DOI: https://doi.org/10.56198/b64h9437

Practicing of Home Nursing Activities in a VR Simulation

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Abstract. Virtual reality has proven to be a valuable addition in the tool belt of teachers. Immersive learning environments are applied in various settings, including, but not limited to the medical and nursing domain. In this short paper we present "We care in VR", a simulation for practicing nursing tasks for care at home, a part of nursing that is currently underrepresented in available VR applications. We investigate how realistic interactions are perceived by end users compared to consistent usage of buttons on the controllers and how they affect the ease of use of the simulation. We conduct an empirical study with 50 participants from three vocational schools of nursing and a university of applied sciences. Results suggest that our simulation already works quite well and is accepted by the target group, but still needs improvement regarding ease of use, especially for users without any previous experience with VR applications.

Keywords: Immersive Learning, Case Study, Nursing at Home, Realistic Interactions.

1 Introduction

Europe has the highest rate of +65-year-old elderly population in the world in comparison with other continents[1]. The rate was recorded as 19 % by the year of 2022, and in Germany the percentage of elderly people was reported to be 18,66% in the same time frame[2]. This information explains the high need of home care for elderly people in Germany and Europe. Every person should have the opportunity to age in place, which is the desire of 90% of the elderly people who participated in a survey[3]. Therefore, more and more nurses are trained in this area, and this consequently leads to a search for better means of training. Together with the launch of Virtual Reality (VR) headsets as consumer goods since 2014, immersive learning has become a cost-effective and productive choice for the education of health care personnel [14]. Also, VR and AR is one of the top 5 educational trends in the world in 2023[4]. Immersive VR training simulations are widely used in the training of nurses, however, as can be seen in the related works section of this study, there are few examples of home care scenarios in the recently produced applications. Since there are not many studies conducted on the acceptance of VR training simulations in nursing, this area needs further research [12].

VR can be defined as "a complex media system that encompasses a specific technological setup for sensory immersion as well as a means of sophisticated content representation, which is capable of simulating or imitating real and imagined worlds" [9]. Currently, VR is mainly accessed through head-mounted displays (HMD), also known as VR headsets (e.g., Oculus Quest 3 or Valve Index). Simulations or 3D worlds accessed through a desktop computer or tablet are referred to as low immersion or desktop VR in the literature [8]. Slater & Wilbur [19] defined immersion as "… a description of a technology, and describes the extent to which the computer

[1] Statista (2024): Proportion of population under 15 and over 64 in the world regions 2022 | Statista. Available online at https://de.statista.com/statistik/daten/studie/71063/umfrage/weltbevoelkerung-nach-alterund-regionen/, updated on 2/14/2024
[2] Statista (2024): Age structure of the population in Germany 2022 | Statista. Available online at https://de.statista.com/statistik/daten/studie/1365/umfrage/bevoelkerung-deutschlands-nach-altersgruppen/, updated on 2/14/2024
[3] Overview of Aging in Place – RHIhub Aging in Place Toolkit (2024). Available online at https://www.ruralhealthinfo.org/toolkits/aging/1/overview, updated on 3/11/2024
[4] Marr, Bernard (2023): The Top 5 Education Trends In 2023. In *Forbes*, 2/17/2023. Available online at https://www.forbes.com/sites/bernardmarr/2023/02/17/the-top-5-education-trends-in-2023/

displays are capable of delivering an inclusive, extensive, surrounding and vivid illusion of reality to the senses of a human participant." It can be easily noticed that this definition is not about an individual's feelings, it rather defines certain properties of a technology. On the other hand, presence or the feeling of presence cannot be used instead of immersion since it is more related with the subjective feeling of a person. Presence is a "… state of consciousness, the (psychological) sense of being in the virtual environment" [19]. Immersive learning differs from other forms of learning by offering high immersion and interaction [8]. It achieves immersion with higher field of view compared to computer monitors, binocular view and completely shutting out the real world, thus psychologically isolating the learner in the virtual environment (ibid.). Interactivity allows for a higher degree of freedom, so the learner is given control over the learning experience as well as high fidelity (the accordance between actual movements and the corresponding visual feedback (ibid.). Our simulation strives to excel in interactivity by providing as realistic interactions as possible.

The research question of our study is therefore as follows: How can the interactions be designed and implemented to maximize user acceptance in an immersive learning environment for home care?

The rest of our paper is structured as follows. We first revisit related work in the area of immersive learning in nursing education. We continue to describe our learning scenario before discussing some technical challenges. Later on, the setup of the empirical study is described and our questionnaire is introduced. We report about the results of the survey, discuss the implications before summarizing our findings and present plans for future work.

2 Related Work

In this section we summarize other work related to immersive learning in nursing education. Keywords used for searching were "immersive learning" AND "nursing". We exclude papers dealing with pediatric nursing, patient-oriented applications, apps focusing on AR, non-immersive desktop VR, 360 videos and interactive videos, as well as papers about educational use of VR in general. Therefore, the remaining papers deal with nursing of elderly or somehow disabled or sick people as well as presenting interactive VR learning applications that target nurses.

Common themes across most applications found in literature (see below) include the use of consumer VR headsets (e.g., HTC Vive, Oculus Quest, Valve Index), which is different from older literature a couple of years ago. They usually focus on realistic scenarios and realistic patient interactions and incorporate haptic feedback where possible. They emphasize professional decision-making and critical thinking skills and stress that VR training should not replace but rather complement traditional methods. Evaluation of effectiveness uses various metrics like usability, presence, or knowledge acquisition.

Anesthesia Crisis Scenario Builder (ACSB) allows medical educators to create VR training scenarios for anesthesia crises without programming knowledge [22]. It uses Unity and VRTK, offering various interaction types like gaze, grabbing, and monitor interactions. However, it requires experienced medical educators with technical skills to adapt the application to the desired scenarios and provides no reasonable out of the box experience.

DiViFaG is the result of a collaboration between universities, creating e-scenarios for nursing education [7]. It combines virtual exercises with real-world practice in skills labs, focusing on linking theory and practice. However, the scope of this application is very limited and figures only the scenarios "*Supporting people with chronic wounds*" and "*Acting in emergency situations*".

The **EPICSAVE** projects [17] develops VR training for emergency paramedics, focusing on rare, life-threatening emergencies. It's a two-person multi-user environment with three phases: familiarization, scenario, and debriefing. The application is improved in a follow-up project called Virtual Augmented Training for Education in Interprofessional Emergency Care (**ViTAWiN**, [18]) by integrating a real manikin for enhanced haptic feedback. It focuses on interprofessional team training in emergency care. However, it is not possible to perform the training on your own, limiting the scalability to one trainer one trainee scenarios.

Immersive Nursing Education System Komizunai et al. [5] focus on imitating expert movements in care procedures, using motion capture and eye tracking. It includes haptic feedback on the wrist to guide trainees' movements. This is an advanced setup but artificially limits the trainee to the personal habits of the person that performed the motion capturing. Not every expert might do the motions in the exact same way despite reaching an equally good result.

Senselab.io provides a virtual care room where nursing students arrange patient rooms for safety [20]. Studies show positive effects on learning outcomes compared to traditional methods.

Simulation Learning System with VR (**SimX**) offers various nursing scenarios with high immersion, allowing free conversation with virtual patients [4]. It requires an instructor as a moderator during training, which again limits the scalability. Furthermore, despite a large amount of scenarios, no home care is included.

UbiSim was developed during the pandemic for training first responders [1]. It explores concepts like affordance and cognitive load in VR training environments. To measure the cognitive load, two different scenes were created. One scene included just the functional objects. The other scene was filled with distraction factors such as flashing lights, falling objects, tables, and emergency signs. The experiment showed that the distraction factors affected the learning negatively by increasing the cognitive load. Due to Covid-19 measures, the test results could not be compared with non-VR simulation training.
ViReTrain focuses on authenticity in nursing training, addressing complexity and uncertainty in decision-making [21]. It offers three modules: surgical, respiratory, and acute stroke nursing care. Since the focus is on decision making, situations are simulated in which the user should make a critical decision. The user can enter data in a virtual tablet, use her phone, and communicate with other virtual non-Player Characters (NPCs) in the simulation. The operational doing is not trained. The technical implementation is not described in the paper.
VR4Care is a simulation developed by imsimity[5], offering scenarios tailored to German care workers' needs, including insulin injection, central venous catheter care, and endotracheal aspiration. Although being developed together with domain experts, there is no scientific evaluation of this application.
XR-Skills-Lab [13] investigates the feasibility and effectiveness of VR in nursing education. Studies show positive acceptance but mixed results on knowledge acquisition compared to traditional methods. Their scenario is based on endotracheal suctioning procedure on a virtual home care patient. The virtual patient is simply animated with two actions: 1) following the user with head and eye movements, 2) coughing and showing facial discomfort when the catheter tube is inserted. Though not explicitly tested, haptic feedback and interactions are suggested to be important factors on the learning outcome. Knowledge acquisition is supposed to be different for the three experimental setups conducted. However, the outcome reveals no significant difference in the knowledge acquisition of the students.
XR Train[6] focuses on stress challenges during medical procedures, particularly endotracheal intubation preparation. It uses high-quality textures for static objects to optimize performance while maintaining realism.
Challenges identified and areas for improvement in these studies include the balance between realism and performance optimization, enhancing haptic feedback and fine motor skill interactions, addressing issues with cables and tracking limitations as well as improving social interactions with virtual patients. An unsolved issue is the relationship between presence and learning outcomes.

Overall, these VR/AR applications show promise in enhancing healthcare education, offering safe, repeatable training experiences for complex or rare scenarios. However, more research is needed to fully understand their effectiveness compared to traditional training methods and to overcome technical limitations. Our simulations stands out by addressing home care scenarios on the one hand and implementing realistic interactions that can easily be transferred to real life.

3 Learning Scenario

In our own VR simulation, the user slips into the role of a nurse who visits a patient at home and performs nursing tasks. The intention is to give novice nurses a possibility to practice important tasks without the need for supervision and build up routine. It is not intended to learn the necessary steps but relies on previous knowledge of the user. The patient's apartment consists of a hallway, where the simulation starts, a bathroom, a kitchen and a combined living room and bedroom. It is modeled after the floor plan of existing apartments for elderly people. Measuring blood sugar and blood pressure, as well as giving an insulin injection are simulated. Putting pills into a weekly planner according to a medication plan is a fourth task, which was implemented, but not used within the study. Furthermore, small household tasks are included, that are sometimes part of a nurse's duties but can also be seen as distractions from the main work, e.g., closing the window and turning off loud music from radio or TV. There is some variation in the simulation to encourage frequent usage.

The simulation is running on standalone VR headsets like Pico 4 or Pico Neo 3 and use the controllers of these devices for interactions. Common VR interactions like teleportation (using the thumbstick) or grabbing (using the grip button) are implemented as in most other VR apps. The trigger button is used for activating things, e.g., the disinfection spray. More complex objects like the sphygmomanometer needed several buttons to be handled correctly. Users need to hold it using the grip button (middle finger), pump with the A button (thumb) and release air using the trigger button (index finger). The design decision was because of the trigger button being pressure sensitive, so that simulating releasing the air very quickly or rather slowly is possible. The A button is a binary sensor that differentiates only between pressed and released, which is enough for the pumping process, but wouldn't be adequate for the release of air. With the left controller, users could show and hide a smartphone

[5] VR4care - imsimity. Available online at https://imsimity.de/produkt/vr4care/, updated on 9/22/2023.
[6] XRTrain - XRCONSOLE. Available online at https://xrconsole.net/xrtrain/, updated on 8/24/2023.

(button Y) that shows the simulated time and includes an app for recording blood pressure measurements. The X button shows and hides a task board that includes hints for open and already completed tasks. To make interactions as realistic as possible, the smartphone and blood pressure monitor got a "touch" control. When the user got close to the touch screen or respective buttons, the hand changed from the normal visualization into a pointing gesture with the index finger extended and the other fingers building a fist to indicate the possible interaction (affordance).

The **visualization** is realistic as far as the limited computational power of the standalone VR headset allows for (see **Fig. 1**). Limiting the number of polygons was necessary to achieve acceptable frame rates of 50-60 fps. Therefore, especially task unrelated objects like chairs and tables were modeled with as few triangles as possible in order to save polygons for the task objects like blood sugar monitor, insulin pen or sphygmomanometer. The application was implemented in Unity. The 3D models used were collected from public marketplaces like cgtrader, sketchfab, turbosquid and blendswap. Often, models needed to be modified to fit the specific needs, especially reducing the number of polygons. Other objects were so specific, that they were not found in the mentioned marketplaces and therefore needed to be modeled by the authors (e.g. blood sugar monitor, insulin pen). Suitability of models was checked with domain experts from project partner Murimed and OTH Regensburg. An example for the cooperation with domain experts was the choice of the 3D model for the simulated patient. We knew that patients fall into the elderly people category, but can also be younger people with certain diseases or problems. We therefore made a pre-selection of models that were available and technically feasible (reasonable number of polygons) and presented them to the domain experts (n=6, three experiences nurses, three instructors with a nursing background, 1 male, 5 female). They voted in favor of models one, five and six (see **Fig. 2**) and strictly against models three, four and eleven. We plan on including various models for the future to increase variability and therefore motivation to use the simulation several times, but started with model one.

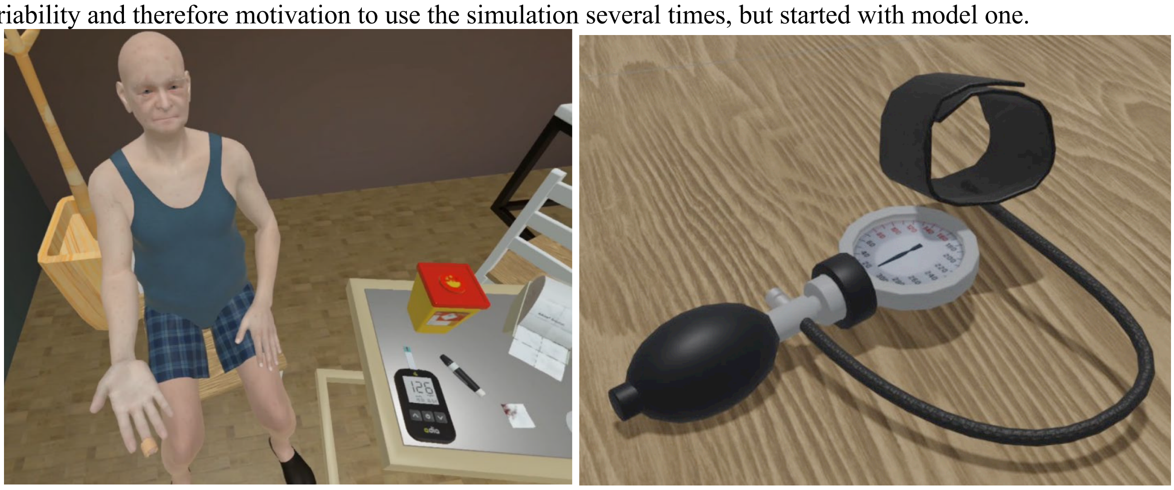

Fig. 1. Scenes from the VR nursing simulation that showcase the treatment (https://vr.iisys.de/vr-projekte/we-care-in-vr/).

Besides graphics, additional attention was paid to providing both audio and haptic feedback for user interactions. Turning on the light using a wall switch provides haptic feedback using a pulse of vibration on the controllers as well as a click sound. The patient's heart beat can be heard with the stethoscope during blood pressure measurement and the release of air from the sphygmomanometer makes a typical sound which is softer or louder depending on the speed of release that can be controlled with the trigger button.

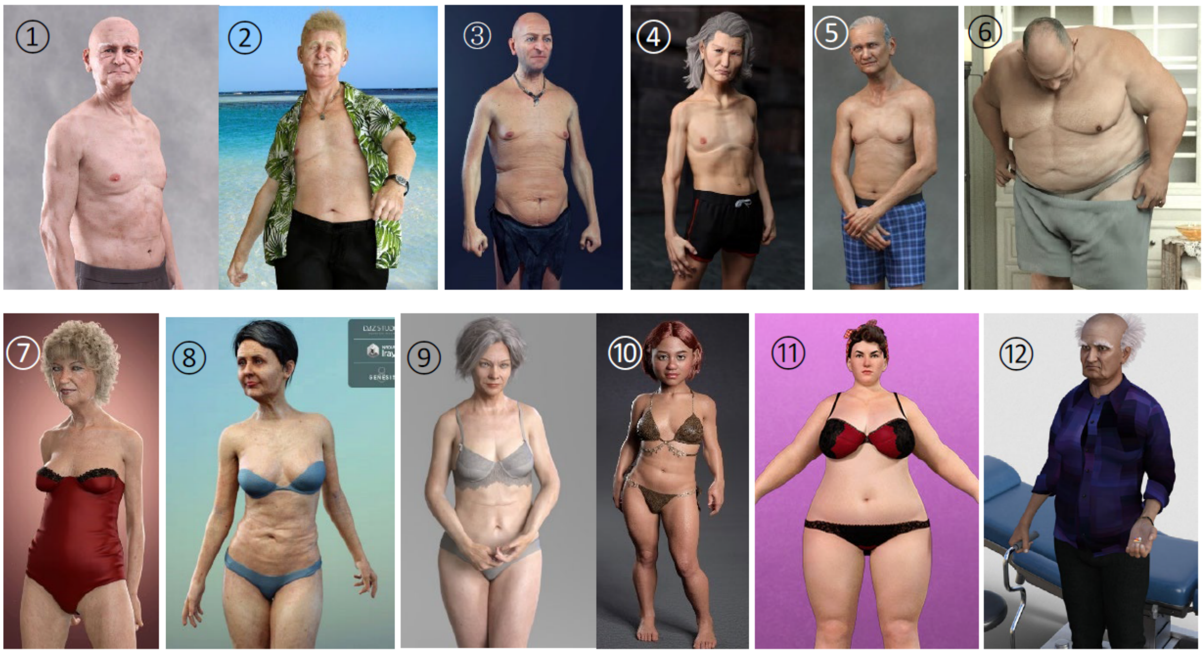

Fig. 2. Pre-selection of virtual characters to be used as patients. All models are from public marketplaces like DAZ3D.

Fig. 3 shows examples of the interactions we implemented. The lancet must be inserted into the lancing device and closed with the lid (left). The test strip needs to be inserted into the monitor and it needs to be turned on. After the patient's finger has been pricked, a drop of blood oozes out. This must be placed on the test strip (middle). The finger is then covered with the plaster. The blood sugar monitor needs a few seconds to show the result. The user needs to determine the correct dose of insulin (right) to give to the patient based on the measured blood sugar and the doctor's prescription.

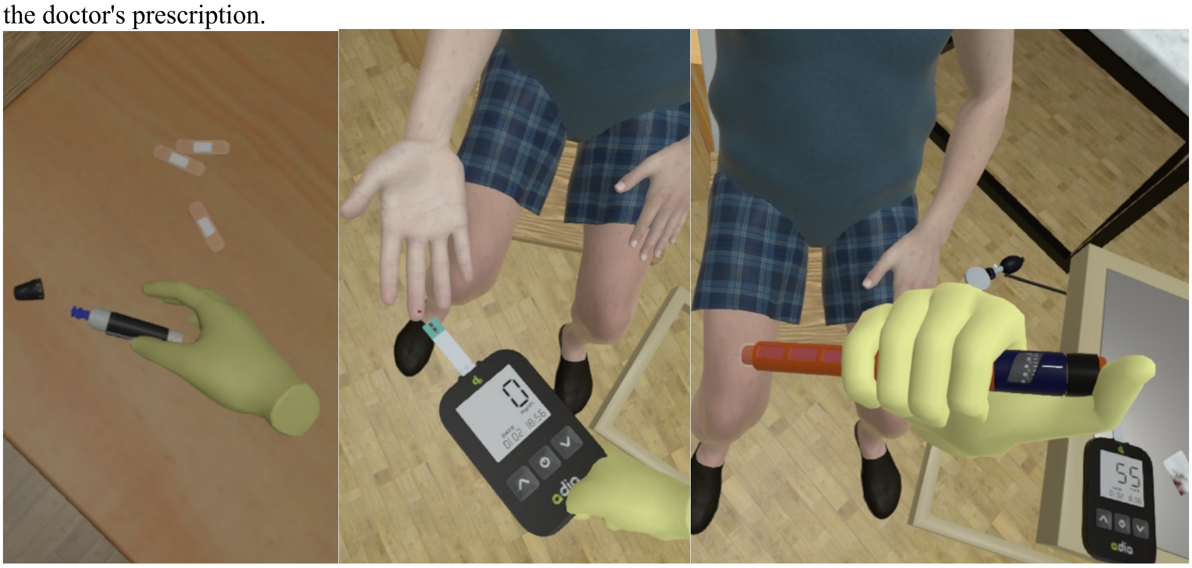

Fig. 3. Interactions with the lancing device(left), blood sugar monitor (middle) and the insulin injection (right).

4 Technical Challenges

Cables are notoriously hard to simulate in VR. There are existing solutions like Obi Rope, that can be used, but according to VR experts in our community, still have problems and are no ideal solution. We therefore developed an own approach that was used in both the stethoscope and the sphygmomanometer. We first tried to use Unity's physics engine, but it soon turned out that this won't work, because of the forces applied when grabbing the object. We therefore ended up with using the chain IK feature from Unity's animation rigging package. The tube is modeled as a cylinder in Blender together with a skeleton, to simulate the bending similar to a human spine. It turned out, the chain IK solver can handle a maximum of 17 bones, which limits the smoothness of the curvature and was undocumented. Using animation rigging means on the other hand, that you cannot simultaneously apply physics, so that tubes move through tables and other objects with colliders. This sometimes breaks immersion and could potentially have been avoided using Obi Rope. However, in most cases, our solution works quite well.

5 Empirical Study

In our observational study, we investigate the relationship between different influencing factors as shown in **Fig. 4**, which is based on the technology acceptance model (TAM, [2]). Relevant system features are mainly the realism of the graphics and interactions. Wölfel [26] further lists affordance, discoverability and signifiers that influence the perceived ease of use. On the outcome side, we add "improved technical skills" that are the goal of immersive learning environments. We therefore survey both technology acceptance (ease of use and usefulness) as well as user acceptance (intention to use).

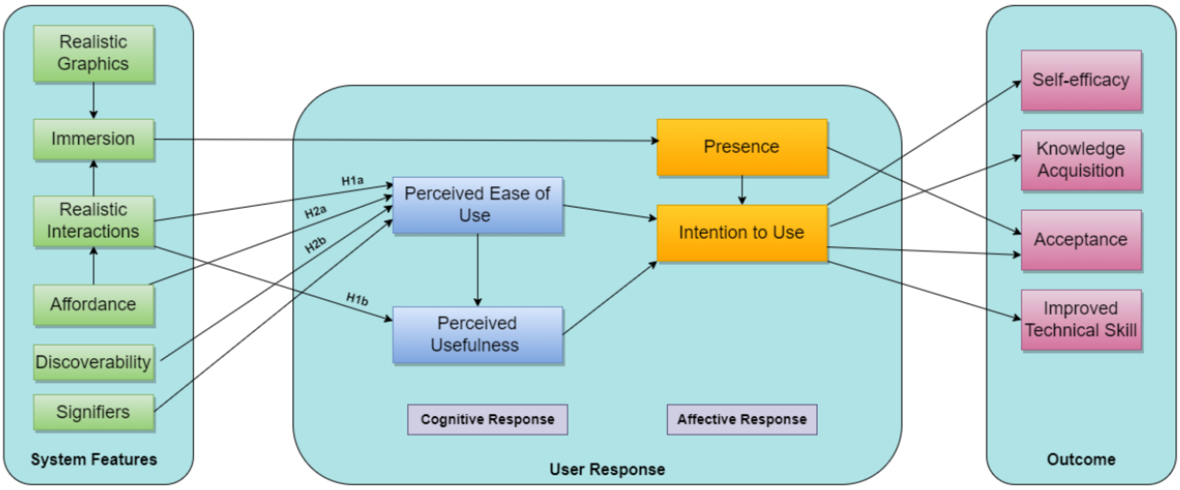

Fig. 4. Model showing dependent and independent variables of influencing factors for user acceptance (own illustration).

Our research hypotheses are

- **H1a:** Realistic interactions affect perceived ease of use.
- **H1b:** Realistic interactions affect perceived usefulness.
- **H2a:** Discoverability affects perceived ease of use.
- **H2b:** Affordance affects perceived ease of use.

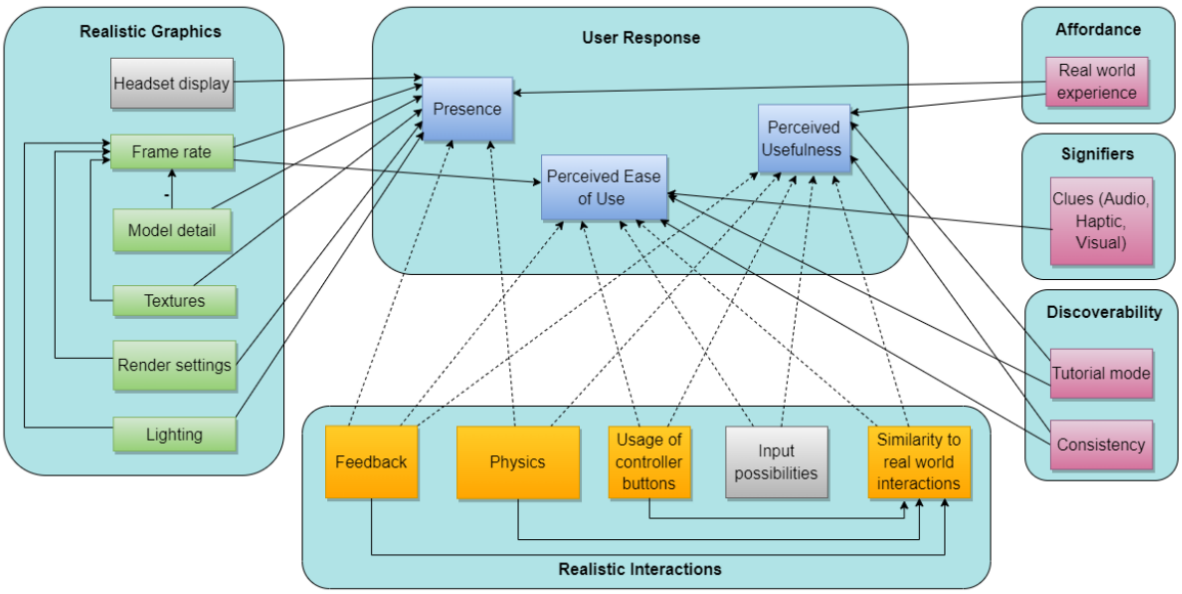

Fig. 5. Refined model showing detailed influencing factors for realistic graphics and interactions (own illustration).

Diving deeper into the variables realistic graphics and interactions, we discovered ten more detailed factors as shown in **Fig. 5** Input possibilities are greyed out, since developers cannot influence those as they are given by the headset. The only real choice is between hand tracking and controller-based interactions. This model is the basis for our empirical study and questionnaire.

The application was evaluated in three different vocational schools of nursing and in one university in south-eastern Germany, specifically Bamberger Akademien, Berufsschule BSZ Schneeberg, Berufsfachschule für Pflege der Kliniken Hochfranken and OTH Regensburg. The total number of participants was 50. The target group for the survey includes nursing trainers/ instructors and trainees/ students. Since most of the users had no previous VR experience, they were initially given brief instructions for the use of the hardware. This part took about 5 minutes. Afterwards, a practical experience for 20 minutes was completed by each user. Then, the users were asked to fill out the post-test questionnaire which roughly took 15 minutes. Participants got no incentives for participation but considered it as part of their vocational education and a glimpse into a potential future addition to their schedule. They all participated voluntarily. Therefore, we saw no ethical problems associated.

Nine out of the 50 participants were experienced nurses and 41 of them were trainees or students. The number of females were 37 and males were 13. The high percentage of females (74%) reflects the demographics in this field in Germany (82%)[7]. 38 participants were younger than 25 years. Seven participants were between 25 and 35, three participants were between 35 and 45, and two participants were older than 45. 12 of the participants had VR experience before and 38 of them were first time VR users.

6 Questionnaire

The questionnaire contained a total of 34 questions. Most of them were geared towards the perceived realism of interactions, since this was the main focus of the study. The other questions regarded affordance (2), discoverability (2), realistic graphics (4), presence (4), perceived ease of use (3), perceived usefulness (4), and intention to use (1). The questionnaire ended with sociodemographic questions (5). Responses could be given on a Lickert scale reaching from 0 to 10, or from -5 to +5, except the sociodemographic ones, and two free text questions asking for more details on distractions, of the users have confirmed that they felt some.

The main goals of the questionnaire are to verify the hypothesis and check user preferences for realistic interactions compared to consistency. One example is the insulin pen. Consistency would mean using the trigger button (index finger) to activate it. On the other hand, the visualization suggests that the thumb rests on the trigger of the pen (see **Fig. 3**) so that the A button of the controller should be used.

The second and third versions of the PQ [24] and [25], UTAUT questionnaire [27] and a questionnaire from a recent immersive learning project [11] were used as a reference. From these references, some of the questions are used without any change, and some questions were adapted to better fit our scenario. Seven new questions were formulated and evaluated in a pretest with three candidates, that ask about the specific interactions in our simulation. The whole questionnaire took about 15 minutes to answer. Some examples for questions are presented in table 1.

Table 1: Examples of questions used in the questionnaire.

Were there any distracting events which destroyed your feeling of being present in the virtual world? If yes, please give examples.	Custom
When using the dispenser, would you prefer grabbing and pulling one pad from the dispenser to get one, instead of using the trigger button?	Custom
How important was the vibration of the controller for accomplishing the following tasks? (1) Record blood pressure values on smart phone, (2) Putting the stethoscope on the head	Custom
It would be easy for me to become skillful at using the system. Agree/disagree -5 ..0 .. +5	UTAUT EOU5
I find the VR simulation useful for training nursing. Agree/disagree -5 ..0 .. +5	UTAUT EOU5
How easy was it to anticipate which buttons to use for performing the interactions?	PQv2-9
Were there moments during the virtual environment experience when you felt completely focused on the task or environment?	PQv3-30

[7] Statista (2024): Geschlechterverteilung unter Pflegekräften 2022 | Statista. Available online at https://de.statista.com/statistik/daten/studie/1029877/umfrage/verteilung-von-pflegekraefte-in-deutschland-nach-pflegeart-und-geschlecht/

7 Results

Affordance and discoverability. The affordance of the ILE has been rated as good with mean values around 7 of 10. On the other hand, discoverability values were lower with 5.6 and 6.1. This shows that the input mapping with the interactions is a bit complex to learn fast and the texts cannot be read as well as expected in the environment.

Realistic graphics. In terms of realistic graphics, the general visual quality of the ILE has been rated quite high around 8. However, when the user is asked if there has been any distraction from performing the tasks caused by display quality, the average rating is around 4 (0 means no distraction and 10 means too much distraction). This value is a positive evaluation; however, it also displays a negative tendency that the visual quality may interfere with the task performance. It is also consistent with the feedback for discoverability (textual information). During the tests some of the participants said that they could not read the insulin dose values on the insulin pen, and some said that they cannot see the numeric blood pressure values clearly on the scale of the manometer. More work is needed for the rendering of the textures which contain textual information. Also, this may have resulted from the incorrectly aligned lenses according to the eye distance of the user.

Feeling of presence. The participants had a high feeling of presence with the average value of 8, 58 and they could focus on the tasks with a mean value of 8.22. These values are high, and they show that the realistic illustration and the optimization of the ILE together with the realistic interactions work well to provide high immersion. On the other hand, nine of the 50 participants stated that there were distracting elements which cause a break in presence: three of them complained about the noise coming from outside or people talking in the room; three of them criticized about the small play room and the boundaries, which are elements of distraction with VR applications. One user wrote about the crash with real objects in the environment; two of them stated that the technical failures such as flying objects in the ILE had interrupted the feeling of presence, while one of them favored hand tracking.

Realistic interactions. The visual feedback for the bloody finger and the hand pose for the insulin pen were found good with mean values of 7.46 and 7.14. However, the mean value of the band aid was relatively low with 5.26. There were two problems with the band aid. Many users could not apply the band aid because it fell on the ground at the time of rolling around the finger, and it could not be attached to the finger anymore. And sometimes the band aid flew around during teleporting, and it got lost. These problems have been addressed above with the other known flaws. In terms of similarity to the real world, four objects had been rated: lancing device, dispenser, insulin pen and the smart phone. All had good evaluations with more than 6.5 and the smartphone got the best average value of 8.14 with a small standard deviation of 1.66. This shows that the virtual hand interaction technique has an advantage of similarity to the real world. The second high rating was with the insulin pen which had a mean value of 7.48. The aligned hand pose had probably a positive effect on this result. In the two questions about the user's preference between realism and consistency, two objects had been asked: the dispenser and the insulin pen. The answers showed different directions in these cases. Users preferred realism over consistency in the dispenser case with a mean value of 6.78 and a standard deviation of 3.42. However, they showed no specific preference for the insulin pen, and they gave a neutral value of 5.54 with a standard deviation of 3.83. The high standard deviation values show that the issue is not easy to decide. Moreover, this should be evaluated case by case without making a categorical decision.

In terms of **physics**, the general behavior of the objects was found to be good (7.18) and the physical behavior of the blood pressure measurement devices were found fair with 6.38. This means that there is plenty of room for improvement in the blood pressure measurement devices and the users saw the technical problems with the behavior of these devices. On the answers to the question about the audio feedback, nearly all the four options (manometer air release, disinfection spray, heartbeat, and insulin injection) were found good with a value over 7.28. The highest value has been given to the air release sound of the manometer with 7.78. This is probably because of the changing level of the air release sound with the float value of the trigger button. This provides the user with a highly realistic experience during the measurement activity. In similarity to real world interactions, three objects were asked the users: blood sugar monitor, smart phone, and light switch. The overall evaluation was high with 7.6 being the lowest value. And the light switch interaction has been found to be more like real world experience with a rating of 8.34. This is probably because of the multimodal feedback of the light switch: auditory, visual, and haptic. All these give a similar feel like real world object interaction. Also, haptic feedback has been found important with the smart phone, the stethoscope, and the light switch with a mean value of minimum 7.28. Here the most important vibration was the haptic feedback in the recording values on the smart phone. This has also been the developer's impression that without haptic feedback it is hard to use the virtual smart phone. That's why haptic feedback is probably a guiding feature here by increasing the ease of use.

User acceptance. Acceptance questions had a Likert scale from -5 to +5. The users rated the system moderately easy to use (2.54). Becoming skillful at using the system was judged slightly better (3.2). This is probably the result of two facts: most of the users are new in VR and it took some time to learn the conventions in the system. Some of the users' problems were due to general VR usage like teleporting or grabbing and not application specific. To handle this situation, a tutorial mode of the application was developed later on to avoid similar situations in the future. The second important result is about knowledge acquisition. While the users find the system useful for nursing training (3.28), they also think that they do not learn much with it (1.46). This is mainly about the fact that the home care ILE was created for practicing skills while it does not include a high level of new knowledge for nursing trainees. Therefore, this result is not surprising. The users still consider it a good complement to traditional education (3.58). Since the aim of this research is to maximize user acceptance by using realistic interactions, intention to use is one of the important variables in this study. The 50 participants want more training content delivered as a VR experience with a high average value of 3.82 (σ^2=1.77). This shows that the motivation of this research corresponds with the end users' requirements.

8 Discussion

This study uses Cronbach's Alpha as the index of reliability. Values between 0.70 and 0.80 mean reliability is considered adequate for group comparisons. Values between 0.80 and 0.90 indicate a good reliability and values greater than 0.90 are considered as excellent. In our study, Cronbach's Alpha has been calculated as 0.86, which shows that the reliability of this questionnaire is good, and it is suitable for applied research.

Hypothesis H1a says that realistic interactions affect perceived ease of use. The significance value for H1a is 0,0125, which is smaller than 0,05 so that the null hypothesis is rejected. The R square of the model is 0.33 which shows that the overall effect is moderate. Hypothesis 1b is realistic interactions affect perceived usefulness. The significance value here is 0,0027, which is even smaller than 0.01, so that there is strong evidence against the null hypothesis. The R square of the model is 0,39, which indicates a moderate effect on the perceived usefulness.

Hypothesis h2a suggests discoverability affects perceived ease of use. The value of overall significance for this hypothesis is 0.049. The null hypothesis is slightly rejected. The R square value is 0,12 which displays a weak influence. This means that discoverability has a weak effect on ease of use. Hypothesis h2b is *affordance affects perceived ease of use*. The significance value of this hypothesis is measured as 0.154, which is more than 0.05. The null hypothesis could not be rejected.

The results indicate that the application needs improvement in terms of ease of use. Parts of that missing ease of use might be attributed to the missing experience of users with VR in general and is not due to the application design. Another part of the problems can be explained with the high complexity of the interactions to be simulated. A last aspect is the limitations of the headset and programming environment used (Unity). From time to time, the sphygmomanometer flew through the air when operated with two hands without any indication of why this was happening, therefore breaking immersion and requiring users to start over with attaching it to the patient. Furthermore, several users struggled with keeping the stethoscope head in the crook of the arm, because the resistance that you usually feel before dragging it out when moving the head away from the patient is not simulated. Despite those problems, the simulation was evaluated as a good supplement for traditional nursing education. Users also stated their high intention to use, which is a positive outcome for user acceptance.

9 Limitations

Realism in simulated environments is always a tradeoff. Virtual objects, that are not necessary for completing the tasks to be learned can be seen as visual distractions leading to cognitive overload or as necessary to create a life-like environment instead of a barren and therefore somehow lifeless world that is unattractive. We care in VR is geared towards the realism edge and accepting the potential drawbacks. For the future, we should provide an option to first train without these distractions and only include them if wanted to incorporate the learning from UbiSim. Despite our best efforts, a few users experienced technical glitches which might have affected the empirical analysis. The varying levels of VR familiarity among participants are another limitation. Experienced users found less problems getting accommodated with using the controllers to achieve the desired result. VR novices struggled for some time, despite the 5 min introduction to VR, to perform basic things like teleporting and grabbing objects. A future version of the application should contain a tutorial mode, that explains all the activities step by step including which buttons to press.

10 Conclusion and Outlook

The study shows that practicing nursing tasks in VR is feasible and accepted by the target user group. It is a good addition to traditional training but cannot replace it due to missing opportunities to build up manual dexterity. The focus on home care sets our study apart from existing solutions. Since four out of five people in need of care are treated at home and the number of employees in outpatient care services has more than doubled in the last twenty years (+138% between 2001 and 2021 [28]), there is a huge need for such kind of training opportunities, both to learn the skills, but also to make the vocational training more interesting and modern in order to attract employees.

Feedback from study participants showed that including a believable simulation of the patient's behavior including speech recognition and speech synthesis would take the simulation to the next level and increase its value dramatically, since manual tasks can be trained with puppets and real tools, but social interaction cannot. Small animations like breathing, glimpsing and following the user's actions with the eyes could be an intermediate step, that would slightly enhance the presence feeling and overall experience. Nevertheless, the simulation of the nursing task was necessary as a first step before tackling the more complex simulation of human behavior. We are currently working on a large language model (LLM) to simulate not only dialogs between patient and user, but also to plan for meaningful actions that could be taken based on the environment and the status of the patient in order to simulate believable behavior. Furthermore, we are investigating whether physics-based animations can be learned with reinforcement learning in order to have a flexible animation component fitting the actions chosen by the LLM.

To transfer results to other immersive learning scenarios, one needs to consider the type of tasks to simulate. Those tasks that can easily be trained in real life should not be the focus of a VR learning experience. Tasks that are hard to train in real life because of ethical considerations, missing opportunities, cost or danger to either the trainee or the patient are well suited. Interactions for these simulations should favor similarity to real life experiences in the interactions over consistency, especially when addressing VR novice users.

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