LA in VR:
Perspectives on LA and VR: from tracking guitar chords to discussing airplane design.

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Virtual Reality *... XR*

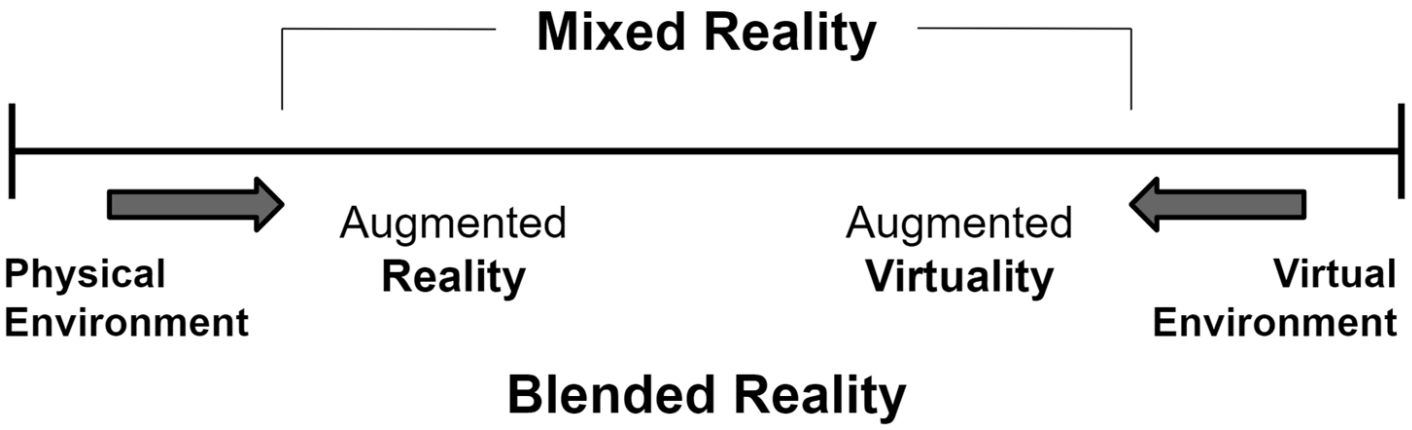
- **Gaze tracking** is fundamental
- **Contextual** (environmental) **awareness** is optional
- The user is “cut off” from reality; vision and hearing are simulated

Augmented Reality

- **Gaze tracking** is optional
- **Contextual** (environmental) **awareness** is fundamental
- The user (and the device) should to some extent be able to hear and see reality

Mixed Reality

A spectrum



Blended reality in relation to the physical-virtual environment continuum (adapted from Milgram & Kishino, 1994, as presented in Bower et al, 2010)
(known as the reality-virtuality continuum)

Virtual Reality (VR) in Education

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Virtual Reality - Types

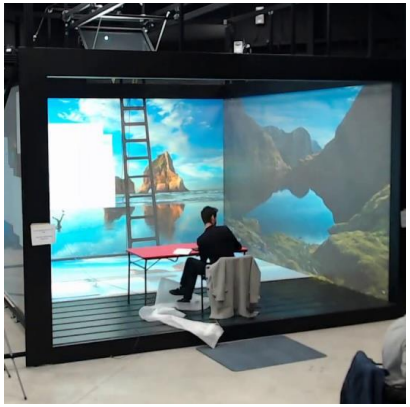
Then and now

1: **(3D) Virtual Environment**

2: **CAVE**

3: **Head-Mounted Display (HMD)**

Second Life
(2003)



CAVE
(1992)

Oculus Rift (DK1)
(2012)

Affordances of Virtual Reality in Education

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Virtual Reality - Affordances (1):

*Enhances **experiential learning***

"**Immersive VR allows a user to learn how they would feel and respond (physiologically, tactfully, and procedurally) when interacting with virtual situations that the brain treats as real**"
(Concannon, Esmail et al., 2019)

"**Allowing players to navigate freely through the [VR] game has positive effects on presence and cognitive interest**"
(Ferguson, van den Broek et al., 2020)

Interaction & Imagination → Learn by doing

- Ferguson, C., van den Broek, E.L., van Oostendorp, H. (2020) On the role of interaction mode and story structure in virtual reality serious games. *Computers & Education, 143*.
- Concannon, B. J., Esmail, S., Roberts, M.R. (2019) Head-Mounted Display Virtual Reality in Post-secondary Education and Skill Training. *Frontiers in Education*, 4.
- Moro, C., Štromberga, Z., Stirling, A. (2017) Virtualisation devices for student learning: Comparison between desktop-based (Oculus Rift) and mobile-based (Gear VR) virtual reality in medical and health science education. *Australasian Journal of Educational Technology 33 (6)*.

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Virtual Reality - Affordances (2):

*Facilitates **immersive learning and engagement***

“**Immersion has been outlined as a strong factor to enhance the concentration when learning in a digital environment**”
(Pirker, Holly et al., 2019)

“**The sensory immersion [VR] facilitates is emerging as a potentially revolutionary mode of content delivery - one which both heavily engages the “viewer”, and democratises students’ access to a range of historical experiences**”
(Froese, 2019)

Immersion → Engagement

- Sandu, N., Gide, E., Karim, S. (2019). Improving Learning through Cloud-based Mobile Technologies and Virtual and Augmented Reality for Australian Higher Education. *International Conference on Mathematics, Science and Technology Teaching and Learning*: 1-5.
- Pirker, J., Holly, M., Lesjak, I. et al. (2019) MaroonVR—An Interactive and Immersive Virtual Reality Physics Laboratory. *Learning in a Digital World*: 213-238.
- Froese, M. (2019) The Utilisation of Virtual Reality to Engage High School History Students. *Reflective Practice in Teaching*.

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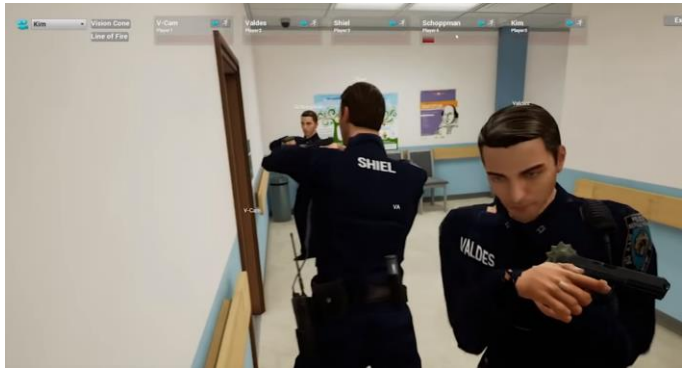
Virtual Reality - Affordances (3):

*Effective method of **training***
deliberate Practice

- **Limited / no danger** compared to real-life scenarios
- High level of **interaction** possible (e.g. controller or even haptic input)
- Immersion creates **convincing simulations**
- **Low cost** compared to real-life enactments / actors
- Allows for **easy repetition**

SurviVR
(2016)



NYPD Counterterrorism VR Training
(V-Armed, 2019)

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Virtual Reality - Affordances (3):

*Effective method of **training***

"**[Virtual Reality] provides a comprehensive and immersive training environment, which would bring new opportunities on safety teaching and learning processes**"
(Le, Pedro et al., 2014)

"**We can use VR for the training of specialists such as preparing teams for security against nuclear facility attacks and real-time radiation monitoring in nuclear installations**"
(Hagita, Kodama et al., 2020)

- Le, Q.T., Pedro, A., Park, C.S. (2015) A Social Virtual Reality Based Construction Safety Education System for Experiential Learning. *Journal of Intelligent & Robotic Systems, 79 (3-4)*: 487-506.
- Hagita, K., Kodama, Y., Takada, M. (2020) Simplified virtual reality training system for radiation shielding and measurement in nuclear engineering. *Progress in Nuclear Energy*, 118.

Virtual Reality - Affordances (4):

*Enhances **collaborative learning***

“Many researchers argue that the virtual reality technology has great potential which may change the collaborative learning experience”
(Zheng, Xie et al., 2018)

Three affordances:

1. **Social interaction**
2. **Resource sharing**
3. **Knowledge construction**

DinoVR
(2016)

- Zheng, L,. Xie, T., Liu, G. (2018) Affordances of Virtual Reality for Collaborative Learning. *2018 International Joint Conference on Information, Media and Engineering*.

Virtual Reality - Affordances (4):

*Enhances **collaborative learning***

Training & Simulation: Collaborative VR Procedural Trainer
(ST Engineering, 2018)

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Affordances in summary

- **Experiental** learning is effective,
  freedom of exploration
- **Immersive** learning and focus and engagement
- Deliberate **practice**
- **Collaboration** in and across platforms

- Capturing expert and novice practice in similar environment also XR
- Observation, Demonstration, Based on Models

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#1 Observing learner behaviour in VR

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Centre for Education and Learning

Universiteit Leiden
The Netherlands

TU Delft
Delft University of Technology

Erasmus University Rotterdam

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TU Delft Campus

Objects explored

NPC Interaction

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Creative World

Objects created

Materials, Structures used

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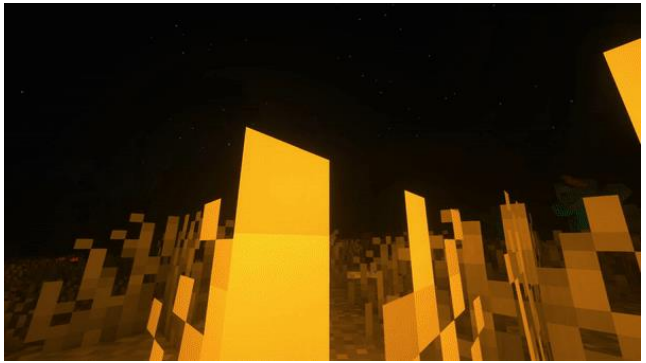
Survival World

Challenges achieved

Cooperation



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Minecraft Escape Room Course Computer Organisation

Problems solved

(a) Lecture hall

(b) Instruction hall

Figure 4: Overview of the first builds

(a) Input example

(b) Answer selection example

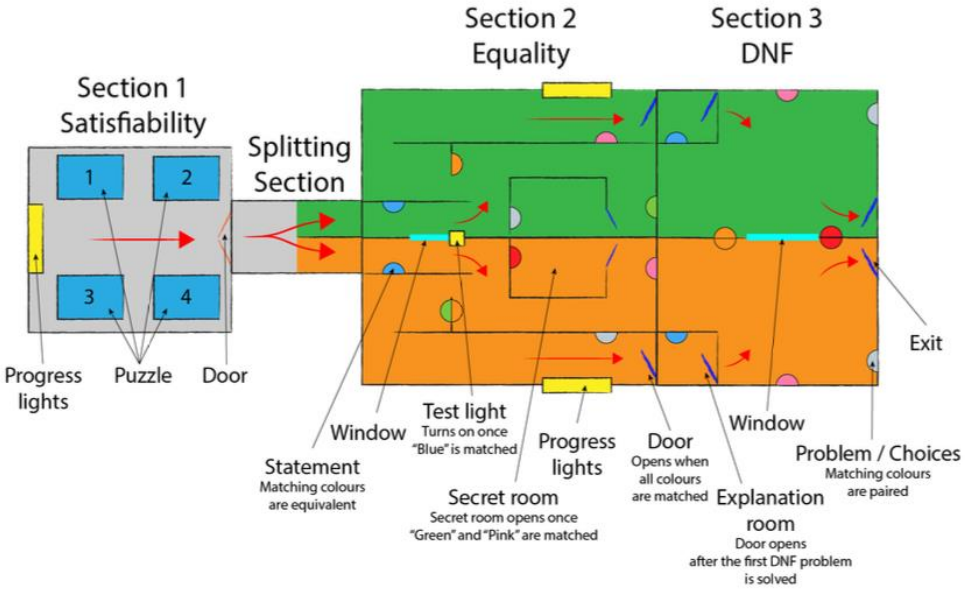
Figure 5: Overview of the example instructions

(a) Overview from entrance

(b) Overview showing exit

Figure 6: Overview of the Playground

- Learning about Logic Gates observing problem solving behaviour



Objects explored

Minecraft Geology Museum

- Information about different parts of a bigger process, tracking of exploration

Figure 5: Different platforms are scattered throughout the area, each providing different pieces of information.

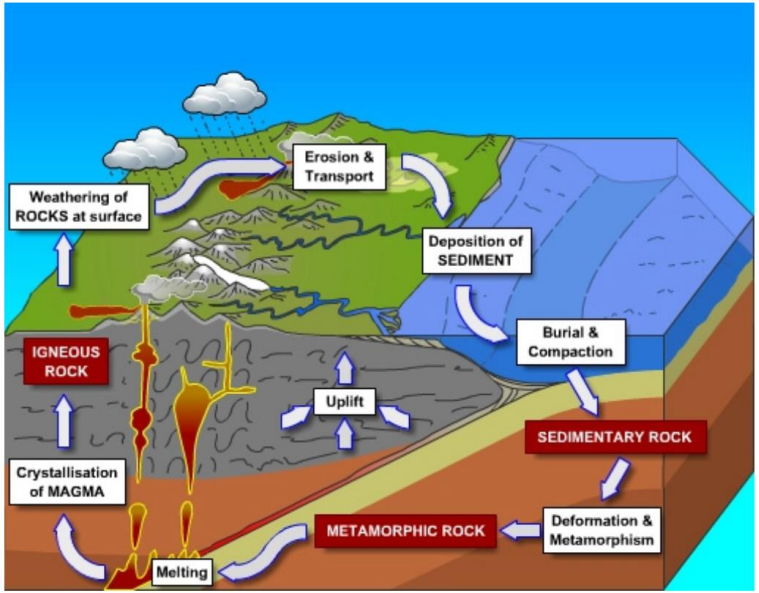


Figure 1: The rock cycle [12].

#2 Capturing expert performance in VR

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Expert Performance

Expert Performance

Expert Performance

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Practice explored

Performance

Practice, Repetition

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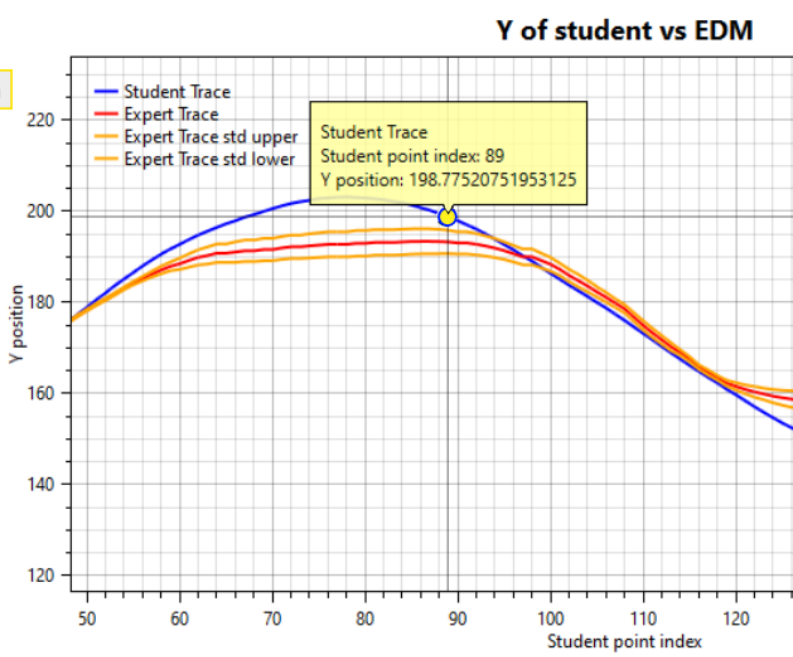

Calligraphy Trainer: Handwriting Feedback

Limbu, B. H., Jarodzka, H., Klemke, R., & Specht, M. (2019). Can you ink while you blink? Assessing mental effort in a sensor-based calligraphy trainer. *Sensors*, *19*(14), 3244.

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GuitarJam (Student Project 2022)

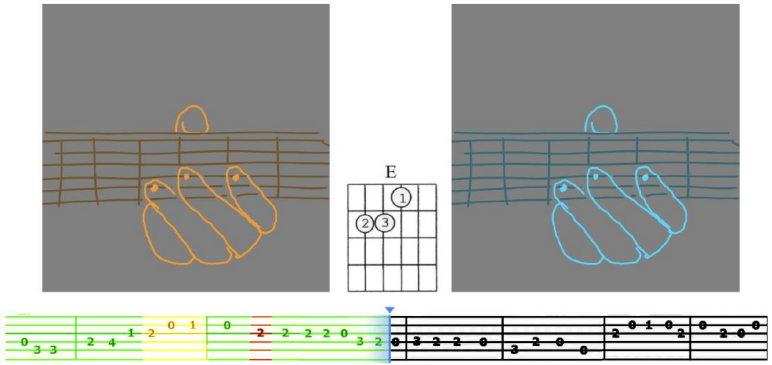
- Objective: Learn how to play the Guitar
- Practice on Specific Chord changes

- Senseglove for creating expert recordings

- For giving instruction and feedback

Expert Performance

Practice



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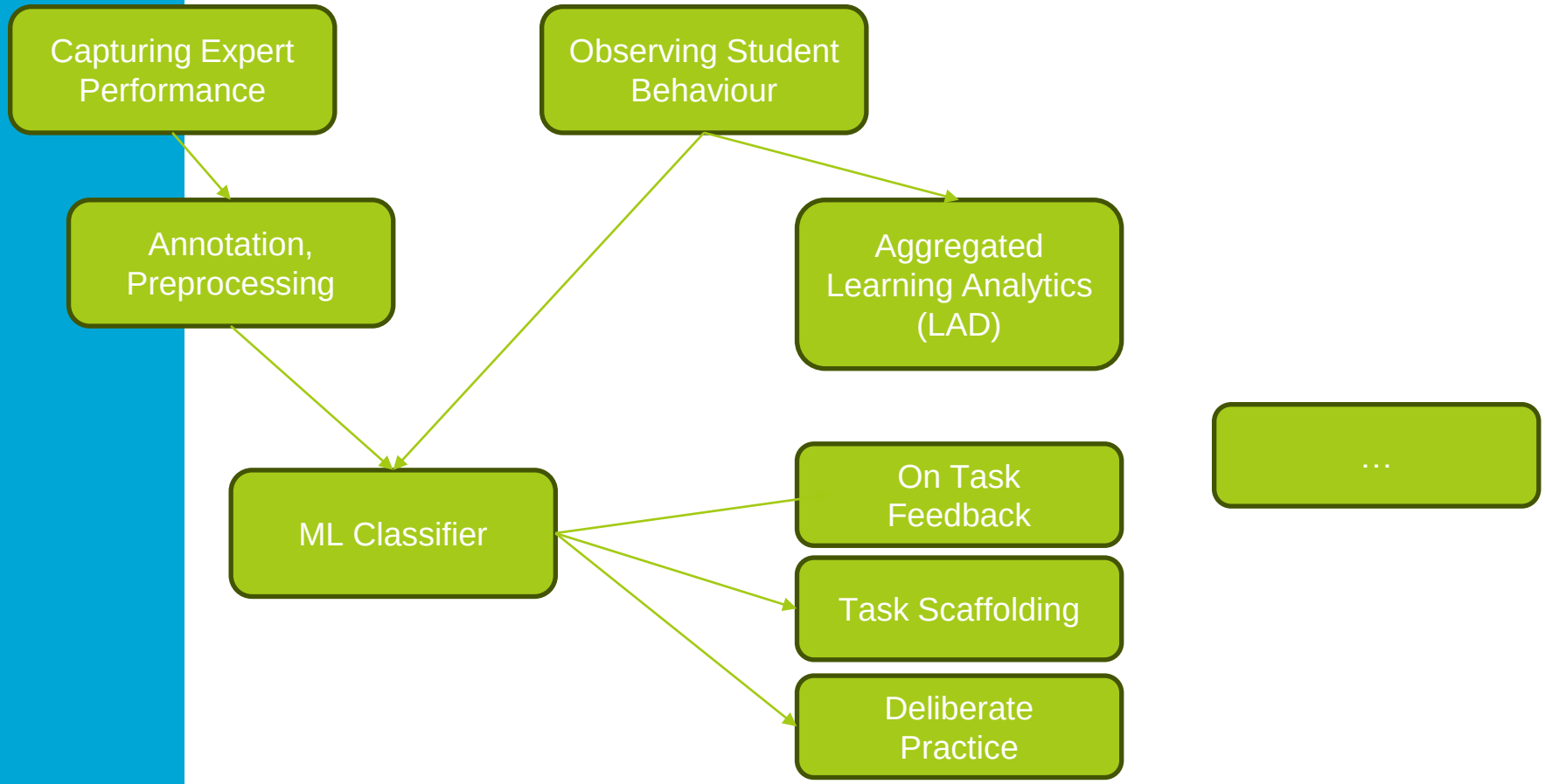
Capturing Expert Performance
Observing Student Behaviour
Annotation, Preprocessing
Aggregated Learning Analytics (LAD)
ML Classifier
On Task Feedback
Task Scaffolding
Deliberate Practice
...

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#3 Structuring Collaboration in VR

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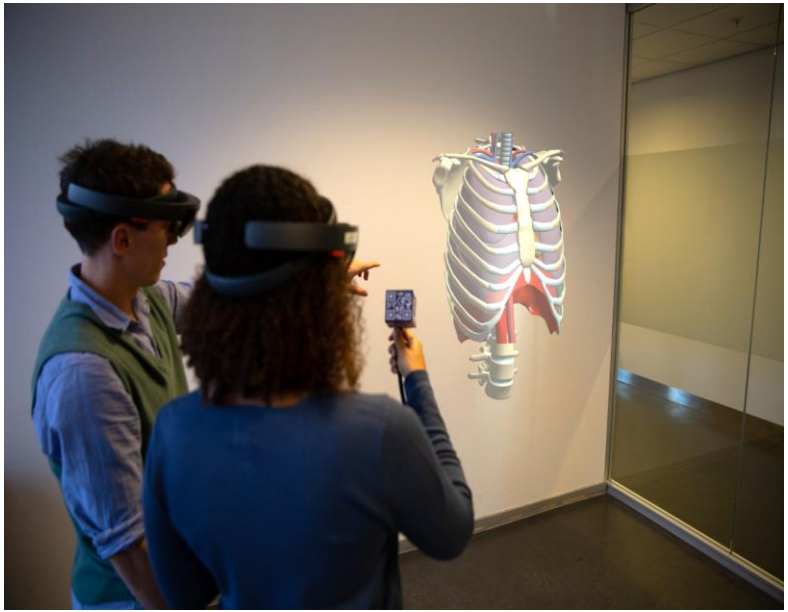
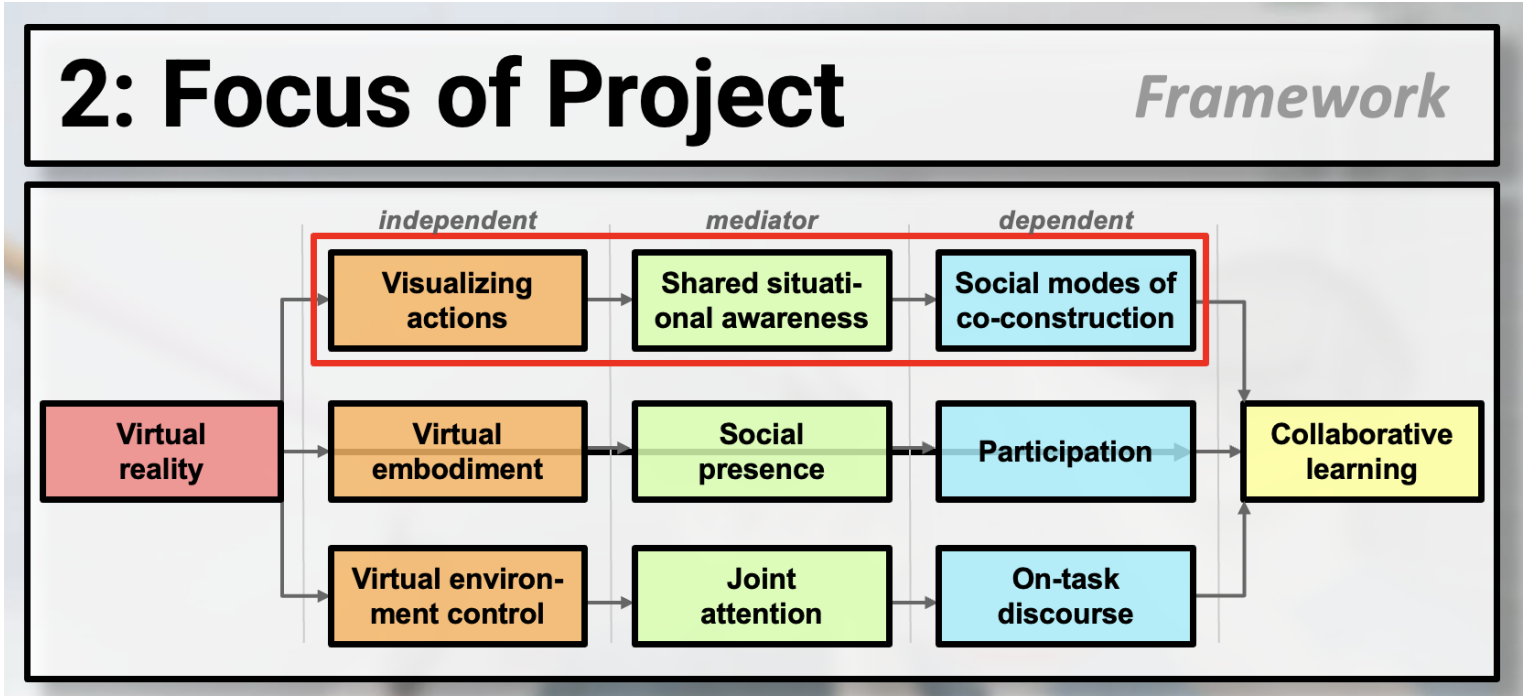
Collaboration in AR

- Interaction with AR Model and physical devices
- Loading of different pathologies for diagnostics training
- Collaborative exploration and diagnostics

- Foot, Lung and other models used in education

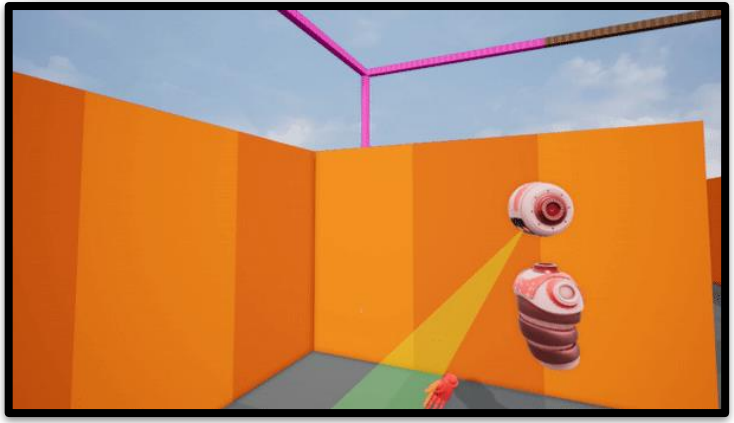


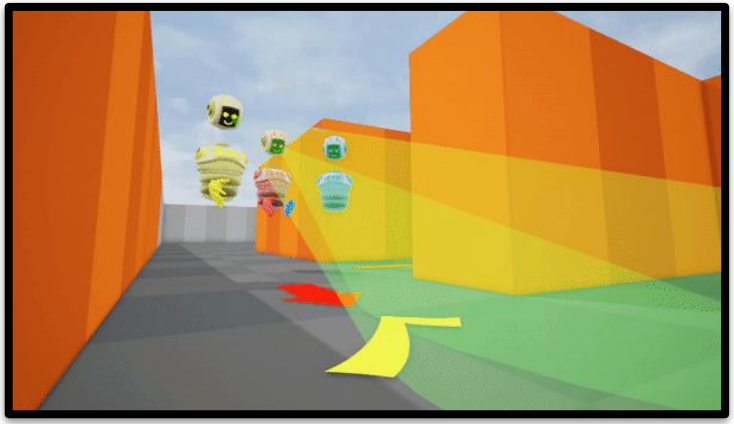
Collaboration in VR



3: Experiment

Visualization of actions





Visualization of actions

1: Vision cones

- Visualization of a user's view
- Others can see what is (and isn't) inside a user's vision
- Does knowing what your group members are (and aren't) looking at create a higher level of shared situational awareness and transactivity?

2: Highlighting / pinging

- Ability to highlight anything considered a point of interest
- Used (at will) to attract the attention of other users
- Does the ability to point out any elements of interest at will, both from far away and up close, create a higher level of shared situational awareness and transactivity?

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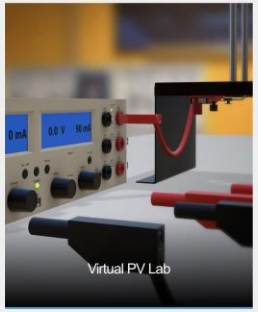
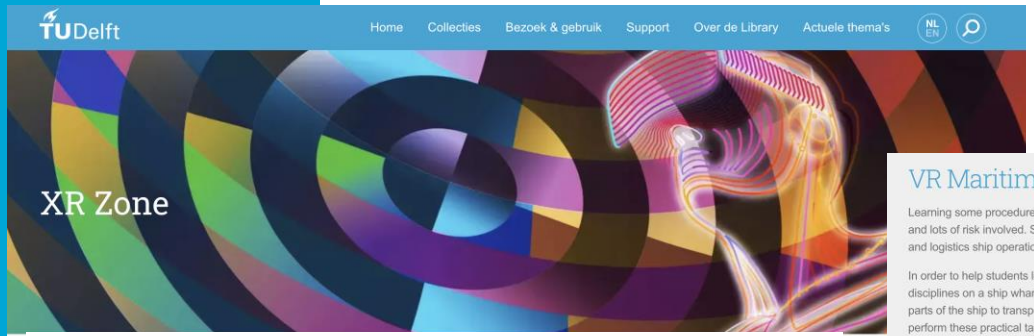
Thanks





About VR4VET

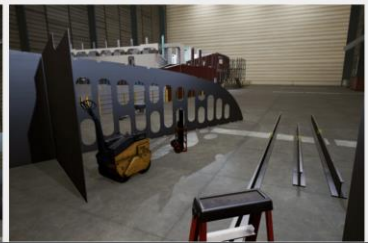
Virtual Reality for Vocational Education and Training – VR4VET – is a project funded by the European Union's Erasmus Plus program, grant agreement 2021-1-NO01-KA220-VET-000028033.

VR Maritime

Learning some procedures required for working on a ship wharf is usually a difficult and costly process due to limited access to an actual location and lots of risk involved. Still, students of the faculty of 3mE (Mechanical, Maritime and Materials Engineering) have to practice some assembly and logistics ship operations.

In order to help students learn easily and safely, the NewMedia Centre created a multiplayer VR application where they can learn multiple disciplines on a ship wharf in a virtual environment. Once in VR, the students perform different tasks from identifying and locating the required parts of the ship to transporting them and assembling the hull of the ship with a crane. During the whole experience they work in a team and perform these practical tasks while learning to navigate through the ship together. All the team members communicate through virtual walkie talkies, created specifically to increase the realism of their communication in VR.

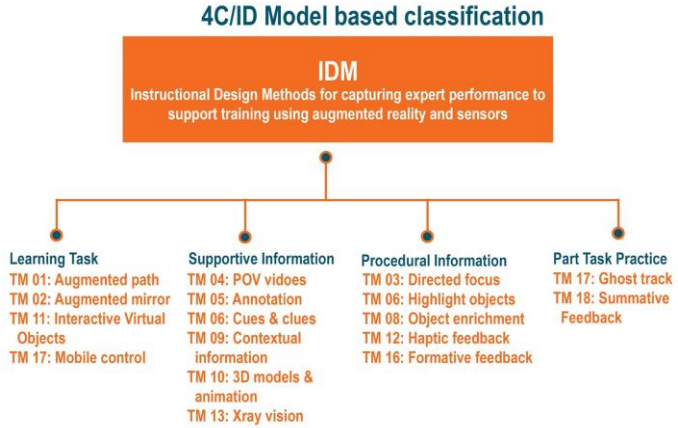
" For this project a ship and a ship wharf have been created in 3D, using Unreal Engine, and optimised for VR. The application features a multiplayer environment."



Conclusion and Discussion

- Pregiven sensors built into the system
  - Eyetracking, movement, pointing, deictic references,
  - Object interaction,
  - NPC scaffolding,
  - Collaboration sensors

- Task manipulation (4CID)
  - Support, Procedural, Part Task Simplication
  - Scaffolding
  - Highlighting, Prompting



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Conclusion and Discussion

- Single user learning objectives and selection of indicators can be nicely linked to performance objectives considering
  - Capturing, expert performance
  - Observation, model practice
  - Exploration, object and task level
  - Practice and Training
  - Problem Solving

- Collaboration
  - Monitoring of practice (real-time feedback)
  - Demonstration of practice
  - Information distribution for collaborative tasks