Ref. Ares(2024)8192002 - 18/11/2024

Deliverable D7 (D6.1)

AR/VR- based training/assessment materials referenced to the modules.

Date: 31/10/2024

DDS_MAP

Co-funded by the European Union

DDS-MAP

Dynamic Digital Skills for Agility and Resilience

Table of Contents

1. List of Abbreviations

DDS-MAP
The Dynamic Digital Resilience for Medical and Allied Professions in Health

XR - Extended reality

HMD - Head mounted display

AR - Augmented Reality

VR - Virtual Reality

PROJECT DURATION:	**2023/01 – 2025/12**
WP:	WP6
DELIVERABLE:	D6.1 (D7)
LEAD BENEFICIARY:	SETU
SUBMISSION DATE:	28th June 2024
DISSEMINATION LEVEL	Public
DUE DATE:	30th June 2024
REVISION HISTORY:	

DATE	VERSION	AUTHOR/CONTRIBUTOR	REVISED BY	COMMENTS
28th June 2024	1.0	Ian Mills, Daniel Hickey	N/A	N/A
31st October 2024	**1.1**	Ian Mills, Daniel Hickey, Florian Scheibein	N/A	N/A

Table 1Revision History

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Acknowledgments:

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2. Executive Summary

DDS-MAP (Dynamic Digital Resilience for Medical and Allied Professions in Health Services) is a groundbreaking project co-funded by the European Union under the EU4Health program. Its mission is to revolutionise healthcare training and development across the EU by focusing on digital competency. Through mapping existing digital skills, developing training modules, and assessment through augmented and virtual reality platforms, DDS-MAP aims to enhance the readiness of healthcare professionals for the digital age.

The purpose of this document is to detail Deliverable 7 (D6.1) which is a pan-European extended reality training and assessment platform. The goal of the platform is to embed learners in the immersive and engaging medium of extended reality to further utilise the technology and its benefits to learning outcomes.

The DDS-MAP Extended Reality Training and Assessment Platform is based on a digital twin of the MUTUALIA hospital in Bilbao, Spain. All modules developed as part of D5.1 can be accessed within this environment. Six virtual reality training/assessment scenarios have been developed as of this report, which are focussed on cybersecurity (due to the results of D4.1), and build on previous cybersecurity training research conducted with healthcare workers which experienced the Irish Health Service Executive CONTI cyberattack (Hore et al., 2023). The augmented reality application also enables the learners to explore the hospital and is used to help educate them on the benefits of augmented reality applications for their workloads. The DDS-MAP Extended Reality Training and Assessment Platform is now ready for piloting amongst healthcare professionals.

3. Introduction

WP6 designed and developed a pan-European training platform utilising extended reality technologies including six virtual reality-based assessment scenarios as well as an accompanying augmented reality application showcasing the digital twin visualisation of the Mutualia hospital environment before it was constructed.

4. Extended Reality Applications

The DDS-MAP project developed a virtual learning environment which is modelled on the real world MUTUALIA hospital which is currently being developed in Spain. All modules developed as part of Deliverable 5.1 can be accessed within this online environment .Additionally, a range of training scenarios are assessed as part of Module 2 (as outlined in 4.1 below) and an augmented reality application of the hospital (as outlined in 4.2 below) is used to teach the principles of augmented reality in healthcare. Virtual Reality Scenario-based Assessments

Deliverable 4.1 identified that cybersecurity was the number one identified training priority of healthcare workers. The DDS-MAP virtual reality scenarios were developed in recognition of this priority and were developed by building on a previous study which evaluated cybersecurity training in the critical care environment with nurses who had experienced the Irish health service CONTI cyberattack (Hore et al., 2024)[1]. The scenarios had been developed by researchers and clinicians to evaluate responses to potential cybersecurity risks. The scenarios used are outlined below:

To address the key needs of the project 6 scenarios were design and developed based on the responses.

Scenarios list

- Scenario 1: Personal device – Unknown ex-filtration
- Scenario 2: Unauthorised access to work station data breach, compromised medical device
- Scenario 3: Personal device and data breach
- Scenario 4: Peer-to-Peer sharing
- Scenario 5: Alternative Peer-to-Peer sharing
- Scenario 6: Compromised equipment

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[1]

K. Hore *et al.*, “Cybersecurity and critical care staff: A mixed methods study,” *International Journal of Medical Informatics*, vol. 185, p. 105412, May 2024, doi: 10.1016/j.ijmedinf.2024.105412.

1

Scenario 1;

In this scenario it focused on the correct procedure the participant is requested to go to their workstation while the above scenarios is occurring and must respond appropriately.

Scenario 2: Unauthorised access to work statio

data breach, compromised medical device

The participant is instruction to physically inspect their

surroundings, observe the patient monitor and confirm their

observations. The correct answer is then logged with moodle

Portal.

Scenario 3: Personal device and data breach

This involved another physical attack vector within the hospital environment and the XR device allows us to showcase

that threat in an immersive way. The participant is required tohandle the situation carefully and submit appropriate response

to the staff and log the answer to moodle.

Scenario 4: Peer-to-Peer sharing

The user in this case is required to to physically check their

”XR phone” and read the message from their virtual colleague.

In this case they will have to critically think about the request

and if it is appropriate or not. Answers again are logged to

moodle platform

Scenario 5: Alternative Peer-to-Peer sharing

Within this scenario the participant again receives virtual

communication and must check their XR phone device while

in the virtual hospital. They are presented with a request

similar to the above. They must again choose to the appropriate response and act accordingly within the environment.

Scenario 6: Compromised equipment

This scenario is multi faceted as it involved taking several appropriate actions, navigating the virtual environment and making sure procedures are followed meticulously. This is the showcase XR demonstrator and seeks to show the impact of the XR training to the participants.

4.1. Scenario One VR: Personal device – Unknown Exfiltration

Scenario 1
Personal device – Unknown exfiltration

You are preparing a presentation to give to your colleagues. You bring in your personal laptop to work and connect your device to the hospital Wi-Fi to continue working on your presentation. You receive an email from an address that looks familiar, however when you open the attachment your personal files, photos, presentation become encrypted and you can no longer access them. Afterwards, you receive a ransom demand from another email to release your files.

– **Email on monitor:** "**Subject: Your Files Are Encrypted - Pay Up or Lose Them**
Hi,
Your files are now under our control. We have encrypted them using advanced ransomware, and you will not regain access unless you comply with our demands. To retrieve your files, you must pay a ransom of €1000 in Bitcoin to the following address:
1A1zP1eP5QGefi2DMPTfTL5SLmv7DivfNa
Once the payment is received, we will provide you with the decryption key. Do not attempt to involve law enforcement or tamper with our instructions. Any such actions will result in the permanent loss of your files. Time is running out. Pay now, or say goodbye to your data forever.
Sincerely,
The Ransomware Team"

What should you do? (Select all that apply)

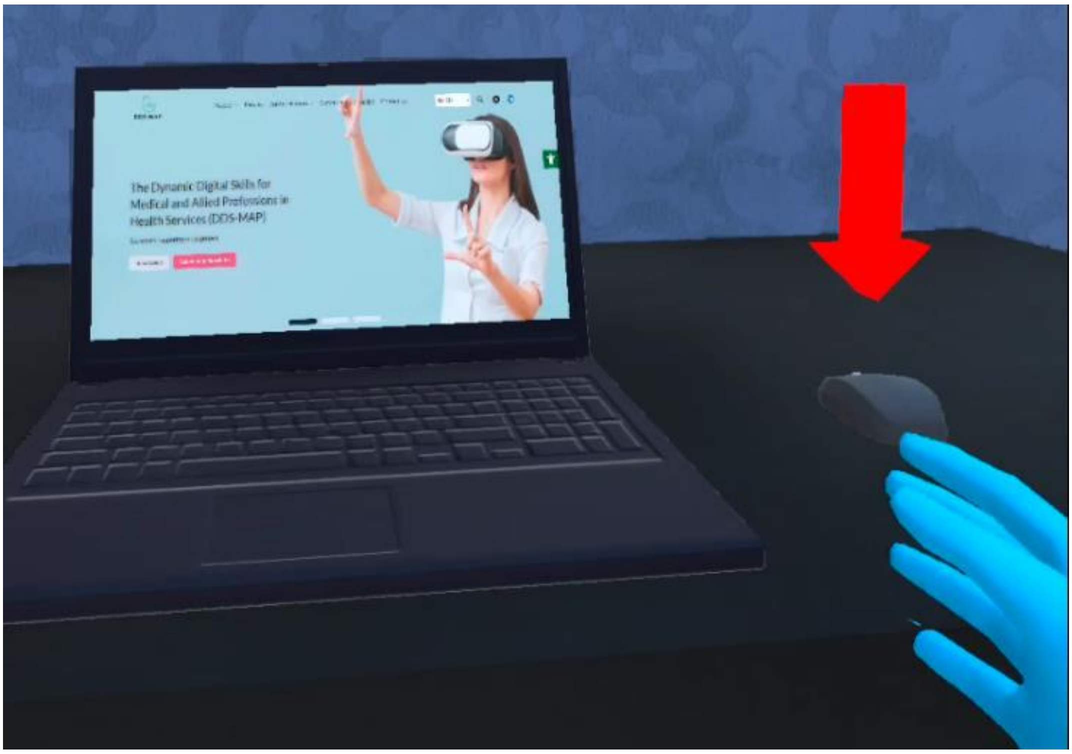
- ☐ Delete the email and continue using your laptop
- ☐ Pay the ransom demand
- ☐ Report the event to the hospital IT department
- ☐ Delete the email and use a different laptop
- ☐ Do not know
- ☐ Other (please specify) __________________

What is your follow up action? (Select all that apply)

- ☐ Make sure you have antivirus software on your laptop
- ☐ Scan for viruses whenever you download or copy a file.
- ☐ Never open unsolicited attachments especially from unknown source
- ☐ I do not know
- ☐ Other (please specify) ___________________

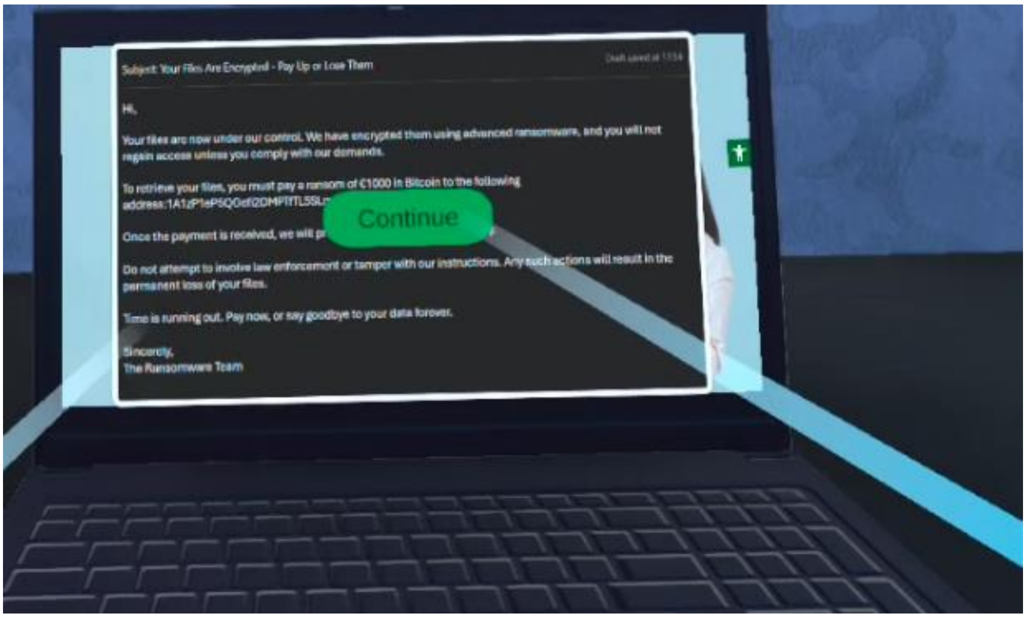
Scenario 1: Virtual reality assessment implementation

To reveal the assessment, the user touches the mouse highlighted by the red arrow.



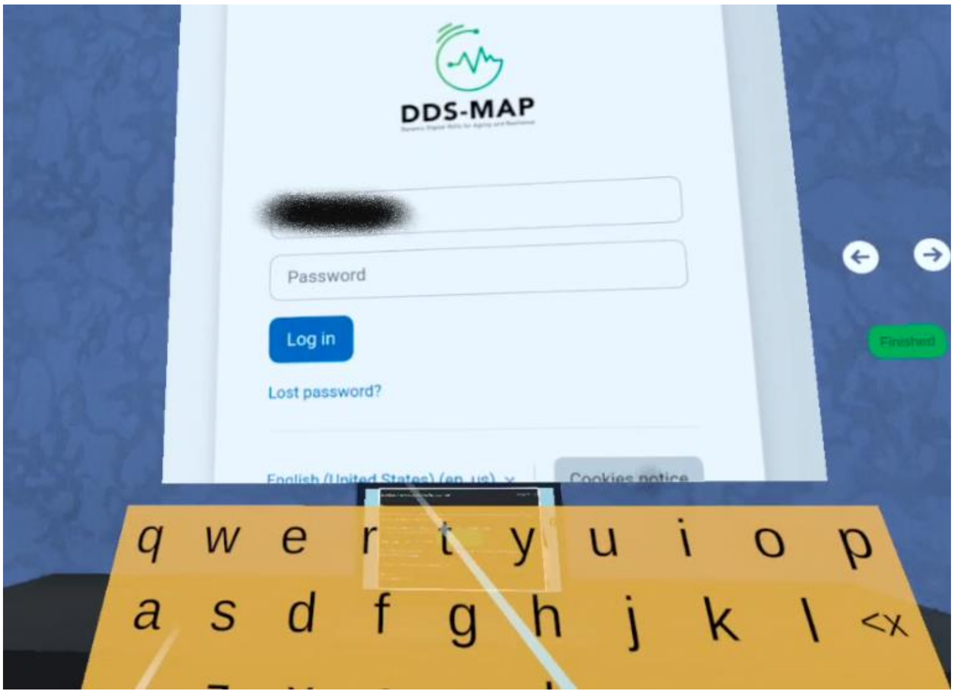
User interaction with XR mouse

The relevant information then appears on the laptop screen. The user selects "Continue" to activate the assessment window and keyboard to begin the assessment for Scenario One.



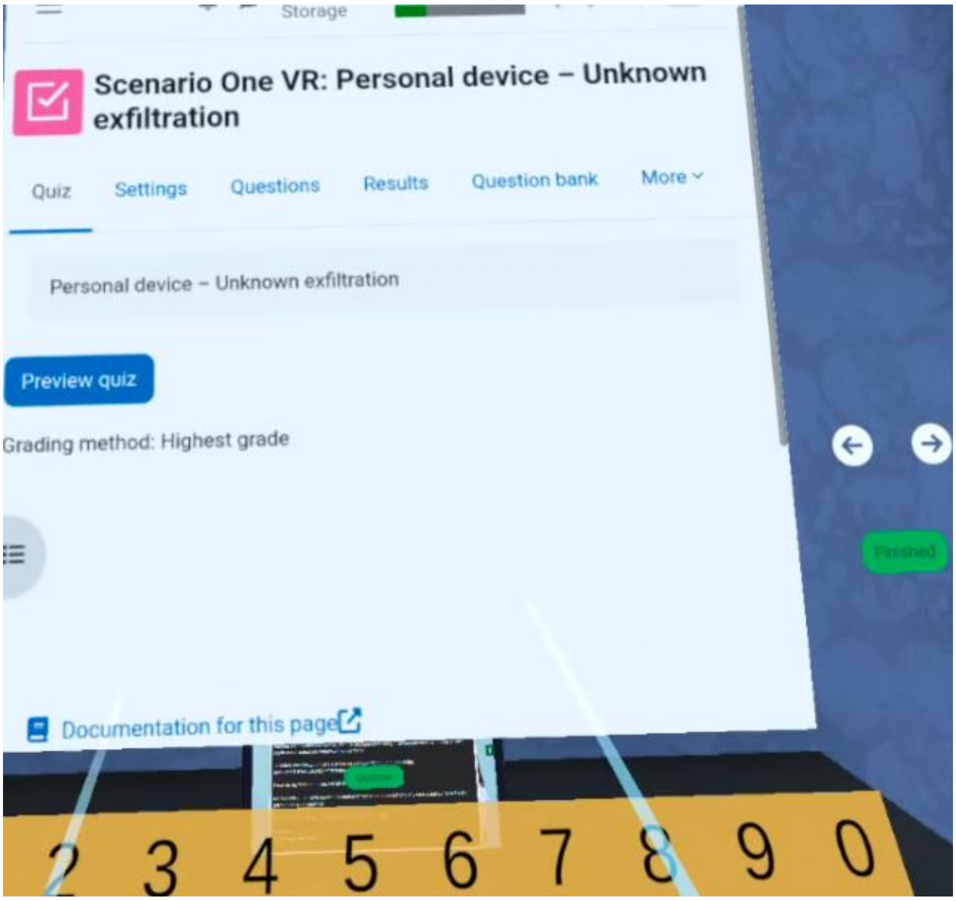
User selecting to proceed with launching moodle window

The user may be required to log in at this stage.



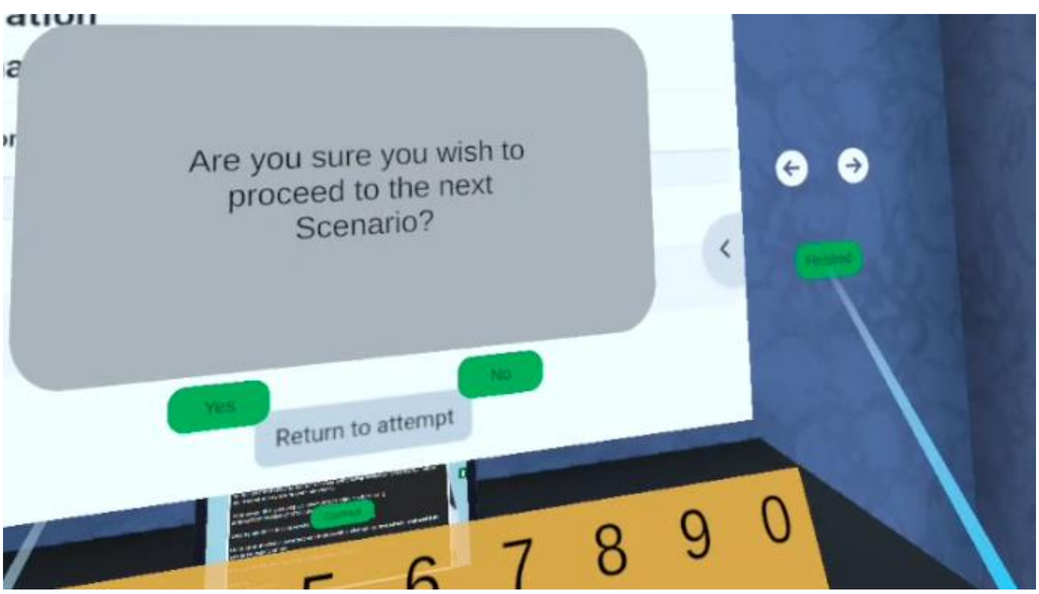
User on login form

The user may now engage in completing the assessment.



User can now view and interact with learning materials in XR

The user selects the “Finished" button when they have finished the relevant assessment in that scenario. Once this is selected the user is presented with the option to proceed or decline via “Yes” or “No” options. Once “Yes” is selected the user will start Scenario Two.



Users navigating through each scenario

4.2. Scenario Two VR: Unauthorised access to workstation, data breach, compromised medical device.

Scenario 2: Unauthorised access to workstation, data breach, compromised medical device

The unit is busy with a constant flow of personnel and care activity. At the patient bedspace, the nurse left the workstation unlocked and unattended to answer an urgent issue at the next patient bedspace. On returning to the original work station, the confidential medical patient history page is open, this had previously been closed. Suddenly, the patient's blood pressure (BP) alarm goes off and the nurse notes the monitor shows the patient's BP is dangerously low. The patient verbally reports feeling well and manual BP checked is normal. The nurse trouble shoots and recalibrates all the equipment. Everything appears to be in order. The monitor continues to display a dangerously low BP. On examination the patient is warm, well perfused, and continues to report feeling well.

Text flashing on the Blood Pressure Monitor –

"WARNING: LOW BLOOD PRESSURE DETECTED

Current Reading: 60/40 mmHg

Normal Range: 90/60 to 120/80 mmHg

Check Patient Immediately!"

Would you consider this activity to be a cybersecurity incident?

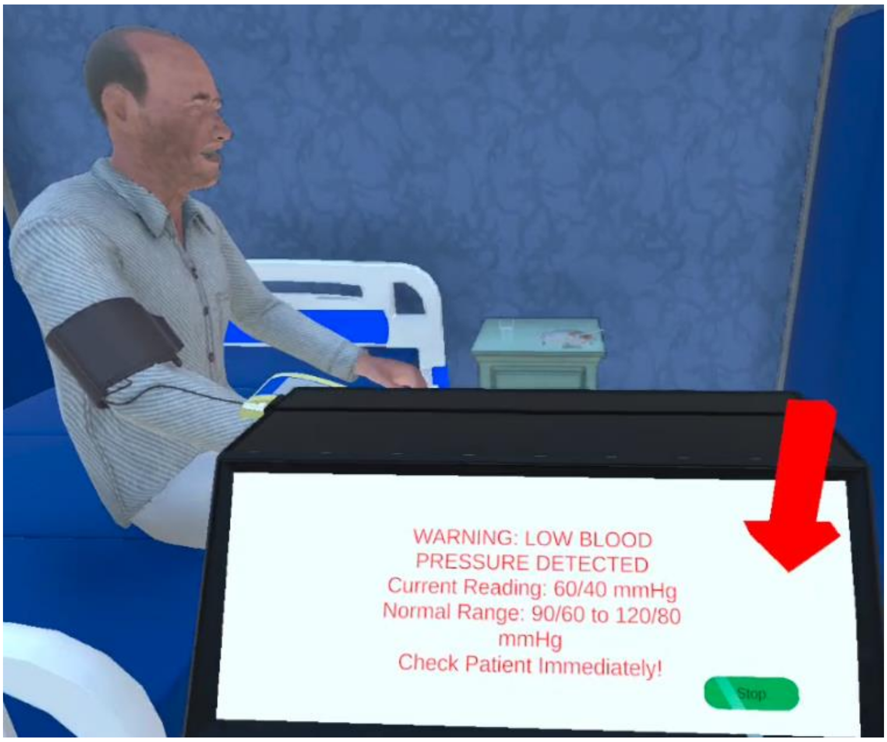
- ☐ Yes
- ☐ No
- ☐ Do not know

How would you handle this incident? (Select all that apply)

- ☐ The low BP displayed on the monitor should be treated
- ☐ The device is malfunctioning due to a technical fault
- ☐ Report the event, and to whom : Manager, Patient's Consultant, IT Dept
- ☐ Ignore it and hope it goes away
- ☐ Patient confidentiality might be compromised.
- ☐ The medical device may be vulnerable, hacked or infected.
- ☐ Do not know
- ☐ Other (please specify) ___________________

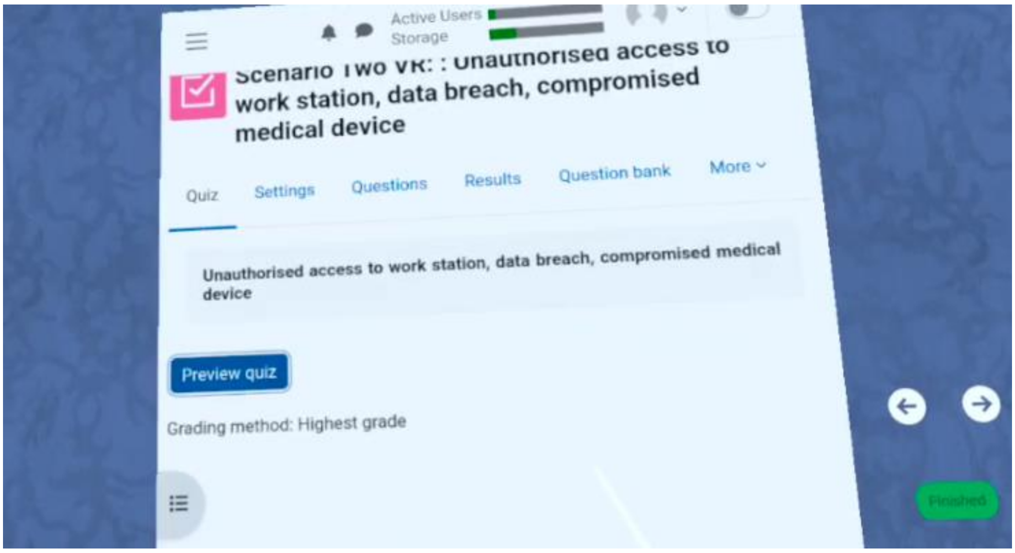
Scenario 2: Virtual Reality Implementation

In the second scenario, the user observes the scene/scenario, navigates to the monitor next to the patient and when ready selects "Stop" (again indicated by the red arrow) to activate the assessment window.



Learner is presented with compromised monitor

Once the assessment window appears the user navigates to the window and completes the relevant criteria.



User completing the assessment

The user then proceeds to the next scenario

4.3. Scenario Three VR: Personal device and data breach.

Scenario 3: Personal device and data breach

You are working on a project / presentation in work that involves confidential patient information. It has been a very busy shift, you did not get a chance finish your project / presentation and so you decide to continue working on it at home. You download identifiable patient data onto your USB and take it home with you. A few days later you cannot find your USB.

What should be the first major step in handling this incident?

- ☐ Report the event, and to whom: Manager, IT Dept, Open Disclosure mandates informing patient and family, Patient's Medical Team, Hospital Risk Department, Gardai
- ☐ Keep looking and hope you will find it eventually
- ☐ Forget about it, it's only a USB
- ☐ I would not report the event
- ☐ Other (please specify) ___________________

Text on monitor of patient data:

"Patient Medical Record Template

Name: Jane Doe

Phone Number: (01) 23492373

Birth Date: 1/1/1997

Address: 23 Planosville, Bilbao, Spain

Weight: 83Kg

Height: 173cm

Name: John Doe

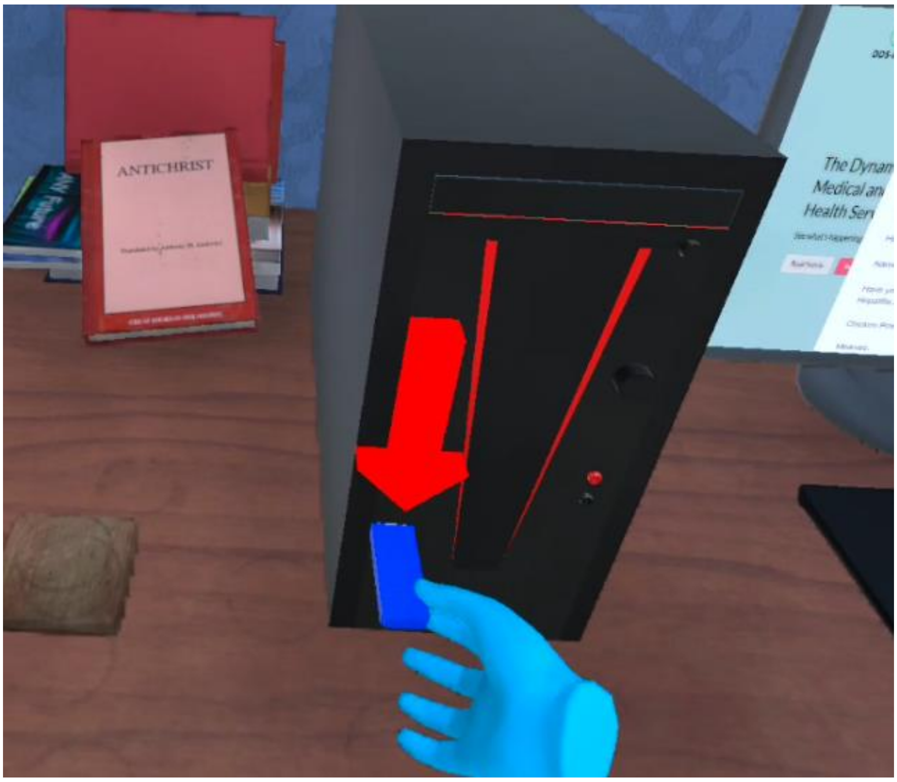
Have you had the Hepatitis B vaccination?: No

Chicken Pox (Varicella): IMMUNE

Measles: NOT IMMUNE"

Scenario 3: Virtual reality implementation

In the third scenario the user observes a scene and subsequently grabs a USB stick from the desktop to proceed.

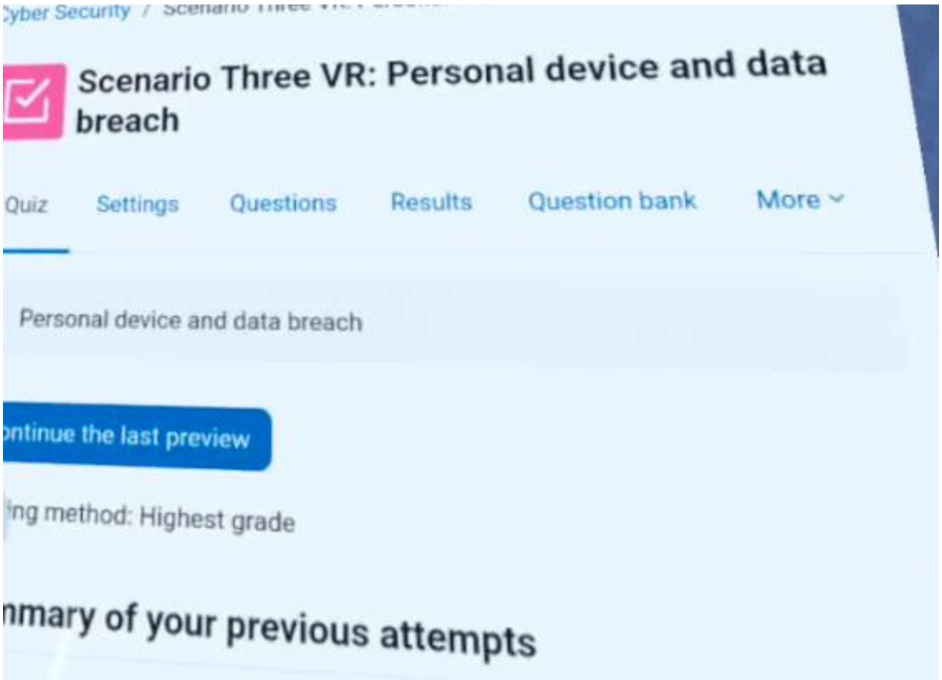


Learner is presented with USB flash drive

On the monitor the user selects the green “Continue” button to enable the assessment.

User can navigate to the next assessment

Once enabled, the assessment is completed and when finished the green "Finished" button is selected to proceed to the next scenario.



Learner is presented with assessment criteria

4.4. Scenario Four VR: Peer-to-Peer sharing A

Scenario 4: Peer-to-Peer sharing

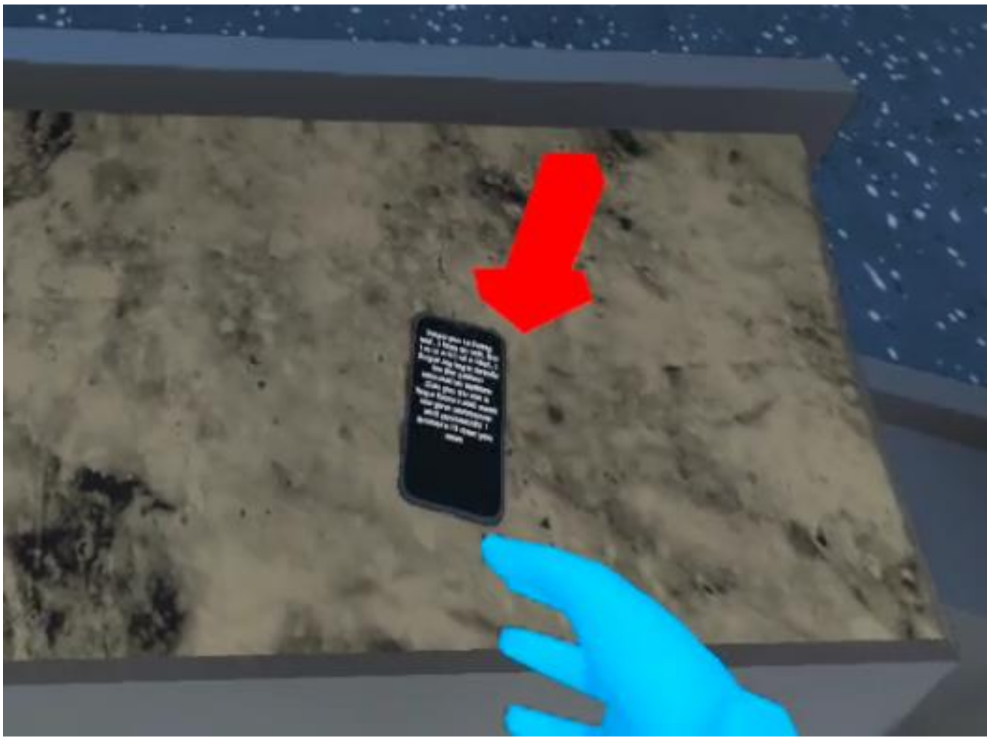
You are working during a busy shift in ICU. You receive a message from a colleague via WhatsApp asking for your login details for a patient information system (e.g. radiology, labs, bed management system) because they have forgotten their own. What do you do?

a) Send your username and password to your colleague using WhatsApp
b) Phone your colleague and share your username and password
c) Share your username and password in person
d) I would not share my username and password

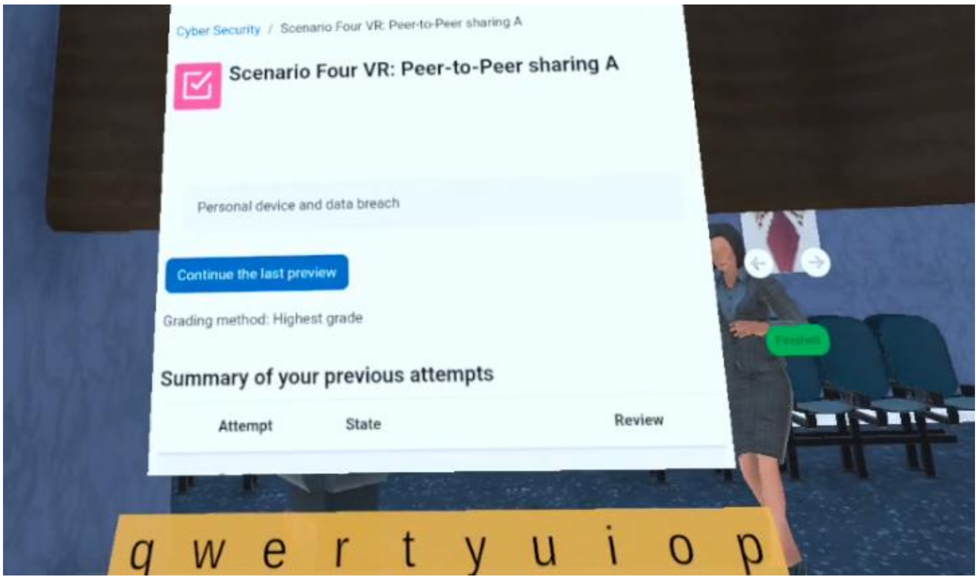
Text on Mobile Phone – "Hope you're doing well. I hate to ask, but I'm in a bit of a bind. I forgot my login details for the patient information system. Can you do me a huge favour and send me your username and password? I promise I'll owe you one!"

Scenario 4: Virtual reality implementation

In the fourth scenario the user observes the scene and grabs a mobile phone in the reception area, highlighted by the red arrow. Once the user is finished reading the message they should release the phone to continue with the relevant assessment for this scene.



Learner is guided towards the interactive mobile device.



User completes the asessment

Once enabled, the assessment is completed and when finished the green “Finished” button is selected to proceed to the next scenario.

4.5. Scenario Five VR: Peer-to-Peer sharing B

Scenario 5: Peer-to-Peer sharing

There is a critically unwell patient in the ICU who needs a surgical consult. The surgeon is on-call from home and asks for photos of an abdominal CT that was performed earlier that day, along with the report via WhatsApp. What would you do in this situation?

Text on Mobile Phone – "Hi, I hope you're well. Could you please send me the photos of the abdominal CT that was performed earlier today, along with the report? I need this information promptly as it is a matter of urgency to assess the situation and provide necessary instructions. Dr. Garcia."

I would send the photos because it's in the patient's best interests

- ☐ Ignore the request and hope supervisor will forget
- ☐ Decline the request and remind them that it is against the organisation policy

Scenario 5: Virtual reality implementation

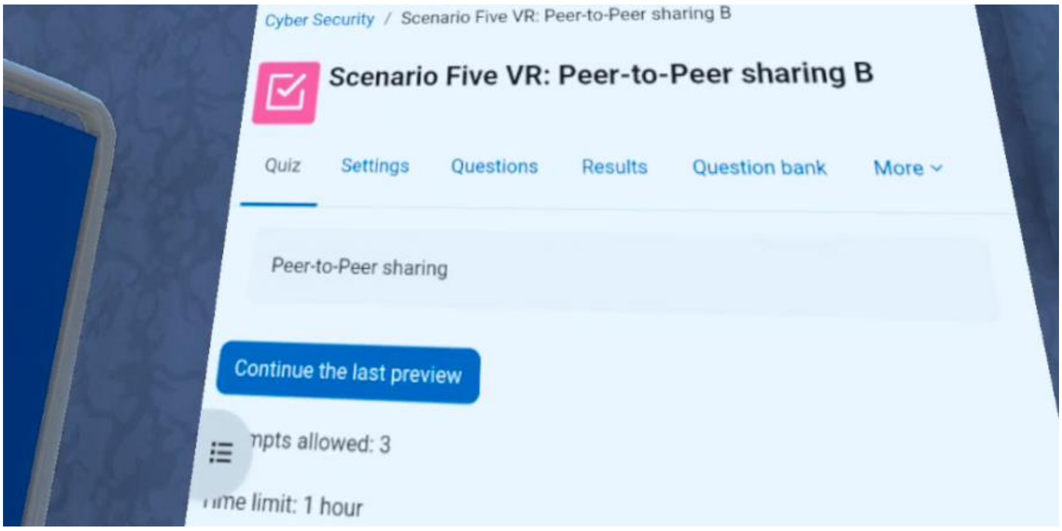
In scenario five the user observes the scene.

Learner observes patient in immersive hospital environment

The user will once again be presented with a mobile phone on the desk and should engage with it in the same manner as the previous scenario.

Learner must read the request on the mobile device.

After the user is done reading the message they will again be presented with the assessment.



Learner finishes scenario five.

Proceed to the next scenario in the same manner as before.

4.6. Scenario Six VR: Compromised Equipment

Scenario 6: Compromised equipment

At the central nurse's station, a work PC and email account are opened and unattended. Since it saves you the trouble to login into your own account, you are happy to use that PC to look up patient information. You see an electronic e-greeting card from HSE and click on it. A number of annoying pop-up advertisements are opening randomly. This suddenly pop up on the work PC's screen – '**Warning! Virus detected**', Please click "Allow" or "Block" button to protect your PC.

Popups on screen:

- "Warning Virus Detected!"
- "Allow or Block"

Select the correct response. (Select all that apply)

- ☐ Select "Allow". It is a fake alert.
- ☐ Select "Block" to block the threat.
- ☐ Select [X] button to close the pop-up windows.
- ☐ Report the event, and to whom: Manager, Hospital IT Dept
- ☐ Ignore it and hope it goes away
- ☐ I would not report the event
- ☐ Do not know
- ☐ Other (please specify) ___________________

How does a user become a victim of a cybersecurity incident? (Select all that apply)

- ☐ By deleting the email from inbox
- ☐ By clicking on links in suspicious emails
- ☐ By not taking time to analyse a received email
- ☐ By forwarding email to other users
- ☐ By opening attachments sent by email
- ☐ Do not know
- ☐ Other (please specify) ___________________

What should you do if you encounter a cybersecurity incident? (Select all that apply)

- ☐ Report the event, and to whom: Manager and IT dept
- ☐ Tell a colleague
- ☐ Download virus removal tool and attempt to remove virus on your own
- ☐ Ignore it and hope it goes away
- ☐ I would not report the event
- ☐ Do not know
- ☐ Other (please specify) ___________________

How do you protect yourself and organisation from cybersecurity incident? (Select all that apply)

- ☐ Make sure you have virus protection on your work PC and do not disable the virus protection tool.
- ☐ Scan for viruses whenever you download or copy a file.
- ☐ Never open unsolicited attachments especially from unknown source
- ☐ All of the above
- ☐ Do not know
- ☐ Other (please specify) ___________________

What are the biggest cybersecurity risks at your work place? (Select all that apply)

- ☐ Lack of cybersecurity training

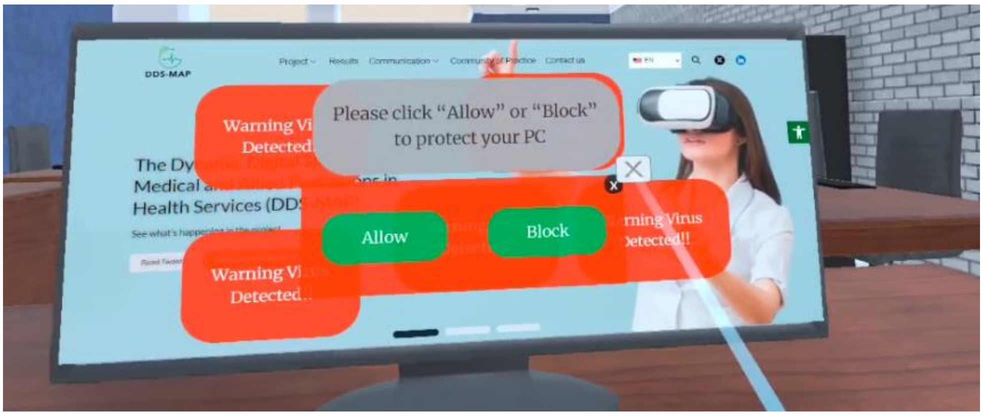
- ☐ Sharing login details / passwords with colleagues
- ☐ Opening attachments / links contained in emails from unfamiliar sources
- ☐ Forwarding an email from an unfamiliar source to other users
- ☐ Downloading programs or applications from unofficial websites or App Store
- ☐ Leaving a computer logged-in while unattended
- ☐ Downloading identifiable patient information on to personal devices
- ☐ Use of personal devices (e.g., laptops, tablets, phones) while connected to the hospital network
- ☐ Use of USB/memory sticks at work
- ☐ Other (please specify) ________________

Scenario 6: Virtual reality implementation

As seen in previous scenarios, in the final scenario the user will need to interact with the object (mouse, highlighted by the red arrow).

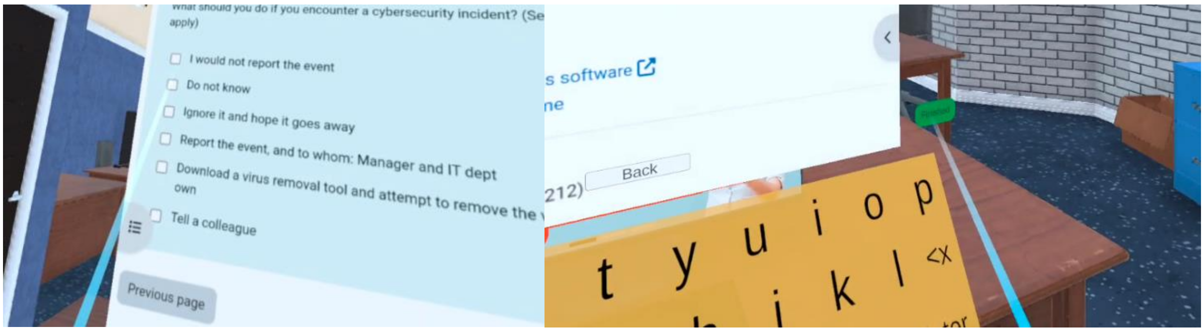
Lerner must again interact with the computer

Once released the user should observe what is happening on the monitor and click the “X” to activate the assessment screen.



Learner is presented with a compromised computer system

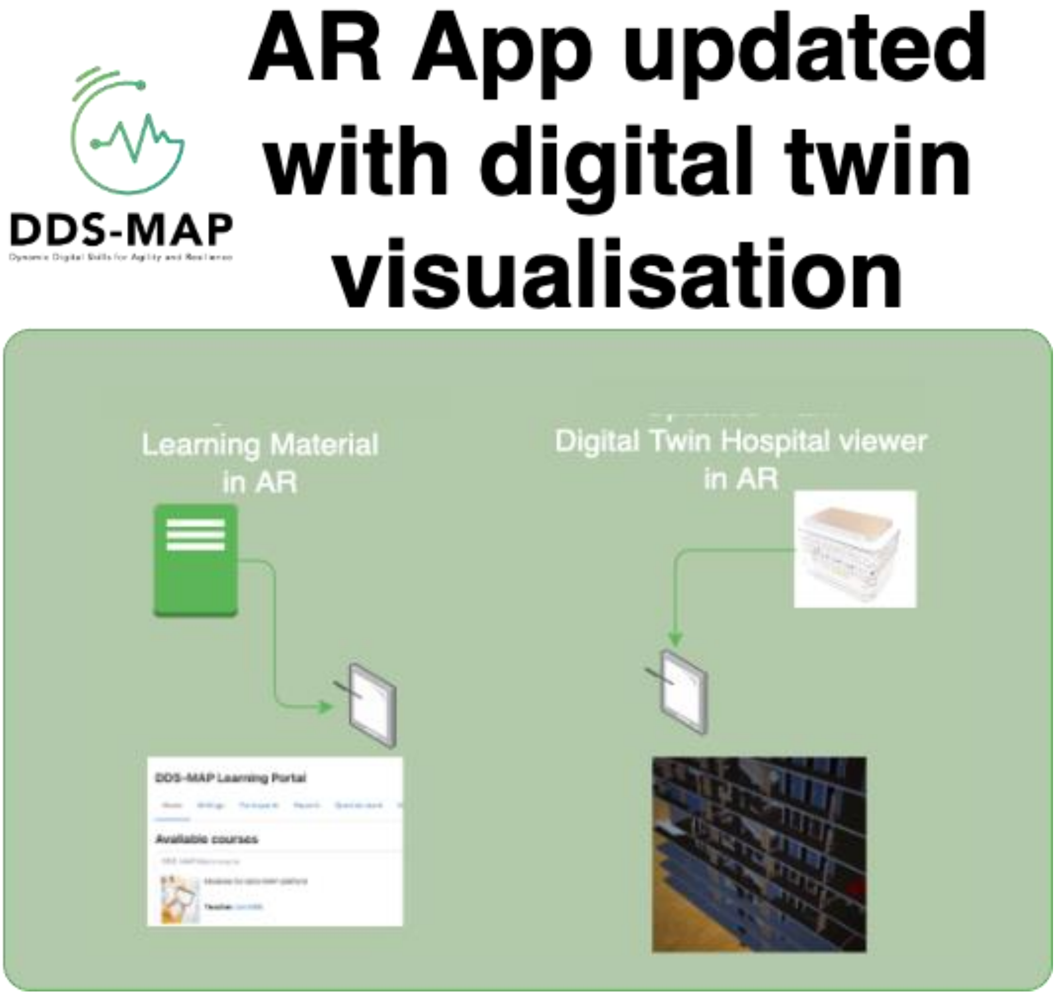
As in previous scenarios the user should complete the assessment and select the green “Finish” button to the right of the UI to finish and exit the VR experience. N.B. Please remember to log out before leaving the VR.



Learner performs the assessment and finishes the scenario.

4.7. Augmented Reality Model

The digital twin of the hospital has been developed into an augmented reality-based application which enables users to view the hospital’s architecture and internal structure in an interactive "dollhouse" mode. This application includes a full external view of the hospital, along with two split-view models that divide the building into halves, an exploded view allowing users to see individual floors and examine furniture and components within each room. Every floor contains individually modelled furniture and equipment, making the interior layout accessible for in-depth viewing. This application is used as a teaching material to introduce students to the topic of augmented reality in Module 3 Digital healthcare implemented.



Extension to the AR application

The Augmented Reality application contents now include a digital twin of the hospital that the end user can place in their learning environment to study and learn about their new learning location before eve setting foot in the location.

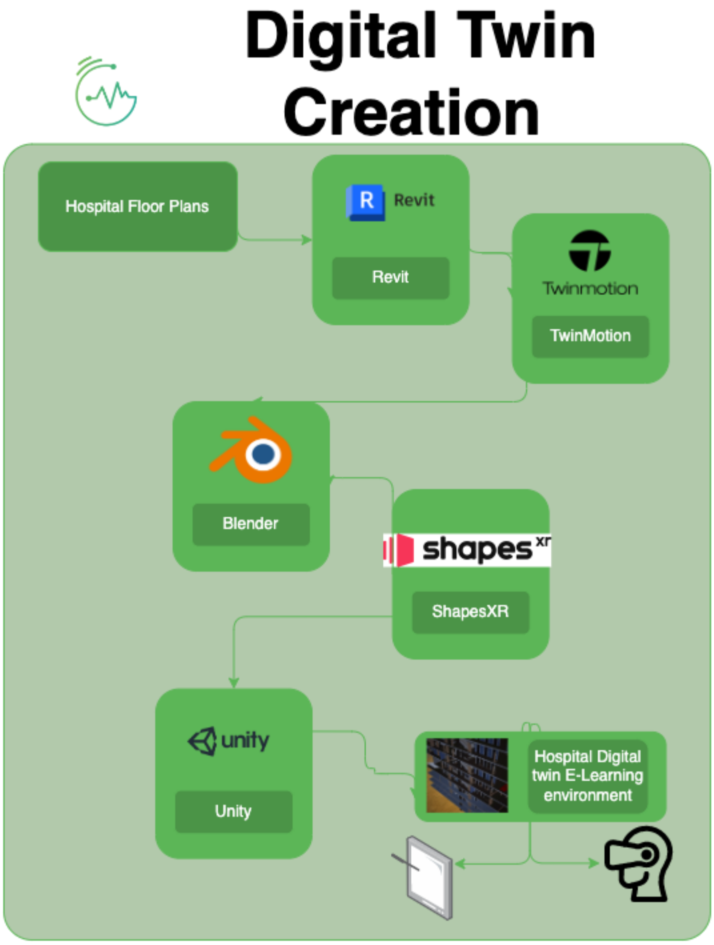
Results

The results of this task produced two XR experiences, the first being the VR based learning and assessment platform, the second of which is the digital twin visualiser application utilising AR. The outline user guide are in section 1 of Appendices

5. Developing a virtual hospital data model based on the new Mutualia Hospital under construction

Components of the new Mutualia hospital will be digitised in a digital twinning process. This environment serves as virtual training environment used within the DDD-MAP project.

The hospital floor plans were obtained from the project partners, these were then imported into the Autodesk Revit in order to create the base model with accurate wall and floor measurements. Renders from this model were generated from and export into the Twinmotion software. Following on from this process the basic model as exported from Revit into Blender. Blender allows for the texturing of the materials in the digital twin such as wall colour and floor coverings. This work was them imported into ShapesXR to allow for rapid prototyping of the software. Several variations were designed and showcased from this process. Once the twin reached a high enough quality level from continuous design that both looked realistic and also could run on mobile VR hardware we imported it into the Unity game engine. The development process then allowed for the integration of the Webview for moodle compatibility as well as the ability to both deploy for VR and AR.



Digital twin creation process flow

Results
This task delivered a full digital twin visualisation replica based on the Mutualia hospital plans. This visualisation now exists prior to the finalised construction of the hospital and acts a pivotal learning experience on the use of digital twins for learning.

6. Testing, Improvement and Validation (standalone)

DDS-MAP virtual reality and augmented reality outputs will be tested, improved and validated with the end user groups through the piloting and roll out of the modules.
Through acceptance testing we carried out the implementation of the core software features. A large degree of performance testing and optimisation was carried out to ensure high quality output was possible while running on a Mobile based VR headset. This occurred over a number

of revisions The software will be further tested for additional feedback alongside the pilot rollout.

6.1. Timeline of DDS-MAP Development

6.1.1. Disclaimer

The DDS-MAP project followed an iterative development approach with frequent feedback loops, cross-tool adjustments, and ongoing performance testing. Due to the nature of the project, certain stages were revisited as requirements evolved and optimisations were needed. The timeline below represents high-level phases and milestones rather than a strict chronological order.

6.1.2. v0.1 Initial Unity Scene Prototypes

- **Date:** Early Phase
- **Objective:** Rapidly develop early VR environment prototypes to explore basic layout and design concepts for the VR hospital.
- **Key Tools:** Unity
- **Tasks:**
    - Created initial Unity-based scene prototypes to demonstrate room layouts and scene arrangements.
    - Captured and attached screenshots of completed scenes to document progress for testing purposes.

Image of Prototype Testing Scene layouts Sept 2023

- **Challenges:** Developed with limited access to the intended Oculus Quest 3; early testing was conducted on Oculus Quest 2, restricting optimisation potential.
- **Output:** Foundation for scene flow, documented through screenshots for testing.

The following are sample images of several other scenes tested in the earlier phases of development.

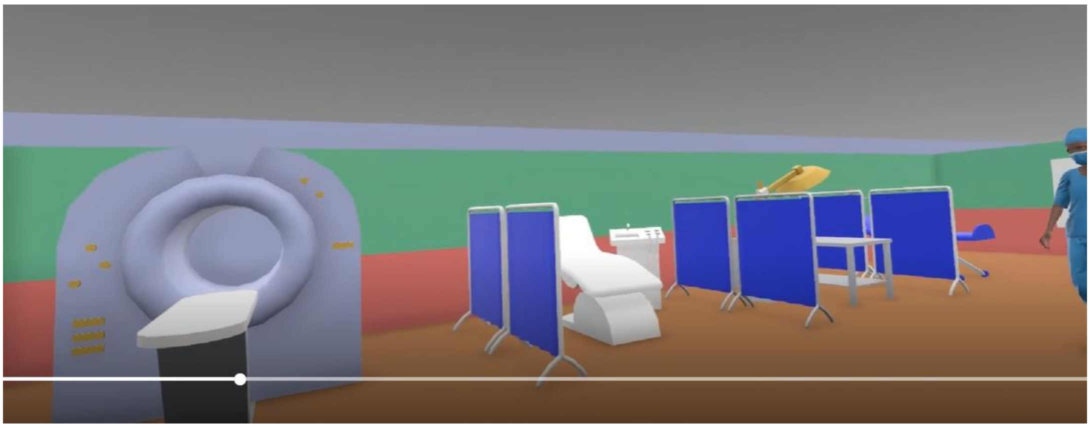


Image of Low Poly Scene Test with Doctor NPC

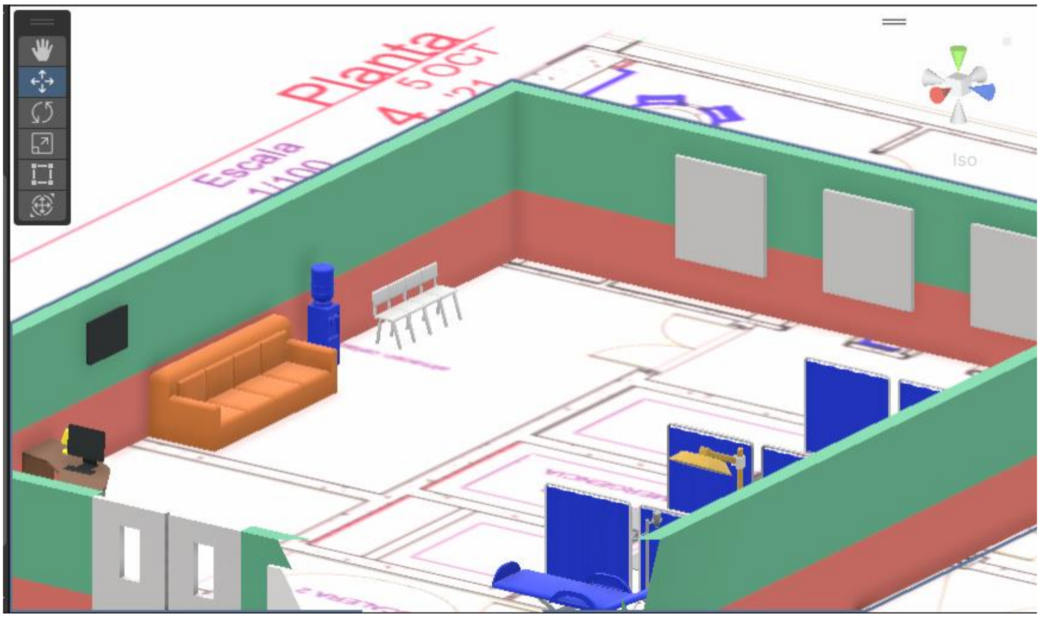
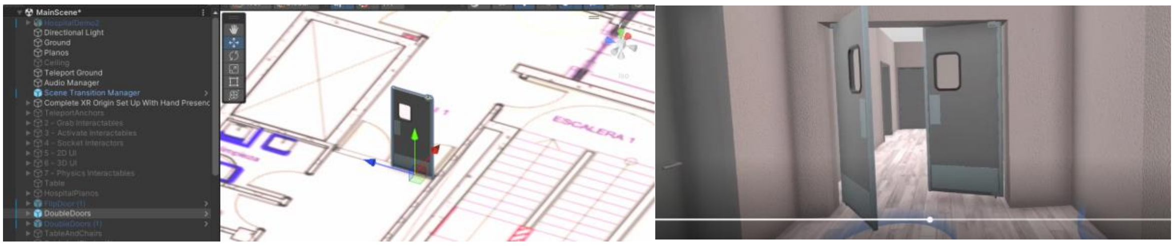


Image of Prototype being laid out on Real world Hospital Blueprints



Images of Unity Testing Door mechanics Oct 2023

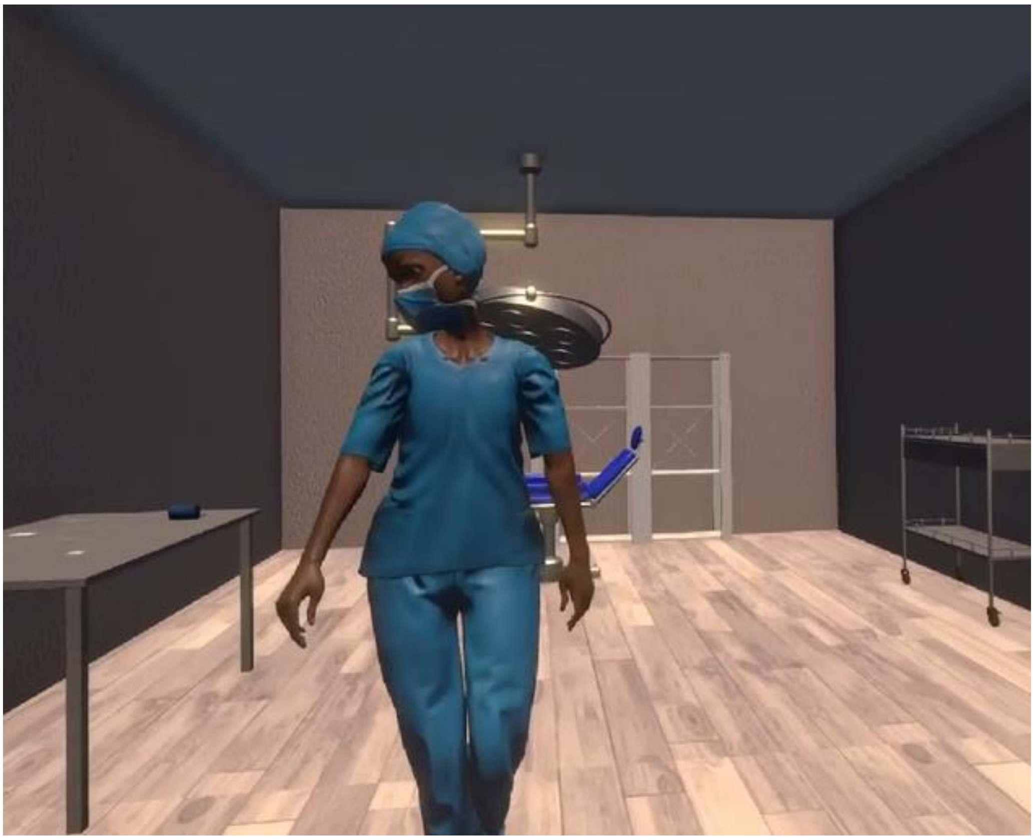


Image of Prototype test July 2023

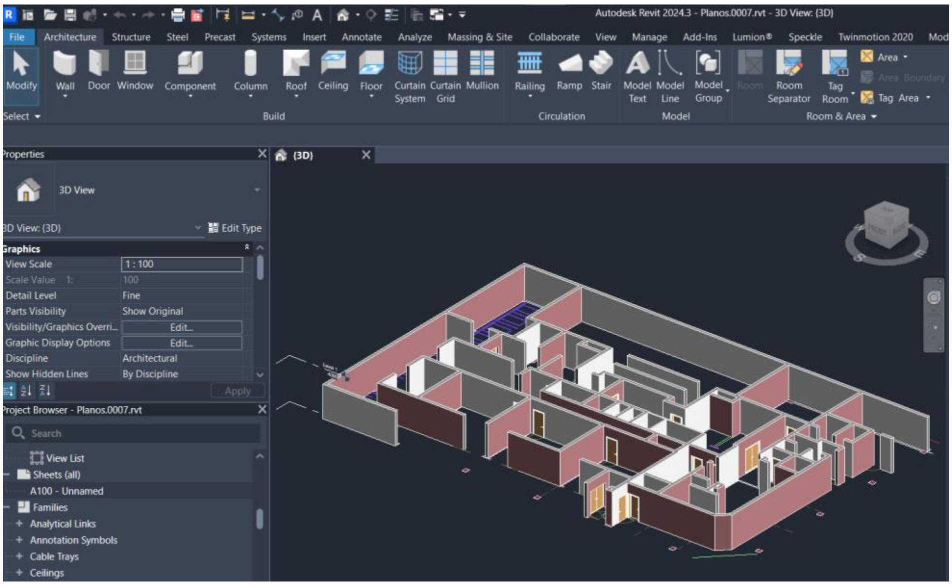
6.1.3. v0.2:Hospital Model Creation (Autodesk Revit & Blender)

- **Date:** Mid-Phase
- **Objective:** Build and refine a detailed 10-storey hospital model for VR and AR.
- **Key Tools:** Autodesk Revit, Blender
- **Tasks:**
    - Designed and iterated multiple hospital layouts in Autodesk Revit, moving back and forth between Revit and Unity to test various configurations and test environment.
    - Utilised Blender to refine materials, bake textures, and ensure assets were optimised for Unity, balancing visual fidelity and performance requirements for Standalone device.
- **Output:** Fully modelled, optimised 10-storey hospital environment with Unity-compatible textures and assets.

  The model consists of:

- **Objects: 5,787**
- **Vertices: 4,495,400**
- **Edges: 7,697,636**
- **Faces: 3,715,209**
- **Triangles: 3,715,209**

The following are sample images of the earlier stages of development of the hospital.



Sample image of 7^{th} iteration of 1^{st} floor of Hospital in production

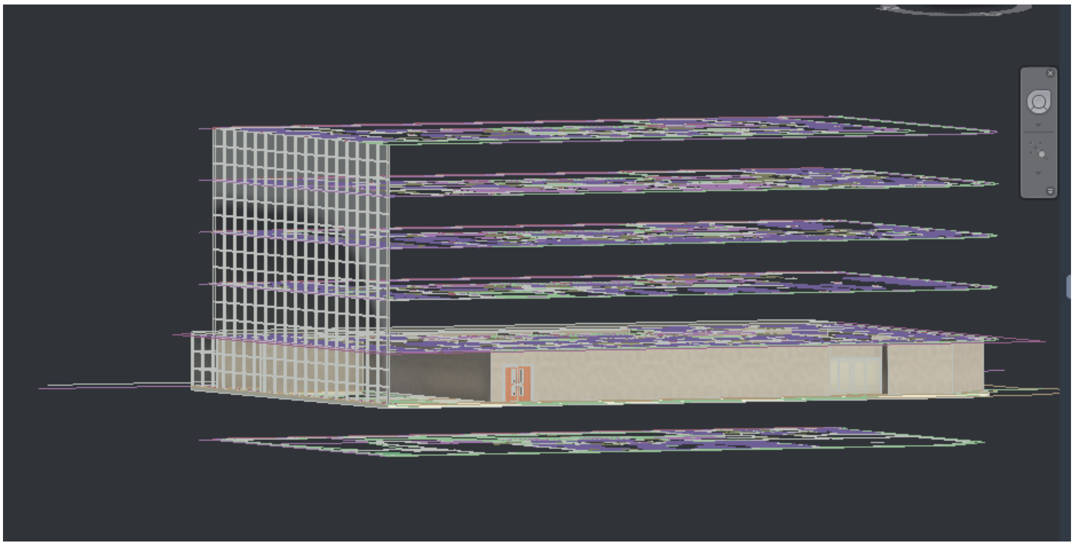


Image Aligning Blueprints for Hospital in Autodesk Revit

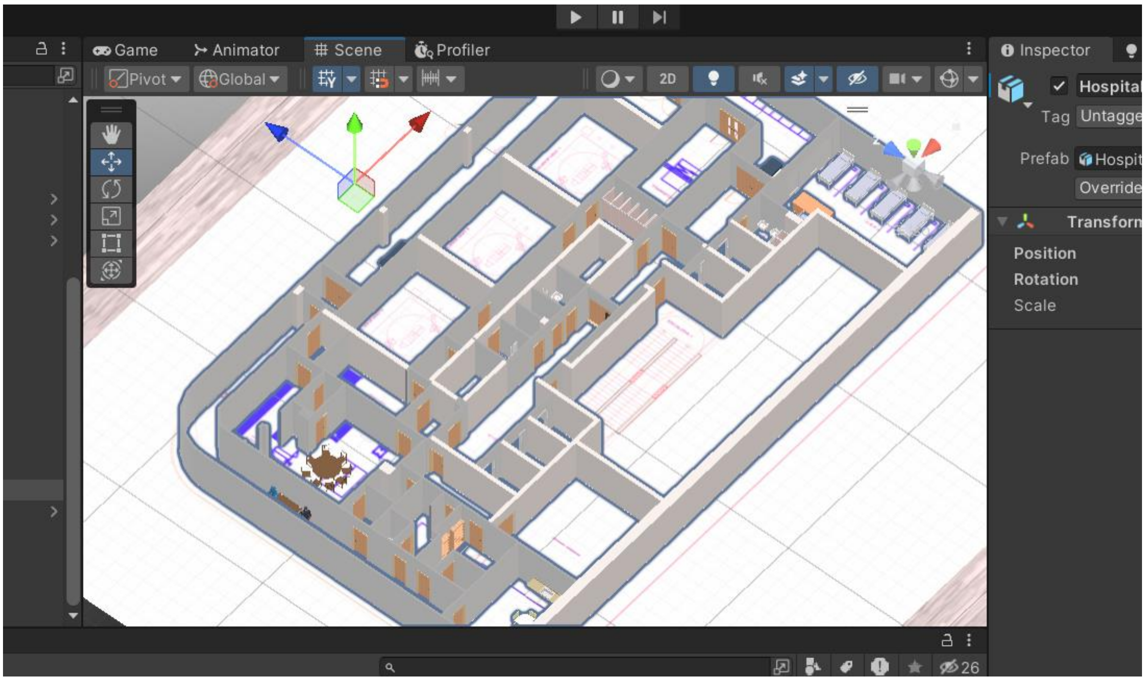


Image of scaling tests with schematics in Unity

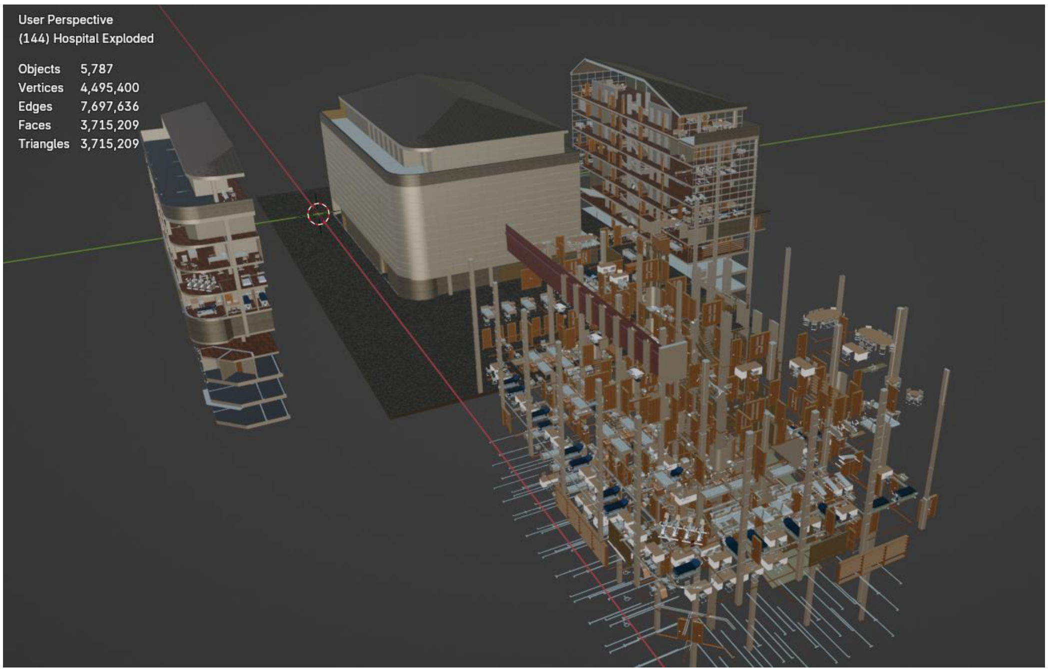


Image of Full Model of Hospital with 3 additional Formats

6.1.4. v0.3 ShapesXR Prototyping

- **Objective:** Create a one-time interactive VR prototype to showcase potential interactions and gather feedback from project partners.
- **Key Tools:** ShapesXR
- **Tasks:**

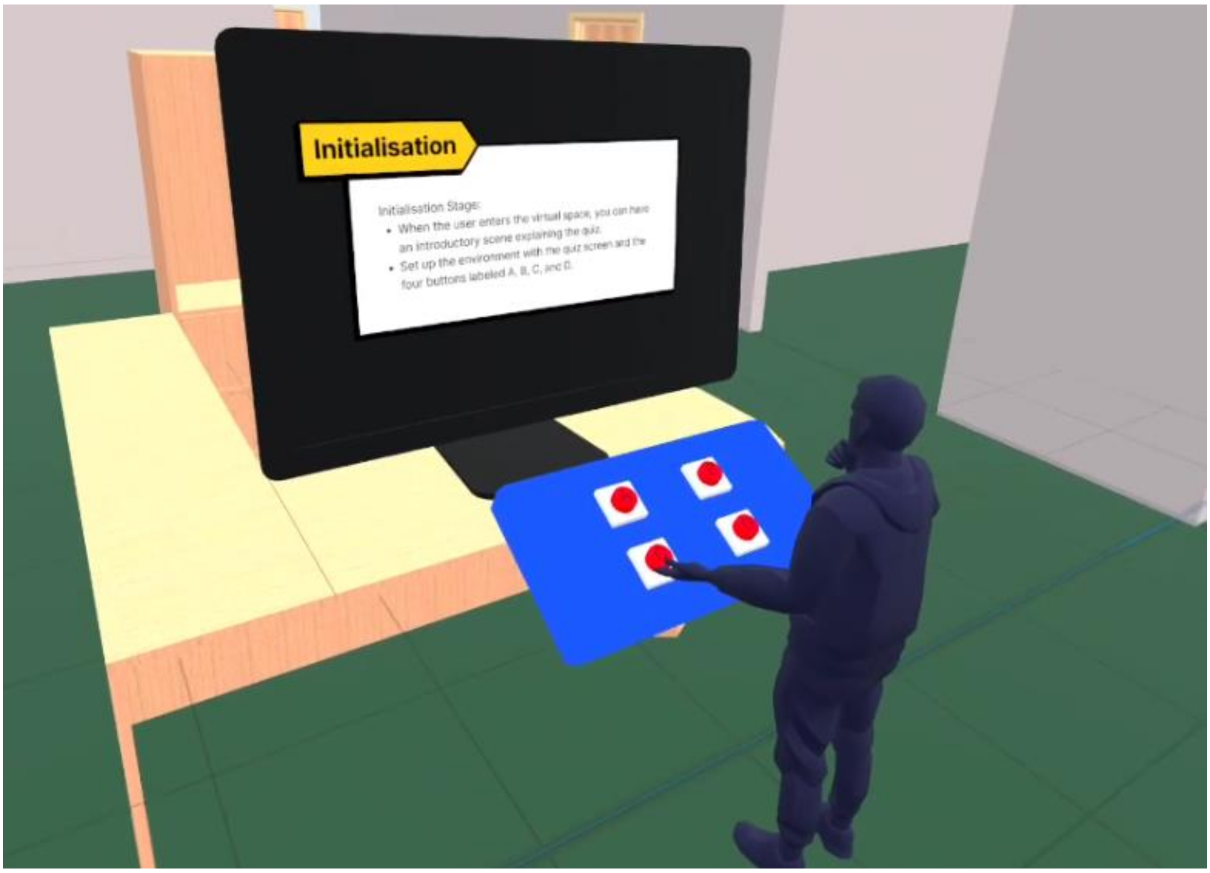
- Developed a prototype with multiple stages, simulating the user interaction process, including an example where users pressed buttons to answer quiz questions.
- Demonstrated how users could interact with the VR environment, providing a clear visualisation of possible interaction methods.
- After gathering feedback, transitioned away from buttons in favour of a raycast-based UI interaction for answering questions, addressing concerns over potential user difficulty with button presses.

- **Challenges:** Iterating rapidly to demonstrate interactive possibilities within the VR environment, ensuring the prototype was both clear and functional for partner feedback.
- **Output:** A dynamic, interactive prototype that effectively conveyed interaction possibilities in VR, helping to refine user interface decisions and engage partners in the design process.

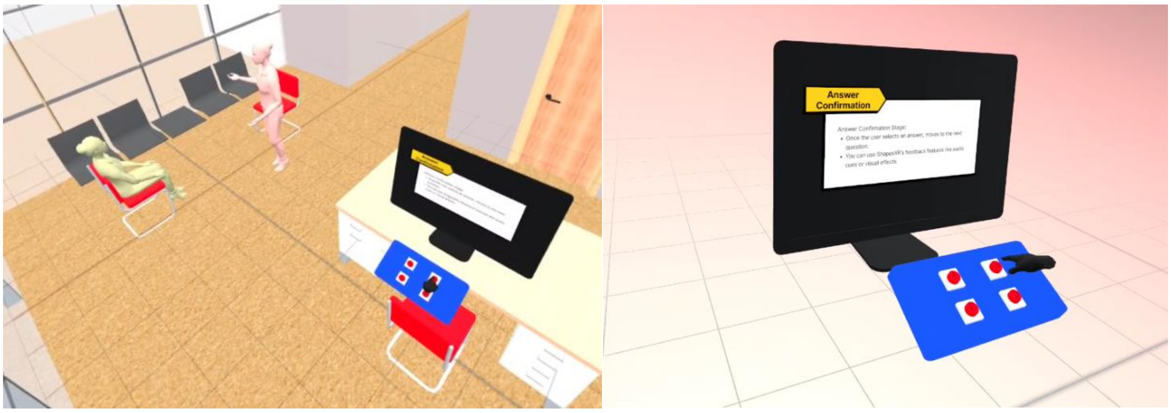
The following images demonstrate how the session was laid out and illustrates the process of cycling through the potential user actions.

A top-down Image of ShapesXR Prototyping

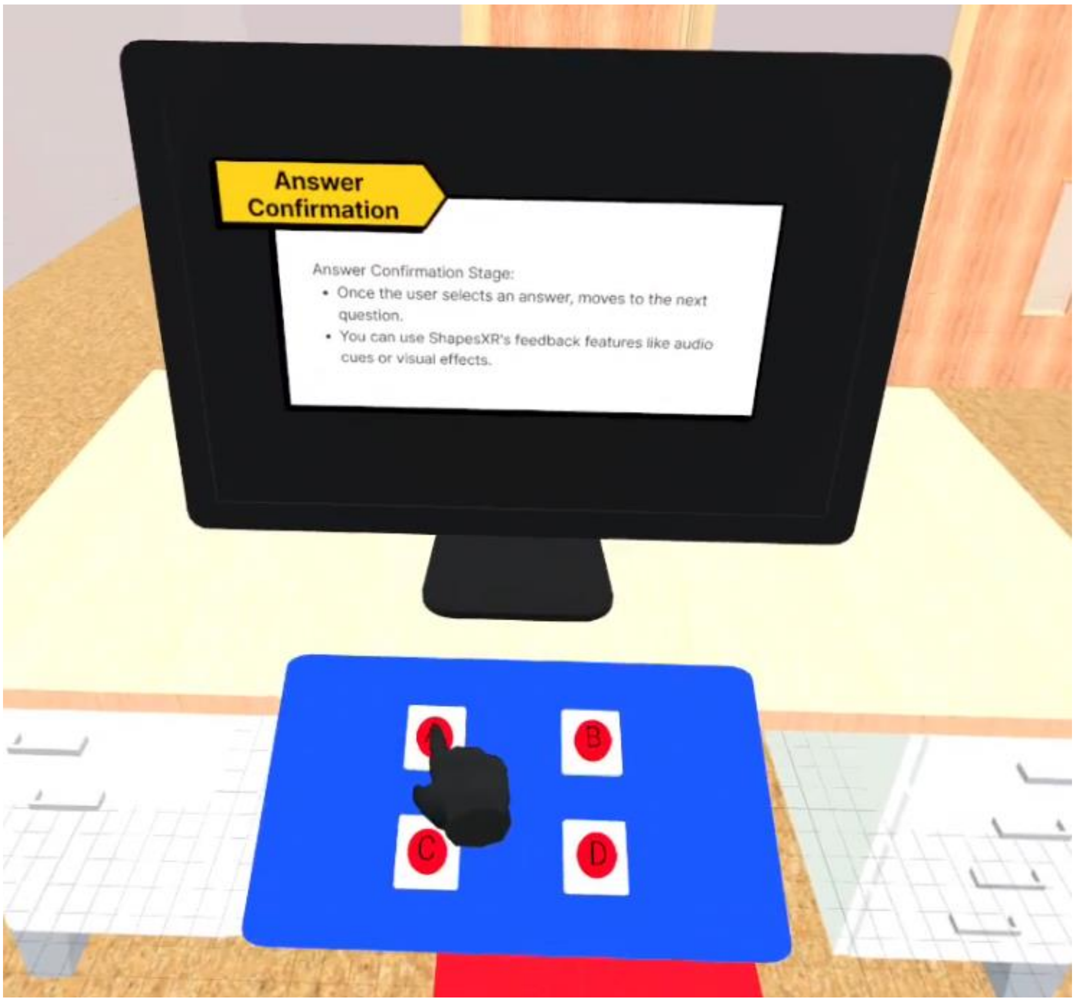
An Image of VR Application Prototyping: User Picking up Controllers



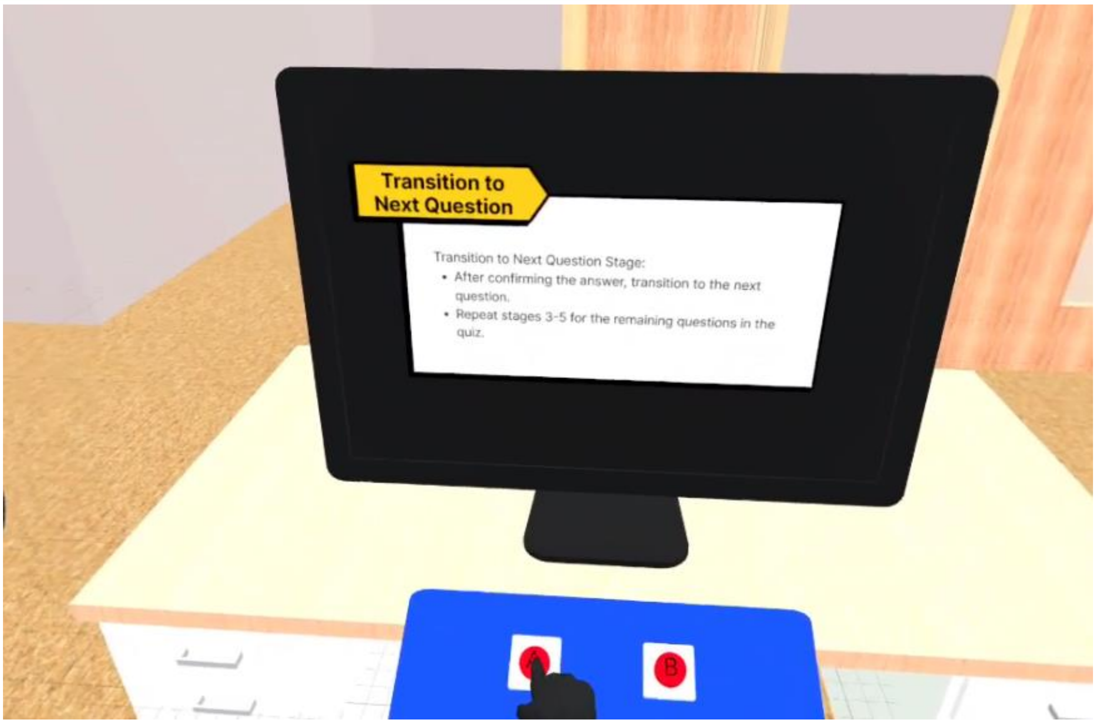
An Image of VR Application Prototyping: User approaches Interactive Buttons



An Image of VR Application Prototyping: Stage Three – User selects option

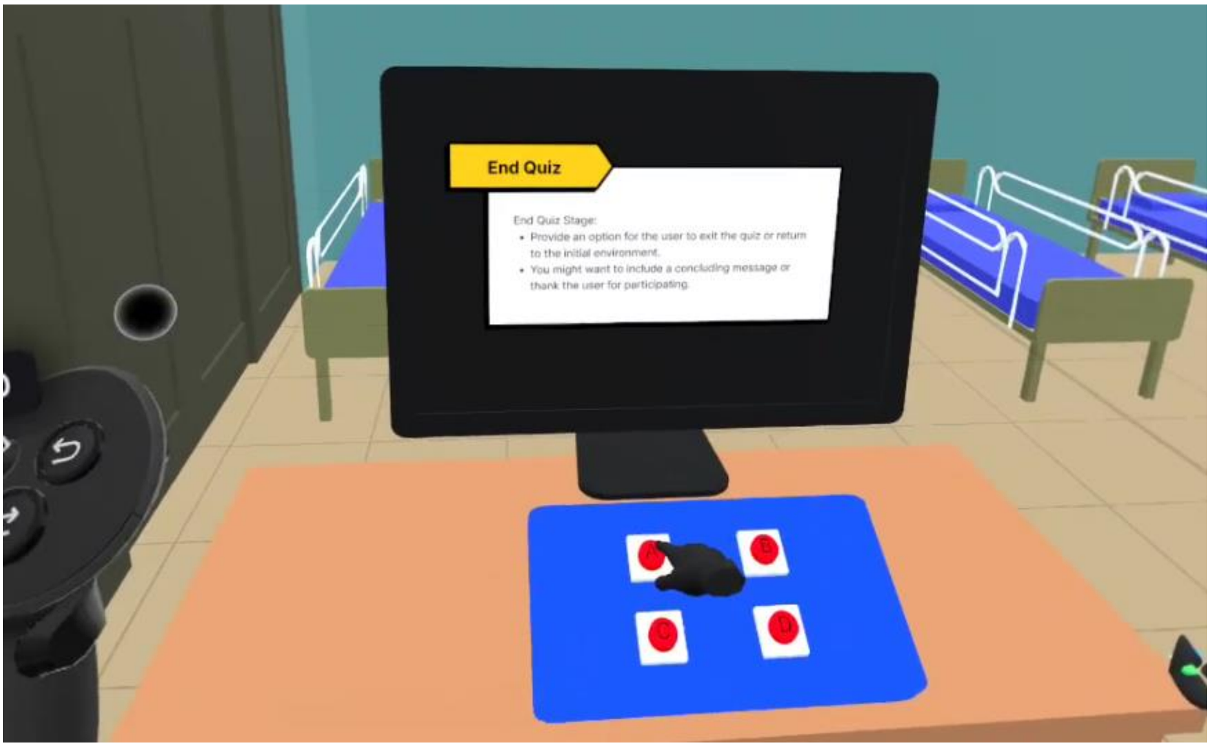


An Image in ShapesXR of user getting Answer Confirmation



An image in ShapesXR of user transitioning through scene

An image in ShapesXR of user completing quiz



An Image in ShapesXR of User Completing Quiz

6.1.5. v0.4: NPC Development and Animation (Adobe Fuse & Mixamo)

- **Date:** Mid-to-Late Phase
- **Objective:** Populate the VR environment with realistic and Diverse NPCs with animations relevant to each scenario.
- **Key Tools:** Adobe Fuse, Mixamo
- **Tasks:**
  - Created 12 NPCs in Adobe Fuse, each tailored for specific scenarios within the hospital environment.
  - Rigged and animated the NPCs in Mixamo, downloading relevant animations for each scene and stitching them together to match scene triggers.
  - Integrated and tested NPC animations within Unity scenes, refining transitions and timing for realism.
- **Output:** A diverse set of fully rigged NPCs, each with scene-specific animations to enhance the immersive hospital environment.

The following images are a simplified representation of the process the creation process for the NPCs from Creation to implementation.

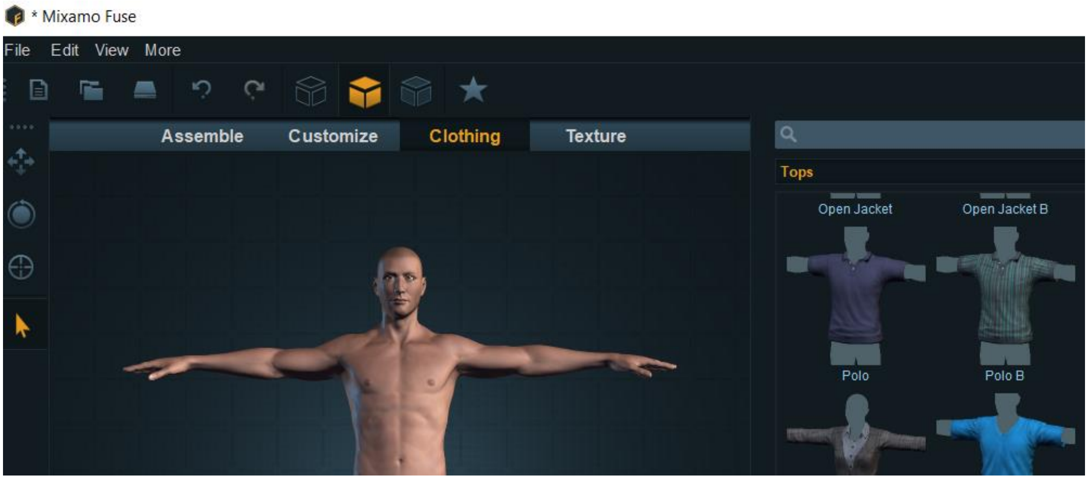


Image of the Creation process of office worker in Mixamo Fuse

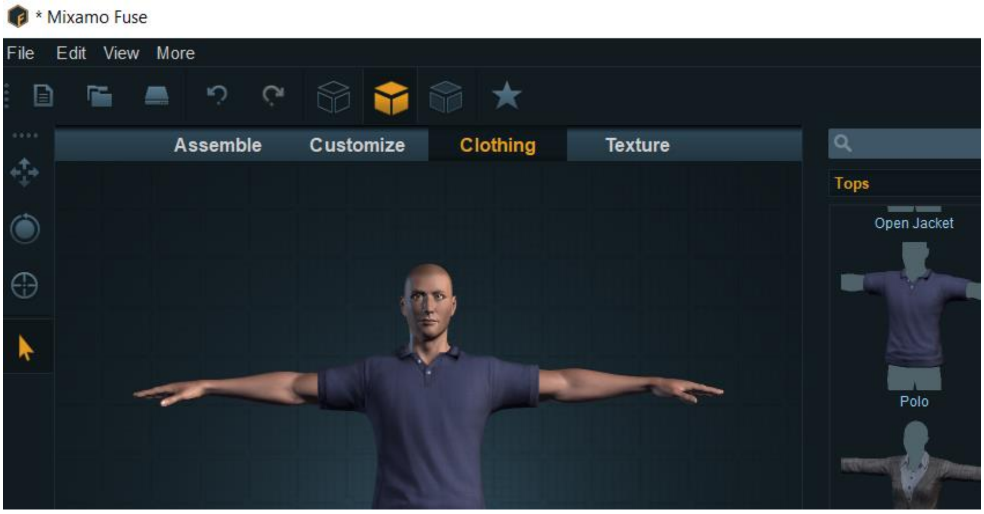


Image of clothing the NPC in Adobe Fuse

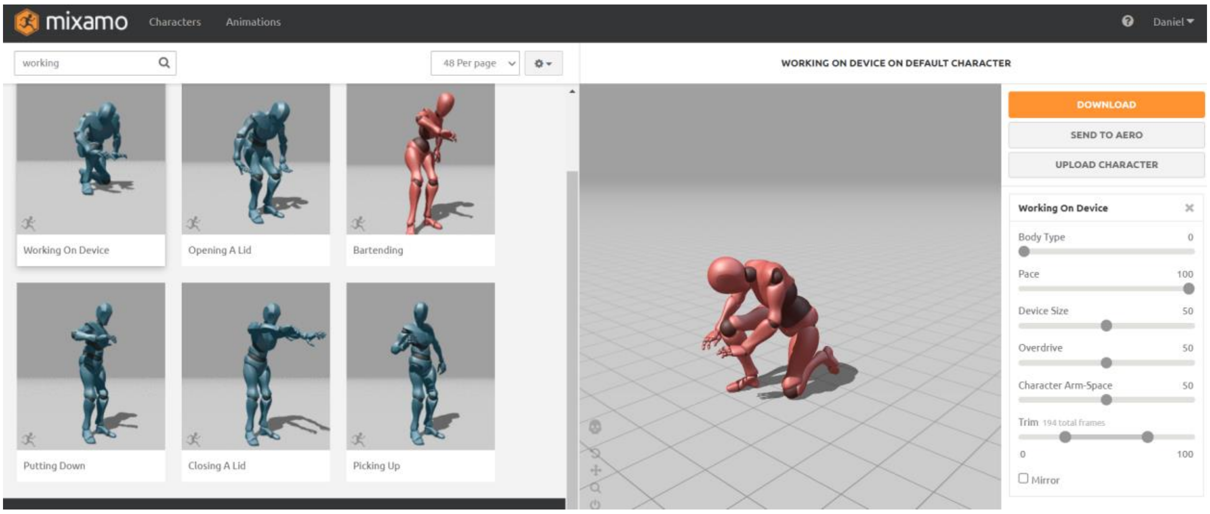


Image of Animation Creation using Mixamo

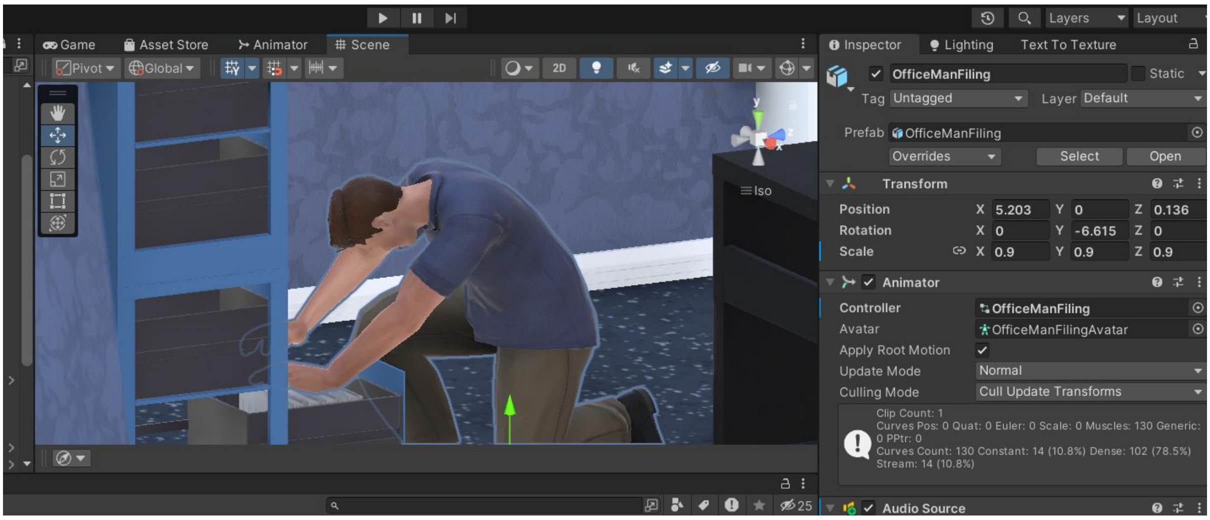


Image of the NPC performing action within Unity environment

6.1.6. v0.5: Scene Assembly and Asset Placement (Unity)

- **Date:** Late Phase
- **Objective:** Build and populate hospital scenes in Unity, integrating assets, NPCs, and interactive UI/Web browser elements.
- **Key Tools:** Unity, Blender (for last-minute asset adjustments)
- **Tasks:**
    - Assembled one full floor of hospital model within Unity, placing individual assets, furnishings, and equipment in realistic layouts across all six scenes.
    - Incorporated interactive elements, such as triggers for animations and user-driven events, within each scene.
    - Conducted performance testing, initially limited by Quest 2 constraints, to ensure optimal operation for VR while preparing for Quest 3 testing.
- **Output:** Comprehensive and populated hospital scenes in Unity, finalised and ready for user testing.

Images/Output can be viewed in application and/or referenced already in this document.

6.1.7. v0.6: User Interface (UI) Design and Development (Unity & Figma)

- **Date:** Parallel to Scene Assembly
- **Objective:** Design and implement accessible UI menus for VR and AR applications.
- **Key Tools:** Unity, Figma
- **Tasks:**
    - Designed VR-friendly UI menus and overlays in Unity, ensuring ease of use and clear navigation.
    - Used Figma to prototype UI elements, syncing designs with ShapesXR to refine functionality based on feedback.
    - Integrated and tested UI within Unity, optimising for VR accessibility and responsiveness.

- **Output:** Interactive and user-tested UI, providing seamless navigation across VR applications.

The following images are samples of the earlier iterations and design processes of the UI elements.

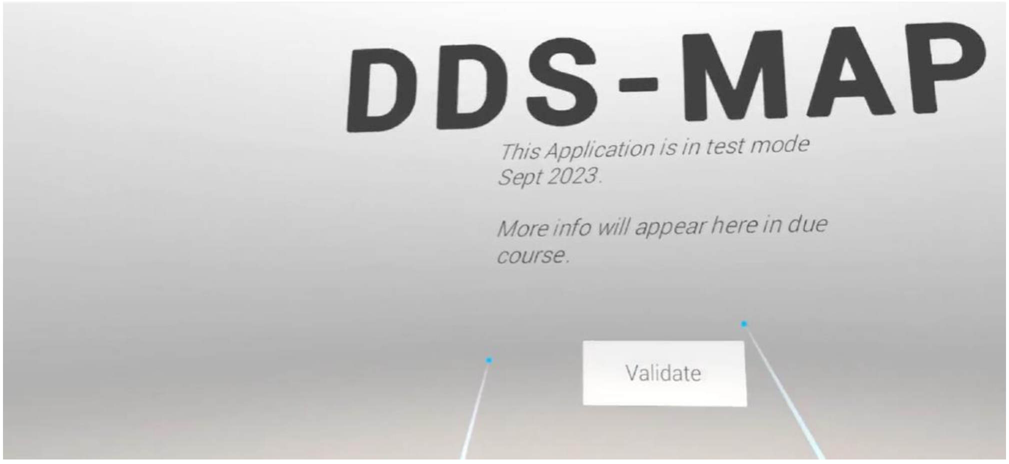


Image of UI Testing Unity

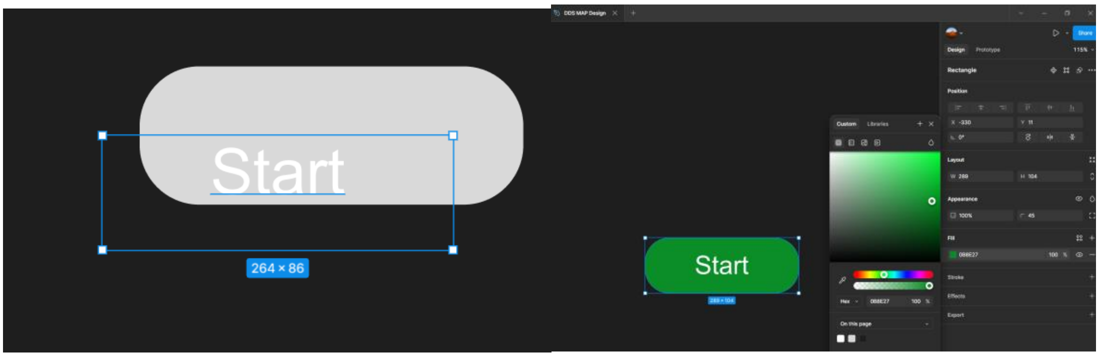


Image of Creating Button Design in Figma

6.1.8. v1.0: Acceptance Testing and Final Optimisation

- **Date:** Final Phase
- **Objective:** Conduct thorough testing and optimise the application for the final VR and AR deployment.
- **Key Tools:** Unity, Oculus Quest 3 testing environment
- **Tasks:**
    - Completed acceptance testing with end-user groups, validating core features and usability.
    - Conducted multiple rounds of performance optimisation to leverage Oculus Quest 3's capabilities, addressing any lag or graphical limitations noted during Quest 2 testing.

  - Incorporated final user feedback, refining NPC performance, scene flow, and UI responsiveness for the polished VR experience.
- **Output:** Optimised and finalised VR application, ready for deployment on Oculus Quest 3.

6.1.9. v1.1: Deployment and Rollout (TestFlight & App Lab)

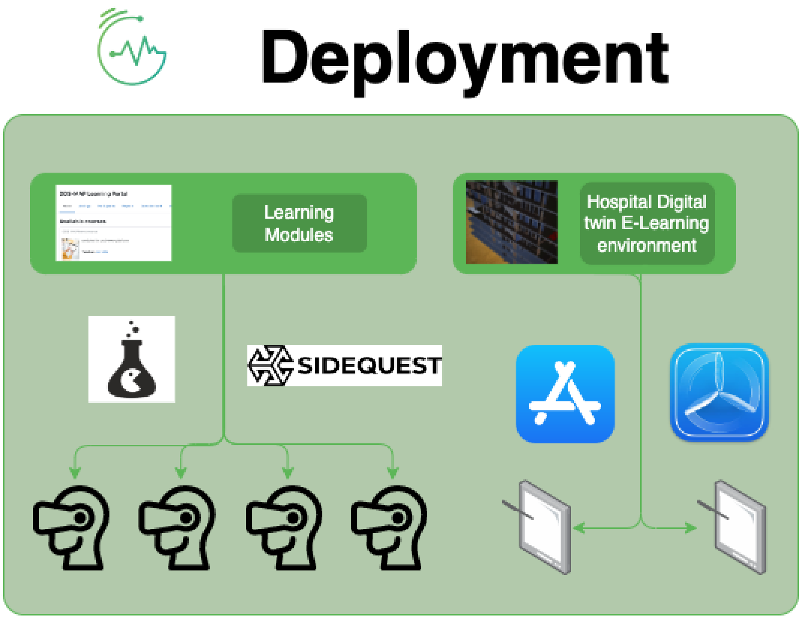
- **Date:** Deployment Phase
- **Objective:** Deploy VR and AR applications for end-user access.
- **Key Tools:** TestFlight (for AR), App Lab/SideQuest (for VR)
- **Tasks:**
  - Deployed the AR application via TestFlight, managing user access through trial site representatives.
  - Configured cloud deployment for the VR application with a deployment guide for App Lab/SideQuest access.
- **Output:** Deployed AR and VR applications, ready for end-user testing and feedback on mobile and VR devices.

Results

Throughout the development lifecycle we tested and deployed several prototypes and showcased them during monthly updates. Using a combination of live demo and captured video we took the platform from initial concept to ShapesXR based prototype to deployable condition.

7. Pilot roll out support

The European Healthcare Training Metaverse will be piloted with the end user groups



Deployed the pilot platform

Deployed the software both AR through the TestFlight delivery platform and VR through our cloud deployment mechanism as well as via our final applab/sidequest deployment guide.

Results
We have delivered a deployment plan and guide on how to deliver the final VR/AR experience. In additional each trial site representative Apple ID/email will be added to a shared excel and included in the testing pool to remote install the AR application within Testflight. This can be found in the appendices.

8. Reports

The following cover handover guides and information distributed as part of WP6 activities.

8.1. User Guide

A user guide outlining the steps to follow within the VR experience

Can be found in the appendix 1

8.2. Development Work diagrams

A development work diagrams delivered through the design and development task of the work package.

Can be found in the appendix 2

9. Dissemination

A number of Publications are planned for this work package, the first discussing the use of immersive technologies for cybersecurity learning in healthcare environment. The project team has secured additional funding, through the SETU PhD Scholarship Program, to fund one 4 year PhD project which will investigate the development, use and adoption of extended reality (virtual and augmented reality immersive technology) in the provision of cybersecurity, patient safety and digital resilience in health service with a particular focus on intersectional issues such as gender and age. A PhD student has been recruited and this project has started. This student will provide additional support for the DDS-MAP project team to enhance dissemination and the longterm sustainability of the project.

9.1. Distribution of source code and assets

The source code and the royalty free assets used in this project will be made available through and open-source repositories such as Zenodo[2]. Pending clearance from our Technology

Transfer Office for the virtual reality environments to be published using the approved license (CC BY-NC-SA 4.0 by Mutualia for digital twin assets)

10. Conclusion

Within this summary report we have outlined the results from each task within the work package. By reviewing the design and development of each stage we showcased the effort of each development section as well as issues encountered steps to remedy these and improve the overall functionality of the platform in doing so.

The work package has delivered an XR platform that can simultaneously deliver and assess the projects learning materials as well as allowing for further post pilot extensibility by allowing integration of additional web based e-learning platforms.

The resulting platform will be used in the upcoming pilot to ascertain the efficacy of e-learning in an XR environment.

User Guides Introduction

In this section we will explore the VR headset user guide and the AR device user guide. Both will guide the user through initialisation, basic usage, deployment of the VR training experience and augment reality digital twin education experience respectively.

11.Extended Reality User Guides

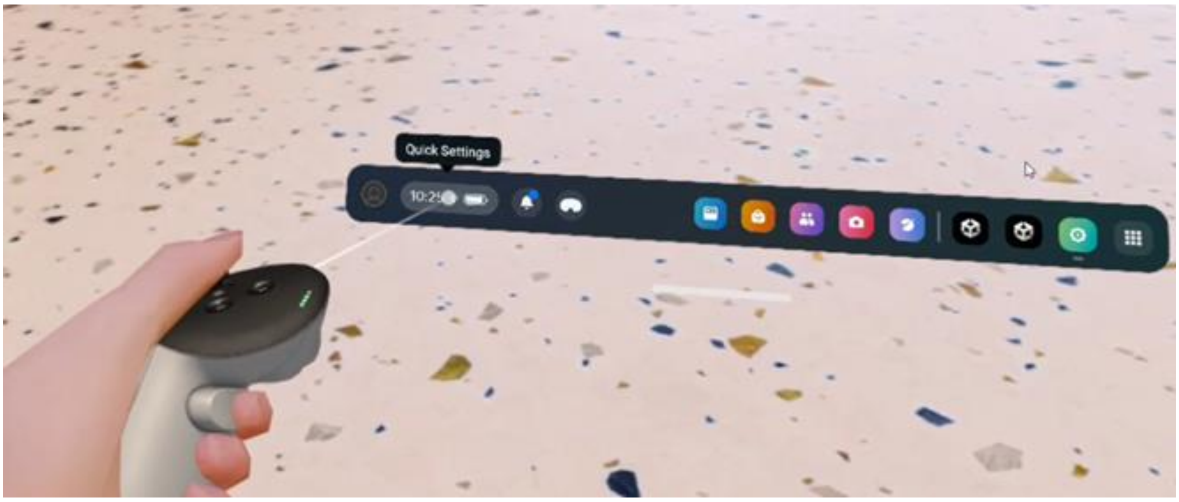
11.1. Virtual Reality Guide Introduction

Welcome to the VR application user guide. This manual will help you understand how to navigate and interact within the VR environment using the Meta Quest 3 headset. Follow these steps to get started and to understand how to navigate the VR application.

11.2. VR Deployment

Adding Your Unique User Account

While in VR, go to “Quick Settings”

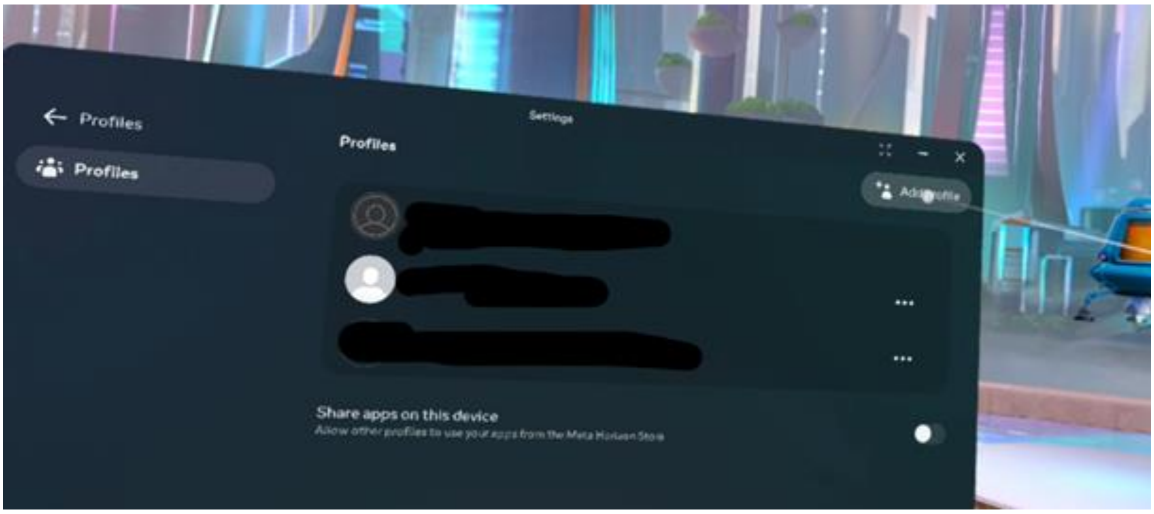


User Should Navigate to Quick Settings

In the Quick Settings window select "Settings" on the top right.

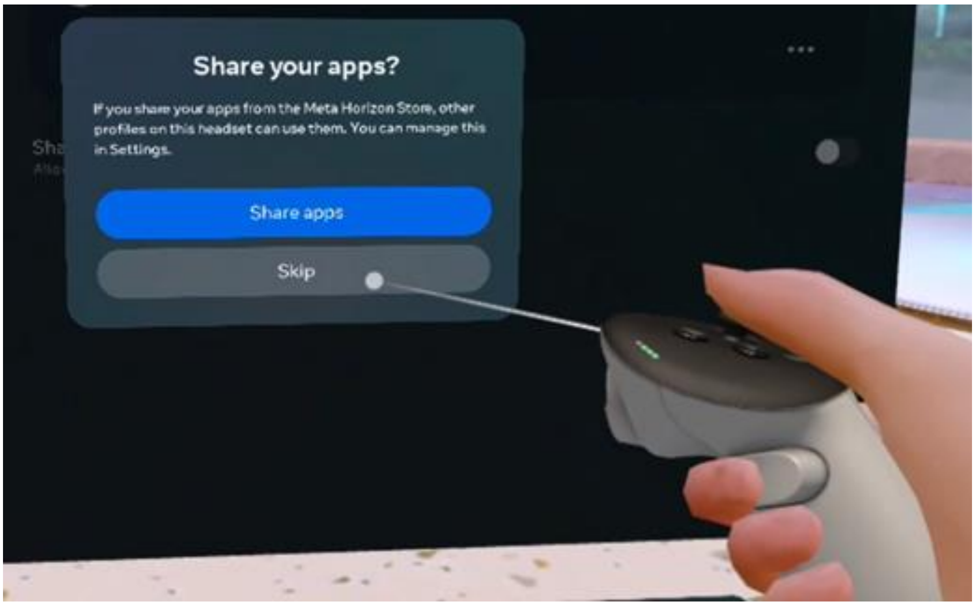
User Selecting Settings

Navigate to and select the "Profiles" icon and then select "Add profile" In the top right



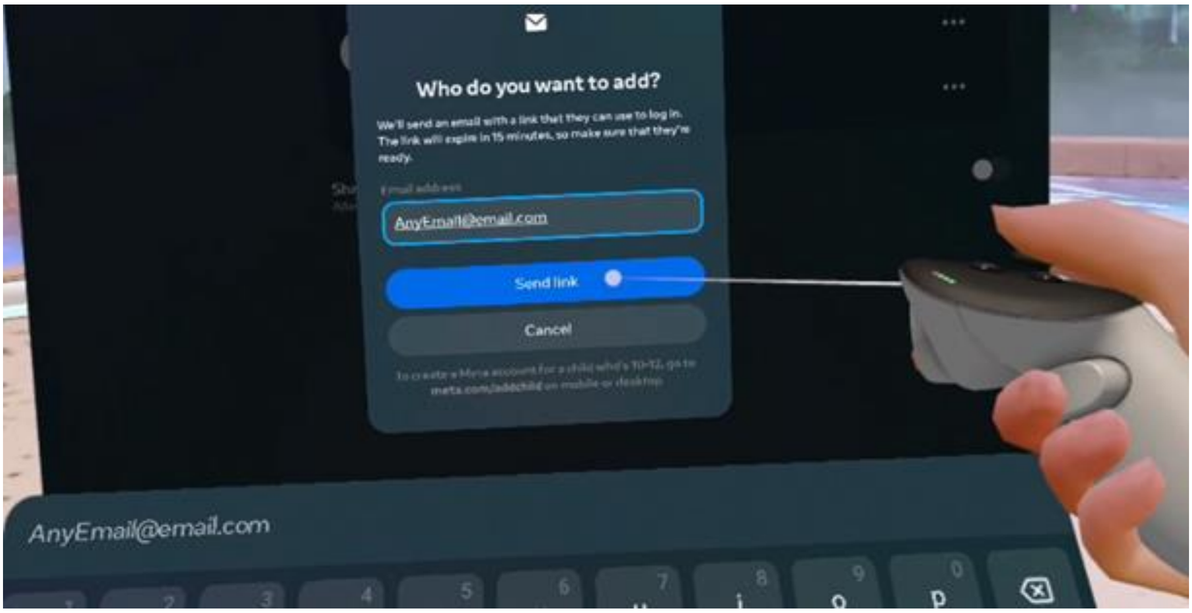
User Selecting Add Profile

Skip the "Share your apps" prompt



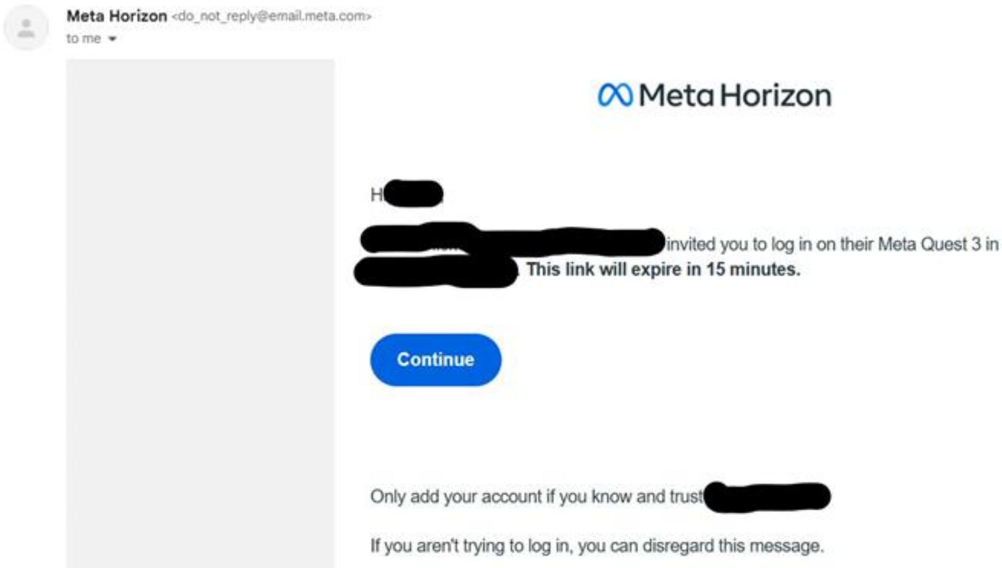
User Should Skip Sharing Apps

Enter an email address that you have access to. **Please note this can be any email address you like and will need to accessible from your laptop/computer.** Select "Send link"



User Clicking Send Link To Desired Email Address

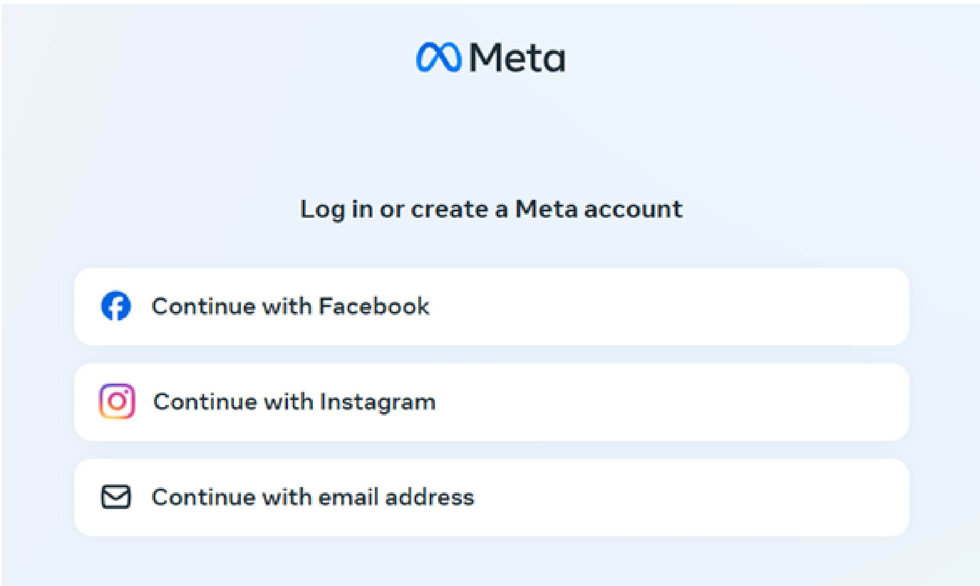
This will send a link to that email address. The link will only be active for 15 minutes. At this stage in proceedings, you will need to go to a laptop/computer to continue the steps.



Email With Link Received From Meta

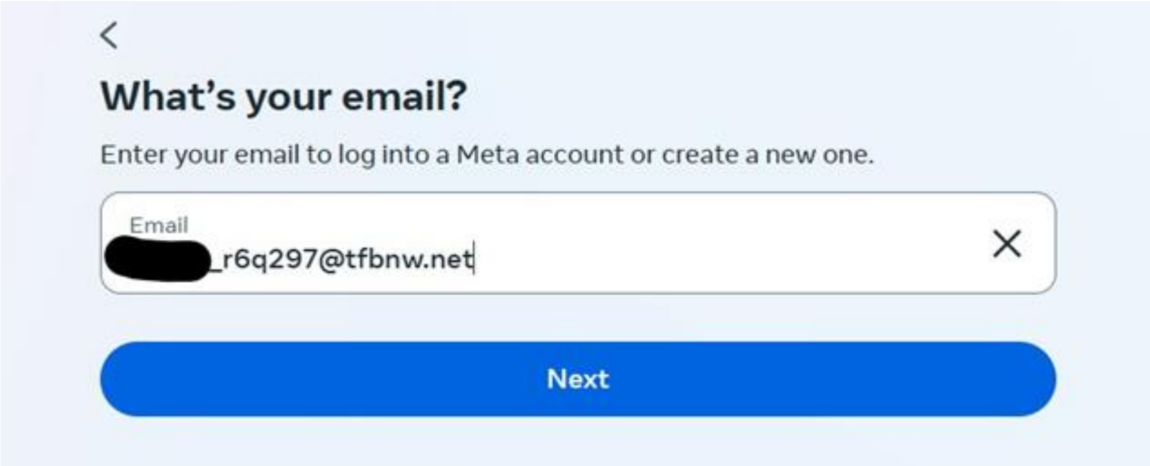
Once the email is opened, select "Continue"

Please note that you may see a message that says "Account already added" this will only appear If you are already logged in with your existing meta account. If this case you will need to log out of the account and just go back to the email and click "Continue" again.



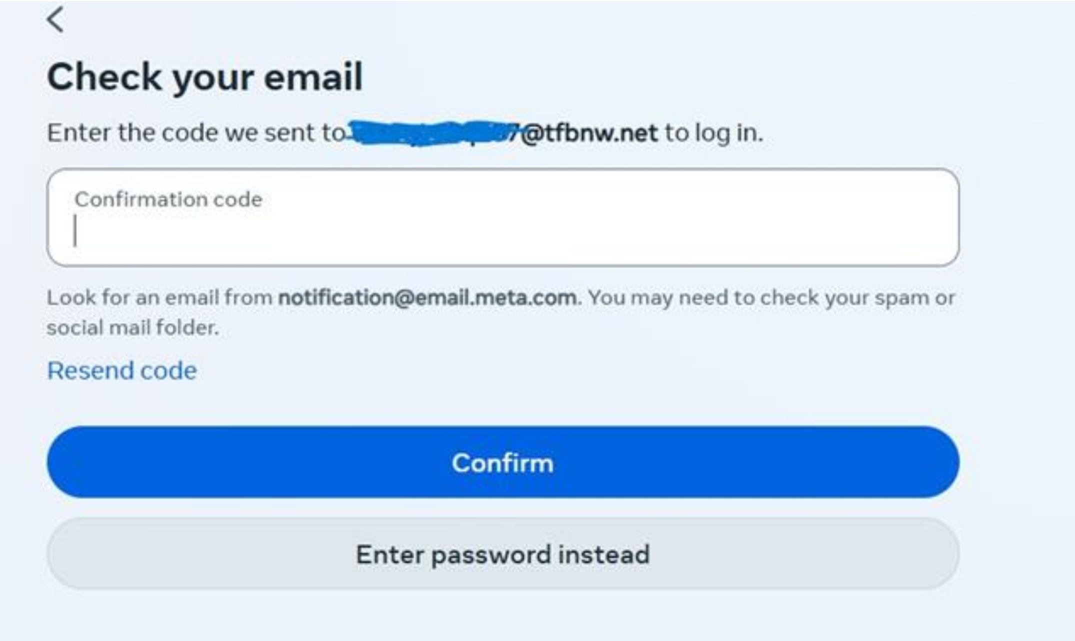
User Should Select Continue with email address

Select "Continue with email address" to proceed



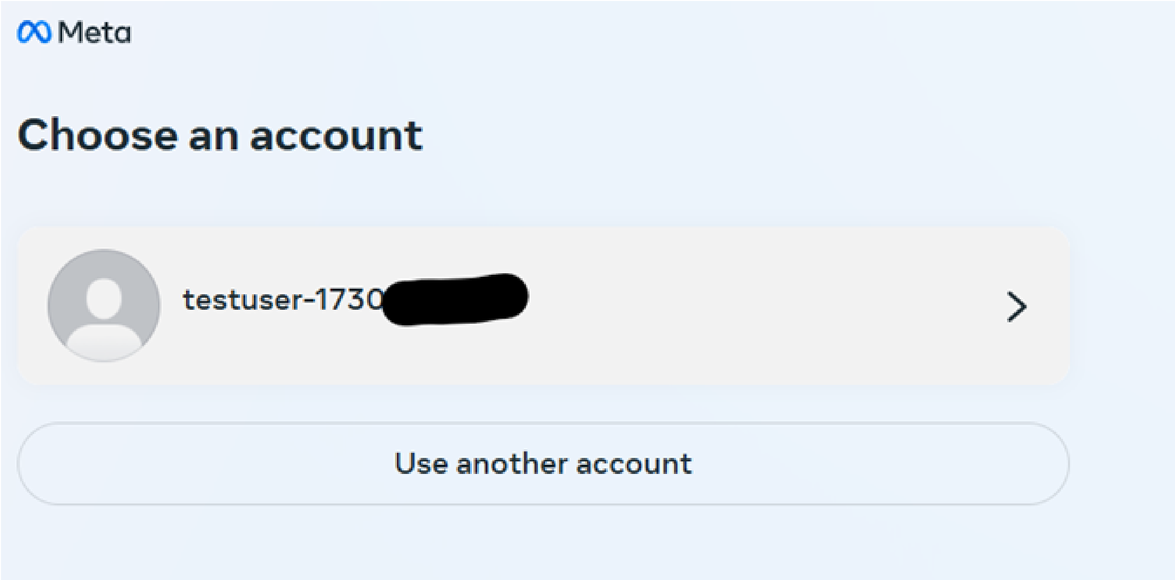
Sample Image of Username Login

N.B. HERE IS WHERE YOU ENTER THE EMAIL/LOGIN THAT HAS BEEN ASSIGNED TO YOU NOT THE ONE YOU USED TO GET THE LINK. This email will look something like this image above and end with "@tfbnw.net" or something similar.



User should select Enter password instead

It will not be possible to receive a confirmation code so instead you will need to select "Enter password instead" Use the password that is associated with your unique user login.

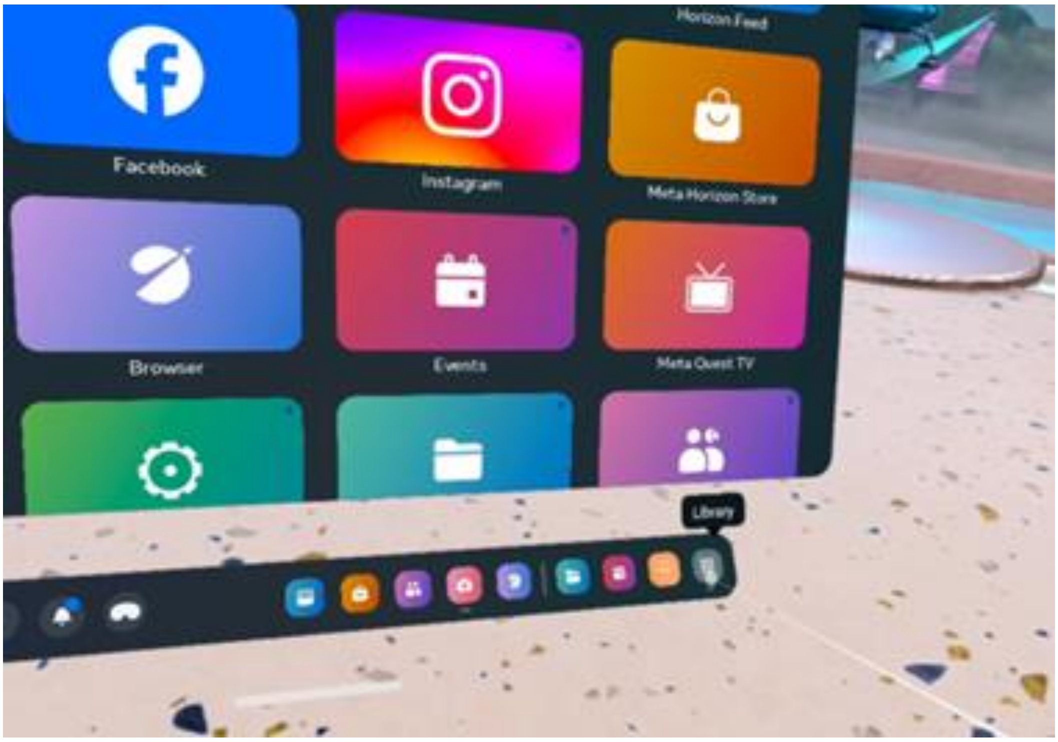


User Should Select testuser

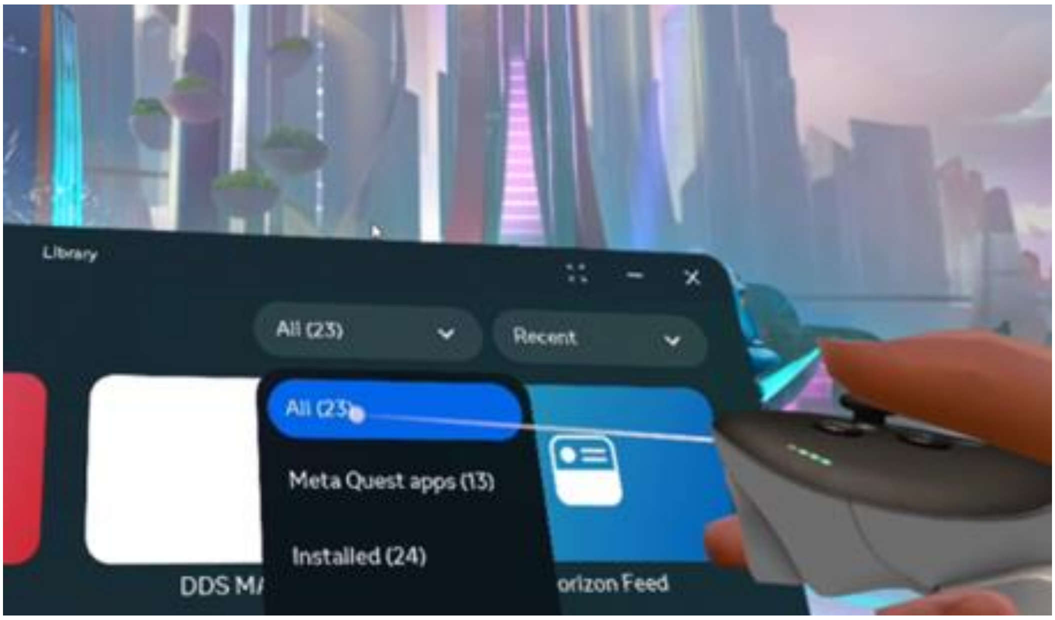
It should look like the image above "testuser-……" Select this "testuser" and then select "Add account". Continue to follow the Meta Quest setup screen on the laptop. Once this setup on completes you will now need to go back to the headset for the final steps.

User Selecting Profile

The Quest should automatically have logged you in with your unique user account. In the unlikely event that you are still on your own meta account just go to "Profiles" at the bottom left, as seen above. This will give you an option to "Switch Profile" on the top right. Select the unique profile from here.

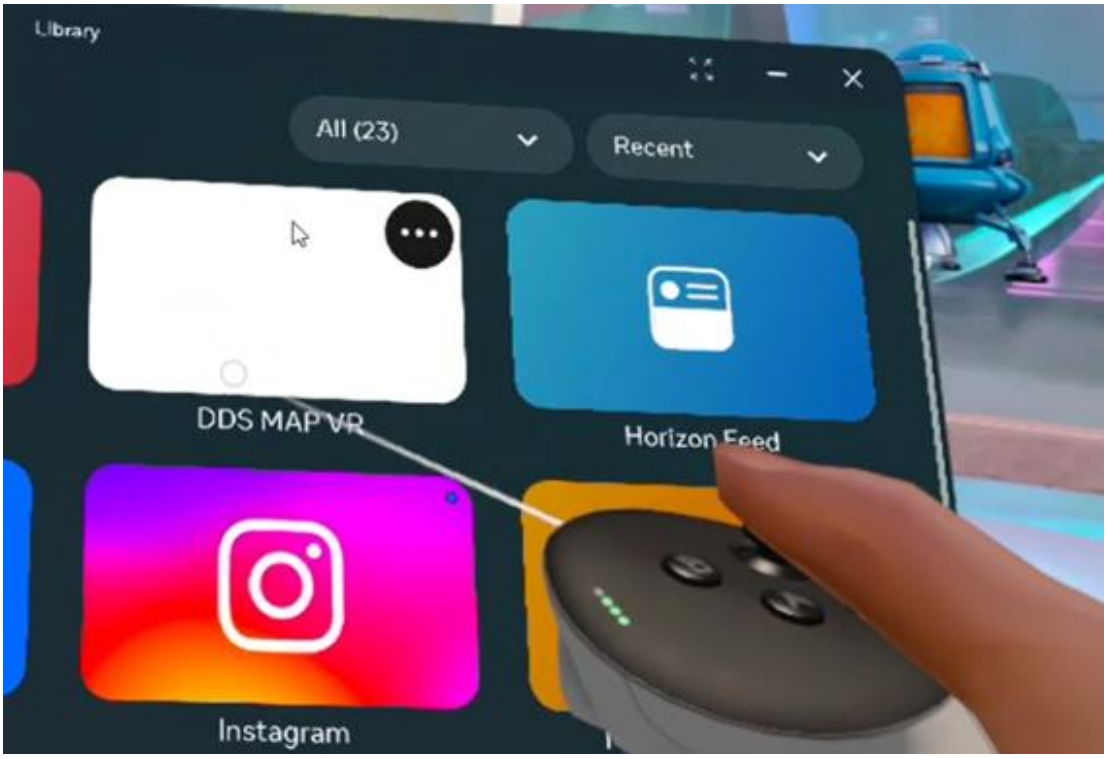


User Selecting Library



User Selecting All Apps

Once in the correct user account go to Library at the bottom right and make sure "All" is selected.



User Selecting the DDS MAP VR app

The application "DDS MAP VR" should now be visible among the list of icons on screen. When doing this for the first time you will need to select to download and then it will be accessible from here going forward. **PLEASE BE ADVISED YOU WILL NEED TO BE IN THIS USER PROFILE TO ACCESS THIS APPLICATION.**

11.3. Starting the VR app

As outlined in the Meta use guide [3]

Put on the Headset:

Adjust the headset for a comfortable fit. Use the straps to secure the headset snugly around your head.

[3] https://www.meta.com/en-gb/help/quest/articles/getting-started/getting-started-with-quest-3/

Head placement of the meta Quest 3 device

1 Meta. 2024. Power On Device. Meta Quest Help Centre. https://www.meta.com/en-gb/help/quest/articles/getting-started/getting-started-with-quest-3/

Turn on the Meta Quest Headset:

Press and hold the power button on the Meta Quest headset until the device powers on. This button is located on the left side of the headset. Ensure the headset is fully charged.

The power button is located on the left side of the HMD

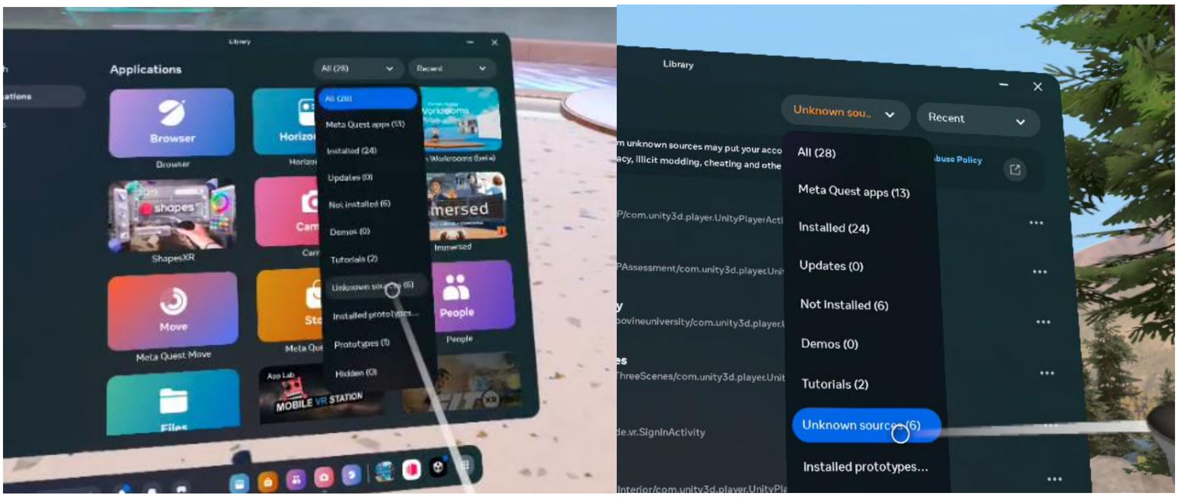
2 Meta. 2024. Power On Device. Meta Quest Help Centre. https://www.meta.com/en-gb/help/quest/articles/getting-started/getting-started-with-quest-3/

Launch the VR Application:

Using the Meta Quest controllers, navigate to the VR application in the main menu. To locate the app, navigate to the library icon Point at the application icon and pull the trigger to select and launch it.

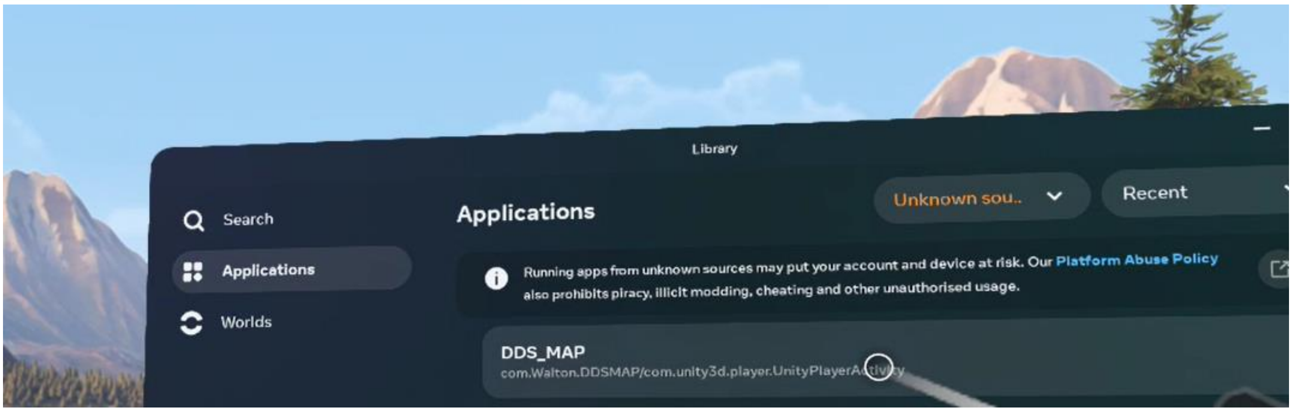
User should navigate to library

From the dropdown menu at the top (to the left of "Recent") select the option unknown sources.



The application is located in unknown sources.

Once Unknown sources has been selected there will be an option for "DDS_MAP".



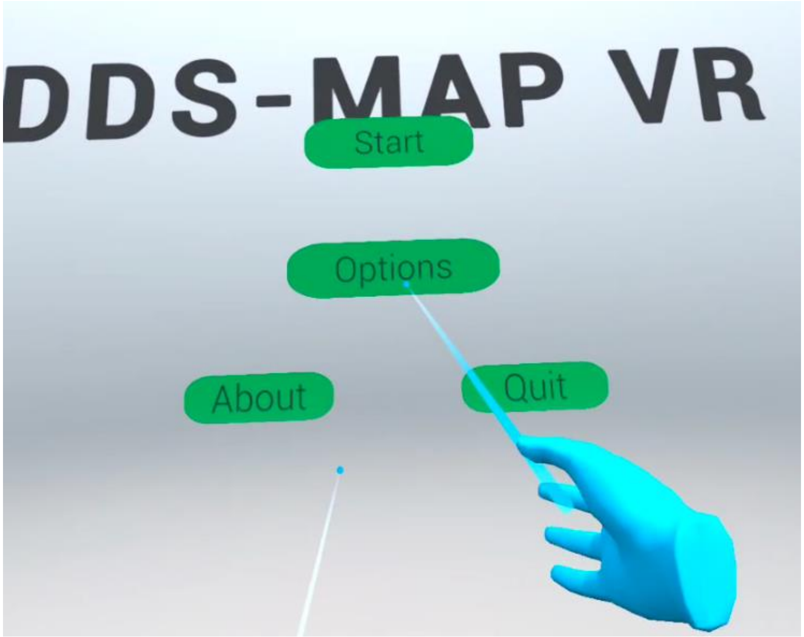
The application in the unknown sources library

Select this option to launch the VR application.

11.4. Basic Navigation, UI interaction and object Interaction

Pointing and Selecting:

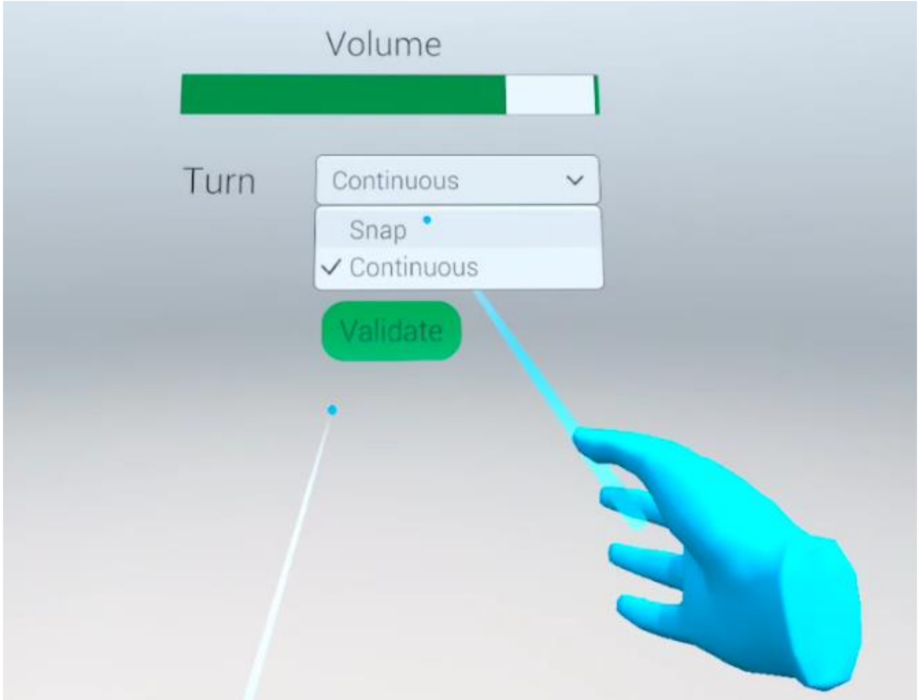
Point the controller at the UI element you want to interact with. A raycast (visible laser) will extend from the controller, indicating where you are pointing.



User selecting options sub menu

Pulling the Trigger to Select:

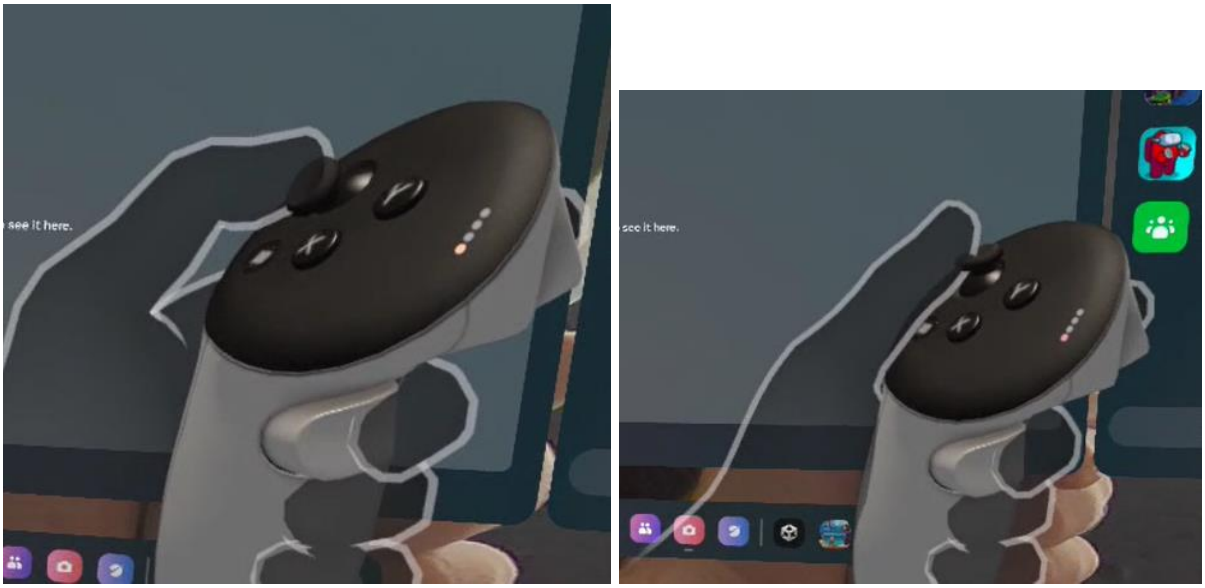
Pull the trigger on the controller to select or click on the UI element.



User selecting VR locomotion method

Moving Forward and Backward:

Use the left controller stick to move your character forward and backward. Push the stick forward to move ahead and pull it back to move in reverse.



Visual of the VR controller buttons

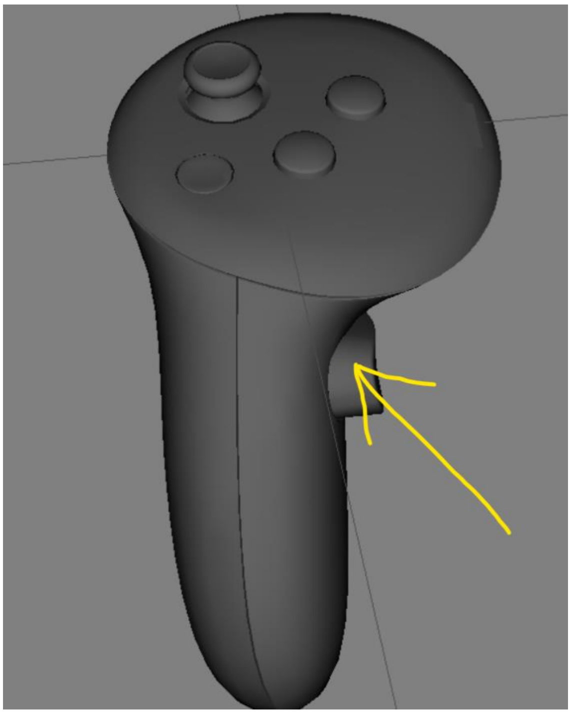
Turning Left and Right:

Use the right controller stick to turn your character left or right. Push the stick left or right to rotate your view accordingly.

Visual showing thumbstick location

Interacting with Grabbable Objects:

The grip buttons on the Meta Quest 3 controllers are located on the sides of each controller. These buttons allow you to grab and hold objects within the virtual environment. Keep the button held to hold the object and release the button when you want to release the object.

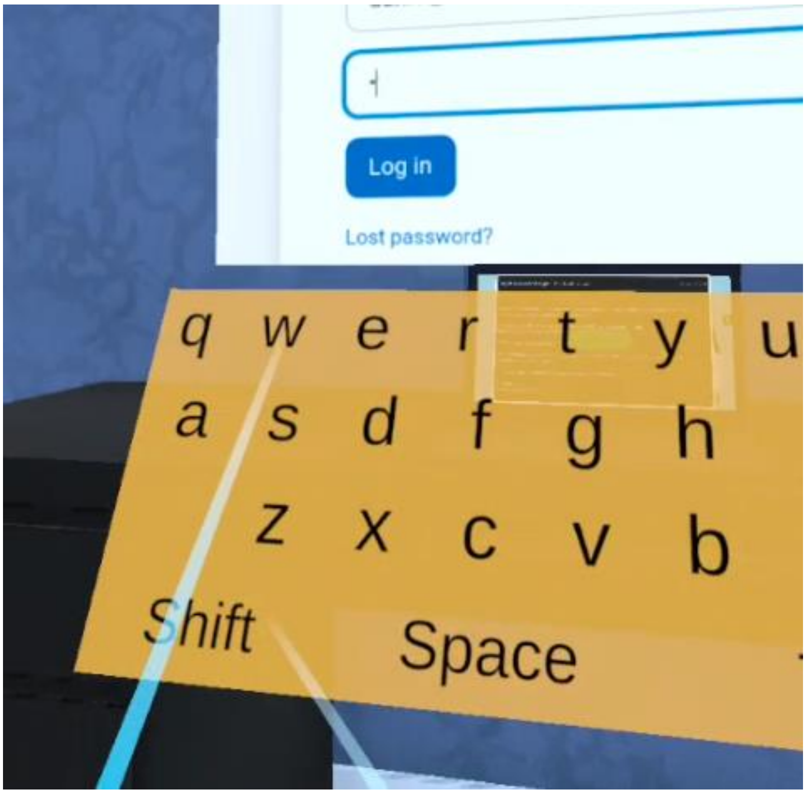


Location of the squeeze trigger

11.5. Using the On-Screen Keyboard

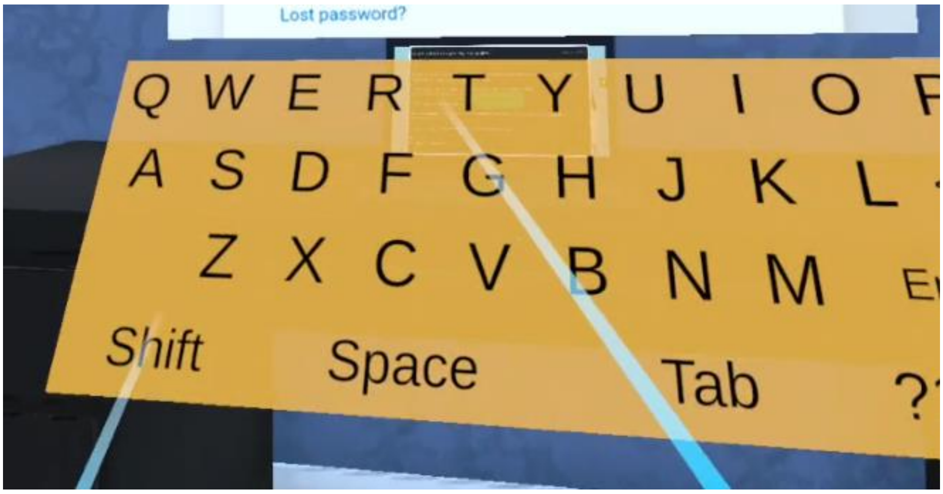
Selecting Characters:

Point at the desired letter or number on the on-screen keyboard. Pull the trigger to select each character.



Showcasing keyboard

For uppercase letters select the “Shift” button.

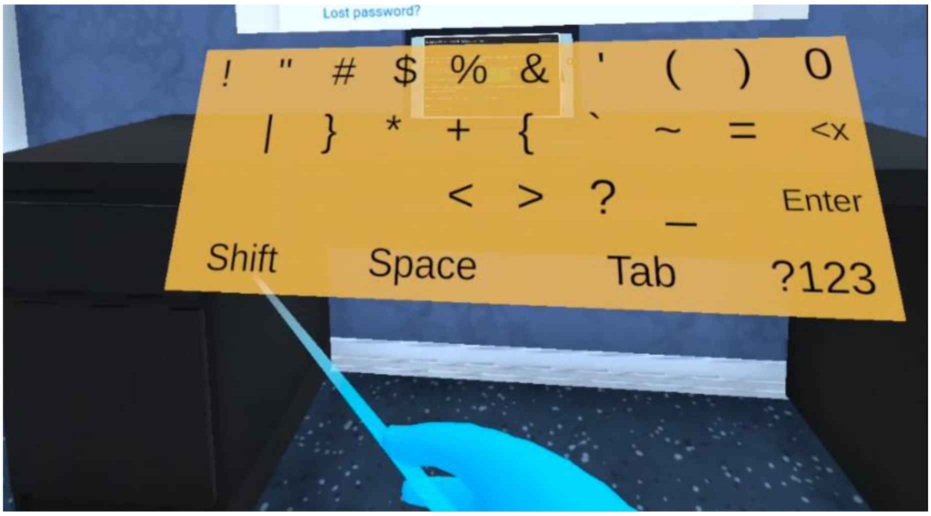


Shuift showing shift alt character selection

To access numbers and special characters select the “?123”

alt character selection

For additional special characters press the shift button while in the numbers keyboard.

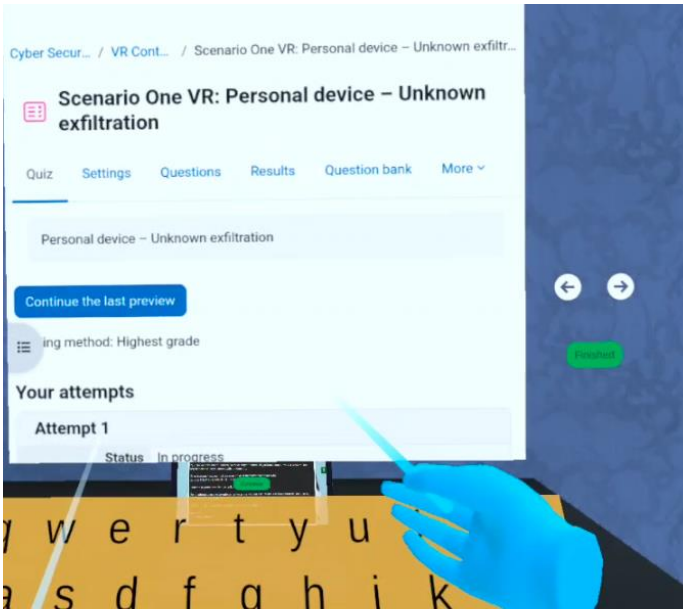


Additional alt character selection

11.6. Scrolling Through Web Pages

Point and Drag to Scroll:

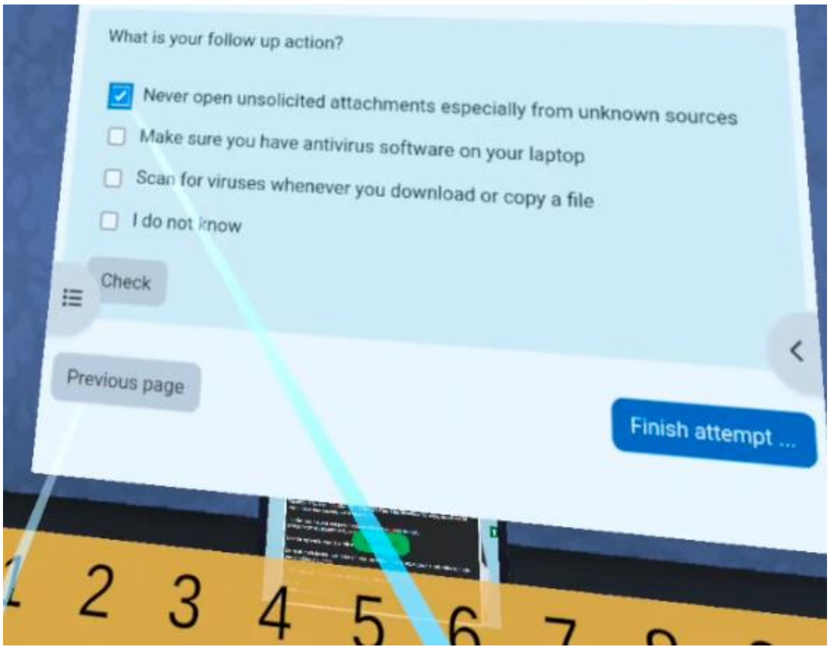
Point the controller at the web page. Pull the trigger and drag the screen up or down to scroll through the content.



Moodle itneractiona and selection

Select Elements on assessment screen:

To select any interactive elements/buttons on the VR Web UI you simply point and pull the trigger.

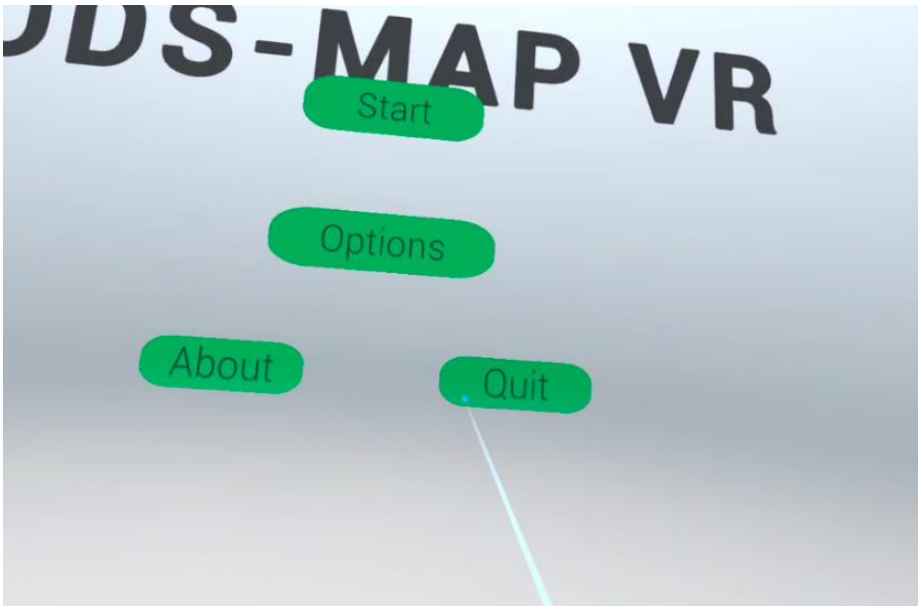


Multiple choice question interaction

11.7. Exiting the VR Experience

Safely Exiting the Application:

You can quit the application using the 'Quit' button available in the main menu. Access this button at the opening scene and again at the end of the VR assessments.



How to exit the VR experience

Alternative Exit Method:

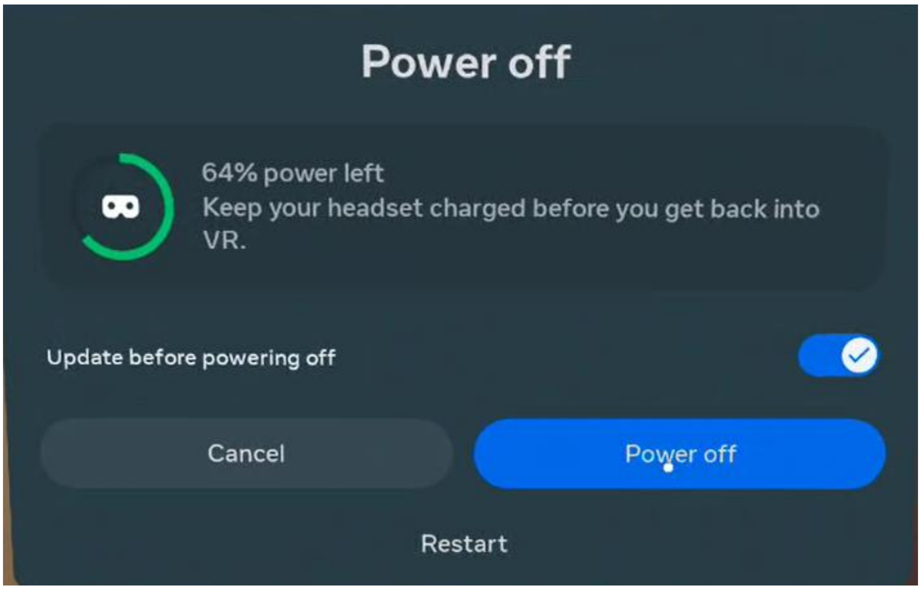
Press the Oculus button on the right controller to bring up the Universal Menu. Select 'Quit' from the Universal Menu to exit the application and return to the main menu of the Meta Quest.

How to quit the overall application

Powering Off the Meta Quest:

The power button is located on the left side of the Quest 3. Press and hold the power button on the Meta Quest headset until you see the options to “Power off”, “Restart” and “Cancel”.

Choose the option according to your needs. Alternatively, you can Press and hold the power off button for 5 seconds to power off the device quickly.



How to turn off the headset

11.8. VR scenario flow

Once the VR experience has been launched the user will need to complete 6 scenarios. Each scenario activity must be completed to reveal the assessment. Once the user has completed the assessment they can move on to the next assessment in sequence.

12. AR User Guide

User guide for the AR application

12.1. Introduction

Welcome to the AR application user guide. This manual will help you understand how to navigate and interact within the AR environment using the Apple iPad 9th generation. Follow these steps to get started and understand how to navigate the AR application.

12.2. AR Deployment

To get started, install TestFlight on the device you'll use for testing. Then, accept your email invitation or follow the public link invitation to install the beta app.

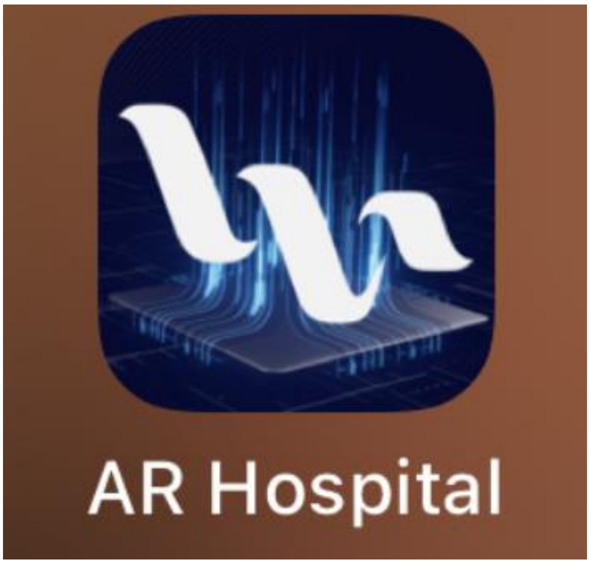
1. Installing a beta IpadOS app via email
2. Install TestFlight on the iOS or iPadOS device that you'll use for testing.
3. PLEASE SEE DEPLOYMENT GUIDE EMAIL: Submit your email to the excel sheet and we will add it to the testing pool.
4. On the ipad you have setup. Open your email invitation and tap "View in TestFlight" or tap the public link on your device.
5. If you're a new tester for the app, tap Accept.
6. Tap Install to install the app on your device.
7. If you're a returning tester, tap Update or Open.

12.3. Starting the AR App

How to interact with the AR application

12.3.1. Launch the AR Application:

Power on the iPad and unlock if necessary and navigate to the home screen. Locate the AR application icon and tap it to launch the app. (see app icon image below)



AR Application icon

12.4. Initial Setup

12.4.1. Finding a Flat Surface:

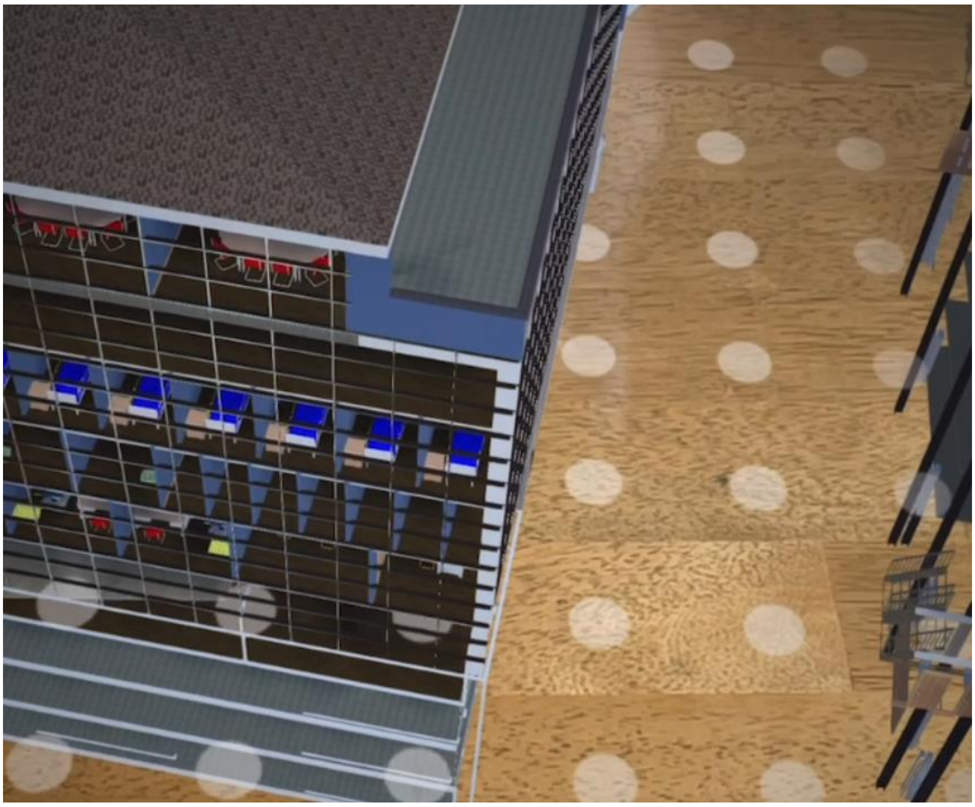
Once the application is launched, follow the on-screen instructions to find a flat surface. Move the iPad around slowly to help the app detect a suitable surface. Detectable surfaces will be indicated with a series of gridded dots.

Placement indicators in augmented reality

12.4.2. Placing the 3D Model:

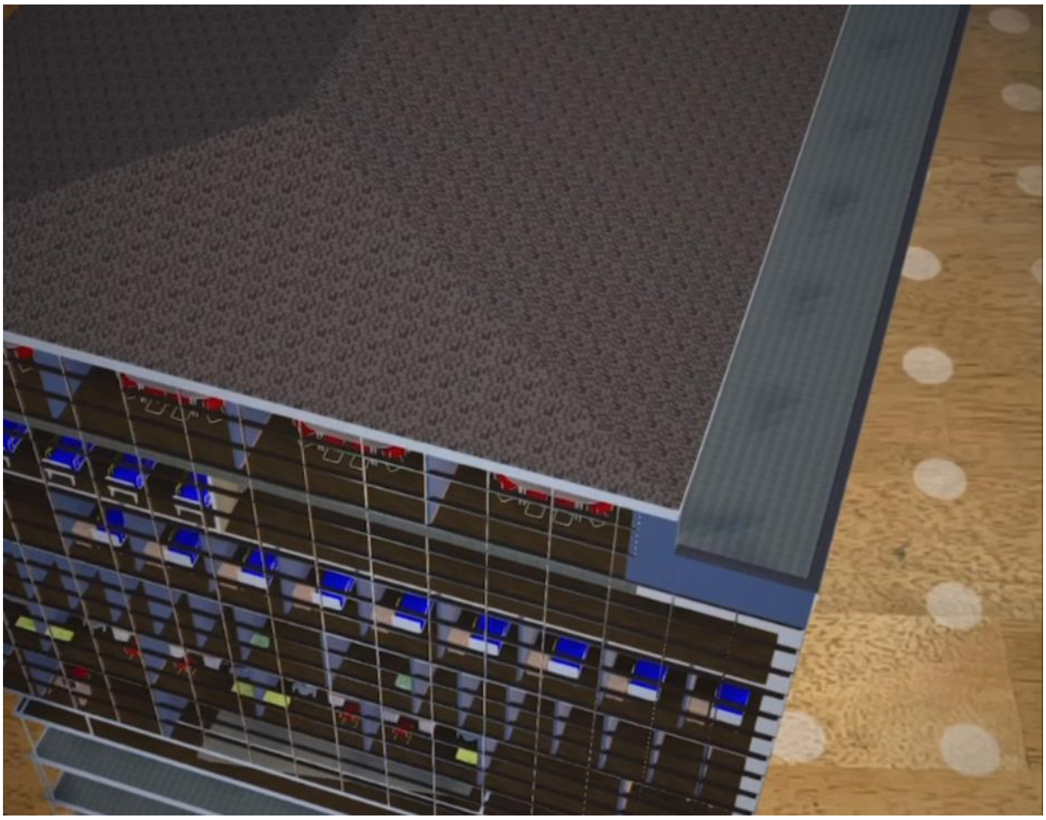
Once a flat surface is detected, you will see instructions on the screen to "tap and hold on a surface to move and place the object."

Tap and hold on the detected surface. A 3D model of a hospital will appear, superimposed onto the flat surface.



Placement of the hospital model in AR

Move the object to your desired position and release to place it.

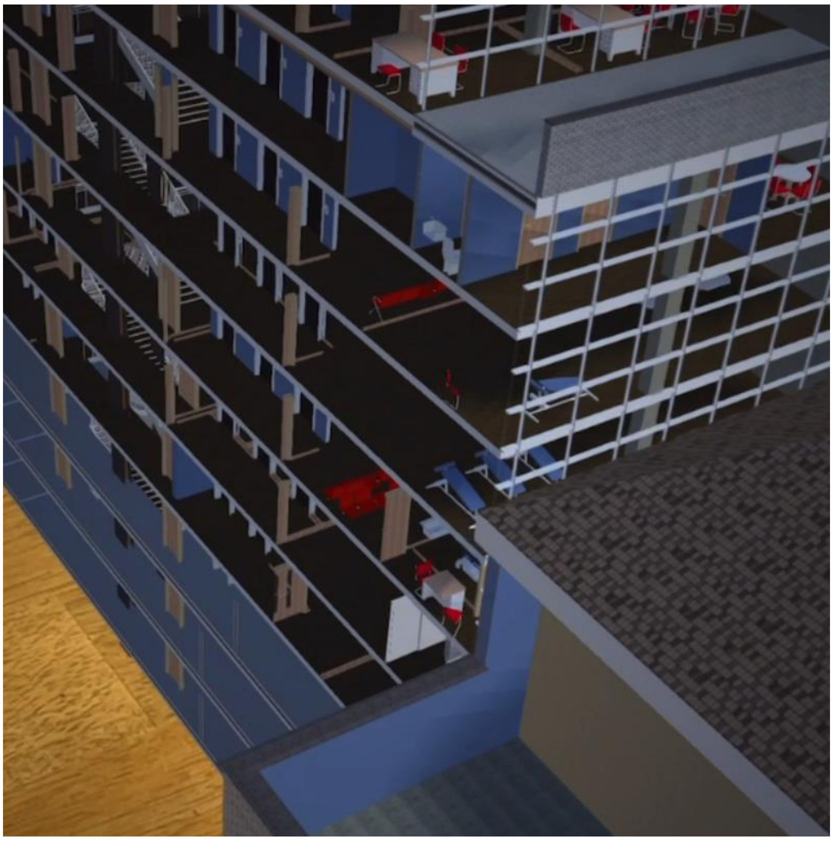


Finalised placement of the digital twin

12.5. Interacting with the 3D Model

Moving Around the Model:

After placing the 3D model, you can move around it by physically walking with the iPad. Use the iPad to explore different angles and perspectives of the 3D model.

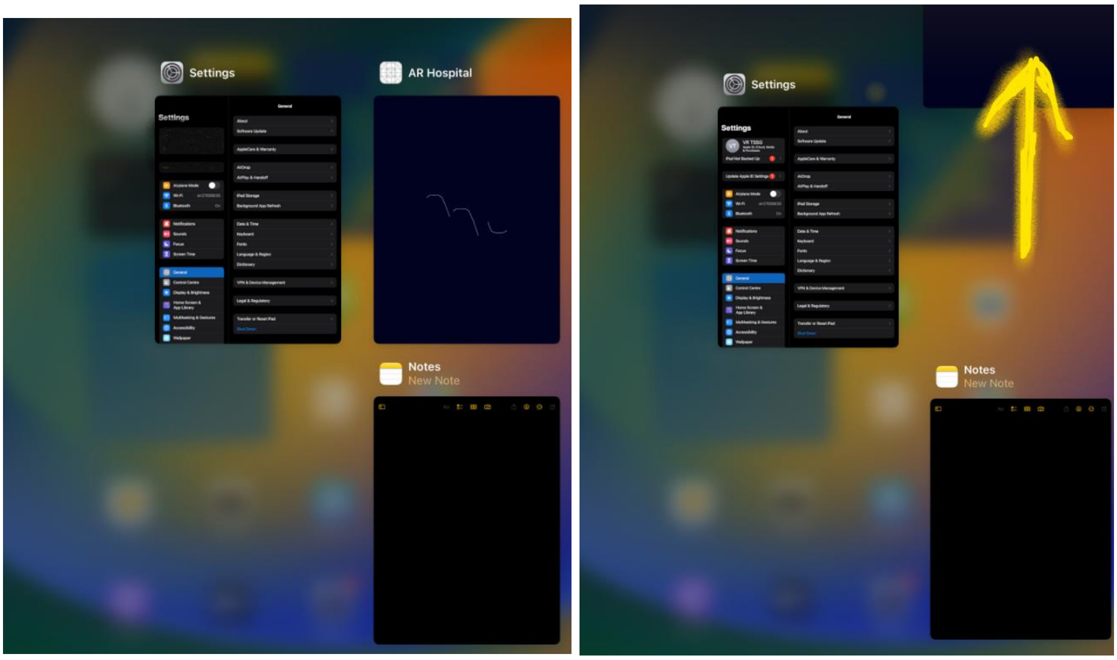


Navigation around the model

12.6. Exiting the AR Experience

12.6.1. Exiting the Application:

To exit the AR application, press the home button on the iPad. Alternatively, swipe up from the bottom of the screen and pause to open the app switcher, then swipe the AR application window upwards to close it.



How to close and exit the application

13. DDS-MAP Equipment specification brief

13.1. Introduction

The below is the equipment specification for the DDS-MAP outlining the device type /model, quantity and safety operation models used in the project for both VR and AR applications.

An overview of the solutions for showcasing the DDS-MAP VR training.

Table of Contents

13.2. VR Experience

The following is based on the exact equipment:

- 4 Meta Quest 3 headsets
    - 2 on standard rotation
    - 2-3 hours per cycle

- 2 headsets being charged at any one time.

- **2 Apple iPads**
    - 1 on standard rotation
    - A headset being charged at any one time.

Guardian is a built-in safety feature that lets you set up boundaries in VR that appear when you get too close to the edge of your play area.

13.2.1. Guardian modes

When setting up Guardian, you can choose from these modes:

Stationary: For using your headset while sitting or standing in place. Stationary mode creates a default Guardian area of 1 by 1 metre (3 by 3 feet) centred on yourself.

Roomscale: For using your headset while moving around inside your play area. Roomscale allows you to draw your Guardian boundaries in your physical space using your Touch controller. We recommend a safe and unobstructed space measuring at least (2 by 2 metres) 6.5 by 6.5 feet.

13.2.2. Safety features

Space Sense is a safety feature that allows you to see outlines of people, pets and other objects that cross over the boundaries of your Roomscale Guardian while you're in VR. Space Sense can show outlines of objects up to 2.7 metres (9 feet) away, provided that they have entered into your play space.

14.Development Diagrams

Development diagrams section

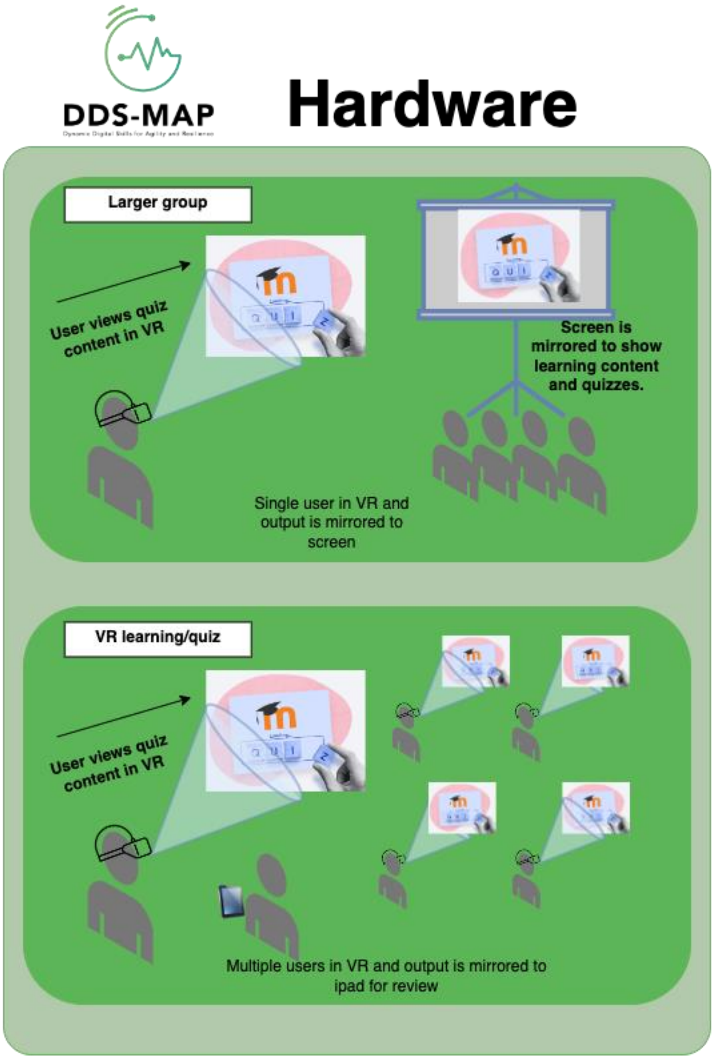
14.1. Introduction

This section outlines the development diagram produced as part of the XR development process. Primarily they outline the system architecture, deployment, process flows of the developed DDS-MAP solution.

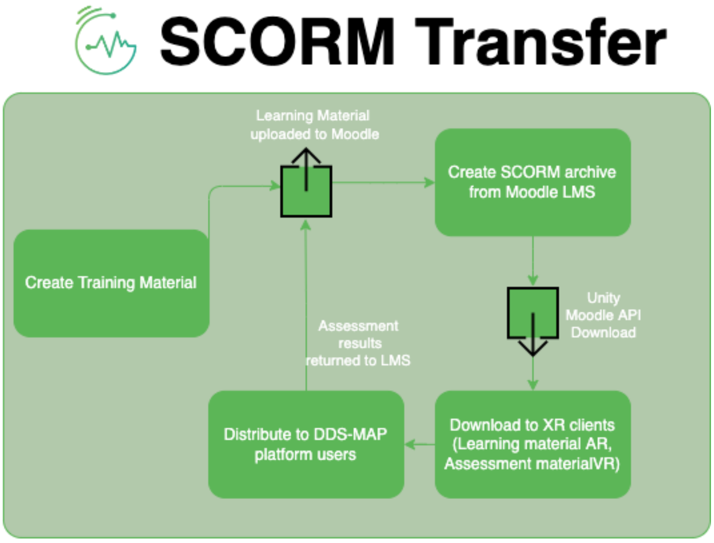
14.2. Justification - Learning diagram

Changing the equipment to multiple headsets and mobile based approach reduces complexity while allowing for additional users to simultaneously use the platform.

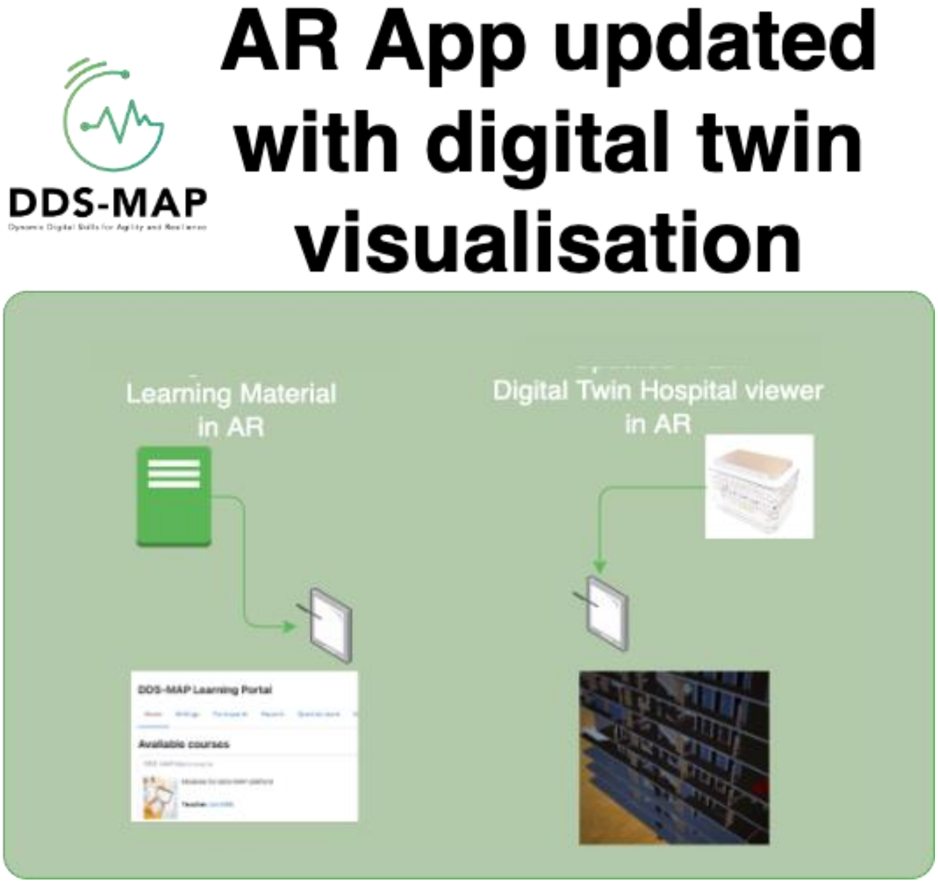
14.2.1. Old setup vs new equipment setup



Old vs new headset setup

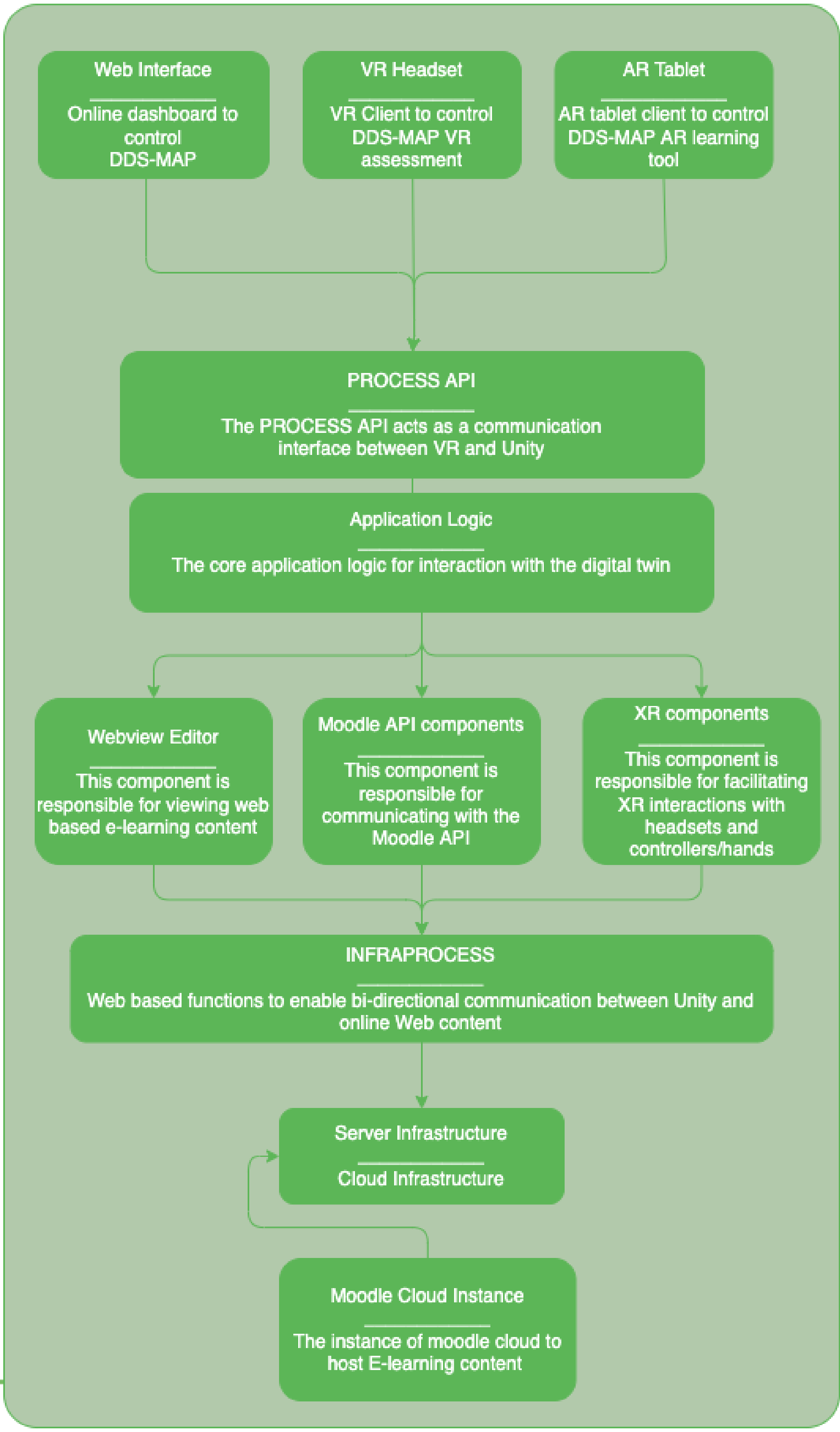


SCORM data transfer

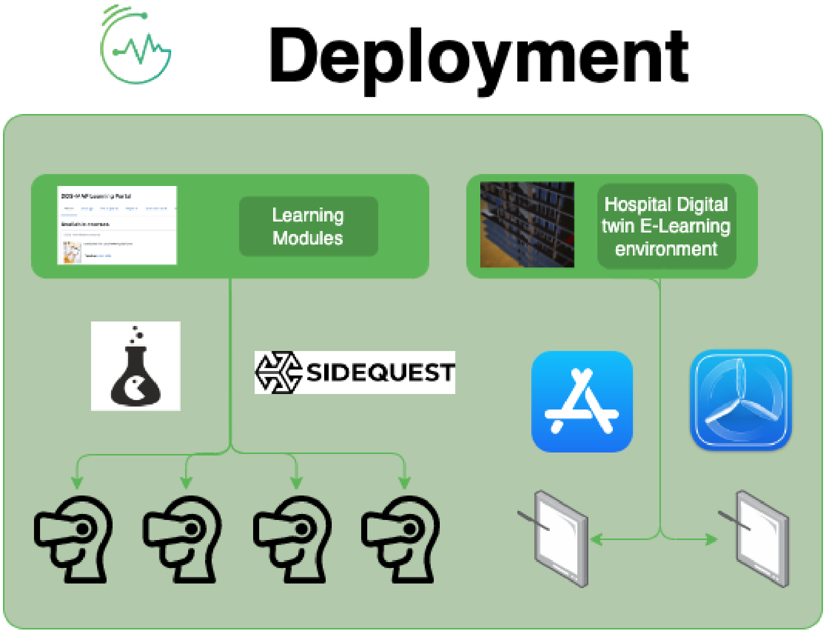


The Augmented reality application updated to showcase the digital twin

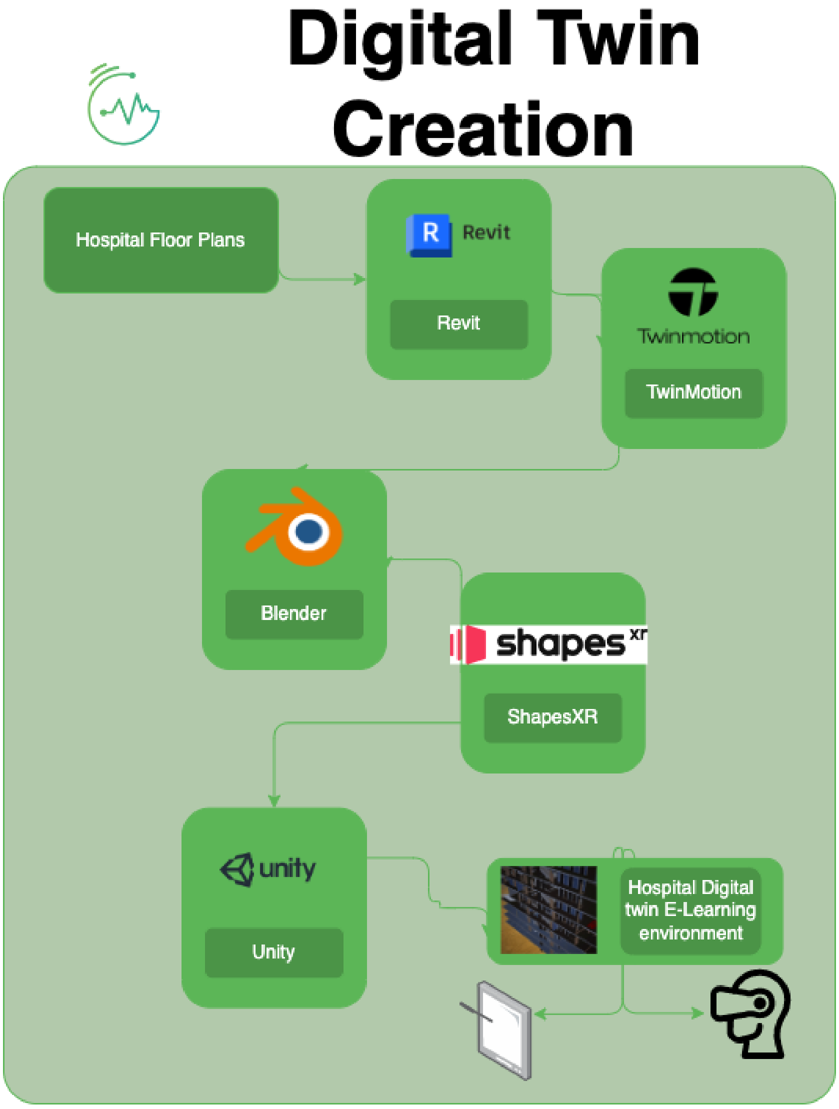
Architecture



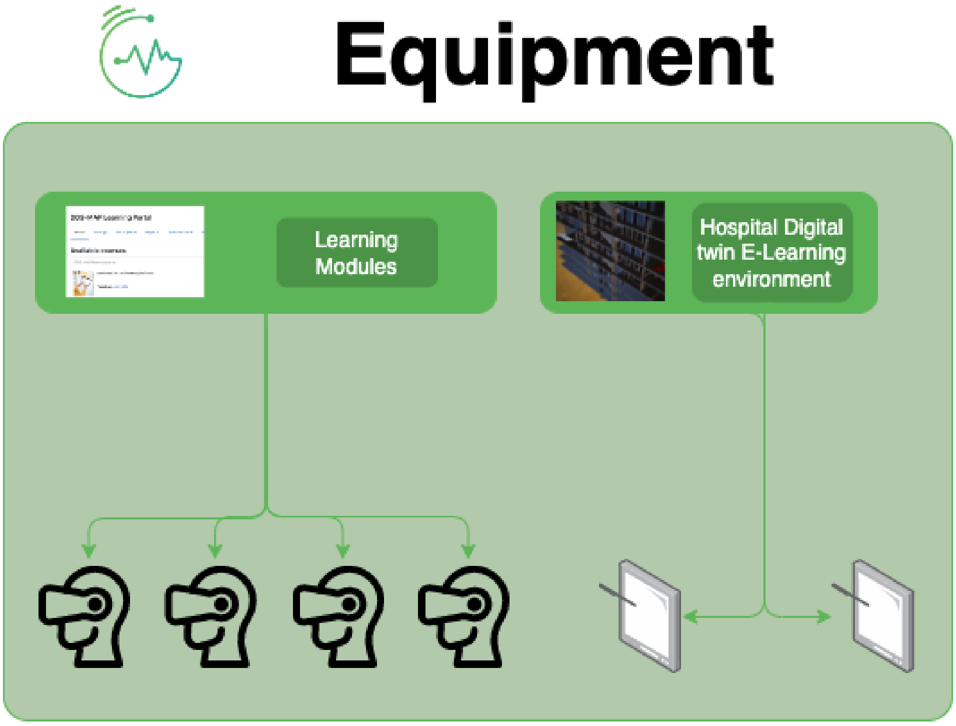
Architecture of the DDS-MAP platform



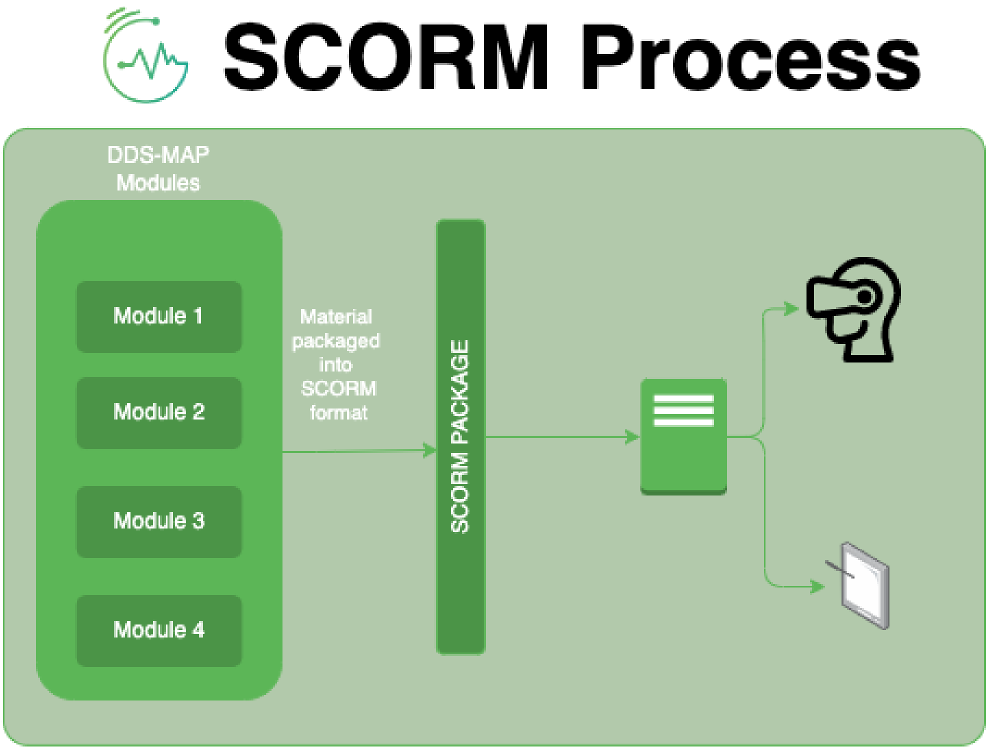
Deployment platform diagram outlining target device and store usage.



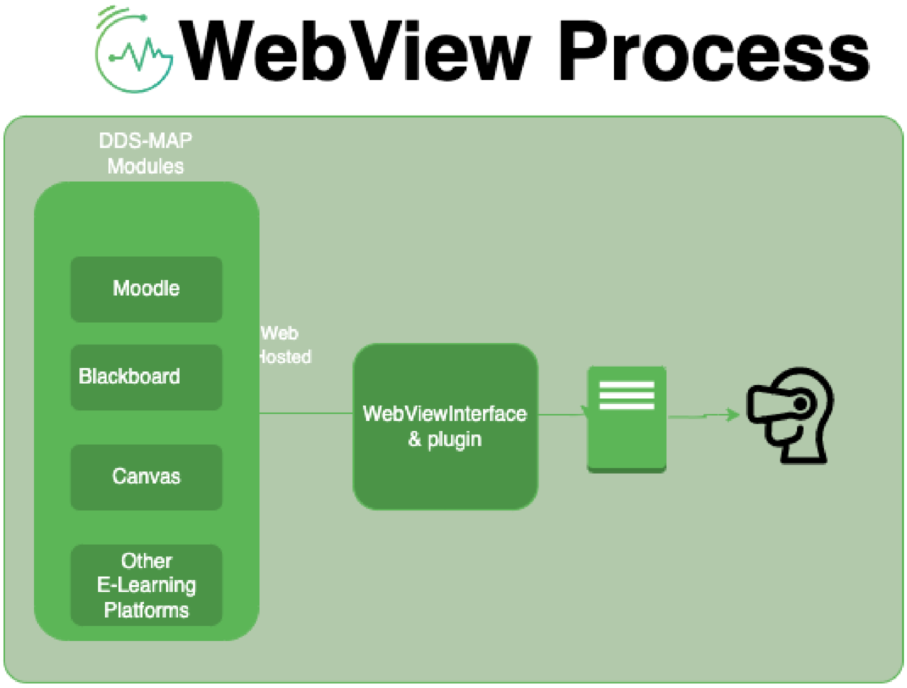
Software tool development process and data flow



Designation of each trial site and their equipment deployment



SCORM packaging process to be use with the moodle instance.



Use of the web view process to allow for extensibility of the platform in future

15.COVID-19 Considerations

Due to developments in recent years (2020-2021) the pandemic outbreak of the coronavirus classified as COVID-19, we have had to take into consideration several potential factors into our overall design and methodological approach:

- VR Headset cleaning
- VR Headset mounting
- Platform-End User interaction

15.1. VR Headset cleaning

Due to the headset coming into close contact with the user's face, the facial interface of the device as well as the extremities of the device, are susceptible to harbouring the virus. So, a necessary cleaning regime will need to be implemented for this project. Based on the work carried out from

[1]
S. C. Roberts *et al.*, "Disinfection of Virtual Reality Devices in Health Care Settings: In Vitro Assessment and Survey Study," *J Med Internet Res*, vol. 24, no. 12, p. e42332, Dec. 2022, doi: 10.2196/42332.

there is no standard operating procedure however we can adapt from.

[1]

N. Moore *et al.*, “Innovation During a Pandemic: Developing a Guideline for Infection Prevention and Control to Support Education Through Virtual Reality,” *Front Digit Health*, vol. 3, p. 628452, Jul. 2021, doi: 10.3389/fdgth.2021.628452.

The procedure adopted by the trial sites for DDS-map is as follows:

15.2. Summary Step by Step Guideline for VR Cleaning and Disinfection

We recommend the following steps for preventative measures and VR HMD cleaning and disinfection in between use. All cleaning and disinfection should be completed using a Therapeutic Goods Administration (TGA) and manufacturer approved disinfectant.

• Perform hand hygiene.

• Remove disposable face pads (interface) and discard.

• Clean reusable face pads with a detergent solution or wipe.

• Clean hands with alcohol-based hand rub or soap and water.

• Use a new wipe to clean the inner surface of HMD.

• Using a new wipe, clean the outer surface.

• Clean the handheld devices with a new detergent wipe.

• Disinfect the reusable components of the headset.

• Leave the items to dry and store them in a clean sealable and disposable bag.

• Perform hand hygiene after completion.

The full guide can be accessed via the Clinical Excellence Commissions website Cleaning and disinfection of virtual reality equipment cited below:

Clinical Excellence Commission NSW Health. *5.5 Cleaning and Disinfection of Virtual Reality Equipment*. (2021). Available online at: https://www.cec.health.nsw.gov.au/__data/assets/pdf_file/0004/644008/Chapter-5-COVID-19-IPAC-manual.pdf (accessed April 29, 2021).

DDS-MAP

Our Team

DDS-MAP

Dynamic Digital Skills for Agility and Resilience