



H-PASS

Deliverable 5.2

VR learning environment



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D5.2 VR learning environment

Silversky 3D (SS3D)

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Table of abbreviations

Acronym	Description
GA	Grant Agreement
SC	Steering Committee
VR	Virtual Reality
GP	General Practitioner
EHR	Electronic Health Record
ER	Emergency Room
PC	Personal Computer

Applicable and reference documents

The following documents contain requirements applicable to the generation of this document.

Reference	Document title
GA	Grant Agreement
CA	Consortium Agreement
Milestone 23	1st VR prototype

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1. Introduction

Deliverable D5.2 relates to the creation of a Virtual Reality Learning Environment for the H-PASS training course. The deliverable itself can be found here: <https://dev.silversky3d.com/hpass/>

This report presents further details on the development of the Virtual Reality (VR) learning environment within the H-PASS training programme. The VR component was designed as an innovative addition to the curriculum, aiming to support the development of digital and transversal skills among healthcare professionals through immersive, scenario-based learning. In particular, the VR experience focuses on patient safety and risk management, allowing learners to engage with a realistic clinical case and apply their knowledge in a simulated environment.

The report outlines the full development process of the VR module, beginning with its conceptualisation and pedagogical design, followed by the definition of the case study, user interactions, and learning objectives. Subsequently, it outlines the technical and collaborative steps taken to design, develop, test, and refine the VR environment. Particular attention is given to the iterative development process, the integration of feedback through task force activities and focus groups, and the localisation of the experience across multiple languages.

In this way, the report demonstrates how the VR learning environment was developed through a structured and collaborative approach, combining educational design, technical implementation, and continuous improvement (conceptualisation section). The result is an interactive learning tool that complements the H-PASS training programme and enhances learners' ability to understand and respond to complex patient safety situations (case study section of this report).

2. Conceptualisation

This section outlines the rationale and approach for developing a virtual reality (VR)-simulated experience for inclusion in the H-PASS training curriculum. In healthcare settings, patient safety is a critical concern that requires constant vigilance and effective communication among healthcare professionals. This VR case study highlights the complex challenges faced by healthcare teams when managing a patient safety incident. The case focuses on an 18-year-old male with a lower respiratory tract infection who experienced complications stemming from medication errors, communication barriers, and insufficient access to medical records. By investigating the underlying causes and risks of this incident through a VR simulation, trainees are tasked with analysing the breakdowns in care coordination and identifying solutions to prevent similar occurrences in the future. This exercise underscores the importance of accurate medical record-keeping, proper medication management, and effective communication between healthcare providers (including community care) and patients, particularly in a multicultural and fast-paced emergency environment. During the exercise, participants apply and integrate the digital and transversal skills developed in the H-PASS training in a practice-oriented context, including the use of digital tools, data analysis, decision-making, collaboration and communication.

2.1. Case Study

An 18-year-old male sought medical attention due to a 2-day history of high fever and productive cough, a clinical syndrome compatible with lower respiratory tract infection.

The patient initially consulted with his General Practitioner (GP) and was diagnosed with a non-COVID19 respiratory tract infection. He was given instructions for supportive care and antimicrobial (antibiotic) treatment and was advised to make a new appointment with the GP if the symptoms persist.

The GP prescribed the antimicrobial agent without knowing that it is not compatible with a concomitant medication that the patient had recently started taking for a newly diagnosed chronic disease. In particular, this pharmaceutical agent significantly increases the prescribed antibiotic's metabolism, thus potentially rendering it ineffective. The clinical pharmacist wasn't involved in the process of selecting the right medication scheme for this patient.

The patient's condition deteriorated during the weekend, and he could not contact his GP. The health centre in his area of residence was closed over the weekend. As the patient's symptoms deteriorated, he decided to attend the emergency department of the hospital, where admission was advised on Sunday morning.

The admissions nurse didn't have access to the patient's health data and medical records from community care, including other medical facilities the patient had visited. The patient struggled to provide accurate and reliable data at the hospital. The problems arose from communication barriers due to the patient's young age and native language skills; the patient was a recently arrived 1st generation immigrant. There was no attempt to communicate with them in their native language or find an interpreter. This made it more difficult to obtain important information about the patient's medication.

Upon assessment at the hospital throughout Sunday morning, the patient was discharged to make room on the ward. As a result, the patient was discharged and instructed to continue with the care suggested by the GP. They returned 12 hours later (in the early hours of Monday morning) as the patient's symptoms became increasingly worse, ultimately resulting in a readmission which led to the submission of an incident report as per hospital policy.

2.2 Incident and Risks

Incident – Readmission within 24 Hours

Hospital policy dictates that readmission within 24 hours is considered a patient safety incident and must be reported and investigated. The patient was readmitted 12 hours after discharge, which triggered the completion of an incident report form. The incident is now being investigated by the trainee.

Risk 1 – Limited availability of Medical Records

The first risk/root cause is insufficient access to medical records. The patient's history was not available through community care medical records or any other way, and this was compounded by the incident occurring on a Sunday when most community care facilities were

closed. Additionally, the doctor faced challenges accessing the unified electronic health records system.

Risk 2 – Patient Communication Issues

The second risk relates to communication barriers between the patient and healthcare professionals. Due to the patient's young age and limited English or local-language skills (he was a recently arrived first-generation immigrant), no attempt was made to communicate in his native language or provide an interpreter. This further complicated the effort to obtain important information about his medication. The nurse in the VR simulation hints at challenges related to physical medical records.

Risk 3 – Medication Error/Medications Policy

The final risk is related to a medication error. The GP's prescription contradicted the existing chronic disease medication, which was not identified. Standard procedures between healthcare practitioners (GP/Pharmacy) and levels of care (Community/Tertiary) were not followed. The correct course of action would have involved the GP contacting the pharmacist to validate the medication choice. Although the GP had access to the patient's chronic disease medication record, no cross-checking occurred. The VR simulation reveals that the nurse found two bottles of medication in the patient's bag and called the hospital pharmacist for her opinion. The pharmacist then explains the issue to the student during the simulation.

2.3 VR Expectations towards the participants

The VR experience asks the participant to conduct an investigation into the readmission incident and identify the risks and underlying root causes that produced the readmission. The participant enters the VR experience and is confronted with an emergency room environment, which includes a number of interaction points. The participant has a set time limit to identify and analyse all the data provided in the room (e.g. 10 mins). The interaction points all provide information - such as the Nurse providing key info about the 2 medications found - with some of this information being useful and some being provided as a 'decoy' (not contradictory, but not useful to the investigation).



Figure 1. H-PASS VR wardroom in the development phase

The use of some gamification was implemented to increase student enjoyment, with some interactions being ‘active’ (e.g. the student needs to click on them) and some are ‘passive’ (e.g. they will appear in the space, and the student must use observation skills to assess them). At the end of the allocated time, the student or student group is asked to complete an incident investigation document.



Figure 2. H-PASS VR working station in the development phase

2.3 User Interactions

Data Point	Type of Interaction	Interaction Detail	Useful for the solution?
Paper Medical Records	Active	Paper-based medical records are collected at admission. They highlight incomplete patient history due to a language barrier and a lack of community care information.	Yes
Computer	Active	A computer with access to Electronic Health Records (EHR). The doctor cannot access community records (not uploaded by the GP).	Yes
Nurse	Active	Provides verbal information about what happened when the patient returned to the Emergency Room (ER) (e.g., medications found, communication issues).	Yes
Doctor	Active	Sat at a computer desk, explaining difficulties with the community-wide electronic health records.	No

Pharmacist	Passive (timed)	Enters midway through the session to provide information on medication incompatibility.	Yes
Vital Signs Machine	Active	Decoy information with no relevance to the patient safety incident task.	No
Incident Report	Active	A 1-page incident report form providing minimal information (hints) about the readmission incident.	Yes
Telephone	Active (timed)	Serves as a distraction and contributed to the noisy environment of the emergency Room	Yes
Tablet	Active	Provides staff notifications about other patients. This is decoy information with no relevance to the task.	No

Table 1. User interactions in the simulation

2.4 Outline for Students

Below you can find the text given to students at the start of the VR exercise:

Congratulations on completing the H-PASS training up to this point. Now, it's time to put your knowledge into practice and conduct a **virtual reality simulation in a lifelike healthcare setting**. In this VR exercise, you will need to identify all the underlying risks associated with a patient safety incident in the emergency department of a large hospital. The patient, an 18-year-old male who sought medical attention due to high fever and productive cough (a clinical syndrome compatible with lower respiratory tract infection), has been **readmitted to the hospital just 12 hours after initially being sent home**. Hospital policy dictates that any readmission within 24 hours must be investigated, and it is your job to undertake this investigation.

You will enter the VR environment and be presented with **a number of data points**, which you can interact with. You might decide to speak with one of the healthcare professionals, review the notes, pick up the telephone or just observe the environment you find yourself in. All the information you collected will need to be used at the end of the experience to complete a **patient safety investigation report** to ensure that you correctly identified all the root causes associated with the readmission. However, beware, as you are conducting this investigation in a busy emergency room, you won't have much time to question staff and engage with case notes. This is a busy healthcare setting, so you'll **only have 10 minutes** to find everything you need. Good luck!

Here are some orienting questions that can help you with your search:

- What might be the main reasons for a readmission, and do they originate in the hospital or another healthcare setting?
- What information would be necessary to conduct a full investigation? Anecdotal evidence from healthcare professionals, written material, technological information?
- How many root causes risks could there be? Do patient safety incidents have multiple underlying factors?

Submission Guidelines:

- Conduct the VR experience in the 10 minutes allotted to you.
- Reflect on the information you identified and analyse it carefully.
- Complete the Patient Safety Investigation Form with all your findings.
- Submit your reflection through the e-learning platform/in person by [insert deadline].

The case study of the patient's readmission emphasises the multifaceted nature of patient safety incidents, where failures in communication, record-keeping, and medication management intersect. Through the VR simulation, students gain valuable insights into how these elements contribute to adverse outcomes, as well as the importance of timely interventions and interdisciplinary collaboration. This experience reinforces the need for healthcare professionals to be diligent in obtaining complete patient histories, utilising available resources such as clinical pharmacists, and ensuring clear communication, especially when language or cultural barriers exist. By reflecting on this case, students can develop a deeper understanding of how to minimise risks and improve patient care quality in real-world healthcare environments.

Lastly, it should be noted that the VR case study is directly linked to the content and learning objectives of all four primary modules of the H-PASS training, as the value of appropriate digital tool implementation, effective communication and teamwork, adoption of protocols in everyday workflows, as well as system interoperability, is underlined.

3. Virtual Reality Development Process

The development of the Virtual Reality (VR) component within the H-PASS project has followed a structured, iterative, and collaborative process, combining pedagogical design, technical implementation, and continuous partner feedback. The VR module was conceived as an immersive learning environment aimed at supporting healthcare professionals in developing patient safety competencies through experiential learning.

This section outlines the key stages of the VR development process, from initial conceptualisation through to technical implementation, testing, and localisation. The

approach adopted emphasised alignment with learning objectives, iterative refinement through task force collaboration, and progressive integration of content, interactions, and multilingual assets.

3.1. Conceptual Design and Initial Structuring

The development process began with the establishment of a dedicated VR task force, which provided a focused environment for advancing the design and implementation of the VR module. The VR task force was led by the WP leader, and all piloting partners were represented in the group. Early work concentrated on defining the pedagogical framework and ensuring alignment with the broader H-PASS training objectives.

A comprehensive conceptual report (summarised above) was developed to consolidate all agreed elements of the VR experience. This report served as the foundational reference for development, outlining the case scenario, learner journey, and key interaction points within the virtual environment. At this stage, the development team proceeded in parallel with ongoing discussions, ensuring that conceptual clarity and technical progress evolved together.

The VR experience was designed around a central task: enabling learners to gather relevant information within a simulated healthcare setting in order to complete an incident report. This task-driven approach ensured that all interactions within the environment were purposeful and directly linked to learning outcomes.

3.2. Content Development

A significant phase of development focused on defining the interactions and data points within the VR environment. Core elements of the experience were identified, including access to medical records, interactions with healthcare professionals, and engagement with both relevant and irrelevant information sources. This distinction was important in promoting critical thinking and decision-making skills among learners.

The interaction design incorporated multiple components, such as:

- simulated conversations with healthcare staff;
- digital and paper-based patient records;
- incident reporting tools;
- supplementary devices such as tablets and communication tools.

Content development was carried out collaboratively, with partners contributing dialogue scripts, case details, and supporting materials. Particular attention was given to ensuring realism and alignment with clinical practice, including the involvement of subject-matter expertise to validate the content.

An introductory script for the VR experience was also developed, with alternative versions explored to balance realism and usability within the learning context. Throughout this phase, content refinement remained ongoing, with updates informed by both pedagogical considerations and technical constraints.

3.3. Iterative Development and Testing

The VR module was developed through a series of iterative builds, allowing for continuous testing and refinement. Early versions of the environment were shared with partners for review, both through browser-based access and through VR headsets, and dedicated VR workshops were organised at the in-person meetings that took place in Nicosia and in Budapest. This dual approach ensured that usability and functionality could be assessed across different modes of access.

Feedback collected during testing cycles informed ongoing improvements to the environment. Key areas of focus included usability, clarity of interaction points, and the accessibility of information within the virtual space. For instance, improvements were suggested to enhance the visibility of key information sources and to address readability issues within certain interface elements.

Regular task force meetings supported this iterative process, enabling partners to provide structured feedback and align on next steps. The development approach remained flexible, allowing for prioritisation of essential features while deferring others where necessary, to maintain project timelines.

3.4. Documentation and Integration

As development progressed, the need for improved documentation and coherence across materials became evident. Project information had become distributed across multiple formats and platforms, which presented challenges for consistency and traceability.

To address this, the conceptual report was revisited and expanded to function as a comprehensive reference document. This updated document integrated all key elements of the VR module, including:

- the case description;
- learner briefing materials;
- interaction design;
- embedded VR data points;
- associated assessment components.

This consolidation ensured that all stakeholders had access to a clear and unified overview of the VR experience, facilitating both development and quality assurance processes.

3.5. Technical development

The technical development of the VR learning environment was carried out using a structured and performance-oriented approach, ensuring compatibility across both web-based platforms and Web/VR smartphone hardware. The application was primarily developed in Unity, enabling flexible deployment and real-time interaction within the immersive environment. Over the course of approximately two years, the development process involved three major iterations within Unity, each focusing on deep optimization strategies to improve loading times, reduce application size, and enhance memory efficiency across devices.

The creation of visual assets followed a dedicated pipeline. Character models were designed using Character Creator, while textures were refined and optimized in Adobe Photoshop to ensure both visual quality and performance efficiency. Environmental assets and 3D models were developed in Blender, with advanced material texturing carried out in Substance Painter. This combination of tools allowed for a consistent and optimized visual output suitable for real-time rendering.

In parallel, custom systems and tools were developed to support multilingual functionality, enabling seamless localisation of content across different languages and regions. Particular attention was also given to user onboarding and the refinement of UI/UX elements, ensuring that users could easily navigate the environment and engage with the learning scenarios. These efforts contributed to a polished and accessible final product, aligning technical performance with pedagogical effectiveness.

3.6. Localisation and Multilingual Implementation

A major component of the VR development process involved the localisation of content into multiple languages. Script files and supporting materials were prepared and distributed to partners for translation, with clear guidance provided on the sections requiring localisation.

The localisation process followed a structured workflow:

1. Translation of scripts and textual content;
2. Review and validation by partners;
3. Generation of corresponding audio assets;
4. Integration of translated content into the VR environment.

Audio files were generated using Synthesia, enabling the creation of multilingual voiceovers aligned with the translated scripts. This ensured consistency across language versions, while supporting efficient production.

Progress in localisation varied across languages, with some versions completed and integrated earlier than others. Completed language versions were successfully implemented within the VR environment, including full integration of translated medical records and incident reports. At the same time, gaps in other language versions were identified and addressed through follow-up actions, including the re-sharing of source materials and requests for missing translations. Additionally, the VR exercise was added via an external link and therefore accessible to different LMS systems during the piloting phase.

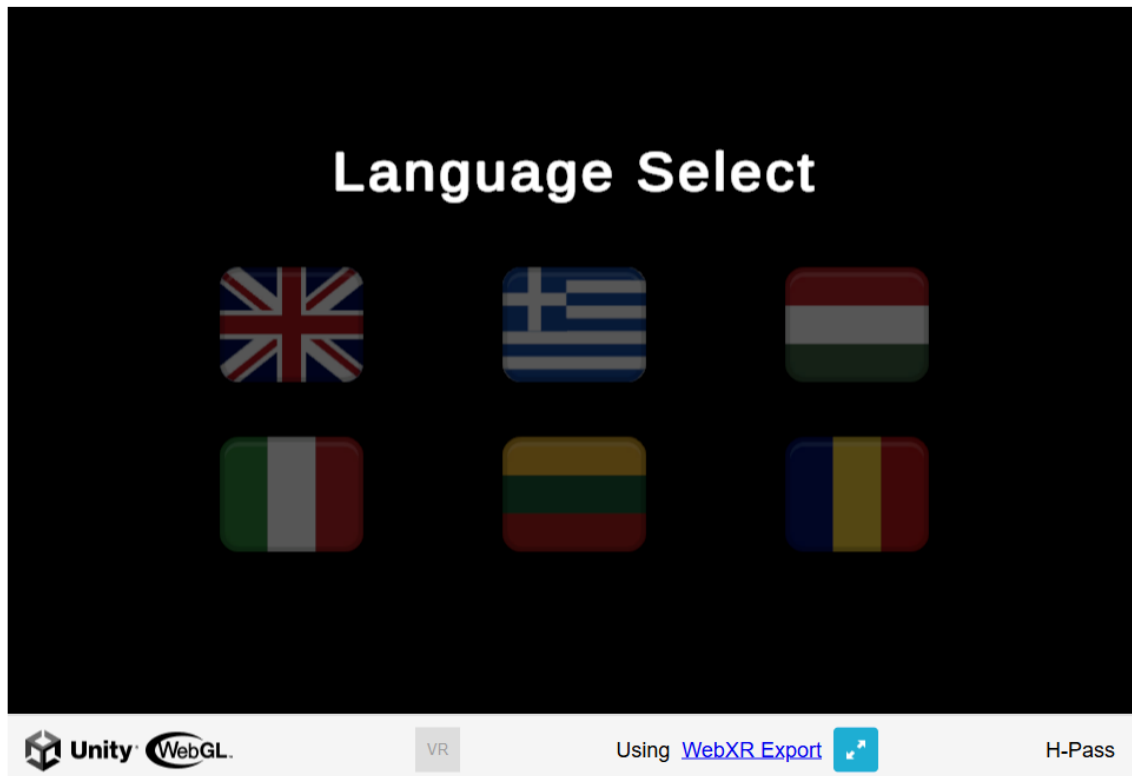


Figure 3. The VR learning environment is available in 6 languages

3.7. Finalisation for Piloting

By the later stages of development, the VR module had reached a high level of maturity, with most core components implemented and integrated into the broader H-PASS learning platform. Updates to the LMS ensured that the VR experience was embedded within the overall training pathway, alongside supporting materials and guidance.

Final development efforts focused on:

- completing localisation across all languages;
- refining user experience elements;
- ensuring consistency between VR content and LMS-based materials.

The successful deployment of completed language versions demonstrated the viability of the development approach, while ongoing updates ensured that remaining components could be finalised in alignment with project timelines. The VR experience was also designed to be delivered in the following ways:

- 1) Onsite individually with bookable timeslots (ca. 30 mins) with technical/educational support
 - 1a. Onsite as a group training exercise (1 player, rest of the group watching and discussing with trainer facilitation)
- 2) At home with own VR headset individually for convenience and sustainability

3) On PC at home individually

This functionality was built into the system to allow for flexibility of use in the piloting sites - with some students taking the course online and other in person there was a need to develop the VR aspects to be functional on a VR headset and a home PC. All students were required to complete the VR exercise; however, the delivering institution can choose freely from the delivery scenarios. Scenarios can be mixed and matched too, and adjusted the scenarios to your resources (e.g. training room characteristics, headset availability, etc.).

3.8. Piloting Feedback

Students described the VR simulation as engaging, realistic, and highly relevant to ICU practice, highlighting its value in reflecting the complexity of real clinical situations, where multiple issues must be managed at once. Overall, they felt it supported better preparation for practice by improving attention, information prioritisation, stress management, and collaboration skills.

"It realistically conveyed the feeling of having to pay attention everywhere at once during the daily work process in an ICU. For me it was exciting, real-life situations were realistically transmitted to the participant in VR."

"I found it interesting that a case can be modelled this way, and also how important information can get lost among irrelevant things."

"The VR simulation is useful because we can experience the presented process in a realistic, immersive environment, thus preparing better for real situations. It can help reduce stress and increase cooperation skills with patients and colleagues."

"I think it was useful, it was good that it presented the topics discussed during the course and that several problems could be identified at the same time, and that it was connected to reality, since in everyday work unfortunately several problems usually exist simultaneously."

"Exciting, because a lot of information has to be gathered in a short time. I wasn't familiar with the device controls, but the instructor quickly taught me to use the joystick and the various buttons. It was a great experience that I quickly found all the information relevant to the case."

4. Focus Group

4.1. Main purpose

Upon completion of the national pilots. A focus group was convened to collect and collate all the feedback for a final round of modifications. The focus groups aimed:

- to collect final feedback on the H-Pass Virtual Reality environment;
- to close off the VR creation cycle for the H-Pass project;

- to identify potential small changes that could be implemented in the remaining month of the project.

4.2. Feedback

Theme	Feedback
Overall VR Experience	• Generally positive feedback across all countries • Appreciated having the environment in local languages • Valued the option to choose between VR headset and PC versions • Loading times were problematic, especially for the PC version • Only about 10% of participants tested the physical VR headset
Controls and Navigation	• Physical VR headset experience was fairly intuitive with proper instructions • PC version was less intuitive and required additional guidance • Navigation issues included difficulty approaching certain objects at the correct angle • Partners created screenshot-based navigation guides to assist participants • Users were hesitant to move around freely in the VR environment • Lack of room-scale boundaries integration was identified as a Meta Quest bug
Scenario Relevance	• Scenario was appropriately designed to be accessible across different healthcare professions • Medical content was realistic without being too technical for non-medical professionals • Successfully incorporated elements relevant to different professions (doctors, nurses, pharmacists) • Connected well to Module 2 and Module 3 content from the H-PASS curriculum • Served primarily as a familiarisation tool with VR technology rather than deep skill development
User Experience Issues	• No clear indication of time remaining during the exercise • Users didn't know how many data points they needed to find • No feedback loop was provided directly via the VR environment" to inform users when they had discovered everything

	• Lack of integration between the VR experience and the follow-up tasks in Moodle
Other topics	• Discussion about how rapidly technology has evolved during the three-year project timeline • Recognition that the project was completed just before large language models could have been integrated • Acknowledgement that transversal skills content remains more timeless than technology components • Consideration of how VR could be better used for interprofessional education discussions

Table 2. Focus groups feedback based on national pilots

5. Finalisation of Virtual Reality Environment

Following the incorporation of partner feedback, a final update to the VR application was implemented, focusing primarily on improving overall performance and enhancing the user experience. The latest version represents a step forward in terms of system optimisation, ensuring smoother operation across both PC and VR headset environments. Load times have been reduced, and the application now delivers a more stable and responsive experience for users.

In addition to performance improvements, several features have been introduced to better structure the user journey. A 10-minute session timer has been integrated into the experience, automatically returning users to the language selection screen once the session concludes. This helps maintain consistency in session duration and supports the intended learning flow.

To further support learners, a smart guidance mechanism has been added. At the midpoint of the session, users receive prompts highlighting any key information they may have missed. This ensures that learners are given sufficient opportunity to engage with all relevant elements before completing the exercise, reinforcing the learning objectives of the VR scenario.

Finally, usability has been enhanced, particularly for PC users. The language selection process has been simplified, replacing more complex controls with a straightforward point-and-click interaction. This improvement contributes to a more intuitive and accessible interface, aligning the overall experience with user expectations and reducing potential barriers to engagement.

The VR experience is now free to access by anyone how wishes to use it for their own learning or training purposes: <https://dev.silversky3d.com/hpass/>

6. Conclusion

The development of the Virtual Reality learning environment within the H-PASS project highlights the importance of combining pedagogical innovation with structured technical implementation. The VR module was designed to provide learners with an immersive and interactive experience, enabling them to explore patient safety incidents in a realistic healthcare context and develop critical thinking and decision-making skills.

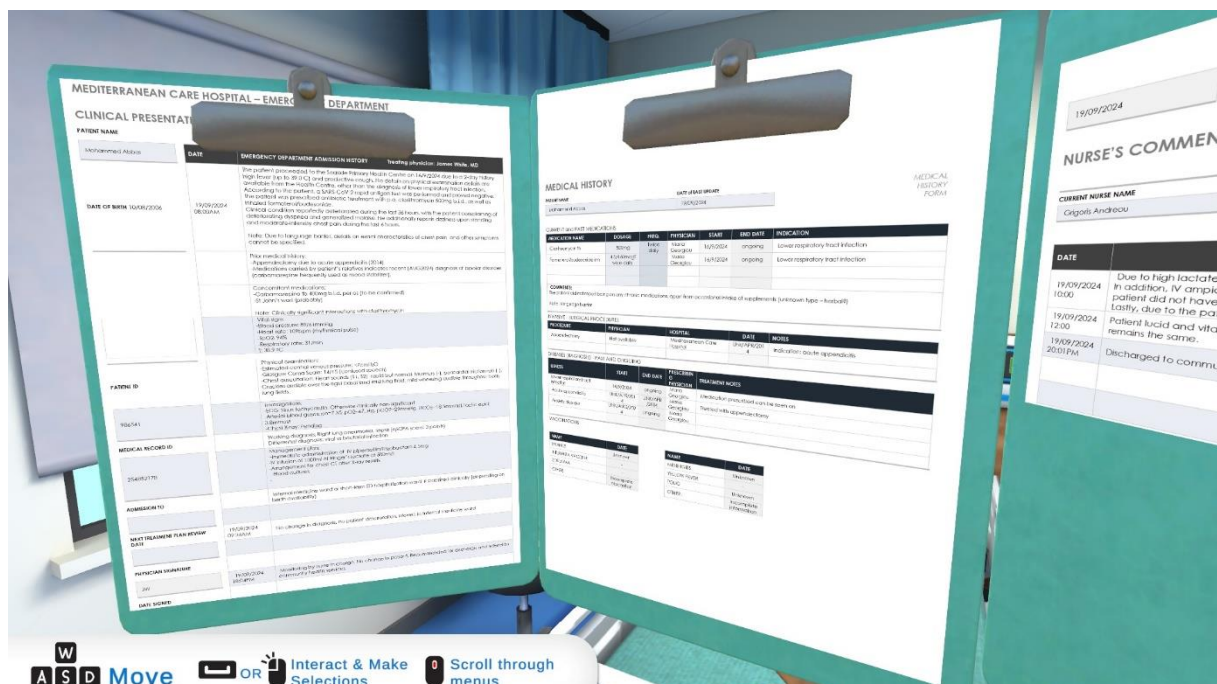
The report has shown that the creation of the VR environment followed a gradual and iterative process. Starting from a clearly defined conceptual framework, the consortium worked collaboratively to develop the case study, define user interactions, and produce relevant content. This was followed by multiple cycles of testing and refinement, ensuring that the environment was both technically functional and pedagogically effective. Feedback collected through task force activities and focus groups played a key role in improving usability, performance, and overall user experience.

In addition, the localisation of the VR content into multiple languages ensured that the learning experience is accessible and relevant across different national contexts. The integration of the VR module within the broader H-PASS training programme further strengthens its value, linking immersive learning with structured educational activities and assessment.

Overall, the VR learning environment represents a significant outcome of the H-PASS project. It demonstrates how immersive technologies can be effectively used to support healthcare education and highlights the potential for further development and application of such tools in the future.

7. ANNEX 1 - Images from the VR Online Learning Environment During Task Completion







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