PrepaCare xr

A PRACTICAL AND PEDAGOGICAL HANDBOOK ON APPLYING XR IN HEALTHCARE EDUCATION

PREPACAREXR IS AN ERASMUS+ KA2 INTERNATIONAL PROJECT BETWEEN 5 INSTITUTIONS:
FH TECHNIKUM WIEN (AUSTRIA), UNIVERSITA' DEGLI STUDI DI BERGAMO (ITALY), LAPLAND UNIVERSITY OF APPLIED SCIENCES (FINLAND), UNIVERSIDADE DE TRAS-OS-MONTES E ALTO DOURO (PORTUGAL) AND CENTRO HOSPITALAR TRÁS-OS-MONTES E ALTO DOURO (PORTUGAL)

The PrepaCareXR project aims at creating advanced technological and pedagogical training solutions for healthcare professionals and students to enable experiential and safe learning opportunities. In the project, the multidisciplinary and international group of experts in healthcare, medicine, engineering, and design and visualization collaborated in order to produce these advanced solutions. Based on the application and products, PrepaCareXR enables the shift of healthcare training to be blended, global and more experiential. This leads to a new way of educating current and future healthcare professionals in order to improve the efficiency and competitiveness of the European healthcare sector.

Read more about the project

Co-funded by the Erasmus+ Programme of the European Union

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SCOPE AND AIMS

In this section, we describe whom this Handbook is aimed at and the importance of using it when planning teaching and training with XR.

1.1 Why this handbook?

This handbook supports **the use of Extended Reality (XR) in healthcare education and training.** As the use of virtual teaching and learning methods is increasing, support, ideas, and shared experiences are needed.

This handbook helps healthcare teachers and educators to plan and execute pedagogically reasonable scenarios based on the previous studies and framework co-developed during the project.

1.2 To whom?

The handbook is for educators who want to utilize XR technologies in their teaching repertoire.

For seasoned XR educators:
*Handbook can be a practical reference and inspiration when planning the teaching session with XR.

For beginners:
*Handbook provides all the basic info and structure to plan and try your first XR-experiences

Picture 1: Students testing the VR Escape Room at Lapland UAS

Picture 2: The facilitator and the student interacting during the piloting of VR

1.3 Limitations

The field of XR technologies is vast and the possibilities for educational use are endless. This Handbook does not try to cover all the possible circumstances and is not a comprehensive study of the theories behind XR.

Despite plenty of research going on the pedagogical application of XR, **this handbook contributes to the current knowledge through hands-on use cases and practical guidelines.**

The handbook does not delve into the technical workflows on how to develop XR applications independently.

2

KEY TECH TERMS

In this section, we describe the most important terms related to XR technology in the field of healthcare education and training as well as some of the features relevant for learning.

2.1 Key terms and definitions

Extended reality (XR) includes three common technologies, which are virtual reality (VR), augmented reality (AR), and mixed reality (MR) technologies (eg., Alnagrat, Ismail and Idrus, 2021).

Augmented reality (AR) can be viewed as a physical world that is augmented by digital information (eg., Andrews, Southworth, Silva, & Silva, 2019). An example of AR is a projection using a see-through display, head-mounted display, or handheld device (Herron, 2016).

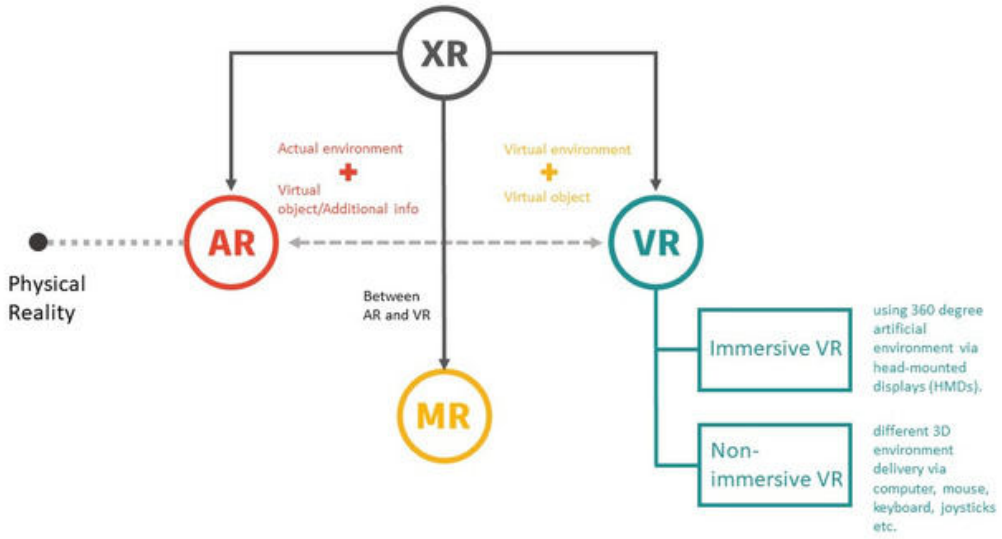


Figure 1. Relation between XR, MR, AR and VR (Li, 2022)

Virtual reality (VR) offers a completely virtual world, where the objects are represented completely through VR technology. This means that all the objects that people see in the virtual world are virtual. VR can be further classified into immersive and non-immersive VR, depending on the degree of isolation from the actual environment and the level of interaction (eg., Bevilacqua, 2019; Makransky, & Petersen, 2020).

Mixed reality (MR) lets people see real and virtual objects simultaneously but adds the possibility of interacting with virtual objects in the real world. It often encompasses the definition of Augmented Reality (AR) but has more virtual features than typical AR.

The blend of what is physically present to what is 100% computer-generated is expressed in the continuum and figure above.

2.2 A SWOT analysis of XR in healthcare education

This SWOT analysis involves mapping *Strengths, Weaknesses, Opportunities,* and *Threats*, and, it can also be used in the development of higher education (Longhurst et al., 2020). During the project, a SWOT analysis of the features of XR relevant to learning in the medical and healthcare education fields was conducted. The synthesis of the results can be seen in the figure below.

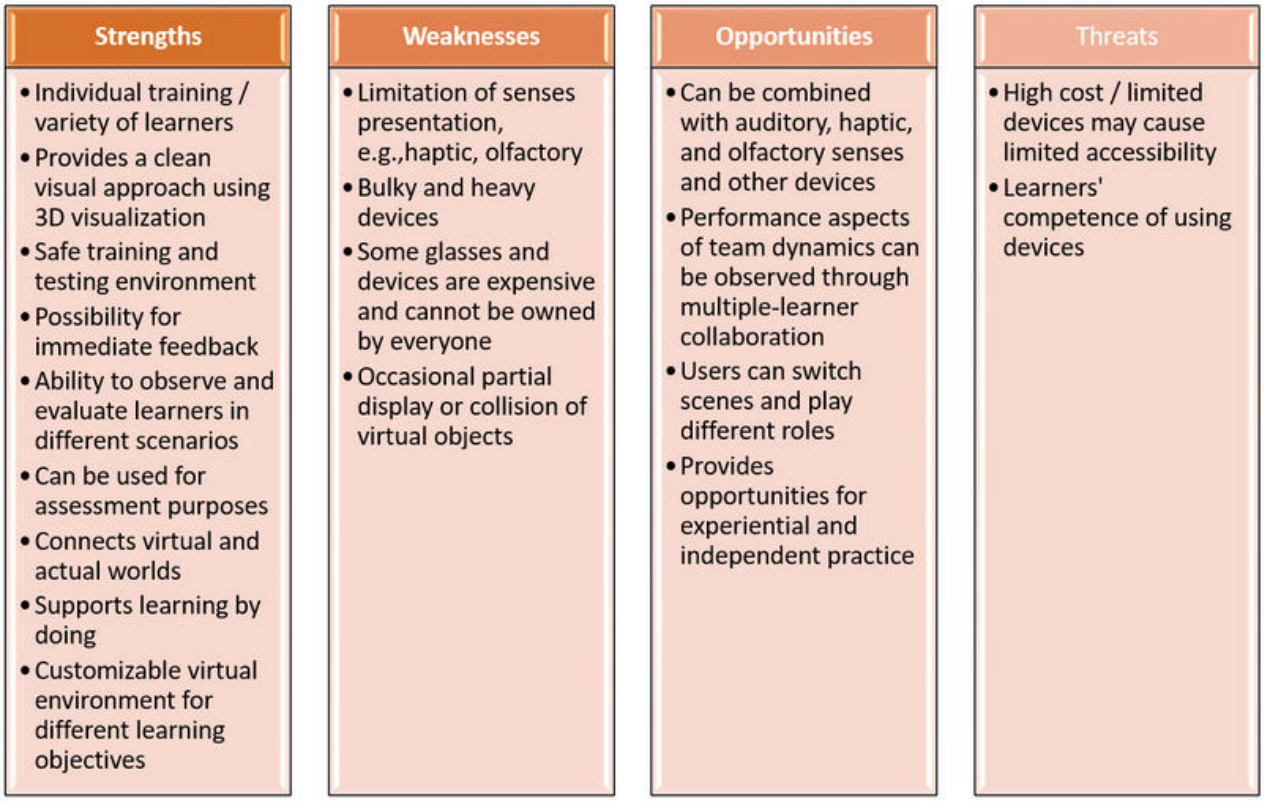


Figure 2: A SWOT ANALYSIS OF THE FEATURES OF USING XR IN EDUCATION (Li, & Keskitalo, 2022)

3

HOW CAN XR HELP YOU?

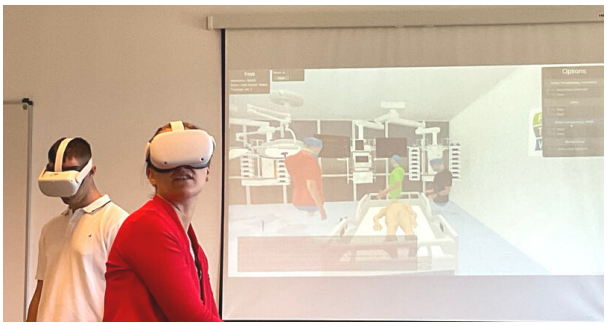
In this section, we provide some information on the benefits of XR to teaching and learning in the healthcare education and training.

3.1 Benefits of XR in healthcare education

"XR is an effective technology for active and experiential learning, enabling users to gain concrete experience that might not otherwise be available. By providing "hands on" experience, XR helps promote student engagement with learning materials and deepens student interaction with complex problems."

(Pomerantz & Rode, 2020)

XR are generally used in education to provide more experiential learning opportunities and to enhance learning. XR also provides a safe environment for training and opportunities for deliberate practice. XR can also break the limitations of space and time, which is why it is suitable for independent learning.



Picture 3: Multi-user collaboration in VR for Difficult airway management simulation

Picture 4: The facilitator and the student interacting during the piloting of VR.

Benefits for healthcare students:

- XR helps to bridge the gap between theory and practice, i.e., it can help to understand and remember the difficult concept related to human anatomy and physiology
- Students are able to get first-hand experience of the healthcare situation in a VR
- It can enhance participants' clinical skills through practice and experience
- It can also help students to evaluate the healthcare procedures and their competence related to it
- Because of the practice, students are more ready before going to the real practice
- For students, XR can be a supplement for actual clinical training

Benefits for healthcare professionals:

- It can maintain participants' clinical skills through repetitive practice
- It can help in orientation, i.e., learning to use new equipment or protocols
- It can help to strengthen non-clinical skills, i.e., teamwork and collaboration

4

INSPIRING CASES

In the next section, we provide a description of some of the inspiring cases developed for healthcare education and training in universities and hospitals across Europe.

4.1 Augmented Reality for Anatomy - University of Leiden

Medical students at Leiden University Medical Centre (LUMC) can now gain advanced insight into the postoperative anatomy of kidney and pancreatic transplant patients using a new augmented reality (AR) app, AugMedicine – Transplant cases. The app, developed by LUMC in collaboration with Leiden University's Centre for Innovation (CFI), focuses on enhancing students' understanding of the spatial relations between 2D CT scans and 3D anatomical models.

The complexity of these surgical procedures and complications means it is challenging to teach students about them outside of an operation theatre.

Traditional visualizations such as CT scans offer 2D images which are difficult for medical students or residents to interpret. In particular, it is difficult for students to understand the spatial relations between the cross-sections that CT scans offer and real-life 3D anatomy:

To overcome this obstacle, LUMC and CFI developed AugMedicine: Transplant cases, an AR app built for Microsoft Hololens. Augmented reality is a digital technology that enriches the real world with 3D holograms, and holds transformative potential for learning environments.

Picture 5: Anatomy students using AR during anatomy classes at University of Leiden, The Netherlands.

Source and more info: Centre for Innovation - Leiden University

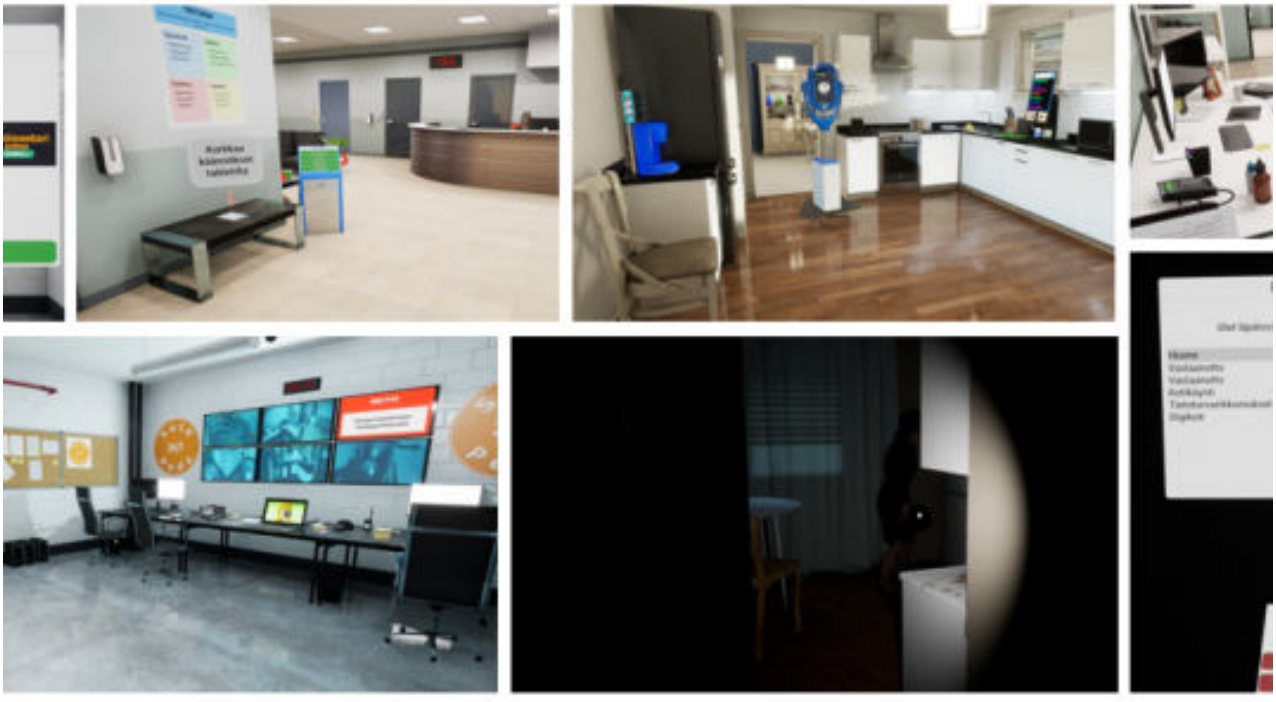
4.2 VR Escape Room for Nursing Education Students - SOTEPEDA 24/7

VR Escape Room was developed during the SOTEPEDA 24/7 project in the years 2018-2020. In the virtual puzzle room/escape room, students solve tasks related to the digitalization of the healthcare sector in virtual reality (VR). To play, you need Oculus Quest glasses or a gaming PC with a pair of virtual glasses and controllers. The game is played alone, but the screen can be shared with companions (e.g. tablet/TV) if required. The game starts with an orientation session (where the player learns how to use the game controllers and various game mechanics) and the actual game.

The order of the game, i.e. the order in which the player enters the different rooms, varies.

In addition, puzzles are randomized so that different tasks have to be solved in different ways at different levels of the game. The role of the player in the different rooms can vary: he or she can play the role of a helper (customer experience) or the role of a nurse.

After the game, there are different ways of looking at learning in line with the objectives. In the spirit of the escape game, the assessment can focus on how quickly and fluently the student has solved the tasks, or it can focus on the rationale for the activity and the learning experience.



Picture 5: An overview of the different simulation scenarios in the VR Escape Room

Source and more info: SOTEPEDA 24/7

4.3 Using VR Before Day Care Surgery in Children - Erasmus MC

Fifty to 70% of children show high anxiety and distress before surgery. Anxious children are more often agitated, sad, and less cooperative than children who are not anxious. Anxiety before surgery is also related to an increased risk of emergency delirium, more intense pain, and poorer recovery after surgery. Furthermore, a child's operation is a stressful experience for parents. In turn, the anxiety of a parent can intensify the child's anxiety. Therefore, it is important to develop an effective strategy to minimize anxiety before surgery.
The aims of the PREoperative Virtual reality Intervention to Enhance Wellbeing (PREVIEW) study are (1) to develop a virtual reality exposure tool that replicates the operating theater of the Erasmus MC Sophia Children's Hospital, Rotterdam, the Netherlands; and (2) to test the effectiveness of this tool to minimize preoperative anxiety of children undergoing elective day care surgery.

Virtual reality exposure offers children a highly realistic virtual environment that mimics the operating theater of a hospital. Children can get accustomed not only to the operating environment but also to the anesthesia procedures.

Picture 6: The virtual reality holding area.

Picture 7: The virtual reality operating room.

Desirable outcome
By preparing children for anesthesia and surgery with an innovative virtual reality exposure tool, instead of distracting them, we hope to improve clinical and psychological outcomes.

Read the scientific publication from the project

Source and more info: Erasmus MC

5

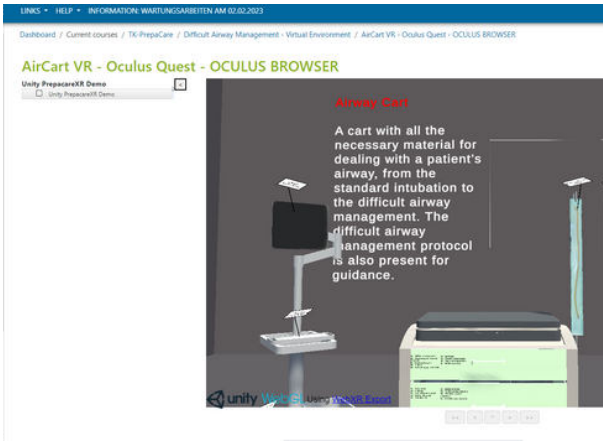
OUR CONCRETE CASES

In the following section, we will focus on hands-on and concrete cases of integrating XR simulation into healthcare education in the organizations which are part of the PrepaCareXR project. These cases are collective knowledge generated by PrepaCareXR partners in their everyday practices but especially during the LTT (Learning, Training, Teaching) pilot in Vila Real, Portugal.

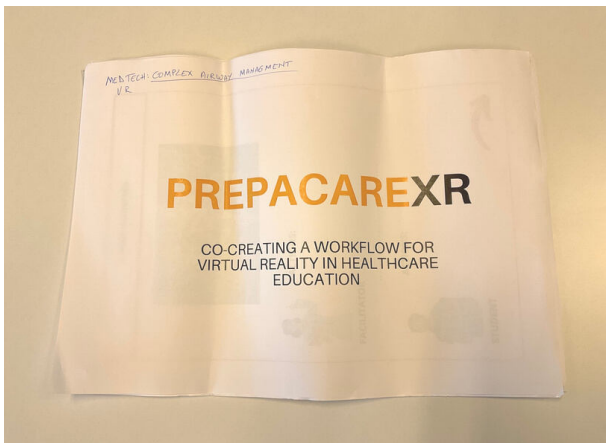
5.1 Difficult airway management: A Moodle course combining interactive content and game-based learning

Introduction

Multidisciplinary experts and medical professionals developed the international project PrepaCareXR. It aims to create advanced digital training solutions for healthcare professionals and students by combining computer-based learning tools with practical experience. In addition to the other outcomes, an e-learning course was created which is running on a Moodle platform, a free, open-source based learning tool. Moodle provides solutions for pure online lessons as well as blended learning and allows you to navigate through the sections and the corresponding content freely and repeatedly.
Combining technological expertise and the hands-on knowledge of medical professionals ensures technological integrity and real-world relevance.
Hence the project covers selected use cases based on real-world training scenarios.



Picture 8: A screenshot of the airway cart embedded in Moodle



Picture 9: Co-creation workshop with healthcare teachers, practitioners and students

Use-case description: Difficult airway management and ABCD pediatrics

Although the developed course concept applies to many clinical scenarios, the e-learning course can cover specific cases, for example, Difficult Airway Management and the pediatric ABCDE approach. A glossary provides further explanation about medical terms and abbreviations used in the course. Additionally, you get information about your progress so you will never miss any important part.

A difficult airway is a clinical situation in which a healthcare provider encounters difficulty with standard methods of airway management. Thus it is crucial to be prepared to act accordingly.
ABCDE stands for Airway, Breathing, Circulation, Disability, Exposure. Using this approach, medical professionals can immediately assess a patient in clinical emergencies for treatment.
A difficult airway is a clinical situation in which a healthcare provider encounters difficulty with standard methods of airway management. Thus it is crucial to be prepared to act accordingly.

Example of the pre-activities - Practicing Difficult Airway Management in Moodle

Different didactic concepts and tools are used to give a broad overview of the content. This includes images, videos, info boxes, medical guidelines, case studies, and Image Hotspots. Other learning techniques include virtual flashcards and self-checks to track students' progress and highlight areas where more training is required.

The second level of the course covers interactive training. In branching scenarios, students are guided through a virtual emergency, where they have to make medical decisions.

The goal of these scenarios is that participants learn to internalize the decision-making process in a safe environment.
Moreover, this part covers a virtual tour through the airway cart and tool. Another example within the Difficult Airway Management use case is an interactive handbook of a ventilator used in intensive care. The handbook provides information about the functionalities of the device. An interactive self-check about the monitor keys and the display options is also available in the course.
In the third level, participants exercise their knowledge in a virtual environment

Picture 10: An overview of the PrepaCareXR Moodle course

The added value of VR

Up to now, knowledge creation and training of medical workflows consist mainly of learning and repeating from books, scripts, and similar materials, and performing role plays. One of the more interactive training scenarios includes the simulation of use cases at the hospital by using mannequins. These are bound to certain time slots and rooms and – depending on the range of functions – are very expensive. Therefore, not every hospital or institution is able to offer this training opportunity to their staff or students.
Overall the collaboration of engineers from various areas with medical professionals elevates the quality of the course to a professional and clinical level.

5.2 Using VR to practice Finnish language skills in two use-cases: Anaphylaxis shock and discharging of patient.

Introduction

The Culture Expert is a research and development project between the University of Oulu, Lapland UAS, and Oulu UAS which aims to enhance the integration of nursing students with immigrant backgrounds into the Finnish working life. The key innovation of the project is using VR simulations to enable nursing students to practice their language as well as clinical skills in a virtual environment that simulates real-life scenarios.

The project explores and utilizes the latest technology to create the VR simulations such as MetaHuman Creator from Unreal Engine 5, body animation and facial expression capture, speech recognition, etc. Consequently, the virtual hospital wards, nurses, patients, and interaction are extremely similar to reality, allowing for greater immersion into the simulation

Picture 11: The virtual patient part of the 'Patient Discharging' VR simulation

Picture 12: Students practicing 'Anaphylaxis Shock' VR simulation

Use-case description: Anaphylaxis shock VR

The anaphylaxis shock is a VR simulation that allows nursing students to practice their clinical decision-making as well as their language skills in a virtual environment that replicates real-life settings. More specifically, the student is placed in a hospital ward next to a virtual patient and nurse where the virtual nurse gives a briefing about the background of the patient and the reason she has come to the ward.

In addition, the virtual nurse suggests giving a dose of the medication intravenously before she leaves the simulation. After that, the virtual patient gets an allergic reaction and the nursing student has to manage the situation and make the right decision in the simulation by communicating with the patient and checking the vital signs monitor.
As the simulation progresses further, the nursing student has to call the doctor in charge and brief the situation and act accordingly.

Co-creation with teachers and developers

The anaphylaxis shock is a VR simulation which allows nursing students to practice their clinical decision-making as well as their language skills in virtual environment which replicates real-life settings. More specifically, the student is placed in a hospital ward next to a virtual patient and nurse where the virtual nurse gives a briefing about the background of the patient and the reason she has come to the ward.

Integration into the curriculum

In addition, the virtual nurse suggests to give a dose of medication intravenously before she leaves the simulation. After that the virtual patient get an allergic reaction and the nursing student has to manage the situation and make the right decision in the simulation by communicating with the patient and checking the vital signs monitor.
As the simulation progresses further, the nursing student has to call the doctor in charge and brief the situation and act accordingly.

Picture 12: Planning the VR simulation by nursing teachers and engineers

The added value of VR

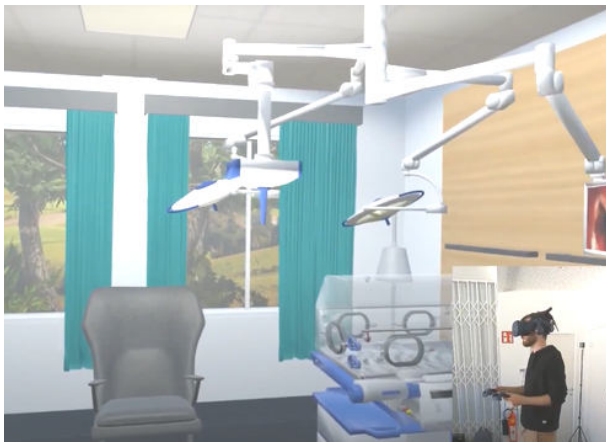
The anaphylaxis shock is a VR simulation that allows nursing students to practice their clinical decision-making as well as their language skills in a virtual environment which replicates real-life settings.

5.3 Multi-user VR simulation of difficult airway management in virtual operating theater

Introduction

The MedTech-mR is an ongoing project at FH Technikum Wien and explores the planning of medical rooms in VR. Simulations of medical and administrative processes are particularly useful in a realistic environment, i.e. in a correctly furnished room that conforms to standards. If there are also appropriately realistic devices in this room, so-called digital twins, individualized training, education, and teaching scenarios can also be carried out. This enables device-specific training, the simulation of typical treatment procedures or administrative processes such as warehouse management and logistics in the virtual world, and also in augmented reality. This also includes the possibility of integrating several users, i.e. the use of a simulation environment by several people at the same time.

Picture 13: A joint VR simulation between healthcare teachers, practitioners and students



Picture 14: Students planning an Operating Theatre in VR

Use-case description: Multi-user VR simulation of difficult airway management in the virtual operating theater

The following goals are thus defined for the MedTech-mR project:

- Possibility of mapping medical technology planning in virtual and augmented reality.
- Embedding of selected medical and related organizational processes for training and analysis.
- Implementation of a realistic simulation environment in the virtual as well as in the real world as a training, development, and test environment.

Through this project, the quality of medical technology planning can be increased and the associated implementation costs potentially reduced. Through training and simulation possibilities, the quality and efficiency of medical and related organizational processes can be increased. In addition, the digital competence of the users can be increased and another form of digital teaching can be established.
Within the framework of the MedTech-mR project, competence is being built up in the areas of virtual and augmented reality, medical technology planning, training, and simulation of medical processes.

6

PREPACARE(XR) FRAMEWORK

In order to use XR in healthcare education, you might need some practical tools, knowledge, or maybe just inspiration. Planning the XR-based education carefully is needed for participants' learning to occur (e.g., Makransky & Petersen, 2020).

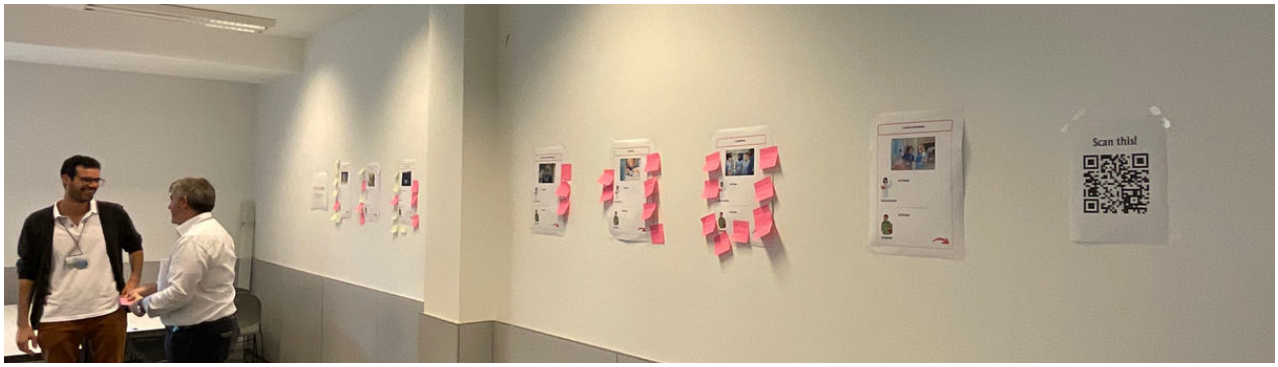
PrepaCareXR framework helps in planning, implementing, and also evaluating the education. The PrepaCareXR framework is based on previous studies (Keskitalo, 2015) but it is also co-designed with participants during the pilots. Therefore, it takes into account multiple viewpoints, that of, students, professionals, facilitators, researchers, and designers of the XR. Next, the PrepaCareXR framework is presented with some practical examples developed during the project.

6.1 General description of the LTT (Learning, Teaching, Training) in Vila Real, Portugal

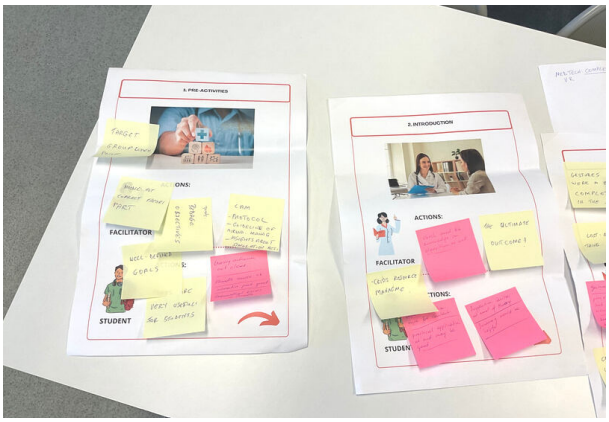
During the PrepaCareXR piloting week, participants (n = 44) had a chance to learn the theoretical knowledge on difficult airway management through Moodle online course as well as practice the hands-on skills related to it with VR that was developed during the project. Participants were biomedical engineering and nursing students as well as healthcare professionals.

During the pilot participants were divided evenly into two groups that practiced different scenarios with XR at the same time. However, both groups had the chance to experience both of the XR applications, as the participants had no (n = 17) or only a little (1–5 times) (n = 25) experience with XR in general.

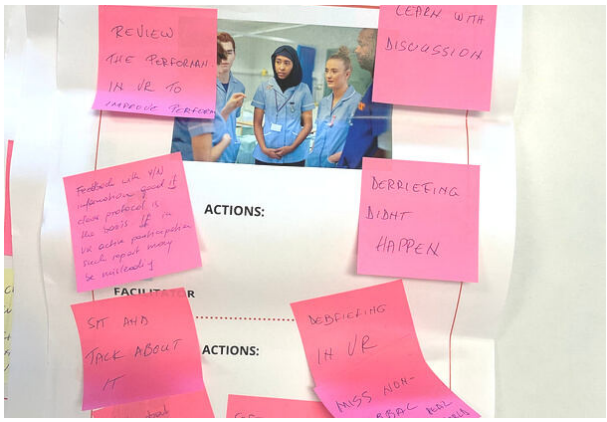
Before the XR-experience students also learned some theoretical knowledge related to the topic. After each learning experience, data were collected using an online questionnaire accessible through a QR code. The questionnaire was based on the standardized simulation design scale (National League for Nursing, 2005). During and after the experiment, participants also co-designed a pedagogical framework based on their learning experience. For this purpose, there was a tentative pedagogical framework on the wall, where participants (n = 44) could provide qualitative answers using sticky notes and pencils.



Picture 15: Co-designing the framework with participants.



Picture 16: Collecting input for different stages of the framework

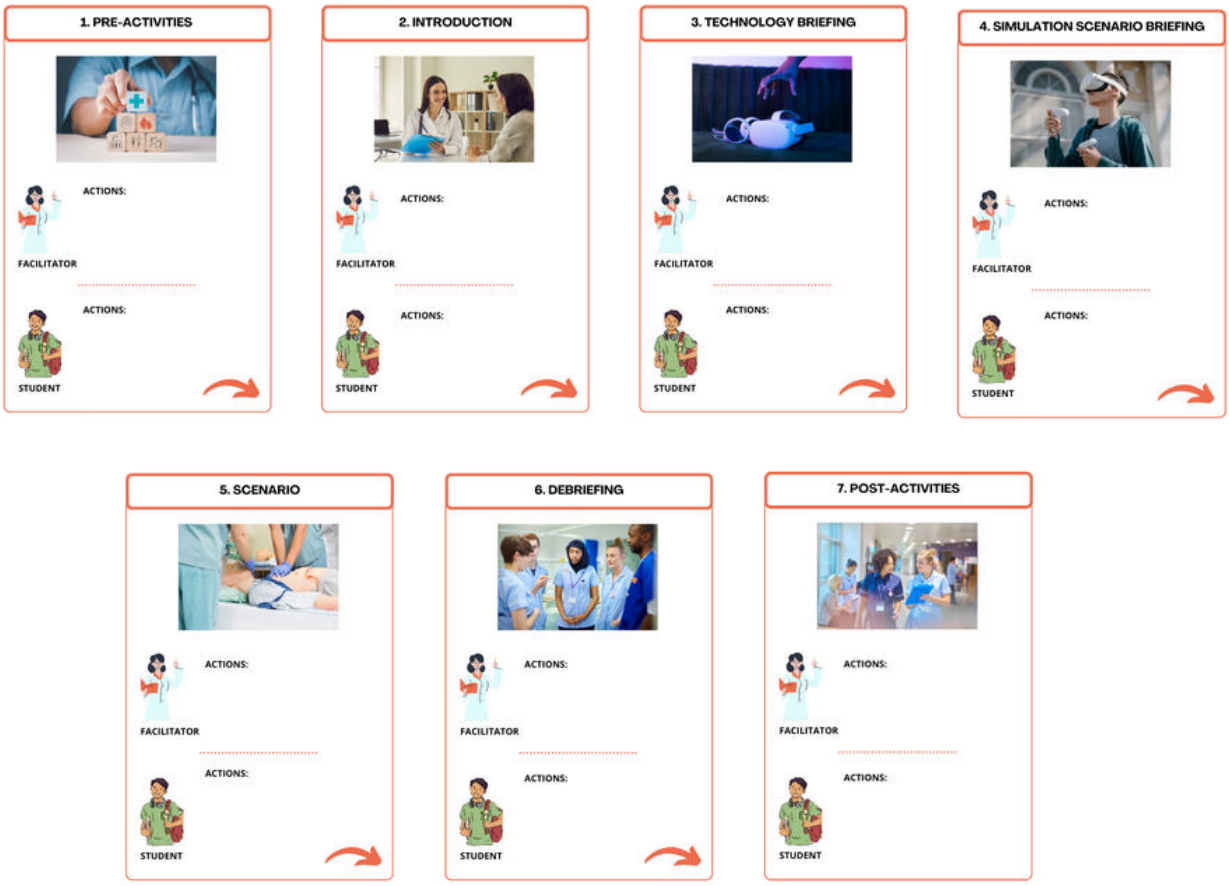


Picture 17: Participants` qualitative answers

6.2 A general overview of the PrepaCareXR framework: The 7 steps from pre-activities to post-activities

Based on the previous studies and the PrepaCare pilot, we have divided the PrepaCareXR framework into seven different phases that facilitators may follow during the planning and implementation of healthcare education and training. However, education is flexible in nature so the order and structure of the overall framework can be modified for the purposes and goals of the target group.

In general, the PrepaCareXR framework involves the following seven phases: Preactivities, Introduction, Technology briefing, Simulation Scenario briefing, Scenario, Debriefing, and Post-activities. Next, we present every phase in more detailed-manner.



Picture 18: PrepaCareXR Framework for healthcare XR education

6.3 STEP 1: PRE-ACTIVITIES

By the end of this phase, learners should have familiarized themselves with the subject matter in order to perform in XR environment.

"Give some knowledge in advance to be sure that everybody has the some background."

1. PRE-ACTIVITIES

FACILITATOR

ACTIONS:

- get to know the learners in order to plan the course
- designing the learning process and learning environment with objectives and learners' characteristics in mind
- E.g., how to time and phase the learning environment and what would be the suitable technology

STUDENT

ACTIONS:

- Familiarizing themselves with the subject matter, e.g., through pre-assignments, lectures, online learning material etc.

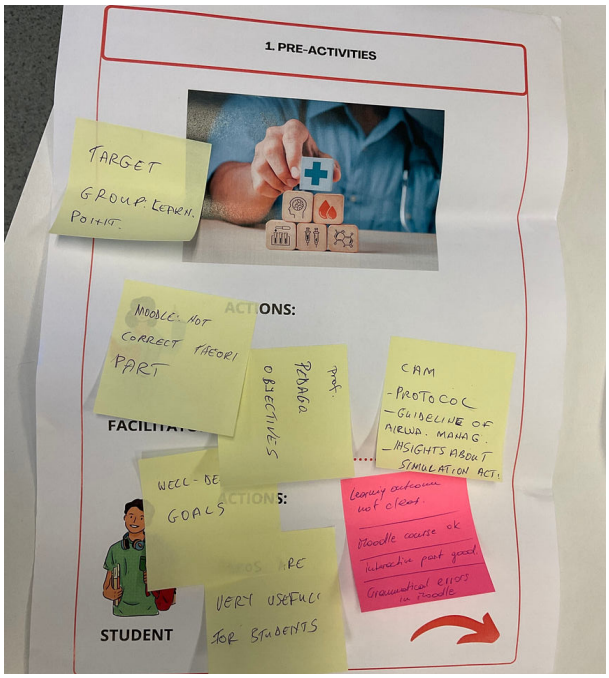
Pre-activities step in practice

Example of the pre-activities - Learning Difficult Airway Management in Moodle

The joint learning goal for the medical engineering and nursing students, as well as healthcare professionals, was decided to be learning Difficult airway management.

During this pilot's pre-activities phase, participants gained common ground before practicing the VR through Moodle course. Moodle course was divided into six phases that involve general course information and theoretical knowledge (e.g. articles) as well as more interactive parts where learners can practice and test their know-how.

In the picture below you can see the structure and parts of the PrepaCareXR Moodle course.



Picture 19: Pre-activities qualitative data

Picture 20: Structure of the Moodle course for learning difficult airway management.

6.4 STEP 2: INTRODUCTION

By the end of this phase, learners should have reflected on their previous knowledge and experiences, and be familiar with the topic, the learning objectives, learning with XR in general, and with the ground rules.

"Explaining and introduction were good. The information beforehand could have been more simple (not so much info)."

2. INTRODUCTION

FACILITATOR

ACTIONS:

- presentation of the topic and other important concepts
- Explaining how the course is organised
- Presentation of the learning objectives through abstract and concrete examples
- Creating psychologically safe environment for learning

STUDENT

ACTIONS:

- Activating prior knowledge and experiences, e.g., through discussion
- Creating one's own learning objectives

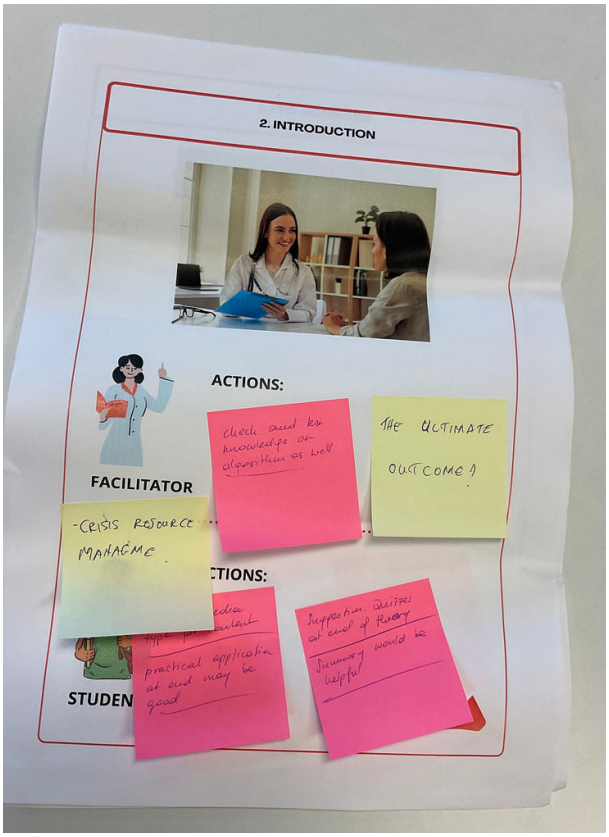
Introduction step in practice

The introductory phase is usually the first phase of face-to-face interaction. That is, the phase when the participants get together.

However, if XR is used for independent training, there might not be an introductory phase, but then the XR should include enough instruction to be used independently.

During our pilot, we introduced the PrepaCareXR project to the participants, how the pilot is structured, and what was expected of participants during a week-long course.

The structure and length of this phase may also vary depending on the learning goals, participants, and requirements of the course.



Picture 21: Qualitative answers regarding the introductory phase

6.5 STEP 3: TECHNOLOGY BRIEFING

Facilitator should provide hands-on time with the technology and help whenever needed, whereas learners should be able to practice with the technology and get comfortable using it. It is important that during the training, the participants are able to concentrate on learning the content, not the technology.

3. TECHNOLOGY BRIEFING

FACILITATOR

ACTIONS:

- introduce student to XR and how to use the devices comprehensively (e.g. controllers and movement)
- ensure that there is a spacious room to perform the XR scenarios
- enable students to take a tutorial with the headsets and controllers so they feel comfortable
- ensure that there is no interference from the real-world (e.g. background noises, objects, etc)

STUDENT

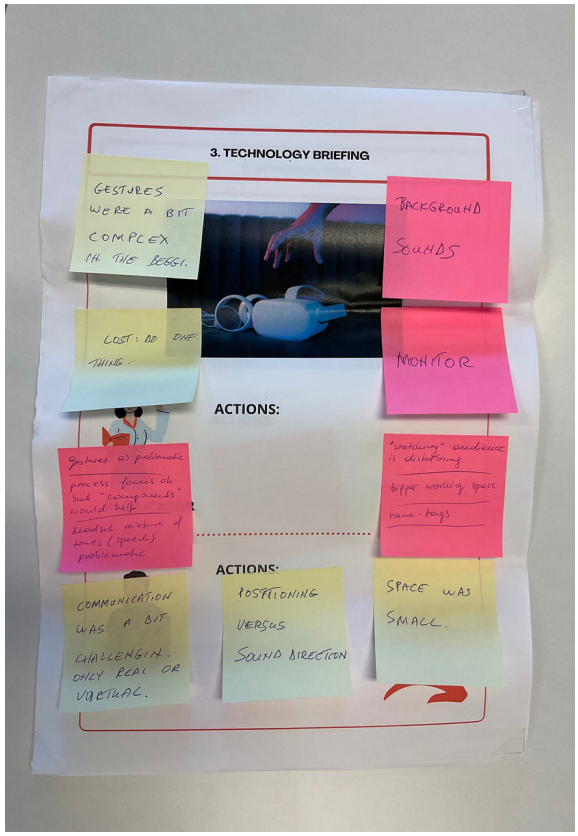
ACTIONS:

- become familiar and practice how to use the XR headsets
- hands-on time with the XR applications

Technology briefing step in practice

During technology briefing, hands-on experience with the technology is important.

The technology briefing stage was identified during the pilot as a crucial step, therefore, we added it as a stand-alone block in the PrepaCareXR framework.
Since VR headsets and devices and not commonly used among students, many of them can be considered new users. Consequently, it is essential that the facilitator introduced the technology thoroughly, step by step on how to use the headset, and controllers and how to navigate in the virtual world.
The students should feel comfortable and skilled in using the VR technology before they are ready to perform the simulation at hand. This would allow them to focus more on the simulation rather than struggling with how to use the VR controllers, for example.



Picture 22: Technology briefing qualitative data

Picture 23: Facilitator guiding students on how to use hand-gesture in VR

6.6 STEP 4: SCENARIO BRIEFING

By the end of this phase, learners should know what kind of activities are expected of them during the case scenario on a general level. An important principle of simulation-based training is to not reveal the surprise by telling too much about the participants.

4. SCENARIO BRIEFING

FACILITATOR

ACTIONS:

- introduction of the scenario, case, problem etc. that participants are required to solve
- introduction of the roles, rules, procedures etc.
- introduce the XR simulation workflow to the students (e.g. through a flowchart)
- maintaining psychologically safe learning environment]
- ensure that the students have a clear understanding of the upcoming scenario

STUDENT

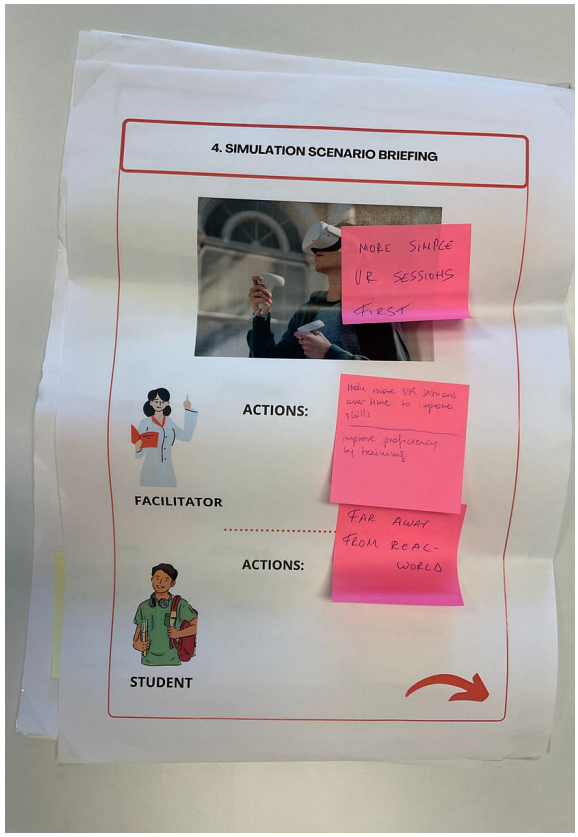
ACTIONS:

- pay attention to the workflow of the XR simulation
- reflect on the theoretical knowledge and connect it to the XR simulation

Scenario briefing step in practice

During scenario briefing, the facilitator must ensure that the students understand the simulation scenario they should perform.

Similar to the technology briefing stage, the scenario briefing plays a key role in students' understanding of the learning goals of the simulation scenario.
During our pilot, the facilitator was explaining the roles of the students and healthcare practitioners in difficult airway management. For example, to perform the simulation, it was required that one participant takes the role of the doctor and then two participants take the role of the nurses.
In addition, the facilitator informed the participants that the facilitator will be a moderator during the simulation, guiding the participants to solve the challenges in VR simulation in real-time.



Picture 24: Scenario briefing qualitative data

Picture 24: Facilitator guiding students through the workflow of 'Difficult Airway Management' VR scenario

6.7 STEP 5: SCENARIO SIMULATION

Introduction

By the end of this phase, learners are more knowledgeable and confident in using XR and applying the theoretical knowledge to the XR experience.

5. SCENARIO SIMULATION

FACILITATOR

ACTIONS:

- facilitating and monitoring learners' activities
- ensure that you are guiding and helping students when its required during the simulation
- Maybe think about relevant other activities in a meanwhile for those who are not participating
- ensure a safe environment for participants, virtual patients according to ethical guidelines
- allow other students to observe the simulation from a common TV sc

STUDENT

ACTIONS:

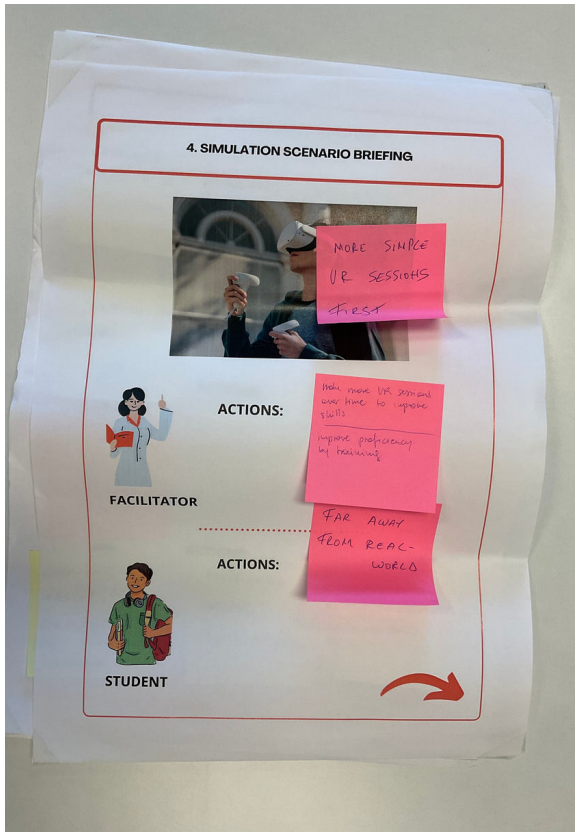
- practice their knowledge and skills with XR
- follow instructions and tasks in the VR simulations and from the moderator if necessary
- recall your theoretical knowledge to solve the situations in the VR simulation

Scenario simulation step in practice

PrepaCareXR pilot involved two kind of XR scenarios that participants could try. However, as mentioned earlier, the possibilities of XR are endless and only the imagination can be the limit.

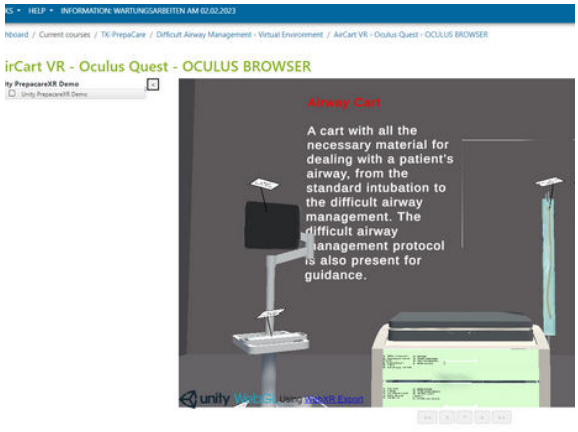
In a first XR scenario, participants...

The second XR scenario was about practicing the use of air cart independently with hand-held devices and VR glasses. During the scenario you were able to open and discover the drawers, and to see what they incluced. This knowledge is important that you are able to act as quickly as possible during the real-life emergency. At the end of the scenario, there was also a query where you could test your knowledge. During the scenario instructors were also present to help you.



Picture 26: Simulation scenario briefing qualitative data

Picture 25: Students testing the VR.



Picture 27: Airway cart VR simulation in Moodle

6.8 STEP 6: DEBRIEFING

Introduction

Debriefing is considered the most important phase of simulation-based healthcare training because during the debriefing participants are able to reflect on their performance and thought-processes and change their mental models. Correcting the behavior and thought processes is important for the patients' safety. For participants learning, it would be also beneficial to create new learning goals.

6. DEBRIEFING

FACILITATOR

ACTIONS:

- guiding learners' reflection according to the learning goals and key treatment points
- providing individual guidance and feedback
- ensuring the psychologically safe learning environment
- the debriefing session can be organized either in XR, in real-world and combine both approaches depending on the simulation

STUDENT

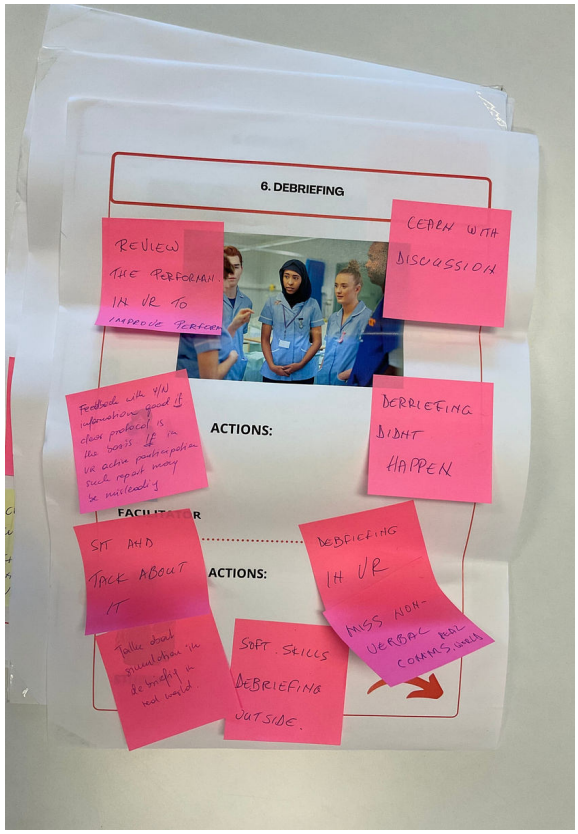
ACTIONS:

- comprehensive evaluation, reflection and critical analysis of the learning process, learning environment and the learning objectives
- setting the new learning objectives
- discuss with your peers about the decisions and the workflow of the XR simulation
- discuss with your peers about the learning outcomes of the XR simulation

Debriefing step in practice

During the PrepacareXR pilot participants were able to review their learning in three ways: 1) by doing query after the XR scenario, 2) through reflective group discussions, and 3) with formal feedback questionnaires.

The best is to hold the debriefing right after the simulation scenario when things are fresh in the memory. Participants may also want to blow some of the steam out and share their feelings with others. However, the use and application of XR are endless, therefore, the application itself may also include the reflection of learning in the form of a written text or maybe an avatar giving gentle feedback. **What should be borne in mind, is that participants should have the possibility to reflect on their learning and correct any misunderstanding.**



Picture 28: Debriefing qualitative data

Picture 29: Students observing the VR simulation

6.9 STEP 7: POST-ACTIVITIES

For the development of education and learners' expertise, it is important that we develop the education based on the feedback as well as provide learners the possibilities for continuous and deliberate practice. Here the XR is useful as it can be used for independent training.

7. POST-ACTIVITIES

ACTIONS:

- development of the education based on the evaluation and feedback
- ensure that you ask students how they are implementing the knowledge in their daily tasks and professional area

FACILITATOR

ACTIONS:

- possibility to test their newly acquired skills and knowledge in the real environment or in a more comprehensive full scale simulation
- provide feedback about the quality of the simulations as well as pros and cons

STUDENT

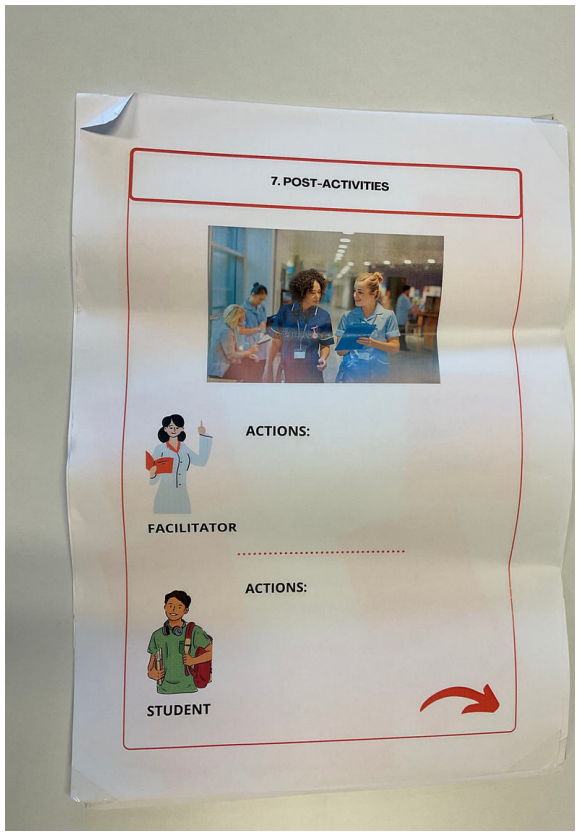
Post-activities step in practice

is the development of education based on the feedback gained during the education? Therefore, we highly recommend you collect some kind of feedback.

In our pilot testing, participants seemed to value the whole learning experience (M = 3.4–4.6; MD = 4.0–5.0). Statements concerning the support during the learning process earned the highest mean scores (M = 4.6 – 4.5; MD = 4.0 – 5.0), whereas statements concerning the fidelity of the scenarios scored lowest (M = 3.4 – 3.5; MD = 3.0).

In the future, we must, therefore, continue to develop the simulated case scenarios. However, we also noticed that technology briefing is very important for participants to be able to train in the XR environment as learning to use the technology can take time. Therefore, it is added as an independent phase to our framework.

For participants learning, it is important that they can continue to practice their skills in a real-life or, for example, during the full-scale simulation training.



Picture 30: Post activities qualitative data

Therefore, in higher education, it is important to think about how the XR and simulation-based training are intertwined in the curriculum or the organizations' workplace learning activities.

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Tuulikki is a Doctor of Education and has worked as a project manager and researcher in several research and development projects since 2007. Currently, she works as a Principal Lecturer at the Lapland University of Applied Sciences (Rovaniemi, Finland). Tuulikki has been a visiting scholar at Stanford University, School of Medicine (Palo Alto, CA, USA) in the years 2009–2010 and 2016. Her Ph.D. is concerned with developing a pedagogical model for virtual and simulation-based learning environments in healthcare. In addition, Tuulikki has studied conceptions of teaching and learning, meaningful learning, playfulness, etc. within novel learning environments. Lately, she has become interested in well-being, and how that can be promoted in work, studies and life in general.

Erson Halili

Erson has a background in Psychology, Media Education, and Service Innovation and Design. Currently, he works as a Research and Development Specialist at FrostBit Software Lab (Lapland University of Applied Sciences) focusing on the development and integration of extended reality technologies and applications in education and industry. Erson is passionate about the meaningful integration of XR technology teaching and learning as well as students' and teachers' XR literacy. Recently, Erson has been working on a project using XR to teach international nursing students in Finland, to practice, and learn the Finnish language.

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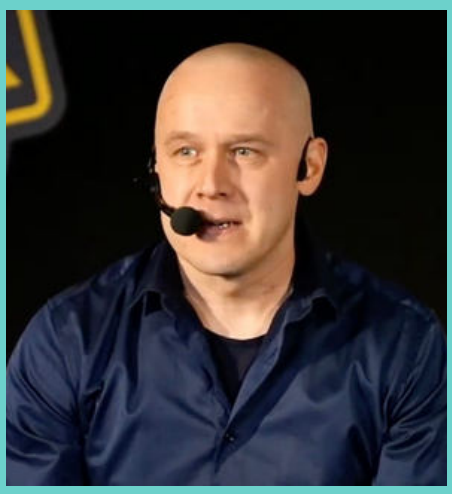
Katja has a Master´s degree in Health and Welfare Management in 2019 and Professional Teacher education in 2021. She is currently working as a Lecturer in the Nursing program at Lapland University of Applied Sciences. Before teaching, she was a nurse in an intensive care unit for 23 years. Katja also worked in a hospital as a simulation instructor for 13 years. The topics of the training were mainly related to the identification of critically ill patients and resuscitation training. In her Master's thesis, she developed a procedure for critically ill patient identification based on National Early Warning Score (NEWS) in a local hospital.



Marko Vatanen

Marko is a senior lecturer and seasoned simulation instructor with over 10 years of experience in simulation in health care as well as other domains. He has been developing simulation pedagogy at Lapland University of Applied Sciences in various different development projects. He is currently working on using simulation to teach rescue and evacuation from wind turbines. He has also a strong interest to explore safety in complex, dynamic environments and to build adaptive capacity for organizations that are working in complex, dynamic environments. Marko has worked as a nurse in the ambulance and intensive care unit for 15 years before joining higher education institutions.