College. The second stage was the presentation of the system to two experts, a teacher from the Faculty of Nursing (HiST), and a professor at the Department of Public Health and General Practice (NTNU).

Abstract (Norwegian)

Beskrevet i denne avhandlignen er detaljene bak implementasjonen av virtuelle mennesker i NTNUs virtuelle universitetssykehus i Second Life. Disse virtuelle menneskene spilte pasienter, og det vil diskuteres hvordan slike virtuelle pasienter kan bidra til utdanningen av medisinsk personell. Arbeidet i dette prosjektet bygger på arbeid gjordt tidligere på det virtuelle sykehuset av studentene Kleven og Heintz. Virtuelle miljøer har blitt utforsket tidligere av andre prosjekter som alternativer til tradisjonell pasientsimulering og papirbasert utdanning. Disse prosjektene har blitt møtt med positive resultater, og denne avhandlingen var en forsøk på å implementere virtuelle mennesker i et virtuelt sykehus for pasientsimulering. Evalueringen av arbeidet ble gjordt i to deler. Den første var en testing av systemet av sykepleierstudenter og -lærere fra Høyskolen i Ålesund. Den andre delen var presentasjonen av systemet til to eksperter, en lærer fra Avdeling for sykepleierutdanning (HiST), og en professor ved Institutt for samfunnsmedisin (NTNU).

Acknowledgments

Glossary

Prim: A prim, or primitive, is in SL a single-part object, consisting of a single mesh. It's a basic object, independent of any other objects.

Linkset: A linkset is a combination of prims into a single object. All the pims in the linkset can be easily manipulated at the same time by changing the object. Only some specific bits of code can access a prim in a linkset.

UUID: An UUID is assigned to every single object and avatar in SL. It's a unique set of characters that is used to identify a specific object or avatar.

Third party program: A third party program is a program that is developed by someone different from the developers of the first party program (in this case, Second Life).

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CHAPTER 1

INTRODUCTION

1.1 Motivation

Virtual reality has seen steady improvements over the years. Its graphics have improved, and its availability has reached a level where its easy for almost anyone to experience a virtual world of some sort. The virtual world of Second Life have seen use by NTNU for a variety of purposes. A virtual campus was created in Second Life [5], which has been used for lecturing. NTNU has also been involved in other educational projects involving virtual reality. Military, a virtual, Afghan village was created for the education of soldiers in cultural awareness [4]. Medically, a virtual hospital was created with the goal of aiding in the education of nurses [22]. With the virtual world having become so cheap, exploring its potential, its limitations and its viability within all forms of education has turned out to be very easy.

Virtual humans have also come into fruition since the emergence of virtual reality, and have become and interesting topic that involve multiple disciplines [8]. Virtual humans are flexible simulations that have near unlimited potential. They have a variety of uses, and research into them is an ongoing and exciting experience [15]. NTNU has explored the use of virtual humans in military simulations [32] [20] and has learned a lot about its potential.

Due to increasing demands and challenges in medical education, it is a field that could benefit greatly from virtual reality. In 2014, a virtual hospital was created by NTNU [22] [21] [14] in order to explore the possibility of using it for the education of nurses. For its first evaluations, the virtual hospital was used to role play patient interaction, but it was suggested that the virtual hospital could have a variety of uses, such as simulating virtual patients. Following the lessons learned from implementing virtual humans in the virtual, Afghan village, it's been decided to explore the possibility of using similar virtual humans in the virtual hospital.

1.2 Problem Description

Virtual Hospital project is an ongoing project involving NTNU, HIST and Sintef Medical Technology. The goal of the project is to create an immersive online virtual environment for training medical professionals and educating general public. To address feedbacks from user studies and to increase realism and interactivity in the environment, it will be enhanced with virtual humans representing patients and health professionals.

The goal of this thesis is to implement virtual humans into NTNU's virtual hospital in Second Life, and then evaluate how they can contribute to the education of medical personnel. This explores key aspects in the field of virtual humans, such as autonomy and personification, as well as how this can be used to create effective virtual patients.

1.3 Research Questions

The research question for this master thesis is as follows:

RQ: *How can virtual patients contribute to the education of healthcare professionals?*

Virtual patients offer the potential to be an inexpensive and safe way to learn medicine and how to deal with real patients. The purpose of the project is to see how virtual patients can be implemented, so that they fulfill this potential, or if it can be done at all. Some sub-questions follow, that will further specify the full research.

RQ_1: *What are the requirements for such virtual patients?*

If virtual humans are to be seriously considered for the education of healthcare professionals, the requirements has to be established. If the simulation is to be valuable, it needs to be immersive and informative, but what kind of functionality does the virtual humans need to accomplish this? How important is it that they look realistic? Questions like these needs answering if virtual humans are ever going to see use in a professional setting.

RQ_2: *How can such virtual patients be implemented?*

There are some technical challenges behind implementing virtual patients on a platform like Second Life. There are a series of ways that virtual patients can be implemented on the platform, and there are also the question of which third party programs to use, and how to use them. Modeling, texturing and animation all have to be done in different programs from SL. There are also some limitations behind what can be done in SL, and some things that would be ideal to implement, may turn out to be impossible.

RQ_3: *To what extent are these virtual patients capable of contributing to the educational process?*

There needs to be a form of evaluation to gauge what kind of impact these virtual patients can have on the educational process. It will be important to get the opinion of both the students who will use the system and experts in medical education. It should be checked whether or not the students will be able to learn from the system, either medicine, problem-solving skills, communication or teamwork.

1.4 Research Methods

For this project, the evaluation consisted of a quantitative and qualitative part.

1.4.1 Quantitative

The quantitative part of the research consisted of the questionnaire that was filled out by nurse students and teachers at Ålesund University College, and one nurse at St. Olavs Hospital, Trond-

heim. The questionnaire's answers were on a 5 point likert scale [33]. Below are the sections of the questionnaire, and what each section covered.

- General. This section covered the participant's background, such as sex, education and experience with virtual reality. It also asked the participant how they felt about the virtual hospital.
- The blackboards. This section asked the participants about the blackboards (see section 3.4.3), and what they thought of them.
- The virtual patients. This section asked the participants what they thought about the virtual patients, and what aspects of them needed the most improvement.
- The virtual hospital. Here the participants were asked what they thought about using such a virtual hospital in education.
- The oculus rift. This final question asked about the oculus rift, but because the oculus rift was not used in the evaluations, the participants were told to disregard the section.

1.4.2 Qualitative

For the qualitative part of the evaluation, a set of questions were prepared, and were posed to nurse students and teachers at Ålesund University College, as well as two experts, in an interview. One of the experts were a teacher at the Faculty of Nursing (HiST), the other was a professor at the Department of Public Health and General Practice (NTNU). In addition to these questions, the participants of the interviews were encouraged to come with opinions and thoughts about the virtual hospital that the questions may not have covered.

1.5 Project Background

With the thought of exploring ways to make the education of anatomy and surgery more efficient, N. F. Kleven et. al. [22] explored ways to improve such education with flexible, low-cost, 3D virtual worlds. The focus of the project was to use role play to train in communicating with medical patients and their relatives. Several scenarios with different kinds of patients were prepared, such as a mother and her child, and a dying man with a brain tumor. A group of students would then be tasked to communicate with these patients in a way that wouldn't upset them further.

An environment had to be created for this, so a small virtual hospital was created in teh virtual world of the program Second Life (SL). By using St. Olav's University Hospital (St. Olav) as reference, they created a waiting room, a sluice and an operating room. most of it was created from scratch, but some of the equipment was purchased from the Second Life Marketplace.

Figure 1.1: The operating room.

A group of post-graduate nursing students from the Faculty of Nursing at HiST were recruited to participate in the role playing and evaluate the system. They were given a description of their character, and a description of the situation, and were left to role play while teacher and other students observed.

In the end, they concluded that the virtual hospital had potential, as it created a realistic, safe and accessible environment for practicing nurse tasks.

Following the work done by Kleven, further improvements were made to the virtual hospital in a project conducted by A. Heintz [10]. In this project, two new rooms were created in the hospital. These rooms were the intensive care unit and the emergency room. The intensive care unit had a series of beds, where patients would rest, and curtains to cover them. The emergency room was designed to look a lot like the operating theatre that was already implemented.

Figure 1.2: The emergency room.

Several other, more general improvements were made the hospital. To help show the way around the virtual hospital, color coded lines were added to the floor, and door sign were added above the doorways. Some sliding doors were added to the doorways in order to separate rooms. Finally, 12 nurse avatars were created, each with realistic clothing.

To evaluate the changes, another group of nurse students were recruited from the Faculty of Nursing (HiST). Again, the result was that the system had potential, but still had a variety of issues that needed to be tackled.

1.6 The CAMO project

This was a project that the developer of the virtual humans in the virtual hospital, Mosand, worked on in his previous semester. It's relevant, because a lot of the experience on virtual humans in Second Life that was gained from the CAMO project was directly translatable to the virtual humans in the virtual hospital.

Short for Cultural Awareness in Military Operations [4], the CAMO project was a collaboration between Norwegian Defense University College, Norwegian University of Science and Technology (NTNU), and the University of Oslo (UiO). The goal of the project was to see if the virtual world of Second Life could be used as an aid to better teach cultural awareness to military personnel. Soldiers who were to travel to international operations in Afghanistan would need education in the local culture, so a virtual, Afghan village was made to help with the process. The Afghan village was designed to resemble a typical Afghan village. Situations would be set up with scenarios, where the soldiers would have a specific goal, and role play with the locals. The local villagers would be played by students and teachers from the Norwegian Defense Language and Intelligence School. They concluded that their simulations couldn't completely replace traditional classroom education, but could be an entertaining and stimulating supplement.

Figure 1.3: An overview of the virtual, Afghan village.

Only a small number of people were brought on to play villagers in the virtual, Afghan village. Because of this, it was commented that the village felt empty and abandoned, suggesting to the soldiers that they could be walking into an ambush. The implementation of crowd simulation was suggested as a solution to this problem, and would turn the virtual village into a more friendly environment. In a project conducted by S. A. Tasdemir [32], a large number of virtual villagers with simple functionality were implemented into the village. Some were given simple animations, like moving their arms or walking around.

The virtual villagers were somewhat simple, and only had limited functionality. In order to increase the realism of the village, and let any visitors feel welcome, a project was undertaken by A. R. Mosand [20] to improve the villagers' behavior and range of animation. Many of the virtual villagers were made to react to any nearby human avatar. Depending on the age and gender of the villager, they would do different things, like greeting or moving away. More animations were implemented for many of the villagers, and some were made to interact with each other.

THEORY AND RELATED WORK

This chapter describes the background theory that was used in this project. The chapter starts with defining virtual worlds and virtual environments, and then Second Life, the virtual world that was used to host the virtual hospital and its virtual patients. The chapter will then go on to mention how virtual environments can be used in education, and medical education in particular. One education method that is widely used in medical education, problem-based learning (PBL), is then explained. PBL is highly suitable for virtual environments, and this is shown next in the chapter, where a couple of projects that attempted to implement PBL in a virtual environment are mentioned. This leads to virtual humans, which are an integral part to PBL in virtual environments, due to the need for a simulation of a patient. Various aspects of virtual humans are then, finally, explained, such as believability, responsiveness, interpretability, autonomy and personification.

2.1 Virtual Worlds and Virtual Environments

There exists a variety of ways to define the concept of virtual worlds and environments [34], and each has its own meaning depending on in which context it's used. The field of virtual reality is in constant development, and so it's difficult to pinpoint an exact definition. One such definition, and perhaps one of the simpler ones, is stated by Schroeder [30] and says that a virtual environment is *"A computer-generated display that allows or compels the user (or users) to have a sense of being present in an environment other than the one they are actually in, and to interact with that environment (Schroeder, 1996, p. 25, as cited in [30])"*

Virtual environments has seen an increase in use over the last few years [7], including entertainment, education, training, commerce and socialization. Entertainment and socialization are the fields where virtual environments see the most use, and have given space for a variety of virtual worlds to emerge.

According to Schroeder, the difference between a virtual world and a pure virtual environment, or virtual reality as a whole, is that a virtual world has a persistent online state. A virtual world is a virtual environment that is constantly online, where a mass of players may enter and often spend a significant amount of time on to socialize with other players. Massively multiplyer online role playing games, such as Second Life [17], World of Warcraft [6] and EVE online [1] are considered a subset of virtual world, because they focus on gaming, a sort of socialization.

2.2 Second Life

Second Life (SL) [17] is a social, massively multiplayer online role playing game that allows its player a large amount of control of their environment. Players are allowed buy land, and then shape that land as they want and build on it. SL offers the ability to upload meshes to be used as objects, vehicles, creatures, clothes, i. e. It also offers the ability to attach scripts to almost anything, which are written in a modified version of the programming language C. Because SL allows its players such massive amounts of freedom, and because it's all relatively cheap, it offers the ability to be a cost efficient alternative to creating virtual worlds from scratch in engines such as Unreal and Unity.

2.3 Virtual Environments in Education

Virtual environments provide a variety of attributes that make them good candidates for being used in education [7]. The technology available is often cheap, and virtual environments are a very safe way to interact. It can offer 3D representations of people and objects, and can provide a high level of immersion. The ability to simulate environments whenever they are needed, and the potential to bring people together for collaborative work are invaluable properties of virtual environments.

Students immersed in such a virtual environment can learn in a way that is visual, experiential, and self-directed [15]. They can manipulate objects to discover their function, see objects from different perspectives and angles or experience an object's physical properties. Virtual environments allow for the simulation of unfeasible scenarios that would be difficult, if not impossible, to replicate in the real world. Simulated scenarios can be repeated over and over again, and can be monitored, so an evaluation of the student can be provided afterwards.

2.3.1 Virtual Environments in Medical Education

For a while, there have been an increasing need to make medical education better and more efficient [28]. Several factors, such as considerable advances in medicine, increasing expectations of doctors from the public and increasing amounts of students all contributes to increasing demand for better medical education. Students' access to patients are also growing smaller [22], mainly due to patients spending less time in hospitals as medicine gets more efficient. Because of this, there has been an increasing need to make the short time that students spend with patients more efficient, or to grant more opportunities for students to spend time with patients. Many have turned to virtual reality to attempt to solve this problem, as it allows the students to simulate patient interaction in a cost efficient way.

2.4   Problem-Based Learning

Problem-based learning, or PBL, is an education method that helps students acquire the knowledge and experience necessary to solve problems [12]. PBL consists of challenging the student with questions and presenting puzzles for the student to solve. Information and knowledge that's involved in the learning process is structured into a context, so that it's easier to understand. Students are taught how to think in a clinical setting, where they need to reason accordingly. It encourages and teaches the student to conduct self-directed learning, which is more motivating, and makes the student look forward to future learning [13].

In a case of PBL, the students will be presented with a case or scenario. The student will first need to ensure that all the case is understood, and that all the terms have the same, clear meaning to everyone. When this has been ensured, the students need to figure out what problems in the case they need to focus on, and then "brainstorm" for hypotheses that may explain the problems. The students will then decide their learning objectives, based on the problems that seem the most pressing or important. Later, after a break where the students will study individually, they will reconvene and discuss the case with newly refined knowledge. Wood [35] tells how PBL not only promotes the acquisition of knowledge, but also several other attributes, such as communication skills, teamwork, problem solving, independent responsibility for learning, sharing information, and respect for others.

To create a good PBL case, a few things need to be kept in mind. The case should be of a scenario that might be relevant for the students' future practice. To make sure of this, it should be of a common and realistic clinical occurrence. It should also be mad sure that the case is on the appropriate level for the students' understanding and current curriculum. Too hard, and it might turn out to be a frustrating experience. Too easy, and it won't motivate the students to learn anything. Some factors that often turns out to be motivating for the students are if the case has some form of medical urgency, or if the case has issues that are often mishandled by medical staff.

Below are examples of two related projects that implemented PBL in a virtual environment setting.

2.4.1   Bringing problem-based learning to life using virtual reality

In response to UK government's policies advocating a need for the use of information technology in nursing education, L. Nelson et al. [16] designed a virtual reality package to be used as a learning resource. This virtual reality package was used with heavy emphasis on problem-based learning methods, which are claimed to be more effective than more traditional education methods. Using real-time modeling software, a virtual community, covering roughly an 8 km area, was created. This virtual community contained, among other things, a series of houses which could be entered where the patients would live, and a complementary health clinic.

2.4.2   The PREVIEW project

The idea behind the PREVIEW project [3] was that virtual reality could offer more realism and more interactivity with the patient than more traditional paper-based PBL. The project wanted do evaluate whether or not current VR technologies could be used to make PBL better. The

PRIEVIEW project didn't create its entire virtual environment from scratch, but instead opted for a cost-effective alternative, namely Second Life.

Within SL, each student had a HUD on screen where the case would be presented, with text, images, video and sound. This HUD was called the screen controller, and also recorded the students' actions. The data associated with each case was stored in XML files in a web application, with each XML file structured according to a standard called MedBiquitous [27]. This allowed for a large pool of different cases to be created beforehand, and then be retrieved and used when needed, without needing a lot of help from medical professionals.
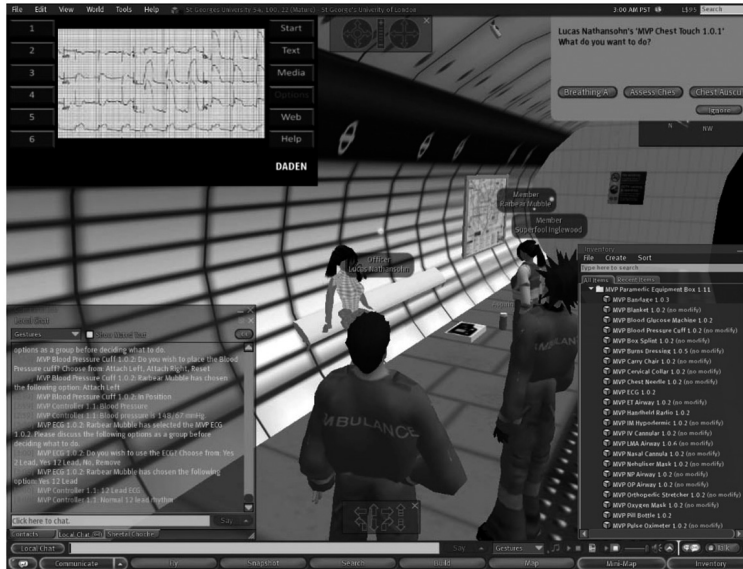
Figure 2.1: An image from the PREVIEW project [3] showing the screen controller (upper left), the interaction with the virtual patient (upper right), the SL chat (lower left) and the player's inventory (lower right).

The majority of the case interaction was done with a virtual patient, and the students could interact with them in three different ways. The students could talk to the virtual patient with the SL text chat. The virtual patient would then attempt to recognize certain keywords, and respond appropriately. The students could also interact with the virtual patient's various body parts. When clicked, the body part would display its status, as well as a variety of actions that the students could take. Finally, the students had a mix of medical equipment in their SL inventory, and could use that equipment in combination with the virtual patients.

They concluded that there were some hurdles that needed to be crossed before the technology could be used in serious healthcare education. Both students and teachers would need time to adjust to the platform, such as getting familiar with SL. SL has some serious usability limitation and complex interfaces that made it difficult for students to act.

2.5 Virtual Humans

Virtual humans are software entities that move and act like people, but live in simulated environments [8]. The potential behind virtual humans i considerable, and in some areas, like education, they can make a big difference. Building good virtual humans, however, is no easy task, and requires expertise from many different areas. Artificial intelligence, computer graphics and social sciences are among the many fields that are needed to make believable and functioning virtual humans.

Kenny et al. [26] mentioned three characteristics that they meant were important for creating engaging virtual humans:

- Believability. The virtual human must convey the illusion that they are a real human, and must therefore act accordingly. This includes attributes such as personality and emotion.
- Responsiveness. The virtual human must respond to its environment in some way, which means responding to human contact and important events in the world by dynamically changing behavior accordingly.
- Interpretability. A human who interacts with the virtual human should be able to judge how the virtual human is responding to events in some way. The virtual human should show some outward sign that it is aware of what is going on in the environment.

Other important aspects about virtual humans are autonomy and personification. These will be discussed in detail below.

2.5.1 Autonomy

Autonomy is an important concept when dealing with virtual humans. Instead of manually controlling each character, such as one would do when creating an animated movie, it's ideal to have them act on their own. Kasap and Magnenat-Thalmann [36] defines autonomy as *"the self-governing of one's actions and acting independent of someone's control"*. Thalmann et. al. [2] defines three levels of autonomy. A virtual human will fall under one of these levels, depending on how much control a human user has over them:

- Participant Actors. These actors are directly controlled by a human, and will copy the human's movement as well as it's able. Sensors on the human will make it so that the virtual human moves in order to copy the real human's movement. The virtual human will need to have a body that accurately corresponds to the human's body.
- Guided Actors. Guided actors are virtual humans that are still controlled by a real human, only not directly via body movements. These virtual humans are moved by input devices, such as mouse and keyboard.
- Autonomous Actors. Autonomous actors are virtual humans that act independently without any human control. They act according to sensor information and goals, but are primarily not controlled directly by humans.

Kasap and Magnenat-Thalmann [36] also talk about three aspects in autonomy that are important to mention:

- Perception. The virtual human should only perceive a limited part of the entire environment. To simulate actions that a real human might take, the virtual human shouldn't be aware of everything, but only a small, perceived part.
- Decision-making and adaption. With the information gathered from the perceived environment, the virtual needs to interpret it, and then decide what to do. This is also called the action-selection process, and can also be influenced by previous experiences, current motivations, plan, personality and emotional state. This level focuses more on the overall goal of the virtual human, and not its next immediate action. For example, it will focus on moving to a location, but not "I need to move my foot, in order to walk".
- Action control. The types of actions a virtual human can perform are divided into two main groups. The first involves methods of communications, such as facial expressions, gestures and posture changes. The second are more complex actions such as walking or picking up an

object. Several such actions can be performed at the same time, which makes synchronizing them important.

2.5.2 Personification

An important stage in creating believable virtual humans is personification. We prefer to have believable agent be as human as possible. To make this happen, seemingly negative aspects, such as emotions, become important. The two factors that are usually considered when talking about personification is personality and emotions.

Personality

To make each virtual human see like different people, they will need personality. Personality differentiates people by making them react differently to the same situation. A widely used personality model is the Five Factor Model, or the OCEAN model[29]. This model describes people based on five different traits. All these traits, and the degree of which they fit together make up a personality.

- Extraversion. An extravert person is active, assertive, energetic, enthusiastic and outgoing.
- Agreeableness. An agreeable person is appreciative, forgiving, generous, kind, sympathetic and trusting.
- Conscientiousness. A conscientous person is efficient, organized, planful, reliable, responsible and thorough.
- Neuroticism. A neurotic person is anxious, self-pitying, tense, touchy, unstable and worrying.
- Openness. An open person is artistic, curious, imaginative, insightful, original and has wide interests.

Emotion

People's perceptions, beliefs, cognitive process and actions are all influenced by emotion. A person might react differently in the same situation depending on whether they are scared, sad or angry. Ekman (as cited in [36]) talks about six types of emotions that he defines as: *"fear, disgust, anger, sadness, surprise and joy following the Darwinian approach to emotions emphasizing the universality of human emotions"*.

Emotion is often expressed in the form of nonverbal communication [25], such as posture, positioning and facial expressions. Nonverbal communication is focused on presenting how people are feeling, mainly through posture, and people are usually not conscious of doing so. Postures are the means to communicate and are defined by a specific position of the arms and legs and angles of the body. Mehrabian (as cited in [25]) describes postures in an open-closed dimension. People may chose to open up to others, or may chose to close themselves into self imposed barriers, such as crossing their arms across their chest, or clasping their hands in front of themselves. Such barriers are meant to symbolically block others out, and keep ones own feelings locked inside.

Relative positioning, meaning the distance and orientation between two people, is also an important element of nonverbal communication. Hall (as cited in [25]), presented four proximity zones.

- Within 50 cm in front of the body is reserved for intimate relationships, such as with partners, children or other family members.
- Between 50 cm and 1.2 meters away is for close conversations with friends.

- Between 1.2 meters and 2.7 meters is a more formal conversation zone.
- 2.7 meters and out is the public zone.

Orientation of the body between two people can also tell something about how close they are. People tend to turn more towards people they find attractive or interesting. As such, a person may turn away if their desire to communicate wanes.

3.1 Requirements design

The requirements for this project were formed with input from a variety of sources. First, opinions and suggestions from experts at the Faculty of Nursing (HiST). After a discussion with these experts, it was decided that a PBL exercise involving virtual patients were the way to go. Some cases would be prepared by the experts, which would each describe a patient with a variety of symptoms, test results and correct treatments. The nurse students would discuss the case amongst themselves, and as they decided on an action, a blackboard near the patient would display the results of that action, such as a discovered symptom. If there was to be any point to this, it was important to make sure that the cases were reflected in the virtual patient, in the forms of correct textures and animations. The experts' input paved the groundwork for the requirements, and provided requirement R1, R2 and R3, as can be seen in table 3.1. They also suggested R1_1 and R3_4, which were added as requirements.

Establishing the requirements for using virtual humans in the virtual hospital came in two forms. First, inserting virtual humans into the background would make the entire virtual hospital seem more alive. Having virtual patients, nurses and doctors walking around would bring up the immersion of the player, as the virtual hospital would no longer seem empty and abandoned. Second, more advanced virtual patients was to be the focus of an educational process. It could go the way of the previous projects [10] [22], where the focus would be on cooperation and communication, but that was a poor choice if virtual patients were to be involved. Virtual patients are more suitable for PBL, which allows them to play a larger role. Because the focus of the exercise is on the virtual human and his problems, and not on the interaction between the human participants.

Experience from previous projects was the second input into forming the requirements. The conclusions from Kleven's project [21] suggested some functions that this virtual hospital could be used for. As can be seen in table 3.2, the first thing that is suggested is using the virtual hospital for patient simulation. That, as well as using virtual humans in a role playing process, was one of the reasons why virtual humans were considered. After Henitz' project [10], the students that participated in its evaluation meant that the hospital needed more possibilities for interaction. They also meant that the hospital could use ready-made scenarios that they could go through alone or with friends.

The CAMO project (see section 1.6) helped a lot to establish what was possible and not with virtual humans in Second Life. It was decided that in this first iteration it wouldn't be necessary

Requirement	Description
R1	The virtual hospital must contain virtual patients.
R1_1	There must be virtual patients in the intensive care unit's beds.
R1_2	There should be virtual patients walking around.
R1_3	The virtual patients should look realistic, compared to real, human patients.
R2	The virtual hospital should contain virtual nurses and doctors
R3	There must be more advanced virtual patients that are connected to a supplied case.
R3_1	The virtual patients that are going to be used in the cases should have symptoms clearly shown in their actions and appearance.
R3_2	The virtual patients that are going to be used in the cases should react to the player's ministrations with animation, sound or text dialogue.
R3_3	The case should be presented on blackboards near the patient.
R3_4	The final treatment in the scenarios should be presented in multiple choice format.

Table 3.1: Table of the project requirements

Activity	Content, facilities and technological solutions
Patient simulation	Operating room, patient ward, emergency area, NPCs, volunteers, interactive hospital equipment, VR interface
Procedure training	Various hospital departments (operating room, patient ward, emergency area), information using videos and posters, interactive hospital equipment, VR interface
Anatomy lectures	Classrooms, lecture halls, 3D interactive models of organs and the human body, posters, videos, VR interface
Role-plays (team training, patient communication)	Operating room, patient ward, emergency area, reception / polyclinics, NPCs, interactive hospital equipment, VR interface

Table 3.2: Educational activities for medical professionals and students (copied from [21])

to have background patients react to the presence of humans, but some should be walking around, as stated in requirement R1_2.

Third, literature of related projects, and articles from relevant disciplines. Kenny et al. [26] and their characteristics for creating engaging virtual humans acted as a guideline for establishing the requirements. In order to create believable virtual humans, they would need to look the part, therefore requirements R1_3 and R3_1. From R1_3, all the virtual patients wouldn't necessarily be dressed in hospital clothing to be believable. They would need to look somewhat realistic, though, in order to maintain the immersion of the students. The other requirement that was necessary for believable virtual humans, R3_1, was necessary because the patient needed to look like he had the condition that was described in the case. If the case said that he was flushed, then that needed to be represented on the virtual patient, or else he wouldn't be very believable, and the students may have lost their immersion. R3_2 was designed with both responsiveness and interpretability in mind. By changing animation or saying something after the students' actions, be it an examination or treatment, the virtual patient would be responsive, and feel more engaging. If this change in animation or spoken words conveyed that what the students did was either right or wrong, then the virtual human could also be considered interpretable.

In the PREVIEW project [3], the cases that the students were to solve were presented on an in-game HUD. Taking inspiration from this, requirement R3_3 was formed. A blackboard would present the case, including its introduction, symptoms, test results, treatment and final result.

3.2 The cases

Teachers from the Faculty of Nursing (HiST) prepared a couple of cases that would each present an imagined patient with a set of symptoms.

3.2.1 Diabetes patient

The first patient was a student named Per that had earlier been diagnosed with diabetes mellitus. Per had been using insulin injections for several years, but had lately lost motivation for dealing with his diabetes, and would consequently miss injections. In the last several hours, he had been feeling poorly, and then fainted, whereupon he was admitted to the hospital and treated for diabetic ketoacidosis[23]. Figure 3.1 shows a chart of the entire case.
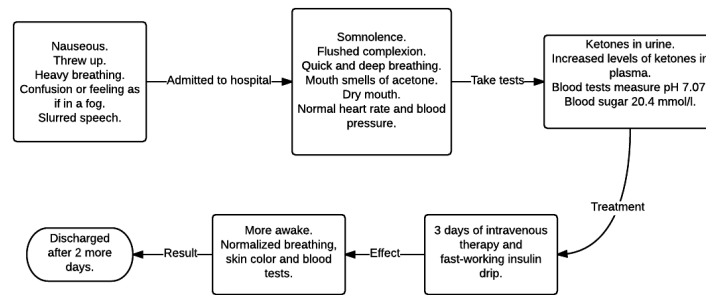
Figure 3.1: An overview of the first case; The patient's symptoms, test results and the correct treatment

The diabetes case only described one outcome, namely the correct one. Because of requirement R3_4, some form of multiple choice had to be present. After some research, three more alternative treatments were found:

- Drunk. The simplest explanation could just be that the patient was drunk. Because the treatment for just being drunk is just sleeping off the intoxication, it could be catastrophic if he isn't monitored.
- Diabetic hypoglycemia[24]. This is another diabetic condition, but the treatment for it won't do anything for diabetic ketoacidosis. Because the patient would be monitored during such a treatment, it would probably not kill him.
- Head injury. Some of the symptoms could mean that the patient suffered a head injury, so the patient would be set up for a CT scan. The patient would probably not die from this either, due to the same reason as diabetic hypoglycemia.

3.2.2 Heart attack patient

The second patient was a man named Olsen who had just arrived at the hospital to visit his wife. Olsen had angina pectoris, and as he entered the hospital, he felt strong pain in his left side, and had to sit down. A nearby spectator would witness this, and go to get help. He would then be tested and treated for heart attack. Figure 3.2 shows a chart of the entire case.
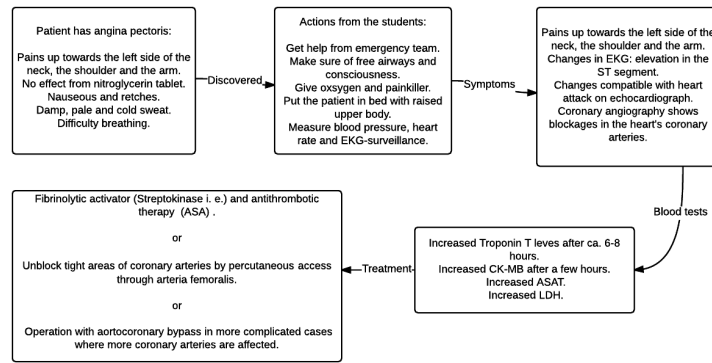
Figure 3.2: An overview of the second case; The patient's symptoms, students' actions, test results and the correct treatment

This case was a little different from the other case, in that it should be rather easy to figure out that the patient was having a heart attack. The focus of the case, then, shifted from finding out what was wrong with him, to finding out what to do with him. Actions like administering pain medication and takes precedence over testing the patient's blood. For the multiple choice aspect of this case, all the three possible treatments were technically correct, depending on the situation.

3.2.3   Background Patients

In the case of the background patients, the goal was to populate the virtual hospital, and make it seem less empty. This was the same motivation as the implementation of virtual humans in the CAMO project [32] [20]. The difference was that in the CAMO project, the objective was to provide soldiers with a correct security assessment of the village, while in the virtual hospital, the goal was to avoid breaking the immersion of the nurses with an empty hospital. Realistically, a hospital would have both nurses, patients and doctors in the hallways and the different rooms. Virtual humans would be implemented to fill up different parts of the hospital, and act as backdrops, so as to retain the immersion of the students.

3.3   Designing the virtual humans

3.3.1   Virtual Humans in Second Life

There are two ways to make virtual humans in SL. The first is uploading meshes and making an object out of them. This object can be a simple prim, or an entire linkset, but a linkset it required if one is to do any advanced animation with the object. The object can be given pathfinding properties in order to move around, and with sensor code, it's even possible to make the it react to nearby human avatars. Advantages of object-based virtual humans are that a lot of them can be created once a basic model is available, and they don't require any botting software. Disadvantages of object-based virtual humans are that they can potentially require a lot of LI, they are hard and expensive to animate, and they need a mesh model to be created for them.

The other available option to creating virtual humans in SL is using avatars with a third party botting software. This works by creating an avatar account, and then marking it as a bot. Private

messages can then be sent to the bot through code, and the botting software will make it do whatever the message says. Advantages to this are that more advanced animations can be performed at lower costs, and SL's own models and clothes can be used, so it's not necessary to create an entirely new mesh model. Disadvantages are that the botting software needs to be running at a computer for the virtual human to be online, and a new account has to be created for each virtual human one wants to make.

The reason object-based virtual humans are hard to animate, is because the only way to create advanced animations with them is through something called alpha animation. In aplha animation, the object that is to be animated is a linkset of several prims, where each prim is modeled to be a frame in the animation. At the start, all the prims will start invisible, and then they will be toggled visible on after another, while the previous prim is once again made invisible. This way, only one prim is shown at a time, and a sort of animation is simulated. Because each frame requires its own prim, the upload costs and LI costs can quickly grow out of hand.

3.3.2 Modeling and texturing

Although the bot-based virtual humans didn't require any mesh model, the object-based model did, so for the modeling process, the free program Blender was used. The modeling process was a time-consuming process, so it was decided that only the virtual patients should be modeled to start with. Virtual nurses and doctors could be modeled later, if there was time, because they were not an immediate priority for the PBL part.

A reference image[11] was used to model the virtual patient, and can be seen in the background of figure 3.3. The head was simplified quite a bit, and the number of vertices were reduced significantly from the original in order to lower the LI and upload cost of the model.
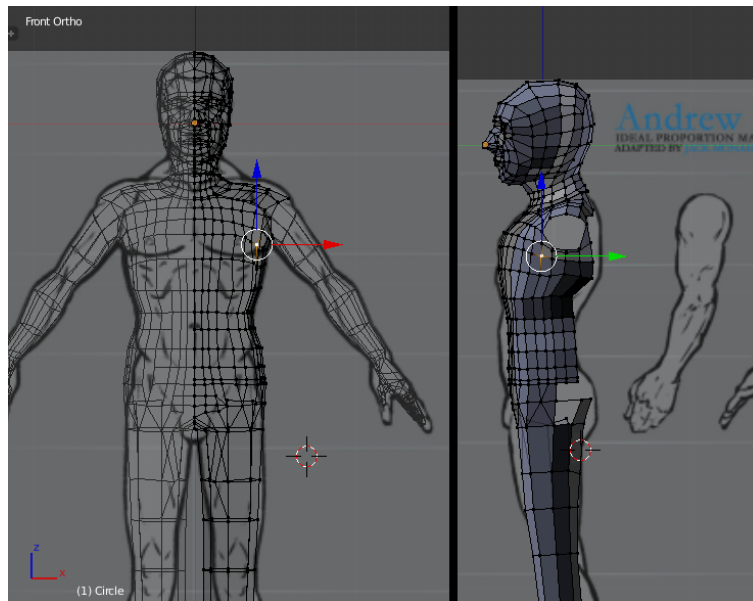
Figure 3.3: The virtual patient in progress of being modeled.

In order to create realistic, virtual patients, it was important to get the right clothes for them. In the case of some of the object-based virtual humans, they are assumed to have been patients at the virtual hospital for a while, and should therefore wear the correct hospital clothing. The clothes that patients on St. Olavs hospital in Trondheim wear are simple pyjamas with a shirt and

pants. It wasn't deemed necessary to model these by themselves, so they were modeled onto the virtual patients, and it was marked where they would end for texturing purposes.

Figure 3.4: A comparison of the clothes used at St. Olavs and a vritual patient wearing them.

As can be seen in figure 3.4, the first iteration of the face textures was simple and not very realistic. After some feedback, they were scrapped, and another method was explored. Other students were used as models, and better texture maps were created using GIMP.
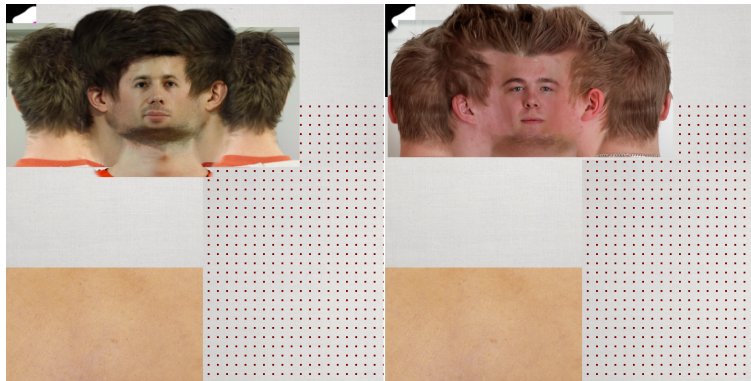
Figure 3.5: The two new texture maps that were created.

3.3.3   Animation

In order to animate its avatars, SL uses keyframe animation. Keyframe animation works by marking specific poses as keyframes[19]. When the animation starts, the computer will automatically generate the frames between the poses. For example, a start frame could be a person sitting, and the end frame could be that person standing. The computer would then generate the frames in between to make that person stand up. Keyframe animation doesn't make sure that the generated movement looks natural. A few extra keyframes should be placed inbetween the start and the end in order to guide the generation.

It was quick and easy to make animations for the bot-based virtual humans, which was done in the free program QAvimator. An animation for when the virtual patients were laying in bed included simulated breathing. This was done by raising the chest, and then lowering it again. As long as no one looked underneath the virtual patient, it would look like he was breathing. The patient would also stop breathing when dead, which applied if the user thought the patient was drunk in the diabetes case. When the correct treatment was selected, the user would sit up on his bed. In

the case of the heart attack patient, he was also given an animation that showed how he was in pain. Administering pain medication would show that the pain was lessened.

Figure 3.6: The heart attack patient showing his pain animation.

Some problems were encountered when trying to make the hospital beds in SL play the animations. The beds that were already present in the intensive care unit had been bought at the SL market place, and their permissions didn't allow for editing the code. That meant that the sitting code had to be rewritten, which didn't prove too hard, as some scripts were already available online[9]. Also, another bed model than the one that was originally in the intensive care unit was used. This was due to difficulties with lining up the animation with the original bed. For some reason that wasn't discovered, only the x and z axis would work, while the y axis was considered a negative z axis, thereby only allowing the virtual patient to lie sideways on the bed.

3.4 Implementing the cases

3.4.1 Second Bot

Second Bot[31] is a free, third party program that works with SL to establish a bot behavior for an avatar. A bot, in SL, is an avatar that is not controlled by a human player, but rather by a program. To make a bot running from Second Bot do an action, a private message have to be sent, either from a script or an avatar, to the bot's avatar. This private message have to be constructed in the form of a command from the Second Bot command library. The bot will then attempt to complete the given action. To make a bot in Second Bot, a variety of things have to be input into the program. Username and password are needed for Second Bot to log in to SL. The master's UUID is needed so that the bot can recognize that only its owner can command it. A passkey can be input so that only commands that contain the passkey are used. This is optional, but allows for additional security against someone trying to highjack the bot.

3.4.2 The virtual humans

For the background patients, two models were used. One was a virtual afghan villager recycled from the CAMO project (see section 1.6), and the second was the virtual patient that was modeled for this project. The afghan villager was placed in the waiting room, sitting on one of the chairs. The other model was used more. One was placed standing in the hallway where the heart attack patient would first sit down, a second was placed sitting on a bed further down the hallway. Two were placed in the two free beds in the intensive care unit.
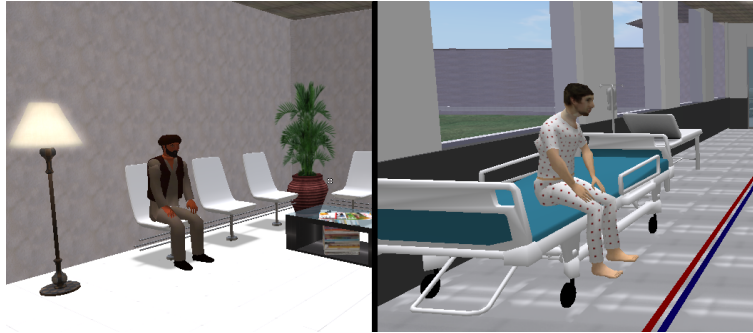
Figure 3.7: The finished implementation of the background patients.

For the diabetes patient, SL's default male model was used, as well as the default clothes. The facial texture was replaced with a new one, which was more red to make him look flushed, as was described in the case. His eyes were closed, so he would be somnolent. When the case would start, he would be laying on the bed with his breathing animation running. This patient wouldn't do much, and just lay there until treatment was administered. Then, he would either die, sit up or do nothing, depending on which treatment was selected.

Figure 3.8: The virtual patient for case 1.

For the heart attack patient, a male SL model with a suit was used. The facial texture was replaced with a pale one, like in the case. Before the case started, he would stand in the waiting room. When the case started, he would move to the chair and start his animation for being in pain. If the students administered pain medication, he would change to a different animation that showed him in less pain. He could also be moved to a bed in the intensive care unit, where he would have two different animation depending on whether or not he was still in pain. When the final treatment was reached, he would sit up, because all the treatments were correct.

Figure 3.9: The virtual patient for case 2.

3.4.3 The Blackboards

In order to present the case as smooth as possible, it should be done within second life. In SL, there are few options for displaying dynamic text on a prim. There are a few scripts that show text on a prim, but they are generally advanced and can only show a few characters[18]. There were two other options that were worth considering:

- Textures. The text that needs to be displayed on the prim can be written on images, and then displayed on the prim as textures. Changing the texture of a prim in a linkset is be easy to do with the llSetLinkTexture function. The advantage of using this method is that it's easy to do, and takes relatively short time. The disadvantages are that it can cost a lot of linden dollars to upload such a large amount of images that are needed to cover the entire case.
- Shared Media. SL has a feature that allows for the display of internet content on any surface. This means that it's possible to create a web site that stores and displays the cases. The advantage of this is that it's a flexible solution with a lot of longevity. This way, new cases can be uploaded to the website in text format, without needing to be converted to images first. The disadvantage is that it's a time consuming and expensive solution.

In the end, the first solution was selected. The amount of time it would take to implement such a web site, including the research needed, just didn't seem reasonable. Converting the text to images, and then uploading them would take far less time than the alternative.

The blackboard itself consisted of 6 rectangular prims connected into a linkset. Together, they shaped the entire blackboard. The blackboard's code would, if the blackboard was clicked, display a menu with an array of buttons. Each button would then represent a part of the case, and would either bring up something on the blackboard, or lead to another menu. For example, the first button on each of the blackboards would be the start button. This button would bring up the introduction to the case on all six prims in the blackboard's linkset.
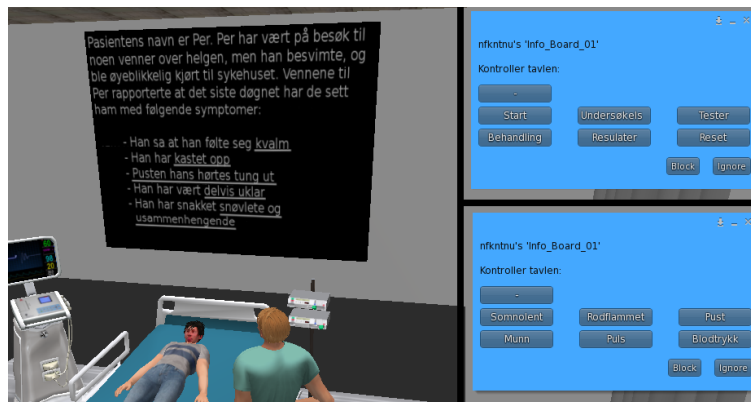
Figure 3.10: The case 1 blackboard, as well as the main menu (top right) and the sub menu for symptoms (bottom right).

Some of the alternatives on the blackboard would bring up a sub menu, from which another list of buttons would allow the user to toggle single pieces of information to appear on the board. These were for the parts of the case where the students would have to discover symptoms on the patient or decide what to do with the patient. For example, in the first case, if a student discovered that the patient was somnolent, the controller of the blackboard would have toggle somnolent to appear on the blackboard. To do this, he or she would have to press "examination" ("Undersøkelse" on figure 3.10) on the blackboard's main menu to bring up the examination sub menu. From here, he or she would press "somnolent", and somnolent would be toggled to appear on the blackboard. To make such a symptom disappear from the blackboard, one would just have to press it again, or press the reset button, which would turn off all the blackboard's text. Below are an overview of the branching in the two blackboards:

Case 1, diabetes patient

- Start Screen. Presents the patient, and the situation he was in before he was admitted, as well as a few symptoms reported by his friends.
- Examination. Symptoms related to examining the patient can be toggled on or off from here.
    - Somnolent
    - Flushed complexion
    - Quick and deep breath
    - Dry mouth that smells of acetone
    - Normal pulse
    - Normal blood pressure
- Test results. Shows the results of tests that the students can ask for.
    - Ketones in urine
    - Increased levels of ketones in plasma
    - Blood tests measure pH 7.07
    - Blood sugar 20.4 mmol/l
- Treatment. Here the four different treatments are shown, and the students can pick one.
    - Treatment for drunk patient
    - Treatment for diabetic ketoacidosis
    - Treatment for diabetic hypoglycemia
    - Treatment for head injury
- Results. Once a treatment is picked, the blackboard will automatically forward to this branch, which shows the results of the given treatment.

- Reset. Resets the blackboard, which clears it, and turns off all toggled symptoms or results.

Case 2, heart attack patient

- Start Screen. Presents the patient, and the situation that lead to him sitting down in a chair with chest pains.
- Actions. The patient needs emergency treatment, and here a series of actions that the students can take are shown.
    - Get help from emergency team
    - Make sure of free airways and consciousness
    - Give oxygen and pain medication
    - Put the patient in a bed with raised upper body
    - Measure blood pressure, hart rate and order EKG-surveillance
- Symptoms. These are the symptoms the patient has, all indicative of a heart attack.
    - Pains up towards the left side of the neck, the shoulder and the arm.
    - Changes in EKG: elevation in the ST segment
    - Changes compatible with heart attack on echo cardiograph
    - Coronary angiography shows blockages in the heart's coronary arteries
- Test results. These are the results of various blood tests.
    - Increased Troponin T levels after about 6-8 hours
    - Increased CK-MB after a few hours
    - Increased ASAT
    - Increased LDH
- Treatment. Here the three different treatments are shown, and the students can pick one.
    - Fibrinolytic activator (Streptokinase i. e.) and antithrombotic therapy (ASA) .
    - Unblock tight areas of coronary arteries by percutaneous access through arteria femoralis.
    - Operation with aortocoronary bypass in more complicated cases where more coronary arteries are affected.
- Results. Once a treatment is picked, the blackboard will automatically forward to this branch, which is the same on every treatment.
- Reset. Resets the blackboard, which clears it, and turns off all toggled symptoms or results.

3.4.4 The Scenario Controller

The bots were controlled from a single script, called the scenario controller, which had a menu with options to initialize the bots, and then move them around. The script was placed on a simple cube, which was placed out of sight, behind one of the curtains in the intensive care unit. The scenario controller was especially necessary for the second case, where the blackboard should only appear when the case started. The blackboard for case 2 would remain invisible, until a message from the scenario controller told it that the case had started. When the students would decide to move the heart attack patient to a bed, someone would need to access the scenario controller, and press the buttons to move the bot and the blackboard to the intensive care unit.

Figure 3.11: The scenario controller (box on the left) and its menu.

EVALUATION AND RESULTS

In all, there were three evaluations for this project. One evaluation consisted of letting a group of nurse students explore the hospital, and then try to solve the cases. The other two evaluations were conducted by experts, who could identify shortcomings and the project's potential.

4.1 Nurse Students

A group of 11 nurse students and 4 teachers from Ålesund University College participated in this evaluation. It was conducted over Skype in an auditorium, where the computer screen of one of the teachers was projected onto a big screen. There were some difficulties picking up sound, because the students were sitting a little far away from the microphone. This hurdle was overcome by having one of the teachers rely what was said by the students, and occasionally take notes.

A few SL accounts with relevant nurse outfits were available, but there were unfortunately not enough for everyone. For the first hour, the students were given time to get comfortable with the software, and explore the virtual hospital. Those that weren't given a SL account opted to make their own, instead of just watching the big screen.

Figure 4.1: The nurse students getting familiar with SL.

When the students had gotten familiar with SL and the virtual hospital, it was time to explore the cases. The virtual patients and the blackboard were controlled from NTNU, and not by any teachers in Ålesund, as they were not familiar with the system.

The diabetes patient was first, and the case was presented on the blackboard. The students were encouraged to study the patient's appearance. When they had all gotten a good look at the virtual patient, they were encouraged to come with suggestions as to what to do next. It was intended that the students should discuss the case amongst themselves. With such a large group of people, however, it seemed better to have the students come with suggestions one and one, so that a teacher could easily relay it over Skype.

Some of the suggestions that the students came up with, such as the patient's temperature, were not covered by the case, so it was implied that these omitted elements were within normal parameters. After discovering some symptoms, the students wanted to take blood tests. The results of the blood tests were shown on the blackboard, and a student immediately suggested that the patient had diabetic ketoacidosis. This lead to the possible treatments, which were also displayed on the blackboard. The students picked the correct treatment, and the patient was shown sitting up. Afterwards, the results of the other, incorrect treatments were shown.

Figure 4.2: The virtual diabetes patient and the results of his blood tests.

The heart attack patient was next. As in the first case, the situation was first described on the blackboard. As expected, it was clear to everyone that the patient was having a heart attack. This case was harder than the first case, and the students had trouble coming up with suggestions to what to do with the patient. They decided to place him in a bed, which moved the patient and the blackboard to the intensive care unit. Results of some of the heart tests were shown, as well as the results of some blood tests. Finally, the possible treatments and their results were shown. It was discovered that this case was much too advanced for the nurse students, and was more suited for doctor students.

After the cases were presented, the students and the teachers were asked to fill out a questionnaire. Finally, a few questions were asked of the students and the teachers.

4.2 Expert Evaluations

The expert evaluations were performed by a teacher at the Faculty of Nursing (HiST), and a professor at the Department of Public Health and General Practice (NTNU). The purpose of the expert evaluations would be to get the opinions of more professional individuals. It was anticipated that they would have a more cynical look on the system than the nurse students, and therefore give different feedback. To prepare for the expert evaluations, a set of questions were prepared that would act as a guide when asking for feedback. The experts came with their feedback while

the system was presented, and often inadvertently covered the prepared guide questions.

Both expert evaluations were performed the same way. First, the background patients would be presented, then both of the cases in order. The audio from the evaluations would be recorded on a phone application, so they could be easily transferred to a computer afterwards.

While setting up the bots and scenarios, the experts got a look at Second Bot, and how the scenario controller was used to teleport the virtual patients into their correct positions. For case 1, the virtual patient's breathing and appearance would be presented first. Thereafter, the case would be presented on the blackboard. The experts were shown how the menu for controlling the blackboards were organized into different sections, depending on where in the case the students would be. They also got a good look at the different treatments, and their results. After everything in the case was shown, the experts came with questions, and things they didn't fully understand were explained.

For case 2, the case was first set up with the scenario controller. The virtual patient was put into his chair, where he would play his in-pain animation, and the blackboard would be turned visible. Like in the first case, each part of the blackboard and its menus would be shown and explained. The patient would be moved to a bed in the intensive care unit by using the scenario controller. The alternative to give the patient pain medication would change his animation, and he would have different animations depending on whether he was still in the chair, or had been moved to the bed.

4.3 Results from the Nurse Students and Teachers

Quite a bit of useful feedback was received from the evaluation with the nurse students and teachers from Ålesund. The two parts of feedback were the questionnaire and the following interview, which provided a lot of useful information.

4.3.1 The questionnaire

10 of the 11 students filled out the questionnaire, and all 4 teachers filled it out. Also included in the questionnaire is a nurse at St. Olav that filled it out at a later date. This nurse was shown the virtual hospital in the same way as was done in the expert evaluation. Of the 15 (14 female, 1 male) who filled out the questionnaire, only 2 had some previous experience with games or virtual worlds. They mentioned the game Sims, a life simulation game that relies heavily on its autonomous virtual humans. Only 2-3 participants had small troubles understanding the cases, but nothing major, so it all went well.

The game experience was fun/motivating

Strongly disagree	●	1	6.7%
Disagree	●	0	0%
Neither	●	1	6.7%
Agree	●	8	53.3%
Strongly Agree	●	5	33.3%

Virtual patients can be a good supplement in the education of nurses.

Strongly disagree	●	0	0%
Disagree	●	0	0%
Neither	●	0	0%
Agree	●	7	46.7%
Strongly Agree	●	8	53.3%
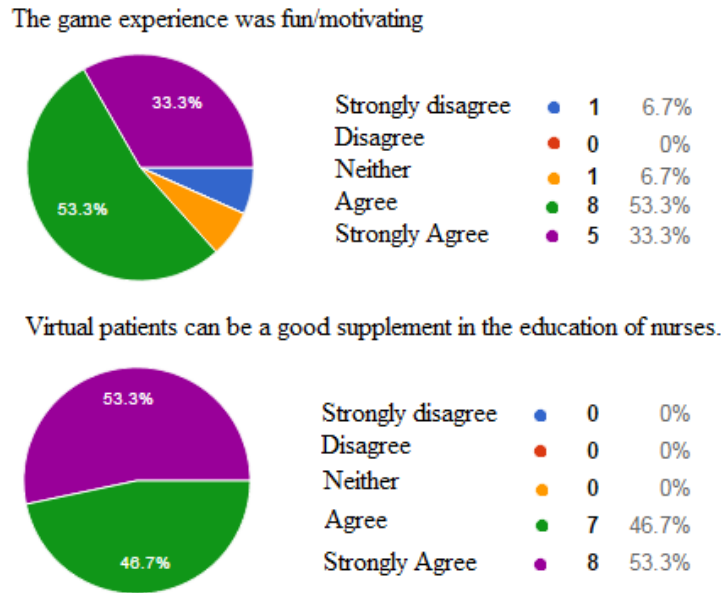
Figure 4.3: The results from the enjoyment section of the questionnaire.

In the first part of the questionnaire, the participants were asked if they found the experience fun or motivating. 86.7 % of the participants were in agreement that they found it fun or motivating, which is a great result. Another great result is that everyone thought that a virtual hospital like this one could be used as a supplement in the education of nurses.

Were the blackboards easy to understand?

Very Hard	●	0	0%
Hard	●	1	6.7%
Neither	●	0	0%
Easy	●	4	26.7%
Very Easy	●	10	66.7%

How much did the blackboards help keeping track of the cases?

Very little	●	1	6.7%
Little	●	0	0%
Some	●	2	13.3%
Much	●	9	60%
Very much	●	3	20%
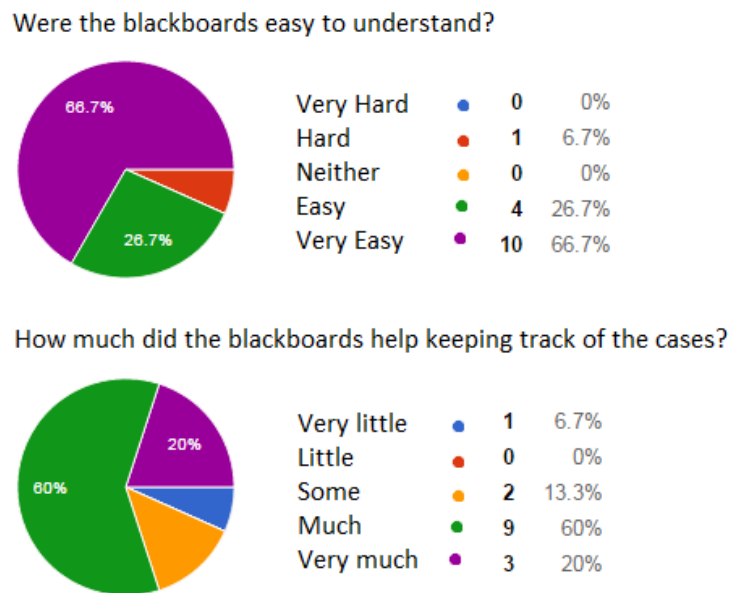
Figure 4.4: The results from the blackboard section of the questionnaire.

In the section of the questionnaire that covered the blackboard, only a single person had trouble understanding the blackboard, which means that 93.3 % of the participants thought that the blackboards were at least easy to understand. 80 % of the participants felt that the blackboard helped them keep track of the cases, and their developments.

How easy was it to find symptoms on the patient directly?

Very Hard	●	0	0%
Hard	●	1	6.7%
Neither	●	8	53.3%
Easy	●	5	33.3%
Very Easy	●	1	6.7%

Figure 4.5: The results from the first part of the symptoms section of the questionnaire.

Only 40 % of the participants found it easy or very easy to find symptoms on the patient directly. This suggests that either the symptoms weren't clear enough, or too few of the symptoms were expressed with the virtual human.

Which aspects of the virtual patients conveys symptoms the b

Appearance / skin color

Breathing

Body language
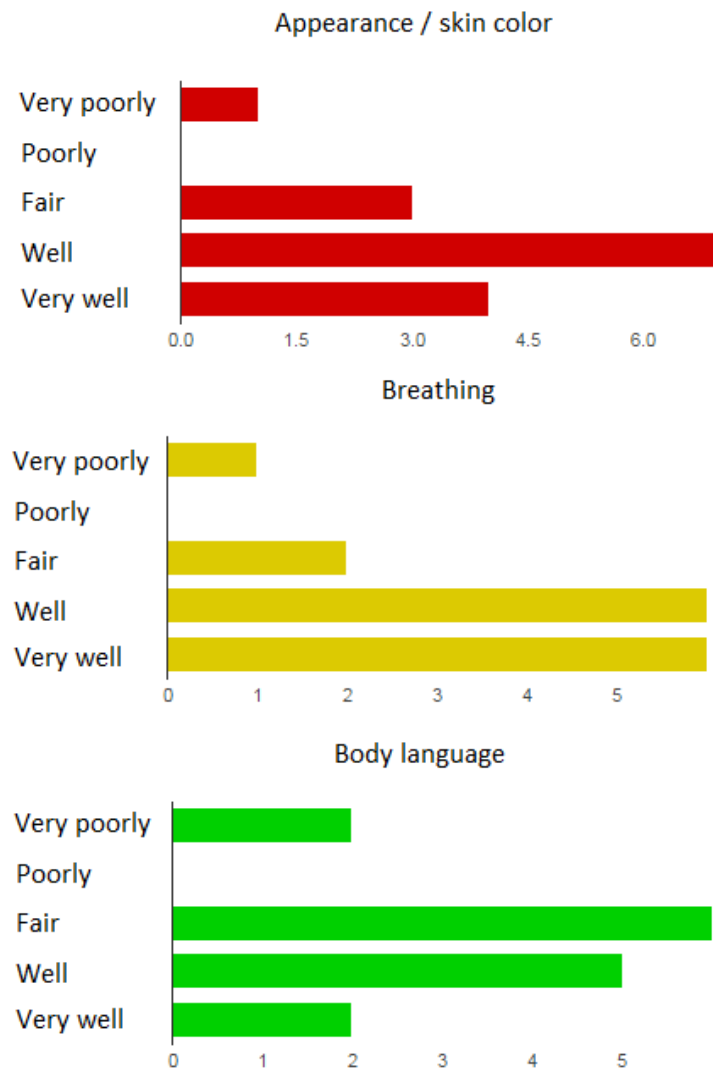
Figure 4.6: The results from the second part of the symptoms section of the questionnaire.

The aspect that the participants found easiest to extract information from was the patient's breathing, followed by appearance or skin color. The patients' body language did not express symptoms very well. This could be understandable for the diabetes patient, because of the somnolence, but suggests that at least the heart attack patient should express himself more.

Figure 4.7: The results from the first part of the further work section of the questionnaire.

Figure 4.8: The results from the second part of the further work section of the questionnaire.

Which aspects of the virtual patients are the most important to improve?

Compatability with equipment
(Ultrasound, EKG, i. e.)
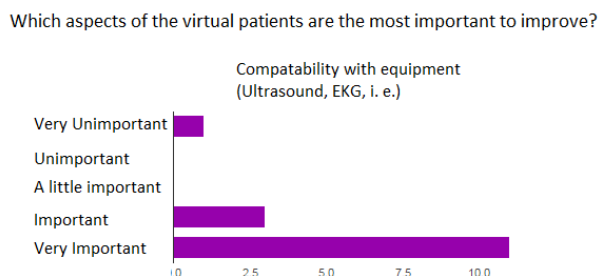
Figure 4.9: The results from the third part of the further work section of the questionnaire.

There was a very clear result when evaluation what was most important to improve. 93.3 % of the the participants meant that both dialogue and compatibility with hospital equipment was important or very important to improve. Especially the dialogue part was something that the teachers commended that they missed during the interview. Sound was the second most important, with 86.7 % of the participants meaning that it was either important or very important. Aspect such as body language or appearance was either good enough, or not deemed too important to improve, as only around 50-60 % of the participants found it important or very important.

I would want to use such a virtual hospital in my education.

Strongly disagree	•	0	0%
Disagree	•	1	6.7%
Neither	•	0	0%
Agree	•	4	26.7%
Strongly agree	•	10	66.7%
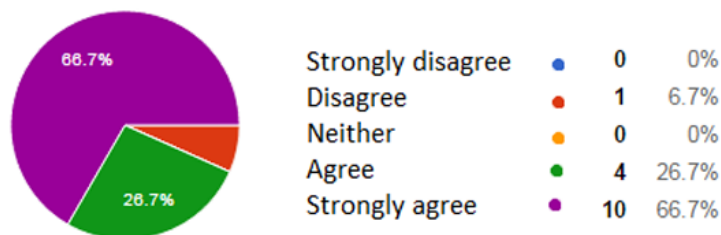
Figure 4.10: The results from the usage section of the questionnaire.
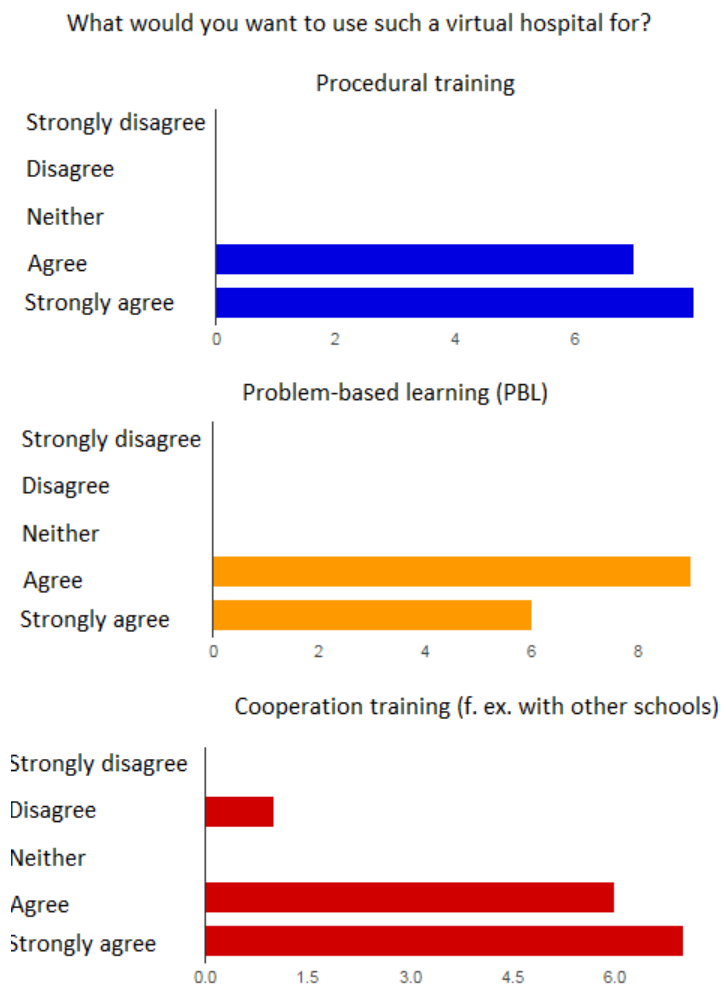
Figure 4.11: The results from the usage section of the questionnaire.

Almost everyone would want to use a virtual hospital like this one in their education. Procedural training, problem-based learning and cooperative training are all training areas that the participants would want to use the virtual hospital in.

4.3.2 Interview

After the questionnaire was filled out, some of the students and teachers expressed their immediate impressions of the system. This was both their positive thoughts, some criticism, and some general observations. One student mentioned that she was somewhat stressed during the first case, as she was somewhat confused as to what to do. She felt less stressed with the second case, as she had gotten a feel for the procedure.

The students thought that showing the results of each of their actions on the blackboard was good. They liked that even though they could have treated the patient wrong, the consequences of their actions were shown. Someone among the students commented they thought the hospital looked foreign, not Norwegian, and maybe inspired from something like the show "Grey's Anatomy". They also missed a proper patient ward, because all the patients were technically in the intensive care unit. Regarding the cases, they meant that case 1, the diabetes patient, was more relevant to their education than case 2. They therefore missed more relevant cases such as diseases and

emergency situations.

The teachers commented that the system was far from a finished product, and that there was a long way to go, still. They also didn't like that some of the alternatives in the cases were out of order. For example, the results from the blood tests on case 2 realistically wouldn't be available until after several hours, but the students got them immediately. They also missed some non-medicinal actions, such as communicating with the patient, or getting his history.

On of the questions that were posed, was whether they thought the blackboard was confusing or easy to use. Both the students and the teachers felt the blackboard was good. They liked how they could guess what to do first, and then it would show up on the blackboard. They did, however, think that a few more alternatives should be added. As for the menu that controlled the blackboard, they thought it was organized and understandable.

As for the patient, some of the students thought that he should make sound, either by breathing or talking. Everyone thought that there needed to be some form of communication with the patient. Breathing noises, groaning, or maybe even talking in the SL text chat would all have been forms that this could have been done.

Figure 4.12: The virtual heart attack patient and the his potential treatments.

Regarding how useful such a virtual virtual hospital could be, the teachers had some valid opinions. One teacher said that she didn't think that this could replace physical simulation, but could be a way for the students to prepare and practice for the actual simulation. The students also thought this system could be good for preparing for either a physical simulation, or an exam. Another teacher said that if bio-engineer students could be brought on board, it could create some good, relevant discussions. Several students agreed, and though it would be a good idea if students from other medical fields could participate in the virtual hospital.

All the students were very positive to the virtual hospital, and would very much like to use it in their own studies. They also meant that it would be a good resource for future students.

The students were asked what they thought about using the virtual hospital to co-operate with other nurse colleges, to which they responded positively. No one thought it would be uncomfortable to meet strangers, and then solve problems with them. They also thought it was an advantage that they would remain anonymous.

When asked about what further work the virtual hospital needed, a lot of suggestions were voiced:

- More rooms, like a patient ward and medicine room.

- Child patients.
- More fragmented cases, such that they take place in more hospital areas. Admittance, operation i. e.
- Patient journals.

4.4 Results from the Expert Evaluations

4.4.1 Teacher at the Faculty of Nursing (HiST)

This evaluation was performed at the 8. of may 2015 by a teacher at the Faculty of Nursing (HiST).

In regards to the blackboards, the expert liked them, but thought it was somewhat hard to read the text. He would have liked the text to be bigger, because some of the text wouldn't necessarily cover the entirety of its delegated space inside one of the six prims.

The expert asked whether or not the nurse students would be notified of what the cases were about, so that they would be able to prepare for the case in some way. He meant that if there was going to be any educational effect from the virtual hospital, the students should be prepared for what the cases were going to be about. The students wouldn't necessarily know the case beforehand, but should have some idea of which areas the case would cover. If the students were prepared for the case, choosing the right treatment shouldn't be particularly hard. Getting the right treatment should be about how prepared the student is.

When asked how easy it would be to discover symptoms on the patient directly, the expert responded that it was all clear and apparent. Especially the heart attack treatment, it was very good that he was twisting around in pain, and rubbing the affected area. He also thought all the patients looked realistic, and represented their case very well. The background patients were wearing pyjamas, which was good.

Overall, the expert thought that if this system could be used as a supplement to normal lectures or if this was done as a group exercise, it would provide a very good contribution. The contribution would be good in theoretic knowledge, because it gets visualized. It would also be very good contribution in group situations because the students would get experience in how to work as a team, and act with others. It was also good if the students could be taught how to deal with administering the wrong treatment, because it's done in a virtual environment. At least the patient would remember the situation, and be wary as to not repeat the incident next time.

With improvement to the cases, the expert mentioned several things. When starting case 2, there should be a person that should alert the students that another person is in pain in the hallway. This could be one of the background patients, or even another virtual human entirely. He meant there should be some natural transition between the two cases, and not a sudden shift from the intensive care unit to the hallway.

It would also be preferable that intravenous fluids or blood would be hanging from a stand near the patient. If the students were to issue something like that, it should be visible near the patient.

He meant it was important to make the virtual hospital seem active, and create the impression that it's an actual hospital that the students are in. Especially in the case of the heart attack patient, where a large part of the case takes place in the hallway. That would mean that virtual personnel would need to be nearby, and be walking around.

4.4.2   Professor at the Department of Public Health and General Practice (NTNU)

This evaluation was performed at the 19. of may 2015.

The expert thought the text on the blackboard was a little hard to read, especially from a distance, and would have liked either the text or the blackboard to be bigger. He also mentioned that it wasn't necessarily intuitive that the blackboards needed to be clicked in order to access their menu.

Regarding the cases, the expert thought they were a bit advanced for nurse students, and meant that they were more appropriate for medical students or advanced nurse students. The cases were more focused on the diagnosis, and not dealing with the patient, so it would be unsuitable in the education of nurses, but maybe more suitable in the education of doctors. He also thought the cases could get hard to solve, because the symptoms would just be listed, and there would be no dynamic review of the cases. The way it was now, the situation was one of remembering knowledge, and not solving a problem. The cases would have to be more advanced, and cover more that not necessarily would be relevant to the correct treatment.

The expert could see the early potential in the system as an upgrade to the more traditional paper PBL he was teaching with, but felt that there were some things that needed to be addressed first. Currently, the paper PBL had the problem that most of them were only text, and the students could almost just as well read the book. What was needed in the paper PBL to make it close to dealing with patients in a clinical setting, as was the point of the PBL to begin with, would be actual patients. Sometimes, the expert's PBL cases would contain videos of the patients, which would help. The added value from the virtual hospital would then have to be dealing with a patient. Currently, the only interaction with the virtual patients was finding the symptoms such as flushed or pale face, and the virtual patients' animations. The way the system was now, it would probably be more cumbersome to use it than to just use paper PBL.

The behavior of the virtual patients were some things that the expert liked, he just missed a lot of interaction with the patient directly. Both dialogue, and functions to examine the patient with medical equipment could solve this. The expert thought the appearance of the virtual humans were a little bit rough, but conveyed its point, so it shouldn't be the main focus of any further development.

Overall, for further work the expert would have like the ability to talk to the virtual patient. He would like the cases to have an order that would allow the students to test ideas, ask the patient questions and a higher focus on clinical reasoning.

5.1   Fulfillment of Requirements

For the first requirement, R1, sub requirement R1_2 was not fulfilled. Due to time constraints, walking background patients were not implemented. The models for the walking patient were uploaded, and the animation worked fine. The problem was that the virtual hospital's floor didn't have any pathfinding properties. Because of this, the virtual human would simply walk in place, and not move anywhere. R1_1 was implemented, and discounting the beds where the bot-based virtual patients would lie, two background patients were placed in the two remaining beds. R1_3 was fulfilled, as the virtual patients looked good enough for their purpose.

R2 was not implemented at all. Virtual doctors and nurses were not as important as implementing virtual patients, and were therefore not prioritized.

For R3_1, both patients would have a skin complexion that matched their case, and the symptoms in them. For case 1, the patient would be somnolent, adn therefore remain unresponsive and have closed eyes. For case 2, the patient would have pains in his left side, and therefore show this by stroking that side of his body.

With R3_2, the patients would only show reactions with animation. They would not react with sound or text, which would have been best. In case 2, the patient would stop hurting in his left side, if the students administered pain killers. Both patients would react to the treatment given, by either doing nothing, sitting up or dying.

For R3_3, blackboards were successfully implemented. They were easy to understand, but the students would have to stand somewhat close to them in order to see them. The menu for controlling the blackboards was also organized, and easy to understand.

R3_4 was also successfully implemented. For case 1, the multiple choice had only one correct answer, and three false ones. For case 2, this was not the case, but the case's focus was not on the final treatment, but rather on what to do with the patient before that.

5.2 Limitations

5.2.1 Medical Expertise

The lack of medical expertise from the developer lead to difficulties when symptoms, treatments or test results that were originally not part of the cases appeared. For example, the diabetes case needed a multiple choice treatment at the end, but the original case only covered the correct treatment, so a significant amount of time had to be spent researching additional treatments.

5.2.2 Evaluation

An attempt was made to recruit students from the Faculty of Nursing (HiST), such as was done in previous projects involving the virtual hospital. Unfortunately, only two students were recruited, where one cancelled and the second didn't show up. It would have been good to get the opinion of different schools, and not only Ålesund University College.

5.3 Discussion of Results

Although the results from the questionnaire were relatively positive, it's important to remain skeptical. A few factors could have lead to inaccurate results in the questionnaire. One such factor is that only a relatively few amount of people filled out the questionnaire. A sample size of 15 people is somewhat small, so a larger amount of people could have lead to different results.

The cases were meant to be solved in a different way from what they were. A small number of people in a group setting were meant to discuss what to do among themselves, and then come to a decision. In the evaluation, however, it was done differently. The students came with suggestions to the teacher, who then related the decision. There was little to no discussion, and at times, all the students were quiet. It's likely that many of the students would have been more comfortable if they had been in small groups, and may have talked more, and come with more suggestions. This way of solving the cases could have skewed the participants' impression of the system.

5.3.1 The Cases

The cases were all sufficient, but could be improved. During the evaluation by the nurses students and teacher from Ålesund University College, the students came with some suggestions that weren't covered by the cases. For example, some of them wanted to take the patient's temperature, but this was not covered by the case, and therefore it had to be implied that the temperature was within normal parameters. Common details like the patient's temperature should be covered by the case, even if they are within normal parameters, for the sake of consistency.

Only one of the cases was a good PBL case [13] [35] for the students that participated in the evaluation. It turned out that one of the cases (the heart attack patient) was not appropriate to the students' current curriculum, which was a problem, as most of the students didn't know what to do. Both cases were of common and realistic scenarios, and both had a for of medical urgency, but the PBL shouldn't be so hard that it would be frustrating to solve.

5.3.2   The Blackboards

The blackboards received a lot of positive feedback, and were praised as organized and under-standable, which meant that at least the menus for controlling the blackboards were implemented correctly. Some of the students at Ålesund University College did have problems realizing that the blackboards could be clicked, however. This means that there should have been some sort of sign or indicator on or near the blackboards that indicated that the blackboards were clickable.

The blackboards that were implemented, by using textures on prims, turned out to be only a short term solution. They had some serious limitations that would make them unfeasible if they were to be used for more than a few cases. First, because they used textures to display the information, it significantly lowered their modifiability. To make changes to the blackboard, an entirely new image would have to be uploaded, which would get fiddly and expensive in the long run. Second, the blackboards were limited to only have six togglable symptoms or test results at a time. Because the blackboards' linksets consisted of six prims, it restricted them to only have six textures. To add more than six symptoms or test results, they would have to be displayed on a new page, or replace one already present on the blackboard. The way forward would probably be to display the needed information with shared media, and develop a web site to hold all the cases. This is how it was done in the PREVIEW project [3], which gave them more freedom to add more cases.

5.3.3   The Virtual Humans

The autonomy in the two types of virtual patients that were implemented came in different formats. The bot-based virtual patients used for the cases ended up being a mix between guided and autonomous [2]. Because they needed to follow the progression of their assigned case, they couldn't act completely independent. They would perform their animation in an autonomous fashion, but the students could technically manipulate their actions depending on the treatment they would give. As such, their perception [36] were the messages they received from the blackboards. Their decision-making was linear, but they would adapt their behaviour depending on their location. For example, the heart attack patient would perform a different in-pain animation depending on whether he was sitting on a chair, or laying in bed. For action control, the virtual patients had a variety of animations that they could perform.

The background patients were fully autonomous, though they had no perception, decision-making or action control to speak of. In the CAMO project [4] [32] [20] (see section 1.6), the object-based virtual humans could both walk, detect the presence of nearby human avatars, and then react accordingly. These virtual humans had fully implemented percpetion, decision-making and action control. When implementing virtual humans in the virtual hospital, however, the priority was on the bot-based virtual humans and their cases. In the end, there simply wasn't enough time to finish the object-based virtual humans.

When compared to the PREVIEW project [3], which was similar to this one, a few things were done differently. A blackboard was used, which was designed to be user friendly and simple to use. This was to avoid having a too difficult user interface, which was a problem in the PREVIEW project. The complex UI of both SL and their screen controller made it difficult for the students. The PREVIEW project provided the students with the ability to click on the virtual patients' body parts, and thereby discover their status. This suggests that they used object-based virtual humans for their virtual patients, which may have restricted their use of animations, but provided a deeper level of interaction for their students, which was a problem in this project.

From all the results, especially from the nurse students and teachers at the Faculty of Nursing (HiST), dialogue turned out to be a very desirable function. The virtual patients were missing in both responsiveness and interpretability [26], and some form of dialogue could have provided both. Interaction with medical equipment was also wanted, such as with ultrasound and EKG. This, combined with the lack of dialogue, it becomes apparent that there needs be more focus on the virtual humans' responsiveness, and the general act of interacting more with the virtual patient.

The lack of interaction was further confirmed by the professor at the Department of Public Health and General Practice (NTNU). The way the system was, it didn't offer enough to be much better than traditional paper-based PBL, and would be less convenient. A dialogue system would be a step in the right direction. Allowing the students to discover more symptoms directly on the virtual patient would also be positive, for example by examining body parts, such as was done in the PREVIEW project [3]. For nurse students, it could also be appropriate if the virtual patient took an action, and the students would have to deal with it. For example, if the diabetes patient attempted to get out of his bed, and the students would have to either restrain him or talk him out of it.

5.4 Retrospective on Research Questions

This project turned out to be informative, and a a lot was learned. Regarding RQ_1, what are the requirements for such virtual patients, it was discovered that having responsive virtual humans that one could communicate with was an important requirement. Appearance, body language and facial expressions turned out to be not as important as communication, though they shouldn't be ignored, as they help to make the virtual humans significantly more engaging.

For RQ_2, how can such virtual patients be implemented, a variety of options were found for each of the requirements. The blackboards were implemented for the short term purpose of exploring whether or not they would contribute positively to the PBl process. For serious use, they should be implemented differently, as discussed in section 5.3.2. The different ways to implement virtual humans in SL were explored, and they each had their advantages and disadvantages that were taken advantage of. For background patients, the simplicity of object-based virtual humans were sufficient for the task. For the case patients, the more realistic appearance and advanced animation possibilities of bot-based virtual humans were more suited. For this, the third party program of Second Bot was used, which allowed for good control of the bots with SL chat messages. For future work on the virtual patients, bot-based virtual humans are probably still the most suited, but it will be necessary to make the virtual patients talk in some way. This could be done either by a dialog box, such as was used as menus for the blackboards and scenario controller, or via the SL chat, such as was done in the PREVIEW project [3].

For RQ_3, to what extent are these virtual patients capable of contributing to the educational process, the virtual patients have the potential to improve paper-based PBL, an already established and valuable part of healthcare education. The virtual patients are good, because they allow the students to look at their target from different angles, and examine an actual patient, instead of a described and imaginary person in the paper PBL. Virtual patients also have the potential to replace the medical mannequins that are in use today, by providing a more cost-efficient and safe alternative.

CHAPTER 6

CONCLUSIONS AND FURTHER WORK

This thesis explored the use of virtual patients in NTNU's virtual hospital. Its goal was to reveal how virtual patients could contribute to the education of healthcare personnel, and nurses in particular. This meant figuring out a set of requirements, a way to implement them, and finally testing how these requirements fared in evaluations. Although this was a good prototype to see what would be needed for such virtual humans to be considered for serious use, a lot of work still remains for that to happen. This was a fun project to work on, and a lot of interesting results were gleamed. The students evaluating the system also had fun, which is important, as it needs to be motivating if there is to be any point to it.

The blackboard seemed like a step in the right direction, as it received a lot of positive feedback, and allowed all the students participating in the case see its progression at the same time. The blackboards presented the cases, its symptoms, test results and treatments in an organized format that was easy to understand. If work on the virtual patients should continue, the blackboards should probably stay, although they should be changed some. The blackboards should be easier to read, for one, and should probably be changed to a more long term format such as shared media.

The virtual patients that were implemented could all use more work. Their appearance was sufficient for their function, and their behavior was realistic and somewhat responsive. The virtual patients' animations accurately conveyed their status, and was realistic in their given scenario. It was discovered that there should be more focus on the interaction with the patient. There should be more ways to discover symptoms other than simply asking the person responsible for the blackboard. The students should be able to talk with the patient in a dialogue, and figure out symptoms that way. The students should also be able to use medical equipment on the virtual patients, or examine them in some way.

The virtual hospital has the potential to be an effective tool in the education of healthcare personnel, and could be used in a variety of different ways. Role play scenarios have shown promise before, and now virtual humans have been introduced to the hospital. The virtual humans could still need a lot of work, but could prove to be a fun and educational engagement for the students, should it take off. The virtual hospital could also need some work, as it is currently somewhat small, and could use more rooms, like dedicated patient wards.

6.1 Contributions

- Designed a 3D model of a virtual patient for use the virtual hospital.
- Developed a framework for blackboards to present PBL cases for many people to see at once in the virtual world of Second Life.
- Proposed a way to to use virtual humans in the process of medical education.

6.2 Further Work

- Implement the unfulfilled requirements.
- Develop more cases. A lot more work should be put into developing cases, which should cover more, and be more appropriate to nurse students.
- Change the blackboard from being texture-based to shared media. This also involves implementing a web site to host the cases.
- Make the blackboards easier to read.
- Develop dialogue systems with the patients.
- Make the patients compatible with medical equipment (Ultrasound, EKG, i. e.).
- Develop a system for examining the patients.

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APPENDIX A

CASES

Case:

«Per» er skoleelev og har hatt insulinkrevende diabetes mellitus i flere år. Han bruker injeksonspenn med hurtigvirkende insulin før måltider på dagtid og injeksjon av lagtidsvirkende insulin før natten. «Per» er lite motivert for å håndtere regulering av sin diabetes. Han har slurvet med å injisere insulin, gir i perioder blaffen i kostholdsråd og har uteblitt fra flere kontroller.

«Per» har i løpet av det siste døgnet vært <u>kvalm</u> og <u>kastet opp</u>, følt seg <u>tungpust</u> og og blitt <u>delvis uklar</u> – <u>snakker snøvlete og usammenhengende</u>. Han blir lagt inn på sykehuset tiltrengende øyeblikkelig hjelp behandling.

Ved innkomst sykehuset er «Per» <u>somnolent</u> (*Søvnighet* (somnolens) er ikke alltid er forbundet med et ønske om å sove. Man kan holde en somnolent pasient våken. Han vil også kunne snakke og bevege seg. Når pasienten overlates til seg selv, vil han imidlertid lett sovne.) og <u>rødflammet i ansiktet, pusten er hurtigere og dypere enn normalt, det lukter aceton av munnen, munnhulen er tørr. Blodtrykk og puls er normale.</u>

Prøver ved innkomst: <u>Ketoner(betahydroxysmørsyre) i urin og forhøyde nivåer av samme stoff i plasma. I blodprøver måles pH 7,07(normalt 7,35-7,45), blodsukker 20,4mmol/l(normalt 4-6mmol/l.</u>

«Per» fikk mye intravenøs væske tilsatt kaliumklorid og hurtigvirkende insulindrypp i 3 døgn. I løpet av behandlingen bel han gradvis mer våken, pust, hudfarge og blodprøver ble etter hvert normalisert og etter ytterlige to dager i sykehuset ble han utskrevet.

Momenter som <u>er understreket</u> kan være egnet for «virtuell tavle»

Hjerteinfarkt case.

Johan Olsen er på veg inn til sengeavdelingen i sykehuset hvor hans kone ligger nyoperert for struma.

Idet han kommer inn i avdelingen kjenner han plutselig en sterk klemmende smerte retrosternalt. Smertene stråler opp mot venstre side av halsen, skulder og ut i venstre arm. Han tar en nitroglyserintablett for sin angina pectoris, men denne har ikke noe effekt. Smertene gir seg ikke, han føler at han vil besvime og må sette seg ned i en stol i korridoren. Johan Olsen er blitt kvalm, brekker seg, er klam blek og kaldsvett. Johan Olsen har åndenød og er redd. En annen besøkende som befinner seg i korridoren oppdager Johan Olsen og varsler sykepleierne i vaktrommet.

Rullegardin 1:

Akutt behandling (ikke nødvendigvis i prioritert rekkefølge):

*skaffe hjelp (akutteam)

*påse at pasienten har frie luftveger (obs evt. brekninger) og sjekke pasientens bevissthet

*gi oksygen og smertestillende(morfin)

*legge pasienten i seng med hevet overkropp),

*forsøke å berolige pasienten.

*måle blodtrykk, puls og EKG-overvåkning

*Siden pasienten er i sykehus og umiddelbart blir tatt hånd om vil behandling med Fibrinolytisk aktivator (Streptokinase o.l.) og antitrombotisk behandling (ASA) være aktuelt.

*Utblokking av trange partier i kransarterier ved percutan tilgang via arteria femoralis er også aktuelt. I mer kompliserte tilfeller hvor flere kransarterier er affisert vil operasjon med aorto-coronar bypass være aktuelt.

*Hjerteinfarktpasienter bør aktiviseres relativt tidlig, dvs. komme ut av sengen første dag etter oppstart av behandling

Jo raskere behandlingen settes inn jo større sjanse for overlevelse og best mulig resultat.

Rullegardin 2:

Noen symptomer og funn ved hjerteinfarkt:

      Smerter blant annet som beskrevet i casen

      Endringer i EKG: elevasjon i ST-segmentet

      Endringer forenlig med hjerteinfarkt synlig på ekkokardiogram

      Coronar angiogafi viser blokkeringer i hjertets kransarterier

Noen funn i blodprøver:

      Forhøyet Troponin T nivå etter ca. 6-8 timer (normalverdi < 14 ng/L)

      Forhøyet CK-MB etter noen få timer (normalverdi 3%-5% av total CK (creatin kinase)

      Forhøyet ASAT (normalverdi menn < 50 U/L)

      Forhøyet LDH (normalverdi < 205 U/L)

Etter en uke som pasient ved hjerteavdelingen med god effekt av iverksatt behandling blir Johan Olsen utskrevet fra sykehuset. Han skal videre til rehabiliteringsopphold i en institusjon for gjenopptrening og veiledning i forhold til å leve med gjennomgått hjerteinfarkt.

Antall personer (kan justeres):

Johan Olsen

Varsler fra korridoren
2-3 sykepleiere
2-3 medlemmer i akutteam
I tillegg div pasienter og besøkende som bakgrunnsfigurer

APPENDIX B

VIRTUAL PATIENTS

Second Life and Second Bot information on virtual patient bots

This is the information that was used in the SL scripts and Second Bot.

Diabetes patient:

First name / username	PasientPer
Last name (Second Bot)	Resident
Password	ntnu123
Passkey (Second Bot)	e3092d4954
UUID	bfe49eaf-2aa1-4908-becb-bf5b4f7683e4
Master's UUID	222cfd4a-06a0-4434-abfe-0fb6a00dd39c

Heart attack patient

First name / username	PasientOlsen
Last name (Second Bot)	Resident
Password	ntnu123
Passkey (Second Bot)	0d87ec8ce7
UUID	43973410-07e8-4969-bb5d-dbe7bf432ad8
Master's UUID	222cfd4a-06a0-4434-abfe-0fb6a00dd39c

EVALUATION

Virtuelt Sykehus Spørreundersøkelse

Målet med denne spørreundersøkelsen er å evaluere de virtuelle pasientene og deres scenarier, i forbindelse med en masteroppgave. Takk for tiden din!

Generelt

1. **Er du mann eller kvinne?**
   Mark only one oval.

   ( ) Mann

   ( ) Kvinne

2. **Hva er din yrkesbakgrunn?**
   Mark only one oval.

   ( ) Sykepleierstudent

   ( ) Legestudent

   ( ) Sykepleier

   ( ) Lege

   ( ) Lærer ved sykepleierutdanningen

   ( ) Other: ....

3. **Har tidligere erfaring med Second Life eller 3D spill?**
   Mark only one oval.

   ( ) I stor grad

   ( ) I noe grad

   ( ) I liten grad

   ( ) Ingen tidligere erfaring

4. **Hvis du har tidligere erfaring med virtuelle verdener eller spill, oppgi noen.**

   ....

   ....

   ....

   ....

   ....

5. **Spillopplevelsen var gøy/motiverende.**
Mark only one oval.

- ( ) Sterkt uenig
- ( ) Uenig
- ( ) Verken eller
- ( ) Enig
- ( ) Sterkt enig

6. **Virtuelle pasienter kan være et godt supplement i utdanningen av sykepleiere.**
Mark only one oval.

- ( ) Sterkt uenig
- ( ) Uenig
- ( ) Verken eller
- ( ) Enig
- ( ) Sterkt enig

Tavlene

Tavlene er de to svarte feltene over pasientenes seng, hvor scenarioet presenteres.

7. **Var tavlene lett å forstå?**
Mark only one oval.

- ( ) Veldig vanskelig
- ( ) Noe vanskelig
- ( ) Verken lett eller vanskelig
- ( ) Noe lett
- ( ) Veldig lett

8. **Hvor mye hjalp tavlene å holde styr på scenariene/casene**
Mark only one oval.

- ( ) Veldig lite
- ( ) Lite
- ( ) Noe
- ( ) Mye
- ( ) Veldig mye

9. **Hvor lett var det å forstå de presenterte scenariene/casene?**
Mark only one oval per row.

	Veldig vanskelig	Vanskelig	Greit	Lett	Veldig lett
Diabetespasienten	( )	( )	( )	( )	( )
Hjertepasienten	( )	( )	( )	( )	( )

De virtuelle pasientene

10. **Hvor lett var det å finne symptomer direkte på pasienten?**
    Mark only one oval.

    ◯ Veldig vanskelig

    ◯ Vanskelig

    ◯ Greit

    ◯ Lett

    ◯ Veldig lett

11. **Hvilke aspekter av de virtuelle pasientene formidlet symptomer best?**
    Mark only one oval per row.

	Veldig dårlig	Dårlig	Grei	Bra	Veldig bra
Utseende / ansiktsfarge	◯	◯	◯	◯	◯
Pust	◯	◯	◯	◯	◯
Kroppsspråk	◯	◯	◯	◯	◯

12. **Hvor realistisk, sammenlignet med virkelige mennesker, opplevde du de virtuelle pasientene?**
    Mark only one oval.

    ◯ Veldig dårlig

    ◯ Dårlig

    ◯ Grei

    ◯ Bra

    ◯ Veldig bra

13. **Hvilke aspekter av de virtuelle pasientene er viktigst å forbedre?**
    Mark only one oval per row.

	Svært lite viktig	Lite viktig	Litt viktig	Viktig	Svært viktig
Kroppsspråk	◯	◯	◯	◯	◯
Dialog	◯	◯	◯	◯	◯
Utseende	◯	◯	◯	◯	◯
Lyd	◯	◯	◯	◯	◯
Ansiktsuttrykk	◯	◯	◯	◯	◯
Interaksjon	◯	◯	◯	◯	◯
Kompabilitet med utstyr (Ultralyd, EKG, anestesi, etc.)	◯	◯	◯	◯	◯

14. **Har du noen forslag til forbedringer, eller hvordan dette virtuelle sykehuset kan brukes videre?**

....

....

....

....

....

Sykehuset

15. **Jeg kunne tenkt meg å bruke et slikt virtuelt sykehus i utdanningen**
Mark only one oval.

- ◯ Sterkt uenig
- ◯ Uenig
- ◯ Verken eller
- ◯ Enig
- ◯ Sterkt enig

16. **Jeg kunne tenkt meg å brukt et slikt virtuelt sykehus til:**
Mark only one oval per row.

	Sterkt uenig	Uenig	Verken eller	Enig	Sterkt enig
Prosedyretrening	◯	◯	◯	◯	◯
Problem-basert læring (PBL)	◯	◯	◯	◯	◯
Samhandlingstrening (f.eks mellom studenter ved forskjellige institusjoner)	◯	◯	◯	◯	◯

Oculus Rift

Du kan ignorere denne seksjonen hvis du ikke brukte Oculus Rift.

17. **Hvordan påvirket Oculus Rift din innlevelse i situasjonen?**
Mark only one oval.

- ◯ Mye verre
- ◯ Verre
- ◯ Ingen forskjell
- ◯ Bedre
- ◯ Mye bedre

18. **Til hvilken grad ville du brukt Oculus Rift hvis du skulle gjort dette igjen?**

Mark only one oval.

- ⬭ Definitivt ikke Oculus Rift
- ⬭ Helst ikke Oculus Rift
- ⬭ Enten eller er greit
- ⬭ Helst Oculus Rift
- ⬭ Definitivt Oculus Rift

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Google Forms

Edit this form

15 responses

View all responses Publish analytics

Summary

Generelt

Er du mann eller kvinne?
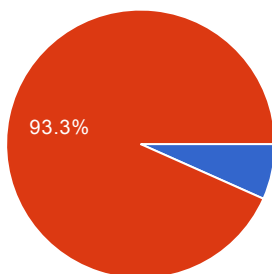
Mann	**1**	6.7%
Kvinne	**14**	93.3%

Hva er din yrkesbakgrunn?
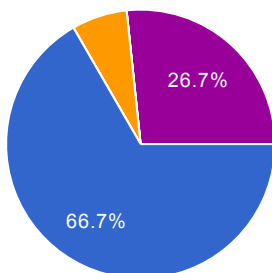
Sykepleierstudent	**10**	66.7%
Legestudent	**0**	0%
Sykepleier	**1**	6.7%
Lege	**0**	0%
Lærer ved sykepleierutdanningen	**4**	26.7%
Other	**0**	0%

Har tidligere erfaring med Second Life eller 3D spill?
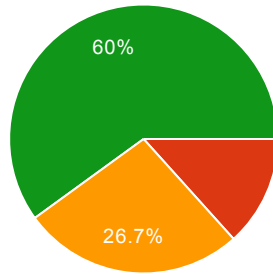
I stor grad	**0**	0%
I noe grad	**2**	13.3%
I liten grad	**4**	26.7%
Ingen tidligere erfaring	**9**	60%

Hvis du har tidligere erfaring med virtuelle verdener eller spill, oppgi noen.

SIMS

Sims.

Spillopplevelsen var gøy/motiverende.
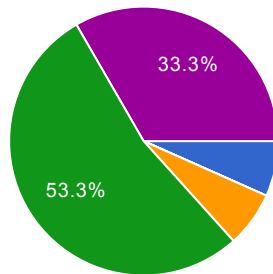
Sterkt uenig	**1**	6.7%
Uenig	**0**	0%
Verken eller	**1**	6.7%
Enig	**8**	53.3%
Sterkt enig	**5**	33.3%

Virtuelle pasienter kan være et godt supplement i utdanningen av sykepleiere.

53.3%

46.7%
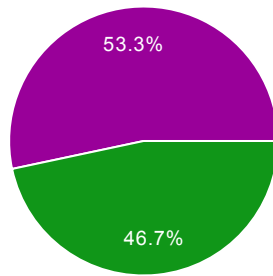
Tavlene

Var tavlene lett å forstå?

66.7%

26.7%
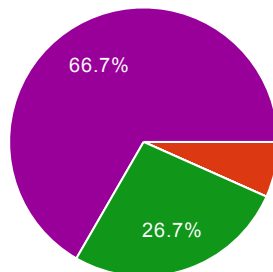
Veldig vanskelig	**0**	0%
Noe vanskelig	**1**	6.7%
Verken lett eller vanskelig	**0**	0%
Noe lett	**4**	26.7%
Veldig lett	**10**	66.7%

Hvor mye hjalp tavlene å holde styr på scenariene/casene

20%

60%
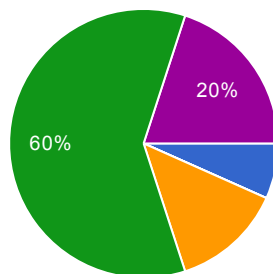
Veldig lite	**1**	6.7%
Lite	**0**	0%
Noe	**2**	13.3%
Mye	**9**	60%
Veldig mye	**3**	20%

Diabetespasienten [Hvor lett var det å forstå de presenterte scenariene/casene?]
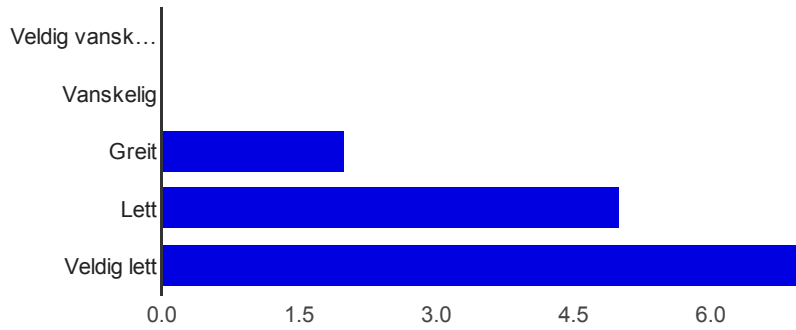
Veldig vanskelig	0	0%
Vanskelig	0	0%
Greit	2	14.3%
Lett	5	35.7%
Veldig lett	7	50%

Hjertepasienten [Hvor lett var det å forstå de presenterte scenariene/casene?]
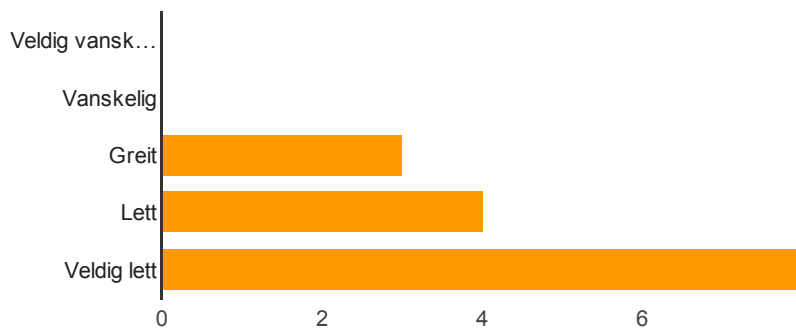
Veldig vanskelig	0	0%
Vanskelig	0	0%
Greit	3	20%
Lett	4	26.7%
Veldig lett	8	53.3%

De virtuelle pasientene

Hvor lett var det å finne symptomer direkte på pasienten?
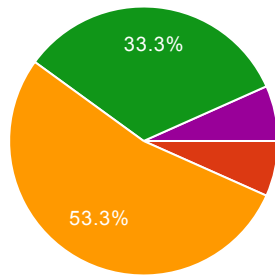
Vanskelig	**1**	6.7%
Greit	**8**	53.3%
Lett	**5**	33.3%
Veldig lett	**1**	6.7%

Utseende / ansiktsfarge [Hvilke aspekter av de virtuelle pasientene formidlet symptomer best?]
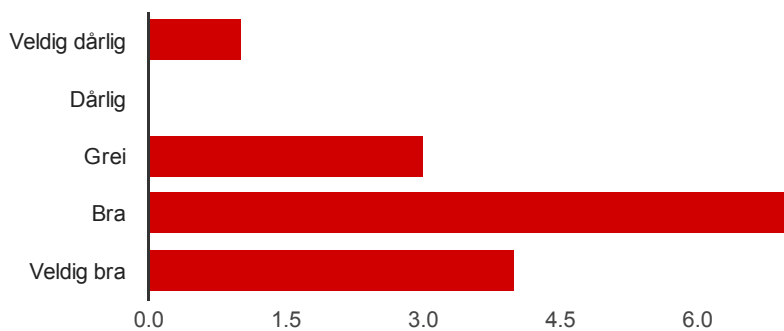
Veldig dårlig	**1**	6.7%
Dårlig	**0**	0%
Grei	**3**	20%
Bra	**7**	46.7%
Veldig bra	**4**	26.7%

Pust [Hvilke aspekter av de virtuelle pasientene formidlet symptomer best?]
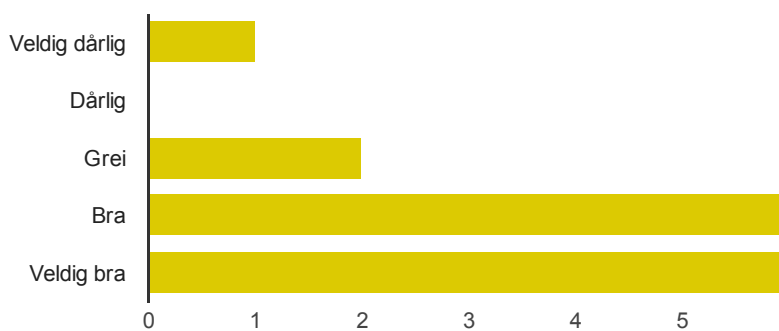
| Veldig dårlig | **1** | 6.7% |
| Dårlig | **0** | 0% |

Grei	**2**	13.3%
Bra	**6**	40%
Veldig bra	**6**	40%

Kroppsspråk [Hvilke aspekter av de virtuelle pasientene formidlet symptomer best?]
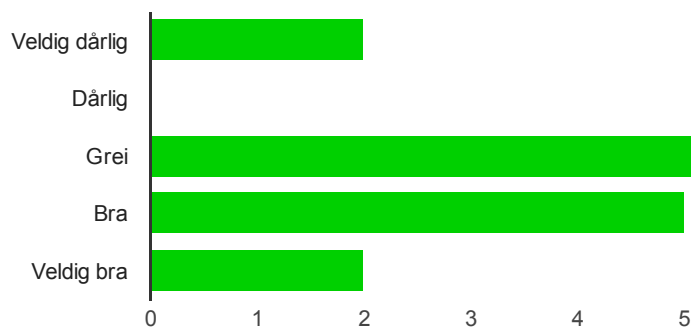
Veldig dårlig	**2**	13.3%
Dårlig	**0**	0%
Grei	**6**	40%
Bra	**5**	33.3%
Veldig bra	**2**	13.3%

Hvor realistisk, sammenlignet med virkelige mennesker, opplevde du de virtuelle pasientene?
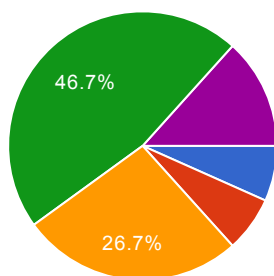
Veldig dårlig	**1**	6.7%
Dårlig	**1**	6.7%
Grei	**4**	26.7%
Bra	**7**	46.7%
Veldig bra	**2**	13.3%

Kroppsspråk [Hvilke aspekter av de virtuelle pasientene er viktigst å forbedre?]

Svært lite viktig	**3**	20%
Lite viktig	**1**	6.7%
Litt viktig	**3**	20%
Viktig	**2**	13.3%
Svært viktig	**6**	40%

Dialog [Hvilke aspekter av de virtuelle pasientene er viktigst å forbedre?]

Svært lite viktig	**1**	7.1%
Lite viktig	**0**	0%
Litt viktig	**0**	0%
Viktig	**3**	21.4%
Svært viktig	**10**	71.4%
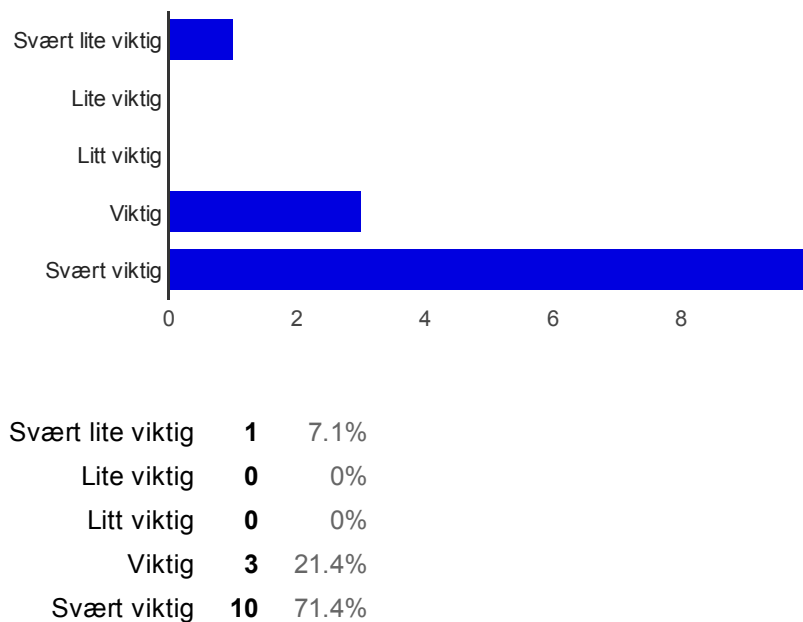
Utseende [Hvilke aspekter av de virtuelle pasientene er viktigst å forbedre?]
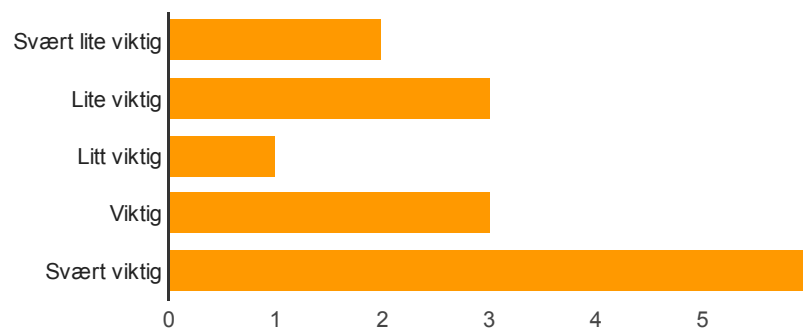
Svært lite viktig   **2**   13.3%
Lite viktig   **3**   20%
Litt viktig   **1**   6.7%
Viktig   **3**   20%
Svært viktig   **6**   40%

Lyd [Hvilke aspekter av de virtuelle pasientene er viktigst å forbedre?]
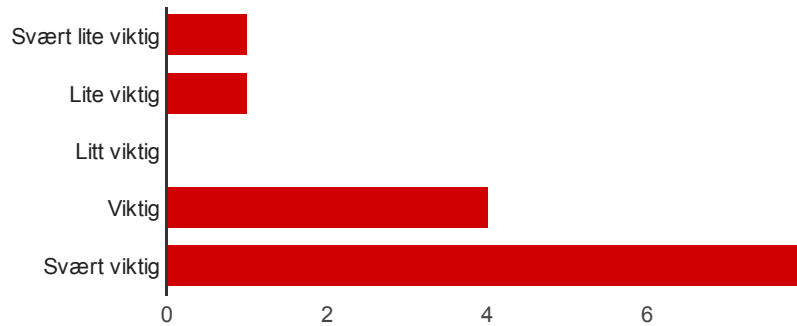
Svært lite viktig   **1**   7.1%
Lite viktig   **1**   7.1%
Litt viktig   **0**   0%
Viktig   **4**   28.6%
Svært viktig   **8**   57.1%

Ansiktsuttrykk [Hvilke aspekter av de virtuelle pasientene er viktigst å forbedre?]
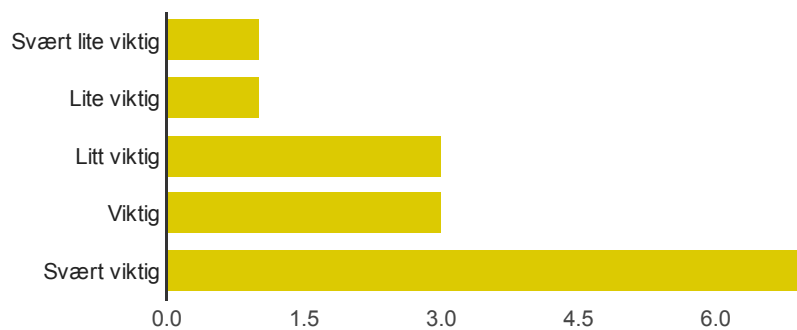
Svært lite viktig   **1**   6.7%
Lite viktig   **1**   6.7%
Litt viktig   **3**   20%
Viktig   **3**   20%
Svært viktig   **7**   46.7%

Interaksjon [Hvilke aspekter av de virtuelle pasientene er viktigst å
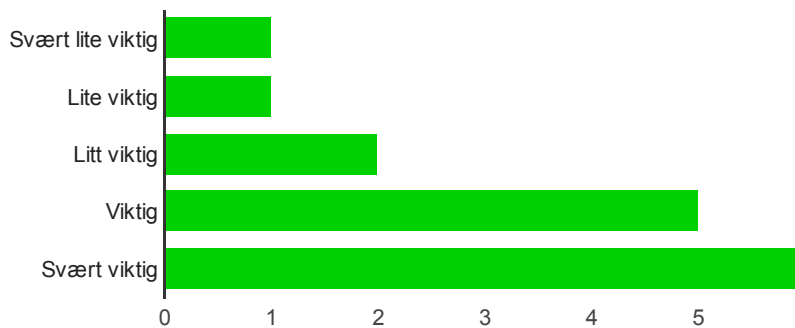
forbedre?]

Svært lite viktig	**1**	6.7%
Lite viktig	**1**	6.7%
Litt viktig	**2**	13.3%
Viktig	**5**	33.3%
Svært viktig	**6**	40%

Kompabilitet med utstyr (Ultralyd, EKG, anestesi, etc.) [Hvilke aspekter av de virtuelle pasientene er viktigst å forbedre?]
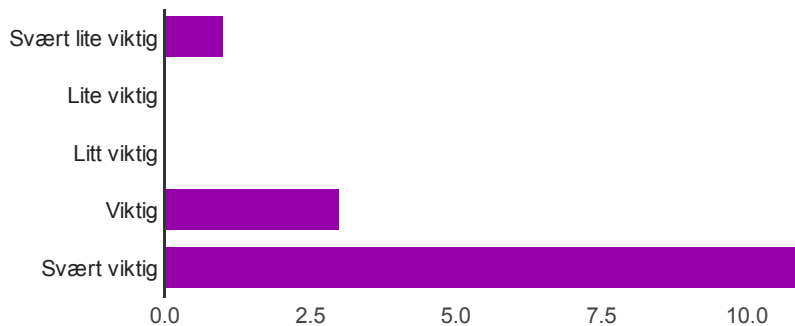
Svært lite viktig	**1**	6.7%
Lite viktig	**0**	0%
Litt viktig	**0**	0%
Viktig	**3**	20%
Svært viktig	**11**	73.3%

Har du noen forslag til forbedringer, eller hvordan dette virtuelle sykehuset kan brukes videre?

Det var en veldig gøy måte å lære på, da det ble mer levende. Det var veldig bra at en kan gjette alternativer til f.eks tiltak først, så deretter kom tiltakene opp på tavlen. En annen ting som var veldig bra var at når behandlingsalternativene kom opp, kom det opp hva som var rett og galt - f.eks at det kom en forklaring/konsekvens på de ulike alternativene. Involere flere parter i rommet, f.eks bioingeniør, sykepleier og

lege. Fokus på kommunikasjon og samhandling. Chat? Og deretter handlinger.

Underveis så en gjør tiltak, kunne det komt frem hvordan pasienten responderte på dette.

Det er svært prematurt. Tiltakene ble ikke ordnet i den nødvendige rekkefølgen for eks. hjerteinfark. ABCD burde vært tydelig , burde fått feil ved å begynne med blodprove sp blodprøve som først ga feil etter 6-8 timer.

det kom svært tydelig frem at pasienten skulle diagnostiseres. annen sykepleie enn tekniske observasjoner burde utvikles, feks er det viktig å berolige, trøste, informere etc

Vanskelig å finne frem til sykehuset når man "landet" på stranden. Upassende klær til sykepleiere Skulle vært forklaringer for eks: hva er ketoacidose.. osv..

Jeg tror lyder og mer direkte kontakt med pasientene kan bidra til å få eit letter inntrykk over pasientens status, og da lettere å iverksette tiltak.

Kan brukes til sykehusenes Pasientforløp ved å vise vei gjennom ulike diagnoserr. Kan videreutvikles til scenarioer på flere pasientgrupper.

Flere pasienter, flere scenarioer, muligheter for å kommunisere med lege samt med pasienten, flere mulige målinger (temperatur, Spo2, EKG osv.)

Ta med flere undersøkelsertyper (f.eks Spo2) og blodprøve-typer i casene. Flott om dere etter hvert får med flere sykdommer osv.

Sykehuset

Jeg kunne tenkt meg å bruke et slikt virtuelt sykehus i utdanningen
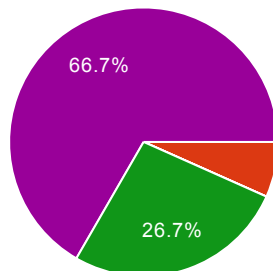
Sterkt uenig	0	0%
Uenig	1	6.7%
Verken eller	0	0%
Enig	4	26.7%
Sterkt enig	10	66.7%

Prosedyretrening [Jeg kunne tenkt meg å brukt et slikt virtuelt sykehus til:]

Sterkt uenig	**0**	0%
Uenig	**0**	0%
Verken eller	**0**	0%
Enig	**7**	46.7%
Sterkt enig	**8**	53.3%
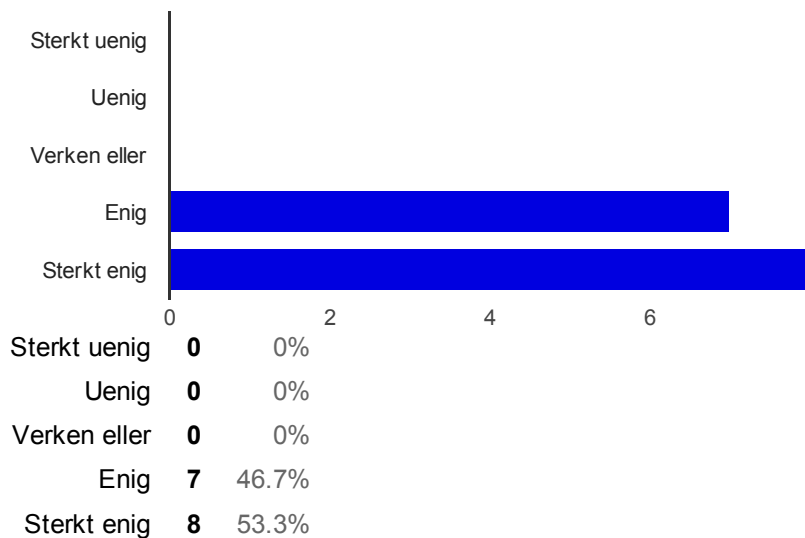
Problem-basert læring (PBL) [Jeg kunne tenkt meg å brukt et slikt virtuelt sykehus til:]

Sterkt uenig	**0**	0%
Uenig	**0**	0%
Verken eller	**0**	0%
Enig	**9**	60%
Sterkt enig	**6**	40%
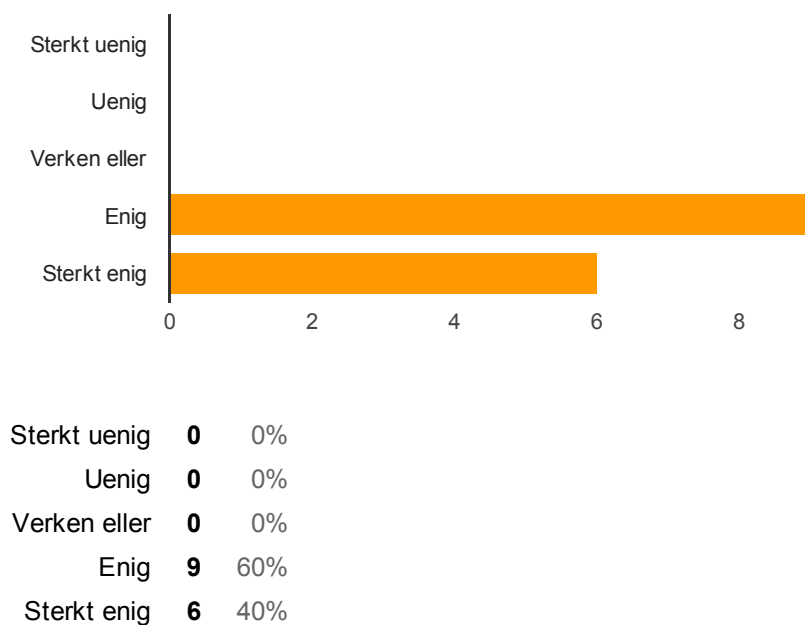
Samhandlingstrening (f.eks mellom studenter ved forskjellige institusjoner) [Jeg kunne tenkt meg å brukt et slikt virtuelt sykehus til:]
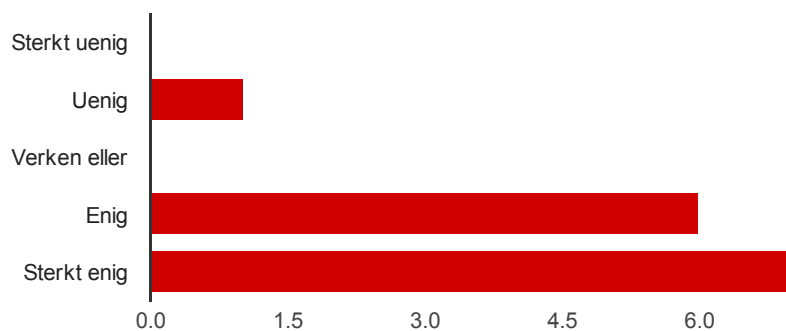
Sterkt uenig	**0**	0%
Uenig	**1**	7.1%
Verken eller	**0**	0%
Enig	**6**	42.9%
Sterkt enig	**7**	50%

Oculus Rift

Hvordan påvirket Oculus Rift din innlevelse i situasjonen?
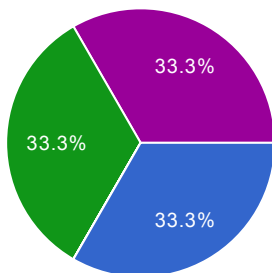
Mye verre	**1**	33.3%
Verre	**0**	0%
Ingen forskjell	**0**	0%
Bedre	**1**	33.3%
Mye bedre	**1**	33.3%

Til hvilken grad ville du brukt Oculus Rift hvis du skulle gjort dette igjen?
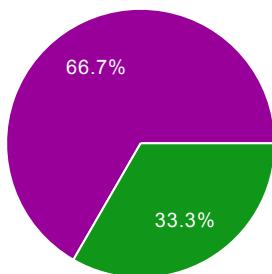
Definitivt ikke Oculus Rift	**0**	0%
Helst ikke Oculus Rift	**0**	0%
Enten eller er greit	**0**	0%
Helst Oculus Rift	**1**	33.3%
Definitivt Oculus Rift	**2**	66.7%

Number of daily responses
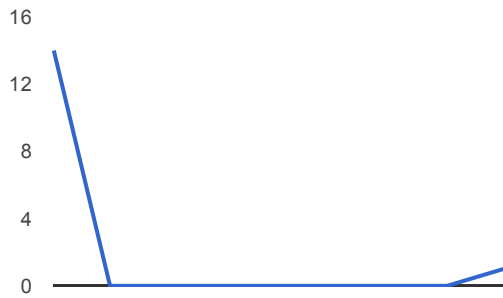
Spørsmål for ekspertevaluering

Tavlene

1. Er tavlene lett å bruke? Er det noe som er forvirrende med dem?
2. Er behandlingene som sykepleierne kan gi realistiske?
3. Hva tror du om hvor vanskelig det er å få rett behandling i scenarioene?
4. Er resultatene fra behandlingene realistiske?

Pasientene

1. Hvor lett er det å finne symptomer direkte på pasienten?
2. Oppfører pasientene seg realistisk i det gitte scenarioet sitt?
3. Hva synes du om utseende til pasientene?

Bakgrunnspasientene

1. Føles sykehuset mer levende med bakgrunnspasienter?
2. Oppfører bakgrunnspasientene seg naturlig?

Generelt

1. Hvor lett tror du det blir for en sykepleierstudent å gjennomføre disse scenarioene alene?
2. Hvor mye tror du disse scenarioene slik de er implementert kan hjelpe med utdanningen av sykepleiere?
3. Hvordan kan implementasjonen av scenarioene bli bedre?

Muntlige tilbakemeldinger etter demonstrasjon og utprøving av Virtual Hospital (VH), Second Life

Dato: 13. mai 2015
Sted: Høgskolen i Ålesund
Deltakere: 11 studenter og 4 lærere
Forklaring til tabellene: Det er mellomrom mellom hva hver deltaker sa for å skille dem fra hverandre.
Kommentar: Alle lærerne var aktive i å gi kommentarer. Ca. halvparten av studentene ga kommentarer. Resten sa ikke noe, men kunne nikke for på den måten vise at de var enige. Dette gjaldt spesielt dette med nytten av VH. Ellers fikk jeg ikke observert dersom noen var uenige ved at de ristet på hodet.

Tabell 1: Umiddelbart inntrykk

Studentene	Lærerne
Spørreskjemaet: **Interaksjon** (ord i spørreskjemaet) var et ord som var vanskelig å forstå (en student spurte om dette). **Spørsmål angående aspekter av de virtuelle pasientene som er viktigst å forbedre.** Her var det en student som lurte på hvordan det ble riktig å svare ifht skalaen. Eksempelvis hvis kroppsspråket var bra, skulle hun da svare «svært lite viktig» eller» svært viktig».	Der er en vei å gå. Hvem legger inn svarene? Dette med kvalitet på casene. Rekkefølgen av tiltakene stemte ikke med virkeligheten. Eksempelvis dette med blodprøven TnT som man ikke får svar på før etter 6-8 timer.
Savnet en ordentlig sengepost	Savnet dette med ikke-tekniske og ikke-medikamentelle tiltak. Eksempelvis kommunikasjon med og informasjon til pasienten Enighet med rekkefølgen. At dette må forbedres.
Bra å få svarene og å få vite hvordan det gikk med pasienten.	
Bra helhet	
Inntrykk av at det var et sykehus fra utlandet inspirert av Grace Anatomy	
Case 1 var svært relevant og bedre å øve seg på enn case 2.	
Tavlene var bra. Oversiktlig meny	Tavlene var informative
Savnet litt flere alternativer som kunne blitt lagt inn.	
Savnet å kunne høre respirasjon, lyder fra pasienten, at de kunne ha sagt noe.	I TPS er kommunikasjon underliggende for å kunne få til dette.

Tabell 2: Nytten av virtuelt sykehus, VH

Studenter	Lærere
Før første simulering sa en student at hun ble veldig stresset. Det gikk lettere andre gang de simulerte. Derfor kan VH være nyttig for å forberede seg til simulering. Og også til eksamen.	Nyttig under forutsetning av at det medisinske blir riktig. Nyttig at man kan nå en hel klasse. Kan være et alternativ til simulering. Kreves flere fakta
Positive til VH og at det kan være en god ressurs for fremtidige studenter.	En lærer sa hun var uenig i at dette kan være et alternativ til simulering, men at studentene kan forberede seg til simulering og ha egentrening før praksis.
Alle kunne tenke seg å bruke VH	Hvis man kan få med bioingeniører, kan man diskutere blodprøveanalysesvar i lag med klinikken, og hvilke analyser som kan utføres «bedside» hvor analysesvarene kan foreligge raskt.
	Nyttig for egentrening eller egentesting. Bra at der var alternativer på de gale alternativene. At det kom frem en forklaring.

Tabell 3: Samhandling på tvers av campuser

Studenter	Lærere
Positive til dette. Studentene kan lære mye av hverandre. Ingen tenkte at dette ville være ubehagelig Men en fordel at de kunne være anonyme. At det ikke var deres ansikt som viste på skjermen.	Positive til dette
	En har ledet et prosjekt om TPS og e-læring for studenter fra Molde og Ålesund. Disse studentene hadde møttes på forhånd, og hadde gitt tilbakemeldinger om at dette hadde vært positivt.

Tabell 4: Hva mer?

Studenter	Lærere
Medisinrom	Hente utstyr som man trenger
Ordentlig sengepost	Spørsmål om tverrfaglig funksjon
Øving for dokumentasjon	Barneavatar
Skrive i journaler – man skal kunne ha tilgang på…	Involvere alle videreutdanningene, her i Ålesund har vi operasjon, anestesi, intensiv, master
Mer fragmentert – at man kan øve seg på flere avdelinger som mottak, intensiv, forskjellige kirurgiske avdelinger…..	Samhandling og kommunikasjon
Det at man kan følge hele pasientforløpet var ønskelig.	
Flere sykdommer og akutte situasjoner, da det er dette de trenger å øve seg på nå da de snart er uteksaminert.	

D.1 Case 1, diabetes patient

Pasientens navn er Per. Per har vært på besøk til
noen venner over helgen, men han besvimte, og
ble øyeblikkelig kjørt til sykehuset. Vennene til
Per rapporterte at det siste døgnet har de sett
ham med følgende symptomer:

- Han sa at han følte seg <u>kvalm</u>
- Han har <u>kastet opp</u>
- <u>Pusten hans hørtes tung ut</u>
- Han har vært <u>delvis uklar</u>
- Han har snakket <u>snøvlete og
  usammenhengende</u>

Han er somnolent

Rødflammet i ansiktet

Pusten hans er hurtig og dyp

Munnhulen er tørr og lukter aceton

Normal puls

Normalt blodtrykk

Ketoner (betahydroxysmørsyre) i urinen

Forhøyde nivåer av ketoner (betahydroxysmørsyre) i plasma

Blodprøver måler pH 7.07

Blodsukker er 20.4 mmol/l

Hvordan vil du behandle pasienten?

1. Pasienten er full, la ham sove ut rusen.

2. Diabetisk ketoacidose, gi pasienten intravenøst væske tilsatt kaliumklorid og hurtigvirkende insulindrypp.

3. Hypoglykemi, gi pasienten intravenøst væske og konsentrert glukose.

4. Hodeskade eller hjernerystelse, sett pasienten opp med CT skanning av hodet.

Pasienten ble lagt for seg selv for å sove ut rusen. Siden pasienten ikke var full, men hadde diabetisk ketoacidose, falt han inn i et koma i løpet av natten. Ved morgenen ble han funnet død i sengen.

Pasienten fikk intravenøst væske tilsatt kalsiumklorid og hurtigvirkende insulindrypp i 3 døgn. I løpet av behandlingen ble han gradvis mer våken. Pust, hudfarge og blodprøver ble etter hvert normalisert, og etter ytterlige 2 døgn ble han utskrevet.

Pasienten fikk konsentrert glukose intravenøst for diabetisk hypoglykemi. Det oppstod ingen øyeblikkelig reaksjon, og etter noen timer falt han inn i et koma. Det ble klart at diagnosen var feil. Urinprøver og undersøkelse av pasientens insulinnivåer viste at pasienten hadde diabetisk ketoacidose. Riktig behandling ble startet øyeblikkelig.

Pasienten ble satt opp til en CT skanning. Skanningen viste at pasienten hadde hjerneødem. Antagelsen av at dette kom fra hodeskade brukte mye tid, men urinprøver og undersøkelse av pasientens insulinnivåer viste at pasienten hadde diabetisk ketoacidose. Riktig behandling ble startet øyeblikkelig.

D.2 Case 2, heart attack patient

Johan Olsen var på vei inn til sengeavdelingen i sykehuset hvor hans kone ligger nyoperert for struma. Idet han kom inn i avdelingen kjente han plutselig en sterk klemmende smerte retrosternalt. Smertene strålte opp mot venstre side av halsen, skulder og ut i venstre arm. Han tok en nitroglyserintablett for sin angina pectoris, men denne hadde ikke noe effekt. Smertene ga seg ikke, og han følte at han ville besvime. Han måtte sette seg ned i en stol i korridoren. Johan Olsen ble kvalm, brakk seg, ble klam, blek og kaldsvett. Han har åndenød og er redd.

Akutt behandling, hva vil du gjøre med pasienten?

Skaff hjelp fra akutteam.

Påse at pasienten har frie luftveier, og at han er bevisst.

Gi pasienten oksygen og smertestillende (morfin).

Legg pasient i seng med hevet overkropp.

Mål blodtrykk, puls og EKG-overvåkning.

Smerter opp mot venstre side av halsen, venstre skulder og venstre arm.

Endringer i EKG: elevasjon i ST-segmentet.

Endringer forenlig med hjerteinfarkt synlig på ekkokardiogram.

Koronar angiografi viser blokkeringer i hjertets kransarterier.

Forhøyet Troponin T nivå etter ca. 6-8 timer (normalverdi < 14 ng/L).

Forhøyet CK-MB etter noen få timer (normalverdi 3%-5% av total CK (creatin kinase).

Forhøyet ASAT (normalverdi menn < 50 U/L).

Forhøyet LDH (normalverdi < 205 U/L).

Hvordan vil du behandle pasienten?

1. Fibrinolytisk aktivator (Streptokinase o.l.) og antitrombotisk behandling (ASA).

2. Utblokking av trange partier i kransarterier ved percutan tilgang via arteria femoralis.

3. Operasjon med aorto-coronar bypass.

Etter en uke som pasient ved hjerteavdelingen med god effekt av iverksatt behandling blir Johan Olsen utskrevet fra sykehuset. Han skal videre til rehabiliteringsopphold i en institusjon for gjenopptrening og veiledning i forhold til å leve med gjennomgått hjerteinfarkt.

E.1 Case 1 Blackboard

```
1 list menuChoices = ["Behandling", "Resulater", "Reset", "Start",
    "Underskelse", "Tester", "−"];
2 list sym01Choices = ["Munn", "Puls", "Blodtrykk", "Somnolent",
    "Rodflammet", "Pust", "−"];
3 list sym02Choices = ["Blod pH", "Blodsukker", "−", "Ketoner i urin",
    "Ketoner i plasma"];
4 list treatChoices = ["Alternativ 3", "Alternativ 4", "−", "Alternativ
    1", "Alternativ 2"];
5 string info = "\nKontroller tavlen:";    // The newline (\n) helps to
    visually separate this text from the dialog heading line
6 key ToucherID;
7 integer dialogChannel;
8 integer commandChannel;
9 integer listenHandle;
10 integer currentMenu;
11 integer currentDia;
12
13 integer totalSpots = 6;
14 list empty = ["Sym−blank", "Sym−blank", "Sym−blank", "Sym−blank",
    "Sym−blank", "Sym−blank"];
15 list symStart = ["Start−01", "Start−02", "Start−03", "Start−04",
    "Start−05", "Start−06"];
16 list sym01 = ["Sym−blank", "Sym−blank", "Sym−blank", "Sym−blank",
    "Sym−blank", "Sym−blank", 1];
17 list sym02 = ["Sym−blank", "Sym−blank", "Sym−blank", "Sym−blank",
    "Sym−blank", "Sym−blank", 1];
18 list treat = ["Treat−01", "Treat−02", "Treat−03", "Treat−04",
    "Treat−05", "Sym−blank"];
19 list res1 = ["Res1−1", "Res1−2", "Res1−3", "Sym−blank", "Sym−blank",
    "Sym−blank"];
20 list res2 = ["Res2−1", "Res2−2", "Res2−3", "Sym−blank", "Sym−blank",
    "Sym−blank"];
```

```
21 list res3 = ["Res3−1", "Res3−2", "Res3−3", "Res3−4", "Sym−blank",
       "Sym−blank"];
22 list res4 = ["Res4−1", "Res4−2", "Res4−3", "Res4−4", "Sym−blank",
       "Sym−blank"];
23
24 //Takes the string of an image, and the list corresponding to that
       image,
25 //in order to show it on the board.
26 list toggle_board( string sym, list symList )
27 {
28    //Check if the "sym" is already on the board
29    integer contain = 0;
30    integer i;
31    for(i = 1; i <= totalSpots; i++)
32    {
33      if(llList2String(symList, i−1) == sym)
34      {
35        contain = i;
36      }
37    }
38    //if the sym is already on the board, toggle it off and collapse
         the board
39    if(contain > 0)
40    {
41      list temp = [];
42      for(i = 1; i <= totalSpots; i++)
43      {
44        if( i < contain )
45        {
46          temp += llList2String(symList, i−1);
47        }
48        else if ( i < totalSpots)
49        {
50          temp += llList2String(symList, i);
51          llSetLinkTexture( i, llList2String(symList, i), ALL_SIDES );
52        }
53        else
54        {
55          temp += "Sym−blank";
56          llSetLinkTexture( i, "Sym−blank", ALL_SIDES );
57        }
58      }
59      integer boardSpot = llList2Integer(symList, totalSpots) − 1;
60      temp += boardSpot;
61      return temp;
62    }
63    //if not, place it on the bottom of the board
64    else if(llList2Integer(symList, totalSpots) <= totalSpots)
```

```
65    {
66       list temp = [];
67       for(i = 1; i <= totalSpots; i++)
68       {
69          if(i != llList2Integer(symList, totalSpots))
70          {
71             temp += llList2String(symList, i-1);
72          }
73          else
74          {
75             temp += sym;
76             llSetLinkTexture( llList2Integer(symList, totalSpots), sym,
                     ALL_SIDES );
77          }
78       }
79       integer boardSpot = llList2Integer(symList, totalSpots) + 1;
80       temp += boardSpot;
81       return temp;
82    }
83    else{
84       return symList;
85    }
86 }
87
88 switch_board(list symList)
89 {
90    integer i;
91    for(i=1; i <= totalSpots; i++)
92    {
93       llSetLinkTexture( i, llList2String(symList, i-1), ALL_SIDES );
94    }
95 }
96
97 //Clears the board, removes all text and resets the lists.
98 reset_board()
99 {
100   currentDia = 0;
101   sym01 = ["Sym-blank", "Sym-blank", "Sym-blank", "Sym-blank",
            "Sym-blank", "Sym-blank", 1];
102   sym02 = ["Sym-blank", "Sym-blank", "Sym-blank", "Sym-blank",
            "Sym-blank", "Sym-blank", 1];
103   integer i;
104   for(i=1; i <= totalSpots; i++)
105   {
106      llSetLinkTexture( i, "Sym-blank", ALL_SIDES );
107   }
108   llSay(commandChannel, "lieDown");
109 }
```

```
110
111 default
112 {
113     state_entry ()
114     {
115      currentMenu = 0;
116      currentDia = 0;
117      commandChannel = -100;
118      reset_board ();
119      dialogChannel = -1 - (integer)("0x" + llGetSubString(
             (string)llGetKey(), -7, -1) );
120     }
121
122     touch_end(integer a)
123     {
124      ToucherID = llDetectedKey(0);
125      llListenRemove(listenHandle);
126      listenHandle = llListen(dialogChannel, "", ToucherID, "");
127      llDialog(ToucherID, info, menuChoices, dialogChannel);
128      llSetTimerEvent(60.0); // Here we set a time limit for responses
129     }
130
131     listen(integer channel, string name, key id, string message)
132     {
133      if (message == "-")
134      {
135        currentMenu = 0;
136        llDialog(ToucherID, info, menuChoices, dialogChannel);
137        return;
138      }
139
140      llListenRemove(listenHandle);
141      //  stop timer since the menu was clicked
142      llSetTimerEvent(0);
143
144      if(currentMenu == 0) //Main menu
145      {
146        if (message == llList2String(menuChoices, 3)) //Start screen
147        {
148          switch_board(symStart);
149        }
150        else if (message == llList2String(menuChoices, 4)) //Patient
               Examination Menu
151        {
152          switch_board(sym01);
153          currentMenu = 1;
154          listenHandle = llListen(dialogChannel, "", ToucherID, "");
155          llDialog(ToucherID, info, sym01Choices, dialogChannel);
```

```
156            llSetTimerEvent(60.0); // Here we set a time limit for
                     responses
157          }
158        else if (message == llList2String(menuChoices, 5)) //Patient
               Testing Menu
159        {
160          switch_board(sym02);
161          currentMenu = 2;
162          listenHandle = llListen(dialogChannel, "", ToucherID, "");
163          llDialog(ToucherID, info, sym02Choices, dialogChannel);
164          llSetTimerEvent(60.0); // Here we set a time limit for
                     responses
165        }
166        else if (message == llList2String(menuChoices, 0))
               //Diagnostics and treatment menu
167        {
168          switch_board(treat);
169          currentMenu = 3;
170          listenHandle = llListen(dialogChannel, "", ToucherID, "");
171          llDialog(ToucherID, info, treatChoices, dialogChannel);
172          llSetTimerEvent(60.0); // Here we set a time limit for
                     responses
173        }
174        else if (message == llList2String(menuChoices, 1))
175        {
176          if (currentDia = 0)
177          {
178            switch_board(empty);
179          }
180          else if (currentDia = 1)
181          {
182            switch_board(res1);
183          }
184          else if (currentDia = 2)
185          {
186            switch_board(res2);
187          }
188          else if (currentDia = 3)
189          {
190            switch_board(res3);
191          }
192          else if (currentDia = 4)
193          {
194            switch_board(res4);
195          }
196        }
197        else if (message == llList2String(menuChoices, 2))
198        {
```

83

```
199                reset_board ();
200            }
201        }
202        else  if (currentMenu == 1)
203        {
204          if  (message == llList2String (sym01Choices ,  3))
205          {
206            sym01 = toggle_board (  "Sym−01−01" ,  sym01  );
207          }
208          else  if  (message == llList2String (sym01Choices ,  4))
209          {
210            sym01 = toggle_board (  "Sym−01−02" ,  sym01  );
211          }
212          else  if  (message == llList2String (sym01Choices ,  5))
213          {
214            sym01 = toggle_board (  "Sym−01−03" ,  sym01  );
215          }
216          else  if  (message == llList2String (sym01Choices ,  0))
217          {
218            sym01 = toggle_board (  "Sym−01−04" ,  sym01  );
219          }
220          else  if  (message == llList2String (sym01Choices ,  1))
221          {
222            sym01 = toggle_board (  "Sym−01−05" ,  sym01  );
223          }
224          else  if  (message == llList2String (sym01Choices ,  2))
225          {
226            sym01 = toggle_board (  "Sym−01−06" ,  sym01  );
227          }
228          currentMenu = 0;
229        }
230        else  if (currentMenu == 2)
231        {
232          if  (message == llList2String (sym02Choices ,  3))
233          {
234            sym02 = toggle_board (  "Sym−02−01" ,  sym02  );
235          }
236          else  if  (message == llList2String (sym02Choices ,  4))
237          {
238            sym02 = toggle_board (  "Sym−02−02" ,  sym02  );
239          }
240          else  if  (message == llList2String (sym02Choices ,  0))
241          {
242            sym02 = toggle_board (  "Sym−02−03" ,  sym02  );
243          }
244          else  if  (message == llList2String (sym02Choices ,  1))
245          {
246            sym02 = toggle_board (  "Sym−02−04" ,  sym02  );
```

```
247            }
248          currentMenu = 0;
249        }
250      else if (currentMenu == 3)
251      {
252        if (message == llList2String(treatChoices, 3))
253        {
254          currentDia = 1;
255          switch_board(res1);
256          llSay(commandChannel, "die");
257        }
258        else if (message == llList2String(treatChoices, 4))
259        {
260          currentDia = 2;
261          switch_board(res2);
262          llSay(commandChannel, "sitUp");
263        }
264        else if (message == llList2String(treatChoices, 0))
265        {
266          currentDia = 3;
267          switch_board(res3);
268        }
269        else if (message == llList2String(treatChoices, 1))
270        {
271          currentDia = 4;
272          switch_board(res4);
273        }
274        currentMenu = 0;
275      }
276    }
277
278    timer()
279      {
280          llSetTimerEvent(0);
281      //Stop listen
282          llListenRemove(listenHandle);
283      }
284 }
```

Parts/Appendices/Code/infoBoard2.c

E.2   Case 2 Blackboard

```
1 list menuChoices = ["Behandling", "Resulater", "Reset", "Handlinger",
    "Symptomer", "Blodtester", "Start", "-"];
2 list sym01Choices = ["Seng", "EKG", "-", "Akutteam", "Luftveier",
    "oksygen"];
3 list sym02Choices = ["Ekkokardiogram", "Koronar angiografi", "-",
    "Smerter", "EKG"];
```

```
4 list sym03Choices = ["ASAT", "LDH", "-", "Troponin T", "CK-MB"];
5 list treatChoices = ["Alternativ 1", "Alternativ 2", "Alternativ 3",
      "-"];
6 string info = "\nKontroller tavlen:";    // The newline (\n) helps to
      visually separate this text from the dialog heading line
7 key ToucherID;
8 integer dialogChannel;
9 integer commandChannel;
10 integer listenHandle_01;
11 integer listenHandle_02;
12 integer currentMenu;
13 integer currentDia;
14 string controllerKey = "bbacddeb-f412-db14-ae93-f4794edbc0d5";
15
16 integer totalSpots = 6;
17 list empty = ["Sym-blank", "Sym-blank", "Sym-blank", "Sym-blank",
      "Sym-blank", "Sym-blank"];
18 list symStart = ["S2-Start-01", "S2-Start-02", "S2-Start-03",
      "S2-Start-04", "S2-Start-05", "Sym-blank"];
19 list sym01 = ["S2-Sym-01-01", "Sym-blank", "Sym-blank", "Sym-blank",
      "Sym-blank", "Sym-blank", 2];
20 list sym02 = ["Sym-blank", "Sym-blank", "Sym-blank", "Sym-blank",
      "Sym-blank", "Sym-blank", 1];
21 list sym03 = ["Sym-blank", "Sym-blank", "Sym-blank", "Sym-blank",
      "Sym-blank", "Sym-blank", 1];
22 list treat = ["S2-Treat-01", "S2-Treat-02", "S2-Treat-03",
      "S2-Treat-04", "Sym-blank", "Sym-blank"];
23 list res1 = ["S2-Res-01-01", "S2-Res-01-02", "S2-Res-01-03",
      "Sym-blank", "Sym-blank", "Sym-blank"];
24
25 //Takes the string of an image, and the list corresponding to that
      image,
26 //in order to show it on the board.
27 list toggle_board( string sym, list symList )
28 {
29   //Check if the "sym" is already on the board
30   integer contain = 0;
31   integer i;
32   for(i = 1; i <= totalSpots; i++)
33   {
34     if(llList2String(symList, i-1) == sym)
35     {
36       contain = i;
37     }
38   }
39   //if the sym is already on the board, toggle it off and collapse
        the board
40   if(contain > 0)
```

```
41   {
42      list  temp = [];
43      for(i = 1;  i <= totalSpots;  i++)
44      {
45        if( i < contain )
46        {
47           temp += llList2String(symList, i-1);
48        }
49        else if ( i < totalSpots)
50        {
51           temp += llList2String(symList, i);
52           llSetLinkTexture( i, llList2String(symList, i), ALL_SIDES );
53        }
54        else
55        {
56           temp += "Sym-blank";
57           llSetLinkTexture( i, "Sym-blank", ALL_SIDES );
58        }
59      }
60      integer boardSpot = llList2Integer(symList, totalSpots) - 1;
61      temp += boardSpot;
62      return temp;
63   }
64   //if not, place it on the bottom of the board
65   else if(llList2Integer(symList, totalSpots) <= totalSpots)
66   {
67      list  temp = [];
68      for(i = 1;  i <= totalSpots;  i++)
69      {
70        if(i != llList2Integer(symList, totalSpots))
71        {
72           temp += llList2String(symList, i-1);
73        }
74        else
75        {
76           temp += sym;
77           llSetLinkTexture( llList2Integer(symList, totalSpots), sym,
                 ALL_SIDES );
78        }
79      }
80      integer boardSpot = llList2Integer(symList, totalSpots) + 1;
81      temp += boardSpot;
82      return temp;
83   }
84   else{
85      return symList;
86   }
87 }
```

```
88
89  switch_board ( list symList )
90  {
91    integer i;
92    for ( i =1; i <= totalSpots ; i++)
93    {
94      llSetLinkTexture ( i , llList2String (symList , i −1), ALL_SIDES );
95    }
96  }
97
98  //Clears the board , removes all text and resets the lists .
99  reset_board ()
100 {
101   currentDia = 0;
102   sym01 = [ "S2−Sym−01−01", "Sym−blank", "Sym−blank", "Sym−blank",
            "Sym−blank", "Sym−blank", 2 ];
103   sym02 = [ "Sym−blank", "Sym−blank", "Sym−blank", "Sym−blank",
            "Sym−blank", "Sym−blank", 1 ];
104   sym03 = [ "Sym−blank", "Sym−blank", "Sym−blank", "Sym−blank",
            "Sym−blank", "Sym−blank", 1 ];
105   integer i;
106   for ( i =1; i <= totalSpots ; i++)
107   {
108     llSetLinkTexture ( i , "Sym−blank", ALL_SIDES );
109   }
110 }
111
112 default
113 {
114   state_entry ()
115   {
116    currentMenu = 0;
117    currentDia = 0;
118    reset_board ();
119    dialogChannel = −1 − ( integer )( "0x" + llGetSubString (
            ( string ) llGetKey () , −7, −1) );
120    commandChannel = −101;
121
122    listenHandle_02 = llListen (commandChannel , "" , controllerKey , "" );
123   }
124
125   touch_end ( integer a)
126   {
127    ToucherID = llDetectedKey (0);
128    llListenRemove ( listenHandle_01 );
129    listenHandle_01 = llListen ( dialogChannel , "" , ToucherID , "" );
130    llDialog ( ToucherID , info , menuChoices , dialogChannel );
131    llSetTimerEvent (60.0); // Here we set a time limit for responses
```

```
132    }
133
134    listen ( integer channel , string name, key id , string message)
135    {
136      if ( channel == commandChannel )
137      {
138       if ( message == "reveal" )
139       {
140         llSetLinkAlpha ( LINK_SET, 1.0 , ALL_SIDES );
141       }
142       else if ( message == "moveToBed" )
143       {
144         llSetRegionPos ( <95.5, 47.7, 29.7> );
145       }
146       else if ( message == "reset" )
147       {
148         reset_board ();
149         llSetRegionPos ( <64.1, 70.3, 29.7> );
150         llSetLinkAlpha ( LINK_SET, 0.0 , ALL_SIDES );
151       }
152      }
153      else if ( channel == dialogChannel )
154      {
155        if (message == "-")
156        {
157          currentMenu = 0;
158          llDialog (ToucherID , info , menuChoices , dialogChannel);
159          return ;
160        }
161
162        llListenRemove ( listenHandle_01 );
163        //  stop timer since the menu was clicked
164        llSetTimerEvent (0);
165
166        if (currentMenu == 0)  //Main menu
167        {
168          if (message == llList2String (menuChoices , 6))  //Start screen
169          {
170            switch_board (symStart);
171          }
172          else if (message == llList2String (menuChoices , 3))  //Action
                 Menu
173          {
174            switch_board (sym01);
175            currentMenu = 1;
176            listenHandle_01 = llListen (dialogChannel , "", ToucherID ,
                 "");
177            llDialog (ToucherID , info , sym01Choices , dialogChannel);
```

```
178              llSetTimerEvent(60.0); // Here we set a time limit for
                     responses
179          }
180          else if (message == llList2String(menuChoices, 4)) //Patient
                 Testing and Diagnostics Menu
181          {
182            switch_board(sym02);
183            currentMenu = 2;
184            listenHandle_01 = llListen(dialogChannel, "", ToucherID,
                   "");
185            llDialog(ToucherID, info, sym02Choices, dialogChannel);
186            llSetTimerEvent(60.0); // Here we set a time limit for
                     responses
187          }
188          else if (message == llList2String(menuChoices, 5)) //Patient
                 Blood Testing Menu
189          {
190            switch_board(sym03);
191            currentMenu = 3;
192            listenHandle_01 = llListen(dialogChannel, "", ToucherID,
                   "");
193            llDialog(ToucherID, info, sym03Choices, dialogChannel);
194            llSetTimerEvent(60.0); // Here we set a time limit for
                     responses
195          }
196          else if (message == llList2String(menuChoices, 0))
                 //Diagnostics and treatment menu
197          {
198            switch_board(treat);
199            currentMenu = 4;
200            listenHandle_01 = llListen(dialogChannel, "", ToucherID,
                   "");
201            llDialog(ToucherID, info, treatChoices, dialogChannel);
202            llSetTimerEvent(60.0); // Here we set a time limit for
                     responses
203          }
204          else if (message == llList2String(menuChoices, 1))
205          {
206            if (currentDia = 0)
207            {
208              switch_board(empty);
209            }
210            else if (currentDia = 1)
211            {
212              switch_board(res1);
213            }
214          }
215          else if (message == llList2String(menuChoices, 2))
```

```
216                {
217                   reset_board();
218                   llRegionSay( commandChannel, "pain" );
219                   llRegionSay( commandChannel, "lieDown" );
220                }
221             }
222          else if(currentMenu == 1)
223          {
224             if (message == llList2String(sym01Choices, 3))
225             {
226                sym01 = toggle_board( "S2-Sym-01-02", sym01 );
227             }
228             else if (message == llList2String(sym01Choices, 4))
229             {
230                sym01 = toggle_board( "S2-Sym-01-03", sym01 );
231             }
232             else if (message == llList2String(sym01Choices, 5))
233             {
234                sym01 = toggle_board( "S2-Sym-01-04", sym01 );
235                llRegionSay( commandChannel, "painkiller" );
236             }
237             else if (message == llList2String(sym01Choices, 0))
238             {
239                sym01 = toggle_board( "S2-Sym-01-05", sym01 );
240             }
241             else if (message == llList2String(sym01Choices, 1))
242             {
243                sym01 = toggle_board( "S2-Sym-01-06", sym01 );
244             }
245             currentMenu = 0;
246          }
247          else if(currentMenu == 2)
248          {
249             if (message == llList2String(sym02Choices, 3))
250             {
251                sym02 = toggle_board( "S2-Sym-02-01", sym02 );
252             }
253             else if (message == llList2String(sym02Choices, 4))
254             {
255                sym02 = toggle_board( "S2-Sym-02-02", sym02 );
256             }
257             else if (message == llList2String(sym02Choices, 0))
258             {
259                sym02 = toggle_board( "S2-Sym-02-03", sym02 );
260             }
261             else if (message == llList2String(sym02Choices, 1))
262             {
263                sym02 = toggle_board( "S2-Sym-02-04", sym02 );
```

```
264              }
265              currentMenu = 0;
266          }
267        else  if ( currentMenu == 3)
268        {
269           if  ( message == llList2String (sym03Choices ,  3))
270           {
271              sym03 = toggle_board ( "S2–Sym−03−01", sym03 );
272           }
273           else  if  ( message == llList2String ( sym03Choices ,  4))
274           {
275              sym03 = toggle_board ( "S2–Sym−03−02", sym03 );
276           }
277           else  if  ( message == llList2String ( sym03Choices ,  0))
278           {
279              sym03 = toggle_board ( "S2–Sym−03−03", sym03 );
280           }
281           else  if  ( message == llList2String ( sym03Choices ,  1))
282           {
283              sym03 = toggle_board ( "S2–Sym−03−04", sym03 );
284           }
285           currentMenu = 0;
286        }
287        else  if ( currentMenu == 4)
288        {
289           if  ( message == llList2String ( treatChoices ,  0))
290           {
291              currentDia = 1;
292              switch_board ( res1 );
293              llRegionSay ( commandChannel, "sitUp" );
294           }
295           else  if  ( message == llList2String ( treatChoices ,  1))
296           {
297              currentDia = 1;
298              switch_board ( res1 );
299              llRegionSay ( commandChannel, "sitUp" );
300           }
301           else  if  ( message == llList2String ( treatChoices ,  2))
302           {
303              currentDia = 1;
304              switch_board ( res1 );
305              llRegionSay ( commandChannel, "sitUp" );
306           }
307           currentMenu = 0;
308        }
309     }
310   }
311
```

```
312   timer ()
313      {
314          llSetTimerEvent (0);
315      //Stop listen
316          llListenRemove (listenHandle_01);
317      }
318 }
```

Parts/Appendices/Code/S2–infoBoard3.c

E.3   Scenario Controller

```
1 key bot_per_UUID = "bfe49eaf-2aa1-4908-becb-bf5b4f7683e4";
2 string bot_per_passkey = "e3092d4954";
3
4 key bot_olsen_UUID = "43973410-07e8-4969-bb5d-dbe7bf432ad8";
5 string bot_olsen_passkey = "0d87ec8ce7";
6
7 list controlChoices = ["S2 reveal", "S2 to bed", "S2 reset", "Olsen
     Init", "Olsen Sit", "Olsen Sleep", "Per Init", "Per Sleep", "Per
     Face", "-"];
8 string info = "\nControl the bot:";    // The newline (\n) helps to
     visually separate this text from the dialog heading line
9 key ToucherID;
10 integer dialogChannel;
11 integer S2commandChannel;
12 integer listenHandle;
13 integer faceData;
14
15 secondbot_process_command_im (key bot, string passkey, string command)
16 {
17   llInstantMessage (bot,""+command+"@@@"+llSHA1String (""+command+""+passkey+""))
18 }
19 default
20 {
21    state_entry ()
22    {
23     dialogChannel = -1 - (integer)("0x" + llGetSubString (
          (string)llGetKey (), -7, -1) );
24     S2commandChannel = -101;
25     faceData = 0;
26
27     llRequestPermissions (bot_olsen_UUID,
          PERMISSION_TRIGGER_ANIMATION);
28     llRequestPermissions (bot_olsen_UUID,
          PERMISSION_OVERRIDE_ANIMATIONS);
29
30     if ( llRequestAgentData ( bot_per_UUID, DATA_ONLINE ) )
31     {
```

93

```
32          llRequestPermissions(bot_per_UUID,
                PERMISSION_TRIGGER_ANIMATION);
33          llRequestPermissions(bot_per_UUID,
                PERMISSION_OVERRIDE_ANIMATIONS);
34       }
35     }
36
37     touch_end(integer a)
38     {
39      ToucherID = llDetectedKey(0);
40      llListenRemove(listenHandle);
41      listenHandle = llListen(dialogChannel, "", ToucherID, "");
42      llDialog(ToucherID, info, controlChoices, dialogChannel);
43      llSetTimerEvent(60.0); // Here we set a time limit for responses
44     }
45
46     listen(integer channel, string name, key id, string message)
47     {
48       if (message == "-")
49       {
50         llOwnerSay(llGetKey());
51         llDialog(ToucherID, info, controlChoices, dialogChannel);
52         return;
53       }
54
55       llListenRemove(listenHandle);
56       // stop timer since the menu was clicked
57       llSetTimerEvent(0);
58
59
60       if ( message == llList2String(controlChoices, 6) ) //Per
               initialize
61       {
62         secondbot_process_command_im(bot_per_UUID, bot_per_passkey,
               "Teleport###NTNU###89###45###26");
63       }
64       else if ( message == llList2String(controlChoices, 7) )
65       {
66         //secondbot_process_command_im("Sit###5787756d-2f91-513d-3a37-379569ee160
67         secondbot_process_command_im(bot_per_UUID, bot_per_passkey,
               "Sit###c19cb034-ddc1-cd19-e1a9-27c6f995c5fd");
68       }
69       else if ( message == llList2String(controlChoices, 8) )
70       {
71         if ( faceData )
72         {
73           secondbot_process_command_im(bot_per_UUID, bot_per_passkey,
                 "Outfit###EvenNormal");
```

```
74        //secondbot_process_command_im(bot_per_UUID, bot_per_passkey,
              "OutfitAdd###5a90a9cd-186a-3e63-9000-609f0b3e3138");
75        faceData = 0;
76      }
77      else
78      {
79        secondbot_process_command_im(bot_per_UUID, bot_per_passkey,
              "Outfit###EvenRed");
80        //secondbot_process_command_im(bot_per_UUID, bot_per_passkey,
              "OutfitAdd###6b67f820-9211-7bc6-5605-801be45c4d45");
81        faceData = 1;
82      }
83    }
84    if ( message == llList2String(controlChoices, 3) ) //Olsen
          initialize
85    {
86      secondbot_process_command_im(bot_olsen_UUID, bot_olsen_passkey,
            "Teleport###NTNU###41###71###26");
87    }
88    else if ( message == llList2String(controlChoices, 4) )
89    {
90      float xxx;
91      float yyy;
92      vector corner = llGetRegionCorner();
93
94      xxx = corner.x + 60;
95      yyy = corner.y + 67;
96      secondbot_process_command_im(bot_olsen_UUID, bot_olsen_passkey,
            "MoveTo###"+(string)((integer)(xxx))+"###"+(string)((integer)(yyy))+"#
97
98      secondbot_process_command_im(bot_olsen_UUID, bot_olsen_passkey,
            "Sit###7ec4cca3-cf7e-017f-ba8e-96b7e0ba26fb");
99    }
100   else if ( message == llList2String(controlChoices, 5) )
101   {
102     secondbot_process_command_im(bot_olsen_UUID, bot_olsen_passkey,
            "Teleport###NTNU###91###50###26");
103     secondbot_process_command_im(bot_olsen_UUID, bot_olsen_passkey,
            "Sit###dd3d0ae7-39cd-83e3-35a0-22cf4178f74d");
104
105   }
106   else if (message == llList2String(controlChoices, 0))
107   {
108     llRegionSay( S2commandChannel, "reveal" );
109   }
110   else if (message == llList2String(controlChoices, 1))
111   {
112     llRegionSay( S2commandChannel, "moveToBed" );
```

95

```
113        }
114      else if (message == llList2String(controlChoices, 2))
115      {
116         llRegionSay( S2commandChannel, "reset" );
117      }
118      else
119      {
120
121      }
122    }
123
124    timer()
125      {
126          llSetTimerEvent(0);
127      //Stop listen
128          llListenRemove(listenHandle);
129      //Stop clapping
130      llStopAnimation("clap");
131      llResetAnimationOverride( "Sitting" );
132      }
133 }
```

Parts/Appendices/Code/ScenarioController.c

E.4 Bed Script Case 1

```
1 // Sit script
2 // Original script by Asp Grelling 23APR07
3 // Modified by Andreas Mosand
4
5 vector sitPosition = <0.0, -0.1, -0.1> ; // Sit offset
6 vector sitRotation; // Sit rotation
7 integer dialogChannel;
8 integer listenHandle;
9
10 key avatar ;
11 key sitter = NULL_KEY ;
12 string anim = "BreathSleep" ;
13 string anim2 = "SitUp" ;
14 string anim3 = "SitUpStill" ;
15 string anim4 = "dead";
16
17 default
18 {
19     state_entry()
20     {
21     dialogChannel = -100;
22         sitRotation = <0, 0, -90> * DEG_TO_RAD;
23         llSetSitText("Sit here");
```

```
24             rotation rot = llEuler2Rot(sitRotation);
25             llSitTarget(sitPosition, rot);
26             sitter = NULL_KEY ;
27         }
28
29     on_rez(integer param)
30     {
31         llResetScript();
32     }
33
34     changed(integer change)
35     {
36         if(change & CHANGED_LINK)
37         {
38             avatar = llAvatarOnSitTarget();
39             if ( avatar )
40             {
41                 // Request permision to sit
42                 llRequestPermissions(avatar,PERMISSION_TRIGGER_ANIMATION);
43             }
44             else
45             {
46                 if ( sitter )
47                 {
48                     llUnSit(sitter);
49                     sitter = NULL_KEY ;
50         llListenRemove(listenHandle);
51                 }
52                 else
53                 {
54                     // We can get here for many reasons
55                     // Do nothing
56                 }
57             }
58         }
59     }
60
61     run_time_permissions(integer perm)
62     {
63         if(perm & PERMISSION_TRIGGER_ANIMATION)
64         {
65             // Sit action
66             sitter = avatar ;
67             llStopAnimation("sit");
68             llStartAnimation(anim);
69
70     //Post sit actions
71     listenHandle = llListen(dialogChannel, "", NULL_KEY, "");
```

```
72              }
73              else
74              {
75                   // We do not have permissions, so unist
76                   llUnSit(sitter);
77                   sitter = NULL_KEY ;
78              }
79         }
80
81    listen(integer channel, string name, key id, string message)
82        {
83             if (message == "sitUp" & sitter != NULL_KEY)
84             {
85                   llStartAnimation(anim2);
86          llSleep(2.0);
87          llStopAnimation(anim);
88          llStartAnimation(anim3);
89              }
90        else if (message == "die" & sitter != NULL_KEY)
91        {
92          llStopAnimation(anim);
93          llStartAnimation(anim4);
94        }
95        else if (message == "lieDown" & sitter != NULL_KEY)
96             {
97                   llStartAnimation(anim);
98
99             }
100       }
101 }
```

Parts/Appendices/Code/bedScript.c

E.5   Bed Script Case 2

```
1  // Sit script
2  // Original script by Asp Grelling 23APR07
3  // Modified by Andreas Mosand
4
5  vector sitPosition = <0.0, 0.4, −0.13> ; // Sit offset
6  vector sitRotation; // Sit rotation
7  integer dialogChannel;
8  integer listenHandle;
9
10 key avatar ;
11 key sitter = NULL_KEY ;
12 string anim = "S2−BedPain" ;
13 string anim2 = "SitUp" ;
14 string anim3 = "SitUpStill" ;
```

```
15 string anim4 = "dead";
16
17 default
18 {
19     state_entry()
20     {
21     dialogChannel = -101;
22         sitRotation = <0, 0, -90> * DEG_TO_RAD;
23         llSetSitText("Sit here");
24         rotation rot = llEuler2Rot(sitRotation);
25         llSitTarget(sitPosition, rot);
26         sitter = NULL_KEY ;
27     listenHandle = llListen(dialogChannel, "", NULL_KEY, "");
28     }
29
30     on_rez(integer param)
31     {
32         llResetScript();
33     }
34
35     changed(integer change)
36     {
37         if(change & CHANGED_LINK)
38         {
39             avatar = llAvatarOnSitTarget();
40             if ( avatar )
41             {
42                 // Request permision to sit
43                 llRequestPermissions(avatar,PERMISSION_TRIGGER_ANIMATION);
44             }
45             else
46             {
47                 if ( sitter )
48                 {
49                     llUnSit(sitter);
50                     sitter = NULL_KEY ;
51                 }
52                 else
53                 {
54                     // We can get here for many reasons
55                     // Do nothing
56                 }
57             }
58         }
59     }
60
61     run_time_permissions(integer perm)
62     {
```

```
63            if (perm & PERMISSION_TRIGGER_ANIMATION)
64            {
65                // Sit action
66                sitter = avatar ;
67                llStopAnimation("sit");
68                llStartAnimation(anim);
69            }
70            else
71            {
72                // We do not have permissions, so unist
73                llUnSit(sitter);
74                sitter = NULL_KEY ;
75            }
76        }
77
78    listen(integer channel, string name, key id, string message)
79        {
80            if (message == "sitUp" & sitter != NULL_KEY)
81            {
82                llStartAnimation(anim2);
83        llSleep(2.0);
84        llStopAnimation(anim);
85        llStartAnimation(anim3);
86            }
87        else if (message == "painkiller")
88        {
89            if (sitter != NULL_KEY)
90            {
91                llStopAnimation(anim);
92            }
93            anim = "BreathSleep";
94            if (sitter != NULL_KEY)
95            {
96                llStartAnimation(anim);
97            }
98        }
99        else if (message == "pain")
100       {
101           if (sitter != NULL_KEY)
102           {
103               llStopAnimation(anim);
104           }
105           anim = "S2-BedPain";
106           if (sitter != NULL_KEY)
107           {
108               llStartAnimation(anim);
109           }
110       }
```

```
111        else if (message == "lieDown" & sitter != NULL_KEY)
112            {
113                llStartAnimation(anim);
114
115            }
116        }
117 }
```

Parts/Appendices/Code/S2–bedScript.c

E.6   Chair Script Case 2

```
 1 // Sit script
 2 // Original script by Asp Grelling 23APR07
 3 // Modified by Andreas Mosand
 4
 5 vector sitPosition = <0.0, 0.1, −0.2> ; // Sit offset
 6 vector sitRotation; // Sit rotation
 7 integer dialogChannel;
 8 integer listenHandle;
 9
10 key avatar ;
11 key sitter = NULL_KEY ;
12 string anim = "S2−Sit−01" ;
13 string anim2 = "S2−Sit−02" ;
14
15 default
16 {
17     state_entry()
18     {
19     dialogChannel = −101;
20         sitRotation = <0, 0, −90> * DEG_TO_RAD;
21         llSetSitText("Sit here");
22         rotation rot = llEuler2Rot(sitRotation);
23         llSitTarget(sitPosition, rot);
24         sitter = NULL_KEY ;
25     }
26
27     on_rez(integer param)
28     {
29         llResetScript();
30     }
31
32     changed(integer change)
33     {
34         if(change & CHANGED_LINK)
35         {
36             avatar = llAvatarOnSitTarget();
37             if ( avatar )
```

101

```
38                    {
39                        // Request permision to sit
40                        llRequestPermissions(avatar ,PERMISSION_TRIGGER_ANIMATION);
41                    }
42                    else
43                    {
44                        if ( sitter )
45                        {
46                            llUnSit(sitter );
47                            sitter = NULL_KEY ;
48                llListenRemove(listenHandle);
49                        }
50                        else
51                        {
52                            // We can get here for many reasons
53                            // Do nothing
54                        }
55                    }
56            }
57        }
58
59        run_time_permissions(integer perm)
60        {
61            if(perm & PERMISSION_TRIGGER_ANIMATION)
62            {
63                // Sit action
64                sitter = avatar ;
65                llStopAnimation("sit");
66                llStartAnimation(anim);
67
68        listenHandle = llListen(dialogChannel , "", NULL_KEY, "");
69            }
70            else
71            {
72                // We do not have permissions, so unist
73                llUnSit(sitter);
74                sitter = NULL_KEY ;
75            }
76        }
77
78    listen(integer channel, string name, key id, string message)
79        {
80        if (message == "painkiller" & sitter != NULL_KEY)
81        {
82            llStopAnimation(anim);
83            llStartAnimation(anim2);
84        }
85        else if (message == "pain" & sitter != NULL_KEY)
```

```
86              {
87         llStopAnimation(anim2);
88              llStartAnimation(anim);
89
90          }
91      }
92 }
```

Parts/Appendices/Code/chairScript.c