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Virtual Operating Room for Collaborative Training of Surgical Nurses

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Abstract. In this paper, we present the first results of a study on exploring how to support collaborative learning of surgical nursing students in a 3D virtual world. A Virtual Operating room, resembling the one at St. Olav's University Hospital in Trondheim, Norway was created in Second Life to accommodate an educational role-play. In this role-play, the operating nursing students could practice communication with patients and cooperation in the team while preparing patients for surgery. At the first stage of the evaluation, the virtual simulation has been tested among nine postgraduate nursing students. The participants gave their evaluation and opinions in the form of questionnaires and discussion after the role-plays. Following the analysis of the data, we present a summary of the most important results in this paper. This study provides a number of suggestions for improving the learning process when role-playing in a virtual environment. We demonstrate that an educational simulation can be implemented with limited resources, and yet be practically useful in education of health personnel. Further research with medical and nursing students is highly applicable and feasible, and should include a larger group of participants. In the next stage of our work, the evaluation of the Virtual Operating room has been conducted with nurses, who are on an earlier stage of their study program, as well as anesthesia nurses and non-medics.

Keywords: 3D collaborative virtual environments, medical training, collaborative learning, virtual operating room, educational role-play

1 Introduction

At the core of educational activities of health professionals at all levels is the patient. The ultimate goal of basic research is the treatment offered to patients. Traditionally, the bulk of the student contact with the patient has been through placement mainly in hospitals. However, there is a major challenge to this – the availability of time for contacting patients. One aspect is the increase in number of students. This is in part ameliorated by increasing the number of patients. The other aspect is not so easily remedied, the fact that patients spend less and less time in hospitals. As the hospitals improve their effectiveness, e.g. by increasing the number of day patients, there is dramatically less time for the contact between students and patients. Consequently, students get less time on the task. Thus, there is a need for solutions that give the students more time on tasks or make the time with the patients more effective.

In addition, in today's hospitals, a patient is treated not by a single practitioner, but by a team of specialists, with complex collaborative procedures and practices within the team. That means that a student needs to practice not only on patient interaction, but also on complex interactions within a team of professionals, such as when preparing a patient for surgery.

One has to look for alternatives to facilitate practice and explorative learning experiences to meet these challenges. Addressing the knowledge needs requires that students are provided with flexible online educational solutions which must be embedded in a holistic system. Therefore, the idea of an online virtual university hospital has emerged, to be a venue for learning, research, and development. The idea is to make a virtual mirror of St. Olav's University Hospital (St. Olav) as it is one of the most modern university hospitals in the world. It has a state of the art technological platform and modern clinical buildings with a unique feature: the faculty of Medicine at the Norwegian University of Science and Technology (NTNU) has integrated its teaching and research facilities within the hospital. In addition, NTNU and St. Olav have developed 'Kunnskapsportalen', a portal for distributing knowledge and information to patients and the general public, as well as to students, staff, and researchers.

In this paper, we present a pilot study within the Virtual Hospital project. The goal of this study is exploring educational role-playing in a 3D virtual environment as a method for training communication, cooperation within a team, and other practical skills of surgical nurses. The study was conducted at the NTNU, involving several other organizations. The major learning objective of the training simulation developed is to obtain in-depth knowledge of communication and interaction with patients and their families. In particular, we focused on the procedures of receiving and delivering patients on their way to complicated operations, something that requires coordination between ward and surgical nurses. The teachers from the Faculty of Nursing at the Sør-Trøndelag University College (HiST) have contributed to providing learning goals and designing scenarios for the study. Another group of subject experts from the Department of Neurosurgery at St. Olav was involved to provide requirements and feedback for the design of the virtual environment.

2 Background

As identified in recent relevant studies in the field, “as available teaching time in anatomy and surgery are expected to continue to decline, the adoption of unique instructional methods such as virtual learning may serve not only to attract more technologically inclined candidates but also improve the efficacy of the relatively fewer opportunities that will remain” [1]. This motivates the exploration of different modes for virtual learning, i.e. flexible low-cost 3D virtual simulations, 3D virtual environments, and associated infrastructure accessible over the Internet. Recent studies in the field indicate that this technology can “[...] effectively replicate clinical PBL scenarios”, with the potential “to considerably augment, if not eventually, revolutionize medical education” [1].

Many studies report the potential of three-dimensional virtual worlds (3D VWs) for educational activities [2]. This technology can benefit educational process due to low cost and high safety, three-dimensional representation of learners and objects, and interaction in simulated contexts with a sense of presence [3,4]. Possibilities for synchronous communication and interaction allow using 3D VWs by various collaborative learning approaches [5], as well we facilitate situated learning [6] and project-based learning [7] approaches. Nowadays, 3D VWs can be used in combination with other VR technologies, such as motion tracking and head-mounted displays, to increase the sense of immersion and, therefore, improve the experience, making it more believable and transferable to the real life.

There have been several cases where 3D VWs have been used in the health care domain, including both desktop-based VWs and other VR applications. Examples include training facilities for nurses [8,9] and doctors (e.g., in palliative care units [10]), health information centers, and 3D visualizations of internal organs. Such training is, on several occasions, reported to provide a cost-efficient and user-friendly alternative to real-life role plays and training programs [10]. As demonstrated in several studies, “virtual worlds offer the potential of a new medical education pedagogy to enhance learning outcomes beyond that provided by more traditional online or face-to-face postgraduate professional development activities” [11].

Desktop-based environments have been augmented with VR elements for treatment of various neurological and psychiatric disorders such as autism, phobias, and post-traumatic stress syndrome, the latter especially in military settings. For example, Virtual Afghanistan/Iraq system has undergone successful clinical trials in using exposure therapy for treatment of combat-related post-traumatic stress syndrome among veterans [12]. VR is being increasingly used for developing educational medical visualizations, for example, to be used in anatomy classes [13].

Several leading world universities and hospitals, especially in the US, UK, Australia, and New Zealand have adopted 3D virtual simulation as a part of their educational programs. Examples include virtual hospitals/medical faculties at University of South Florida, Imperial College of London, and Auckland University Hospital. Such environments typically include an array of different facilities, such as emergency room, intensive care unit, nursing simulation, and general information for the public. Other examples include Maternity Ward at Nottingham University and Emergency Prepar-

edness Training at University of Illinois in Second Life (SL). Our own Virtual Hospital initiative is inspired by these projects but seeks to achieve a more holistic and coherent approach to the development of a virtual hospital.

3 Learning Objectives and Collaborative Scenarios

In this project, we focused on communication with patients. Surgical nurses often have to inform, prepare, and even calm both the patient and their relatives before a complicated operation. These elements can be practiced through role-playing different scenarios in the virtual environment in SL.

The learning objectives below are based on the teaching plan for postgraduate surgical nurses at the Faculty of Nursing at HiST and have been used to develop the scenarios for the simulation. The major learning objective is to obtain in-depth knowledge of how to communicate and interact with patients, and their families, in particular when receiving or delivering patients who are on their way to a complicated operation. The major learning goal is split into several sub-goals:

- Learning objective L1: Reassuring a patient in advance of an important and complex operation
- Learning objective L2: Dealing with relatives
- Learning objective L3: Communicating / dealing with patients with immigrant background, especially women
- Learning objective L4: Reassuring / dealing with children in advance of an operation
- Learning objective L5: Dealing with a seriously ill and potentially dying patient
- Learning objective L6: Performing basic medical tasks prior to the operation (e.g., moving the operating table and disinfection)

In order to address the learning objectives given above, four typical scenarios have been developed, including a variety of medical cases and a variety of patient and relatives groups, as well as both males and females, children and patients with immigrant background:

- Learning scenario 1
 - Actors: A woman (patient), surgical nurse, and ward nurse
 - Plot: A 35-year-old woman is admitted to the gynecological department. She is on her way to a surgery for an abscess that will be operated in spinal anesthesia. She lies on a patient bed transported by a nurse from the ward who delivers her to the surgical nurse.
- Learning scenario 2
 - Actors: An immigrant woman (patient), husband (relative), surgical nurse, and ward nurse
 - Plot: An immigrant woman is going to a scheduled hip operation. She will have general anesthesia during the procedure. Her husband comes with her along with the nurse from the ward. She speaks poor Norwegian, and her husband

must therefore be there to translate. She is concerned with keeping her hijab on and wishes to be treated by female personnel only.

- Learning scenario 3
 - Actors: A young boy (patient), his mother (relative), surgical nurse, and ward nurse
 - Plot: A five-year-old boy arrives to the sluice with his mother and nurse from the ward. He is going to recto- and gastroscopy.
- Learning scenario 4
 - Actors: A man (patient), surgical nurse and ward nurse
 - Plot: A man in the age of 40 is going to surgery due to a malignant brain tumor. He has two teenage children that he alone is responsible for back home.

4 Requirements, Design, and Implementation

4.1 Requirements for the Virtual Operating Room and Avatars

The requirements for the virtual operation room were acquired from the Department of Neurosurgery at St. Olav, including photographs and textual description. However, no formal set of requirements was made, therefore, we employed Scrum methodology for the development. We divided the requirements into two parts: the virtual environment and the avatars.

The requirements to the virtual environment describe three rooms, their size, structure and artifacts to fill them (such as equipment and furniture). According to the final requirements, it consists of a hallway leading to three rooms, described below:

- *Waiting room* is an ordinary waiting room that you find within all ordinary hospital clinics, consisting of a reception desk, sitting chairs for patients and relatives, and a table with magazines and papers.
- *Sluice* in this context is a room that health personnel use for the delivery of patients on their way to an operation.
- *Operating room* is a place where the surgeries are conducted. The room is usually equipped with operation lamps, different medical equipment, and an operating table for the patient.

The avatars are divided into three types: patients, relatives, and nurses. The avatars for the relatives had to match the description in the scenarios, e.g. a ‘mother’ or a ‘person with immigrant background’. The patient and the nurse avatars had more details, and they should have been dressed in accordance with the standards adopted at the Norwegian hospitals.

4.2 Design and Implementation

The process of designing and implementing the virtual environment for conducting role-plays was conducted in two iterations with feedback sessions in between. The first one was based on the initial requirements received from St. Olav’s hospital. The

second iteration was based on the feedback from the Faculty of Nursing teachers which generated new requirements and suggestions for improvements to be implemented. We were, however, not able to implement all the requirements (e.g., certain artifacts/equipment) from the initial set, and there were refinements that could have been done in more details (e.g., images and instruments). The goal of this process was to create a virtual environment (Fig. 1, right) that is realistic enough to give a feeling of being in a real operating room at the Department of Neurosurgery at St. Olav's hospital (Fig. 1, left). Since the environment was meant for conducting role-play with the focus on communication (not on interaction with virtual artifacts), the operating room was not evaluated (e.g., considering the functionality of the medical equipment).



Fig. 1. Real life and Second Life operating room

We designed and implemented the building, its rooms, and some details from scratch, but most of the more complex artifacts, such as the operating table, anesthesia machine, and other similar equipment were purchased at the SL marketplace. The negative side of purchasing items created by others is that some minor conflicting details may follow. For instance, the patient bed on wheel was supposed to be used to animate the transportation of patients from the ward or sluice to the operating room. We purchased the only bed with that function available at that time on the SL marketplace. However, it was an 'emergency bed', with an integrated animation of blood infusion into the patient. This last detail would not be correct in the situations given in the scenarios, and the students were instructed to ignore such details.

Nine avatars were required according to scenarios. Customization of the avatar appearance to fit some of the more detailed role descriptions was a time-consuming task. We created 11 avatars, including two spare ones. The resultant nursing avatars had pale green or white clothing where the former is used for the surgical nurses and the latter for the ward nurses (Fig. 2). SL does not have default avatars matching the description of some of the patients and relatives, such as a young boy and a Muslim person. Therefore, we purchased 'skins' and related accessories (e.g., a hijab and jewelry) at the SL marketplace. All patient avatars were required to wear a plain patient gown with a front opening. We purchased a plain white open shirt for the adult patients and a gown with a back opening for the child.



Fig. 2. Nursing avatars

5 Study Settings and Results

5.1 Role-playing Settings

After completing the virtual environment and a set of avatars, we recruited nine post-graduate nursing students from the Faculty of Nursing at HiST, who were on their last year to become surgical nurses. These students already had a bachelor degree in nursing and at least two years of professional experience in addition. In other words, they were well experienced and should already have acquired skills given by the learning objectives (section 3). Therefore, as we could not expect them to learn much from the role-playing, we used their knowledge and experience to evaluate the teaching method and the environment developed. Instead of assessing the learning improvement, we rather asked them to evaluate the simulation and provide feedback on how well it might be suited in the nursing education at an earlier stage.

Low computer competence and little experience with 3D VWs were expected for such a group. In order to address this, a tutorial on the gameplay, such as camera controls and avatar navigation, and a one-hour practice session were conducted before the role-playing session. In order to accommodate role-playing with four players, four fully equipped computers were set up in two different offices at our university (Fig. 3). The third location with a computer, a large screen, and speakers was prepared for the teachers and those students not playing to observe the role-play.

In the beginning of the role-playing session, the students chose one of the roles from each scenario and received “role-play cards” describing their characters. The cards contained information about name, role description, and a description of the situation. In all scenarios, the students were told to improvise their role as best as they could using their knowledge and earlier experience. The teachers and other students were observing the role-play and discussing questions that have been emerging during the play. After completing a scenario, its players joined this group to have a discussion before going to the next scenario.



Fig. 3. Surgical nursing student participates in the role-play (photo by Anne Midling)

5.2 Data Collection

The data in this study was collected from several sources. The role-play in SL was recorded as a screen capture (with sound), while the subsequent discussions were recorded with written notes and sound capture. In addition, a questionnaire consisting of 28 questions was given the students after the role-playing session. It included multiple-choice questions using a five-level Likert scale, 'check-box' questions allowing to select multiple answers from a list of options and open questions.

The questionnaire was divided into four main topics. The first one covered the competences of the participants in use of computers and their previous experience with SL or similar VWs. The second topic included questions about the use of SL during the role-play, including the process of getting used to the navigation, realism of the environment, and game experience. The third topic contained more subject-specific questions on believability of the simulation and its suitability for providing knowledge and skills described in the learning objectives. The fourth topic contained open questions where the students were asked to input proposals for changes and improvements, describe what learning outcomes a student may gain from the simulation, and suggest other areas within medicine they thought could benefit from it.

The group discussion was conducted to supplement the questionnaire and let the participants express ideas immediately after the role-playing. We used five questions to engage the students in a discussion. However, several other questions appeared too. The major topics were the general impression, possible educational value, level of engagement, alternative solutions, and application domains within medicine.

5.3 General Issues

The teachers reported after the role-playing session that not all the students were prepared for the settings. We observed some hesitations every time we asked who wants to go next in playing a scenario. Some of the nurses said that they did not feel that comfortable role-playing in the VW when they knew the other students and the teachers watched the play on a large screen. "One should like to role play, or else the role

will become limited”, a student mentioned in the questionnaire. One student asked if it was possible to identify the person behind an avatar. Even though role playing while being remotely observed by others made some of them uncomfortable, they all tried to play at least once and they came through all the scenarios. It was also observed that the role-playing became smoother for each new scenario as they started to get hold of the navigation in SL and more immersed into acting. This trend was also reflected in the open questions of the questionnaire where one student answered: “The role plays got better eventually. Got more comfortable after some practice”.

5.4 Previous Experience and Technical Issues

The questionnaire reveals that none of the students had any previous experience with SL or other VWs and/or games. Only three out of nine also describe themselves as having good or better computer competence. This is likely to be the reason to why some of the participants were not so steady when moving around and interacting with objects in the virtual world. Six of them answered “neutral” on the question regarding the difficulty in moving the avatar to different places. This may be interpreted that it has been easy to move the avatar as we did not observe any issues there, but challenges came when they were to move the avatar while interacting with objects, for instance, operating the rolling patient bed.

Half of the participants agreed that it went quickly to learn the interface of SL, while the other half answered neutral to this question. We observed that fewer questions were asked as we proceeded, and the participants even started to inform and teach one another of how to manage different SL controls. The students experienced some echo inside the game while playing. This was most likely due to having two computers with microphones located in the same room with a distance not greater than three meters from each other.

Even though the students got one hour of training before conducting the role play, the avatar and camera movement inside the game were still challenging. The majority of the students expressed (both during the role play and during the discussion afterwards) that it were difficult to focus both on role-playing and movement simultaneously. This was also observed, for instance, when one of them lost control over the patient bed, which turned from side to side when trying to reach the operating room. The student tried to get control of the bed in the game while at the same time trying to role-play. It often resulted in laughter from the audience, which appeared interrupting.

5.5 Collaboration

We observed that when the immersion and acting part became better, the collaboration between the participants in SL improved as well. The reason was probably that while the students became more confident in playing ‘difficult’ patients or relatives, the students playing the nurses had to work harder to get things in order. For example in Scenario 2, the Muslim woman refused to take off her hijab, and the two nurses had to talk their way around to get the patient and her husband understand the rules. Another example is from Scenario 3, where the ‘boy’ resisted a while before positioning

his avatar on the bed. His mother, the ward, and the surgical nurse together tried to convince the anxious boy in cooperating and to calm him down.

At some point in every scenario, the role playing started to halt because of a missing part. It was explained that surgical nurses collaborate most often with anesthesia nurses at the operating room. We observed during the role play that anesthesia nurses/doctors were frequently mentioned in the dialogue between the surgical nurses and the patients. The students and teachers mentioned during the discussion that it would have been natural for an anesthesia nurse to take over some of the interaction, as the surgical nurse could not proceed with their tasks without them doing their job. Therefore, it was concluded that anesthesia nurses should be included in future role-plays. This is implemented at the subsequent evaluation as mentioned in the Future work.

5.6 Evaluation of the Environment and the Play

Even though role-playing is not currently used as a tool in their study program, all students except one reported that they felt engaged in the virtual role-plays and the same people found the experience fun and motivating.

The majority of the students were neutral to the question about how realistic or representative the virtual environment in SL was in comparison to St. Olav. Seven students answered that it was difficult to read and interpreted information from the body language and facial expression from the avatars. The ability to read nonverbal cues or signs such as these is an important aspect of being a nurse [14]. The avatar appearance was easier to interpret, as four of them agreed.

We asked the students about what elements they thought gave the most and least information in the simulation. The most informative elements included room design/environment, avatar clothing and their positioning, while the least informative elements were sound and body language. Six of the students agreed that the simulation in general gave them enough information so that they were able to understand the patients, relatives, and their situation. The rest were neutral on this question.

5.7 Value of Using Virtual Simulation

Evaluating the educational value of the simulation, the participants used what they learnt at the college as well as their professional experience. We gave them nine questions asking how well they thought the simulation would contribute to enhancing skills in collaboration and communication with relatives, other health personnel, and different types of patients.

The positive choices on the Likert scale were more frequent. Therefore, we assume that using a simulated environment may be a positive supplement to the education of practical nursing skills. Eight out of nine students answered positively to the question if the use of role-play in a VW can be a supplement to help the surgical nurse students in communicating with patients and relatives.

We listed six other medical areas that might be suitable for practicing inside a VW and asked the students to choose the areas they believed to be most relevant. Four most popular areas selected by seven or more students were collaboration in teams in

an operation room or emergency department, procedural training, anatomical visualization, and diagnostic training. Other popular areas included education of patients and relatives to improve understanding of the treatment procedures and disseminating health-related information to the public in general.

6 Discussion

6.1 Environment Design

The fact that only three of nine students agreed that the virtual environment were realistic and representative to an operating room in real life could be partly attributed to the fact that not all of them have been to the real Neurosurgery operating room that was replicated in this study. From the questions regarding “potential for improvements”, some of them suggested that we should have “more equipment to interact with”. One student mentioned during the discussion that “more items to interact with needs to be included if surgical nurses are to treat and communicate with a patient”. This was explained by that the surgical nurses often communicate their actions to their patients in order to inform the patient and to keep the patient’s thoughts occupied. The lack of interactive items may be an explanation to why most of the students did not find the virtual environment realistic. Such an item could for instance be a blanket to put over the patient, or other items such as suited clothes for the relatives to put on if they were to follow the patient and the nurse to the operating room. However, tasks such as changing avatar clothing during the role-play would require additional training, and therefore, these details were skipped.

The replies to the question on what aspects gave most information show, however, that six of the students did use information given from the “surroundings” which is also reflected in the recordings of the role plays. For example, when one of the surgical nurses tells the patient’s husband to step away from the instrument table when he gets too close, as these instruments are sterile and prepared for surgery (Fig. 4). Another example is the nurse asking the same person not to be in the way, but stand beside the “machine with the screen” located at a distance from the operating table.



Fig. 4. Role-playing, Scenario 2

Another factor contributing to inhibiting the feeling of realism amongst the students might be the lack of experience working with VWs. All nine students answered in the survey that they had no earlier experience with either SL or other VWs. This lack of experience might have made it difficult to feel immersed inside a VW.

6.2 Using the Technology

There are at least three aspects to look at when considering simulation in a VW as a suitable tool in the education of nurses. The first being how much time and effort it takes for both the students and the teachers to gain enough technical knowledge before it becomes useful to practice inside a VW. Our students had no experience with SL or VWs in general, and they got only one hour of training before they were set to role-play the scenarios. The evaluation reveals that it was challenging for the students to focus on their actual task when they simultaneously had to interact with a few set of objects (such as rolling the patient bed and using the operating table). Observing the role play and the recordings afterwards also reveals several disruptions caused by object handling in game. For instance, some students did lose control over the rolling bed, or those playing patients often misclicked and sat down at other objects rather than lying down at the operating table as supposed to. This often led to some laughter amongst the students, and the need for some help before continuing role-playing.

Even though the study was exploring communication with patients, the role play became to a certain extent challenging considering the number of objects the participants had to handle. One hour with tutorial would not have been enough if the students were to interact more and still conduct role-playing fluently. The students from our discussion remarked themselves that 'it does take a while to learn', however, another uttered that 'a day more with role-playing, and they would be skilled'. A third one said that 'it was difficult to role-play when you had to concentrate about the technical part such as navigation, interaction and camera movement. They all agreed on that a larger quantity of training would have been necessary in order to forget the technical aspect completely and focus on their actual task during the role-play.

6.3 Learning and Improving Skills

The second aspect to consider is whether the simulation supports learning and improvement of practical skills. We did not measure this directly during the evaluation, as our participants were postgraduate students on their last year and had both sufficient knowledge of the procedures and work experience. However, we engaged them as evaluators contributing their subjective opinions of how well this type of simulation would benefit nurse students at an earlier stage.

The survey contained nine questions regarding how well the simulation would improve various practical skills of early-stage nursing students. The feedback was positive overall, but we divided it to three types. The most positive feedback was received in two questions on communication and interaction with the patient and with the other medical personnel.

In five other questions, the feedback was also positive, but with one or two neutral answers. Such moderately positive feedback was given to the educational value of the simulation in calming down the patient, communicating and interacting with the patient from a different culture, the child patient, the relatives of the patient, and relatives of the child patient.

Two answers to the remaining two questions were also positive, but had more neutral and some negative answers. These questions were evaluating the usefulness of the simulation for training communication and interaction with the patient who needs an interpreter and the patient who is visibly under stress.

During the discussion, several aspects were appreciated and many suggestions were made by the participants. The students reported that it would be much more appreciated if they could get some feedback during the role-plays from either a teacher or a more experienced nurse. This could for instance be through an avatar standing in the corner and contributing with inputs, functioning as an expert guide. Another suggestion made was to let teachers play the patients, as they often have more experience and they would be more suitable to play them, as it was done e.g., in [11]. We also observed that it was easier for participants to put themselves into the role of a young boy than of the Muslim woman and her husband. However, the results from the two questions regarding their opinion of how well such simulation would improve the skills in communication and interaction were the same for the two patient types.

The students gave several suggestions for improving the scenarios. They agreed that more strict guidelines for the role-plays would be helpful, as the scenarios were quite open only providing the students with some background information before they were asked to improvise. One of the student mentioned “the scenarios would have been too difficult if you do not have any real experience, one would not know how to proceed”. This is important feedback when it comes to using the simulation with students at earlier stages in their studies and later.

The last suggestion was to integrate different scenarios in a single story with game elements. In such a game, completing one scenario would allow a team of participants to advance to the next level, i.e. to the next scenario.

6.4 Motivation, Engagement, and Fun

The third aspect concerns whether the role-playing activity was motivating, engaging, and fun. This is important if simulation is to be accepted by the students as a part of their educational program. As mentioned earlier, laughter was frequently recorded during role-play, especially when the participants made small mistakes, such as crashing the rolling bed with the patient or making their avatar sit at odd places. This was indeed a new experience to them, but we observed that many were eager to immerse themselves in the role-play when they started to be more comfortable with it. Eight out of nine answered either “agree” or “strongly agree” to the two questions “if the game experience was fun/motivating” and “did you feel immersed in the role-play?”. The fun factor is, however, not enough to make the students want to use the simulation in their study program, as they need to have a stronger reason and motivation.

An important point was raised when discussing changes needed in order to increase the educational value for the surgical nurse students. Surgical nursing is a practical profession and the procedure needed to prepare a patient for surgery is relatively complex. Many of the students stated that it would be natural to do more practical things in the virtual operating room, such as washing hands, covering patients with blankets, position the operating table, disinfect, prepare instruments and similar tasks and routines, which is an important part of their job when dealing with a patient. As one of the students puts it, “use our hands more”. Most of our discussion centered on how we can improve the virtual operating room to make empathy and interaction to feel more like in real life. Therefore, it appears that some of the motivation amongst the students also lies in the possibility to practice on medical procedures as a surgical nurse and working on associated tasks in the VW to gain early experience.

7 Conclusion and Future Work

This study gave valuable information that can be used as guidelines for further development of virtual operating facilities and, on the longer term, of a Virtual Hospital. There is also a need for further exploration of the different ways to support collaborative team training and practical medical training with innovative technologies. The role-playing facilities in a virtual operating room have the potentials to provide the students with a safe, realistic, and accessible environment for practicing their nursing tasks. In order to achieve this goal, the virtual operating room should be equipped with interactive objects related to the tasks and routines of a surgical nurse. This could be simple tasks, such as putting a blanket over the patient or preparing instruments before surgery. Surgical nurses use their hands a lot, and the students should be able to do this within the VW in order to immerse themselves properly into the role. It also follows that interactivity in general, such as navigation, object manipulation and interaction with co-players should be improved and made more intuitive.

Another implication of the study is the need for guidelines and methods for scenario development, including definition of roles. For example, a student might not have experience with certain types of patients and certain medical conditions. Therefore, he/she would not be able to give the correct feedback to co-players. This would require formalized guidelines for how to play this type of patient, and probably some more information and preparation for the student in advance of the role play. A related aspect is interaction between different actors in the nursing team. An efficient learning experience requires receiving cues and other sorts of feedback frequently during the role play. Our participating students got these cues mostly from the dialogue with each other as nurses and patients, though they participated in a reflection round afterwards. The students mostly agreed that this should be improved for the role play to have an educational value. Types of feedback suggested were an avatar guide/game leader played by an experienced person who can join them and give inputs along the way. Another suggested solution was to let a more experienced nurse or teacher play the patient, as well as to implement tasks to be done where you either fail and stay put or complete to advance to the next level with a new set of tasks.

The major limitation of the study is that for practical reasons we were able to recruit only nine postgraduate students at their last year of studies. The small number of participants does not give statistically significant data, but, at the same time, they provide some useful indications for further development of the system. For example, all but one of the participants have been positive towards the use of role-play in a VW as a supplement to surgical nurse training in communicating with patients and relatives. Therefore, despite the limitations of this study, the results provide a motivation for further development of the Virtual University Hospital a basis for further elaboration of design principles for a collaborative virtual training environment.

The ongoing second stage of evaluation is based on our experience and feedback from this study. Both anesthesia and surgical nursing students at their first year were recruited to role play together in the Virtual Operating room at this stage. We attempted to make the gaming experience more intuitive and engaging and enhance the feeling of immersion by using head mounted displays (Oculus Rift). The teachers acted as patients, providing correct feedback and giving the students the possibility to focus on their roles as anesthesia or surgical nurses, teamwork and interaction with the patients. We have also conducted an evaluation among non-medics, as the operating room could potentially be used for informing general public and preparing patients for a surgery. Apart from evaluating their experience in the operating room, both user groups, medics and non-medics, have been asked to suggest services and features to be included in the Virtual University Hospital.

We are currently working on analyzing the motivation, degree of immersion, and learning experience amongst the participants at the second evaluation stage, comparing the findings with the results from the study presented in this paper and outlining requirements for the Virtual University hospital as an arena for health education.

Future evaluations will include a larger group of students, but also different scenarios and groups of patients and medical professionals. One example is language and cultural awareness training for nurses from other countries (e.g., Philippines and Eastern and Southern Europe) recruited to work in Norway. We will continue developing the Virtual University Hospital, both conceptually and technologically. In the longer run, such an environment will be enhanced with other features and facilities for collaborative work and learning, such as library of medical resources, anatomical visualizations, meeting facilities, patient information facilities and so on, normally present in a real university hospital.

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