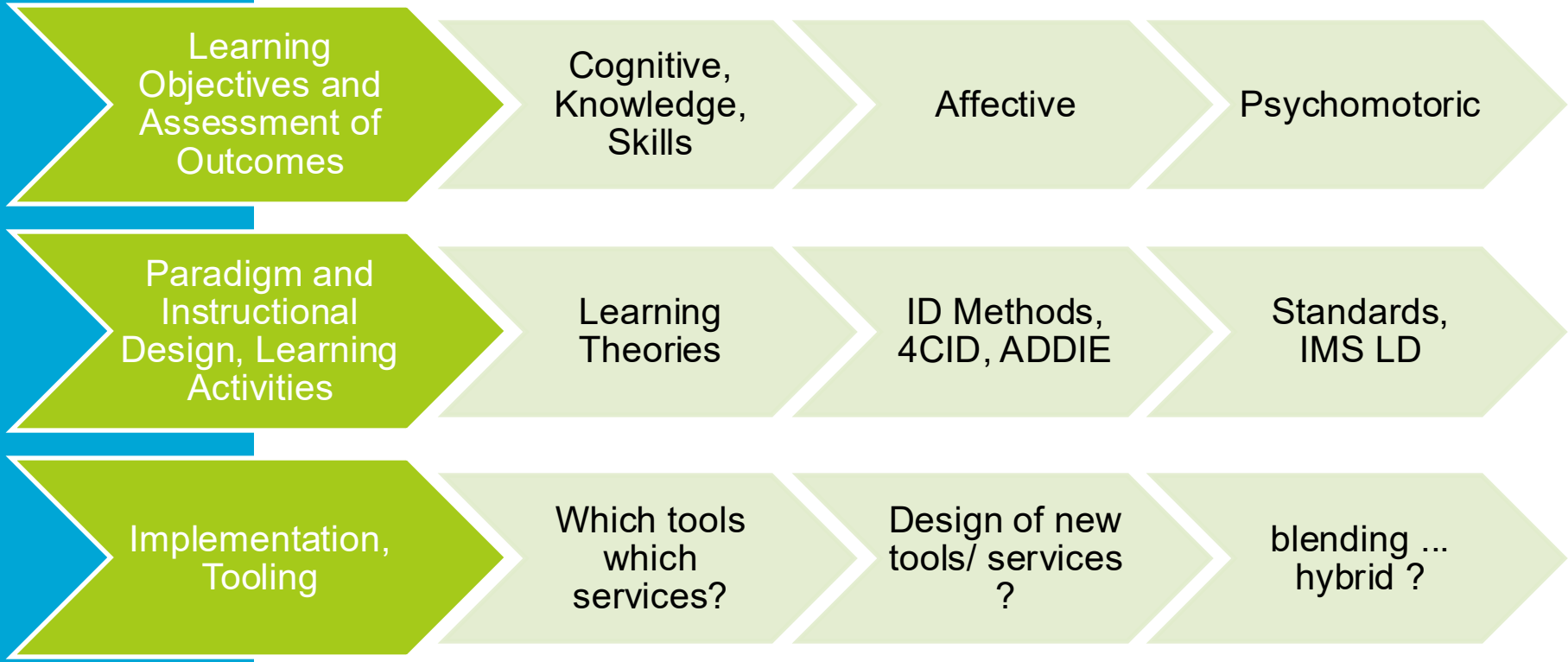
How to measure learning and behaviour change in VR environments ?

Prof. Marcus Specht, Arno Freeke, Roland van Roijen, Michel Beerens, Bibeg Limbu, Nesse van der Meer

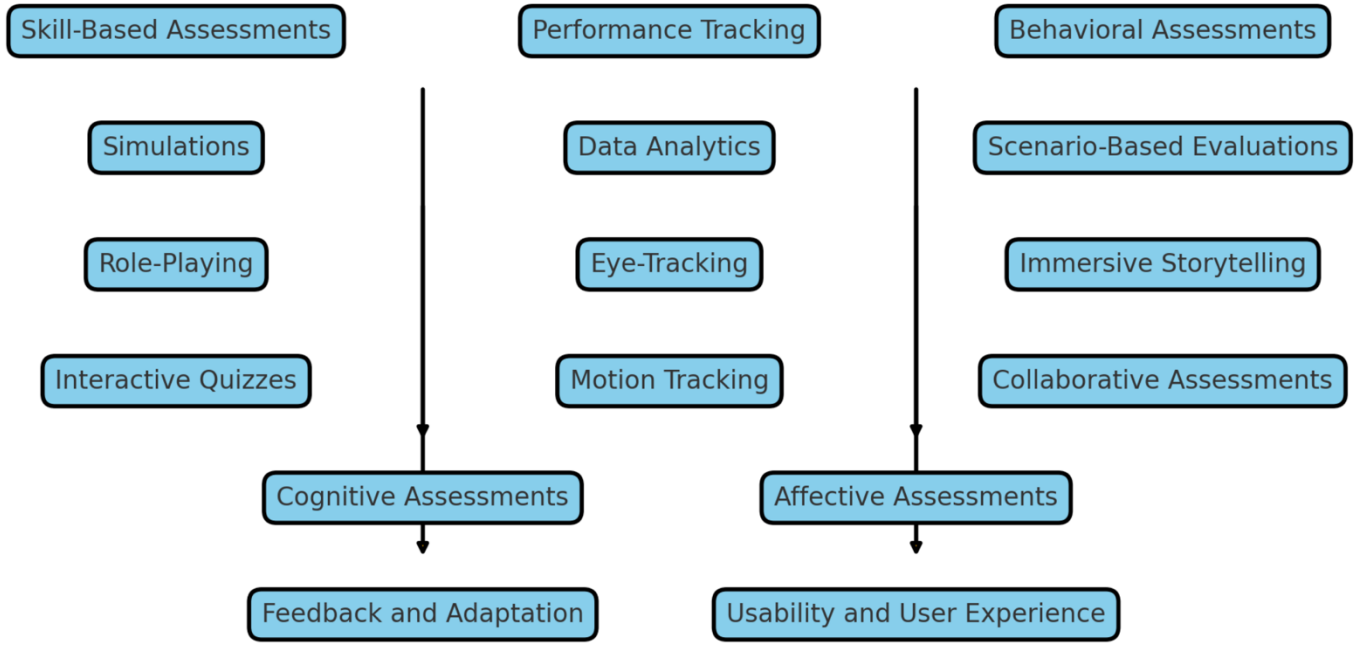
Faculty of EEMCS

TU Delft

TU Delft | NewMedia Centre


Learning Objectives and Assessment of Outcomes
Cognitive, Knowledge, Skills
Affective
Psychomotoric
Paradigm and Instructional Design, Learning Activities
Learning Theories
ID Methods, 4CID, ADDIE
Standards, IMS LD
Implementation, Tooling
Which tools which services?
Design of new tools/ services ?
blending ... hybrid ?

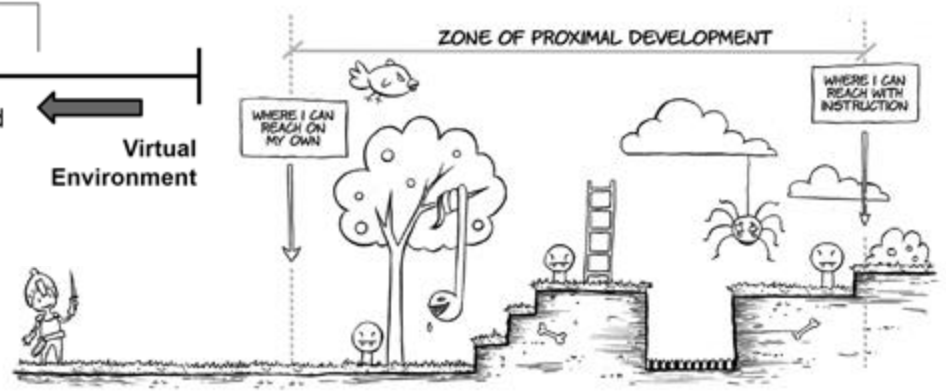
TU Delft


Skill-Based Assessments
Performance Tracking
Behavioral Assessments
Simulations
Data Analytics
Scenario-Based Evaluations
Role-Playing
Eye-Tracking
Immersive Storytelling
Interactive Quizzes
Motion Tracking
Collaborative Assessments
Cognitive Assessments
Affective Assessments
Feedback and Adaptation
Usability and User Experience

TU Delft

… affordances in summary

- Experiental learning is effective, freedom of exploration
  - *can be overwhelming*
- Immersive learning and focus and engagement
  + *positive aspects for autism spectrum*
- Deliberate practice
  + *create safe space, scaffolding of situations*
- Collaboration in and across platforms
  + reduced social anxiety, simulated situations,



'DOTS' Model of Career Development

Making Transitions

Understanding how to seek and secure opportunities.

Decision Making

Being able to weigh up different paths and consider your personal factors in order to make a considered plan.

Self-Awareness

The ability to identify and articulate motivations, skills and personality as they affect career plans.

Opportunity Awareness

Knowledge of opportunities and the ability to research.

TU Delft

DOTS Model Assessment Instruments
|
|-- Career Decision-Making Tools
| |-- Career Decision-Making Difficulties Questionnaire (CDDQ)
| |-- Career Decision Self-Efficacy Scale (CDSE)
|
|-- Opportunity Awareness Tools
| |-- Occupational Information Network (O*NET)
| |-- Labour Market Information (LMI)
|
|-- Transition Learning Tools
| |-- Career Transition Inventory (CTI)
| |-- Work Values Inventory (WVI)
|
|-- Self Awareness Tools
| |-- Strong Interest Inventory (SII)
| |-- Myers-Briggs Type Indicator (MBTI)
| |-- Holland Code (RIASEC)
|
|-- Comprehensive Career Assessment Tools
| |-- Career Assessment Inventory (CAI)
| |-- Self-Directed Search (SDS)
|
|-- Feedback and Reflection Tools
| |-- 360-Degree Feedback
| |-- Personal Development Plans (PDPs)
|
|-- Technological Tools
| |-- Career Guidance Software (e.g., Kuder Navigator, Career Cruising)
| |-- Online Portfolios
|
|-- Qualitative Assessment Methods
   |-- Career Interviews
   |-- Narrative Approaches

#1 Observing learner behaviour in VR

TU Delft

Centre for Education and Learning

Universiteit Leiden
The Netherlands

TU Delft
Delft University of Technology

Erasmus University Rotterdam

TU Delft

TU Delft Campus

Objects explored

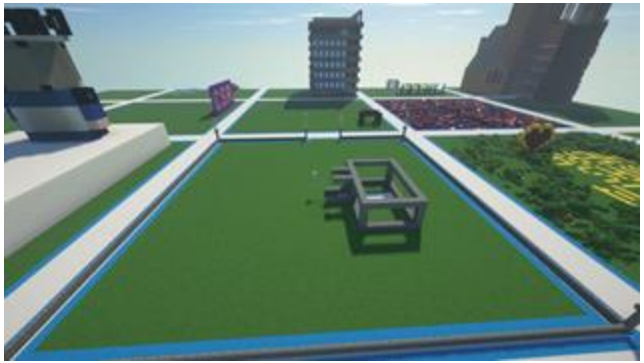
NPC Interaction

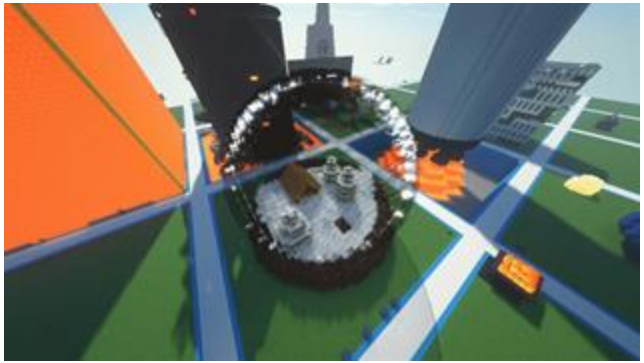
TU Delft

Creative World

Objects created

Materials, Structures used



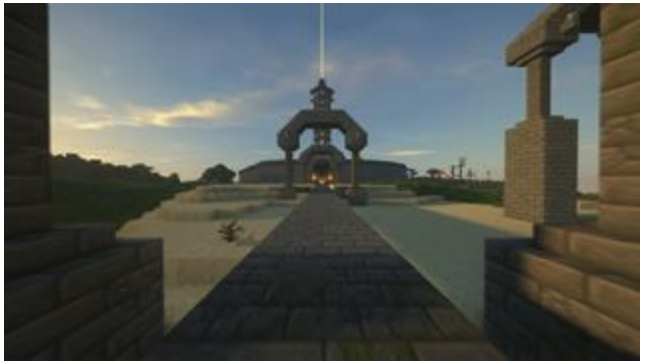


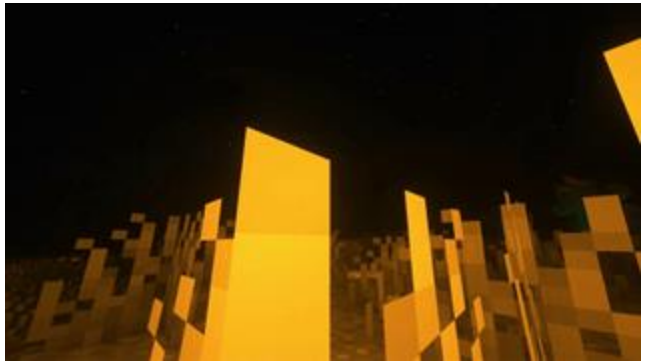
TU Delft

Survival World

Challenges achieved

Cooperation



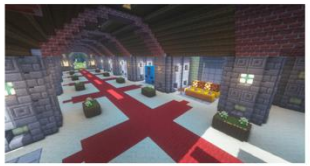


TU Delft

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

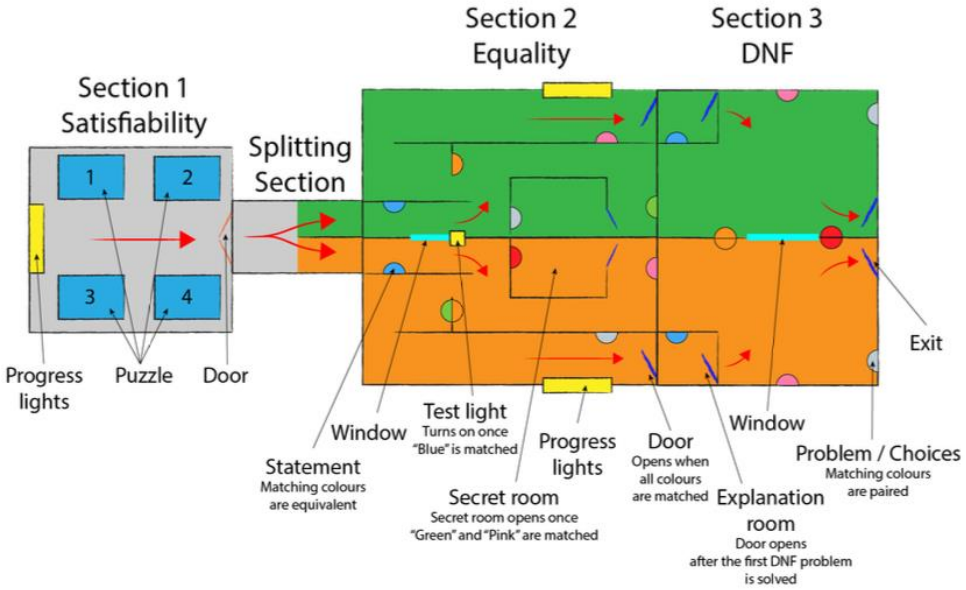
Figure 5: Overview of the example instructions

(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.

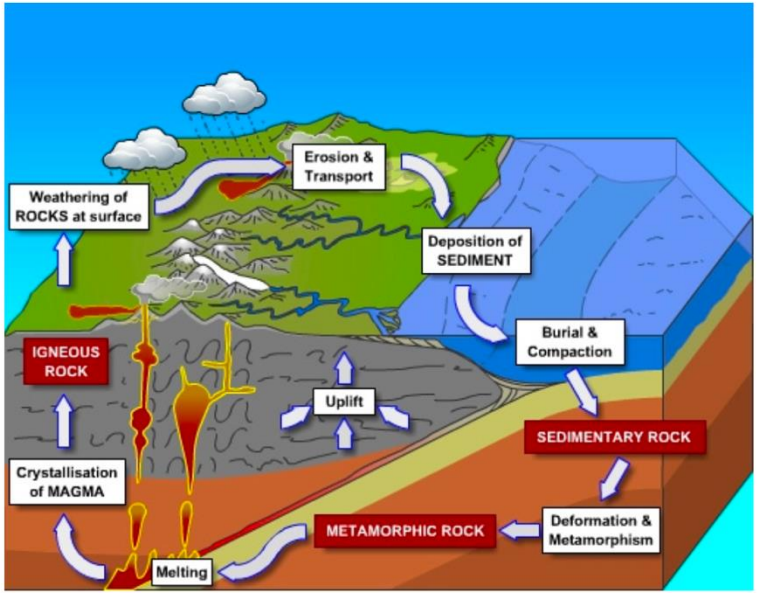
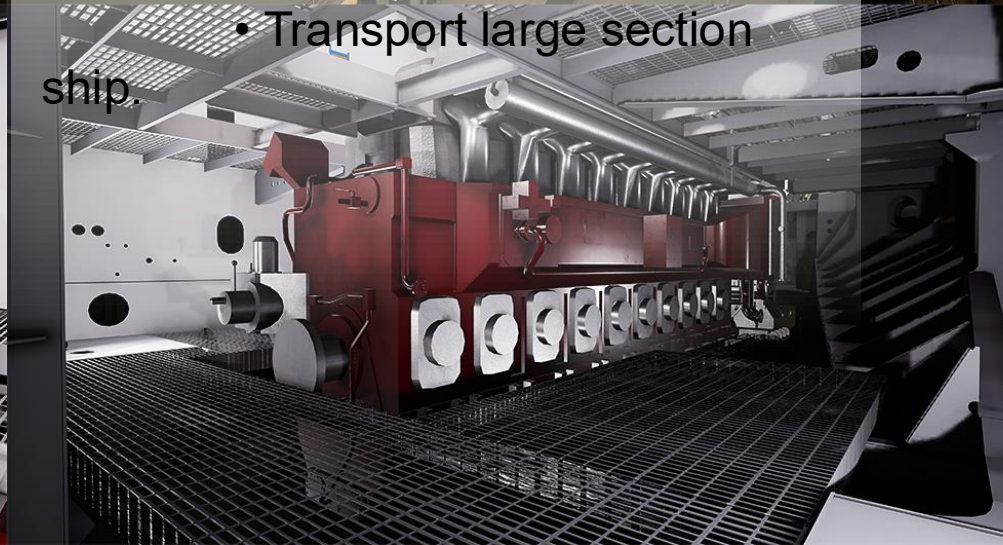


Figure 1: The rock cycle [12].

Maritime Engineering Shipyard

- First year students
- Multiplayer 2-4 people
- 3 Tasks
    - Find objects
    - Use the crane
    - Transport large section ship.

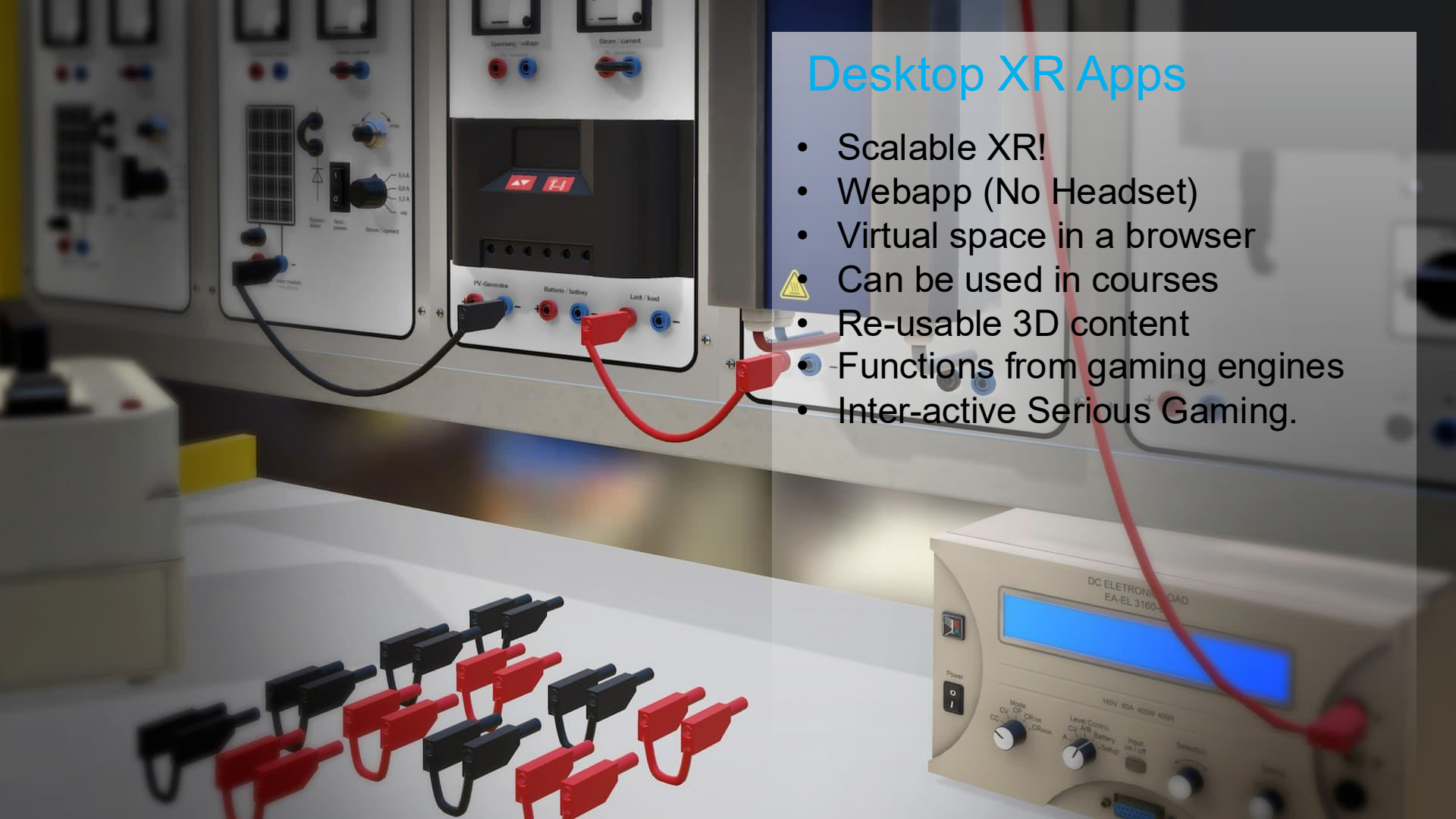


#2 Measuring at Scale

TU Delft

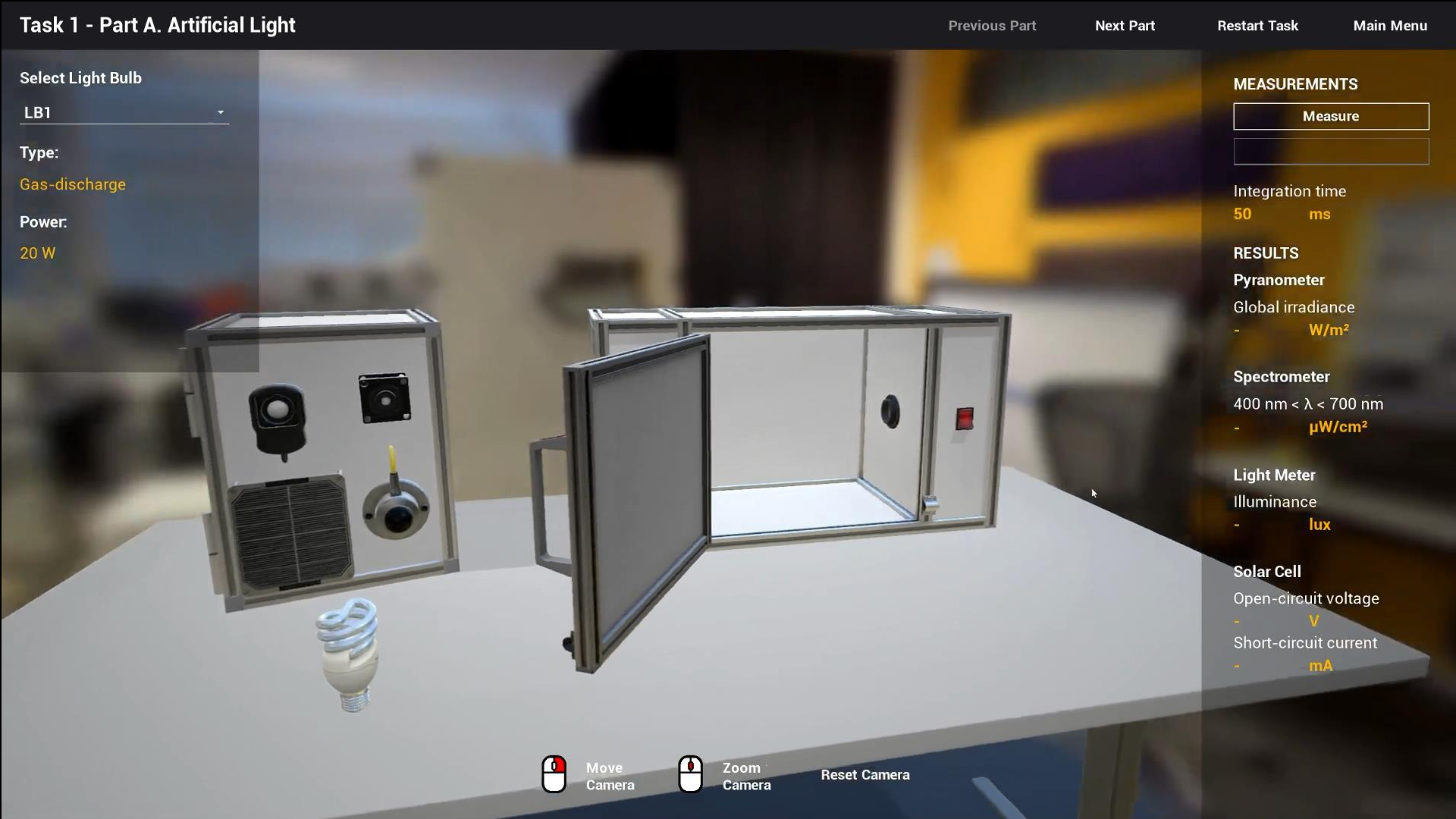
City at Eye Level

- Test architect Design in VR
- Eye Tracking
- Evaluate pedestrians walking and viewing behavior
- Find points of Interest in design.



Desktop XR Apps

- Scalable XR!
- Webapp (No Headset)
- Virtual space in a browser
- Can be used in courses
- Re-usable 3D content
- Functions from gaming engines
- Inter-active Serious Gaming.


Task 1 - Part A. Artificial Light
Previous Part
Next Part
Restart Task
Main Menu
Select Light Bulb
LB1
Type:
Gas-discharge
Power:
20 W
MEASUREMENTS
Measure
Integration time
50 ms
RESULTS
Pyranometer
Global irradiance
- W/m²
Spectrometer
400 nm < λ < 700 nm
- µW/cm²
Light Meter
Illuminance
- lux
Solar Cell
Open-circuit voltage
- V
Short-circuit current
- mA
Move Camera
Zoom Camera
Reset Camera

360 Applications

- Scalable XR!
- New Service & NMC
- 360 Photo or Video
- Add 3D Models & animation
- Add info, images and video
- Add quiz
- Both Headset & Desktop
- Play in all mayor browsers.

#2 Capturing expert performance in VR

TU Delft

Expert Performance

Expert Performance

Expert Performance

WEKIT

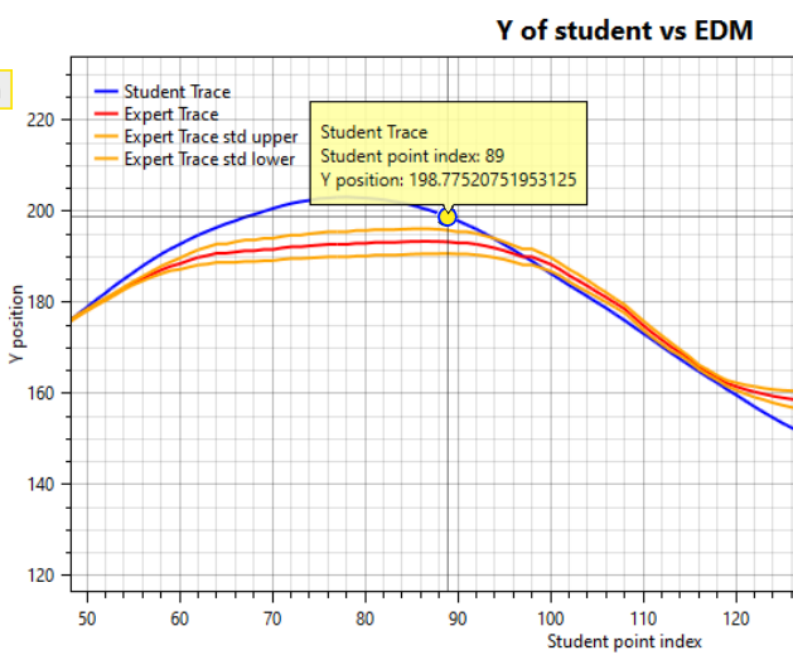
TU Delft

Practice explored

Performance

Practice, Repetition

TU Delft



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.

TUDelft

GuitarJam (Student Project 2022)

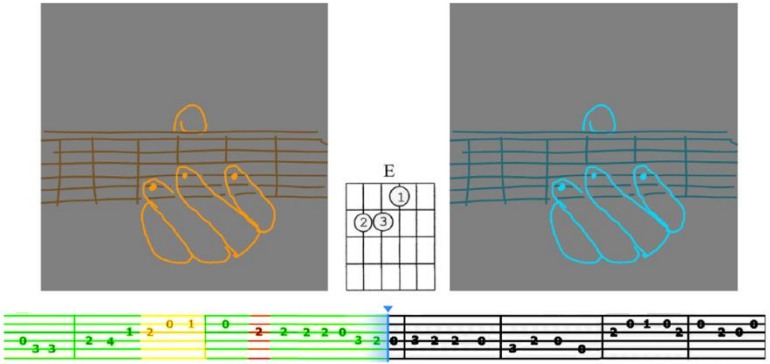
- Objective: Learn how to play the Guitar
- Practice on Specific Chord changes

- Senseglove for creating expert recordings

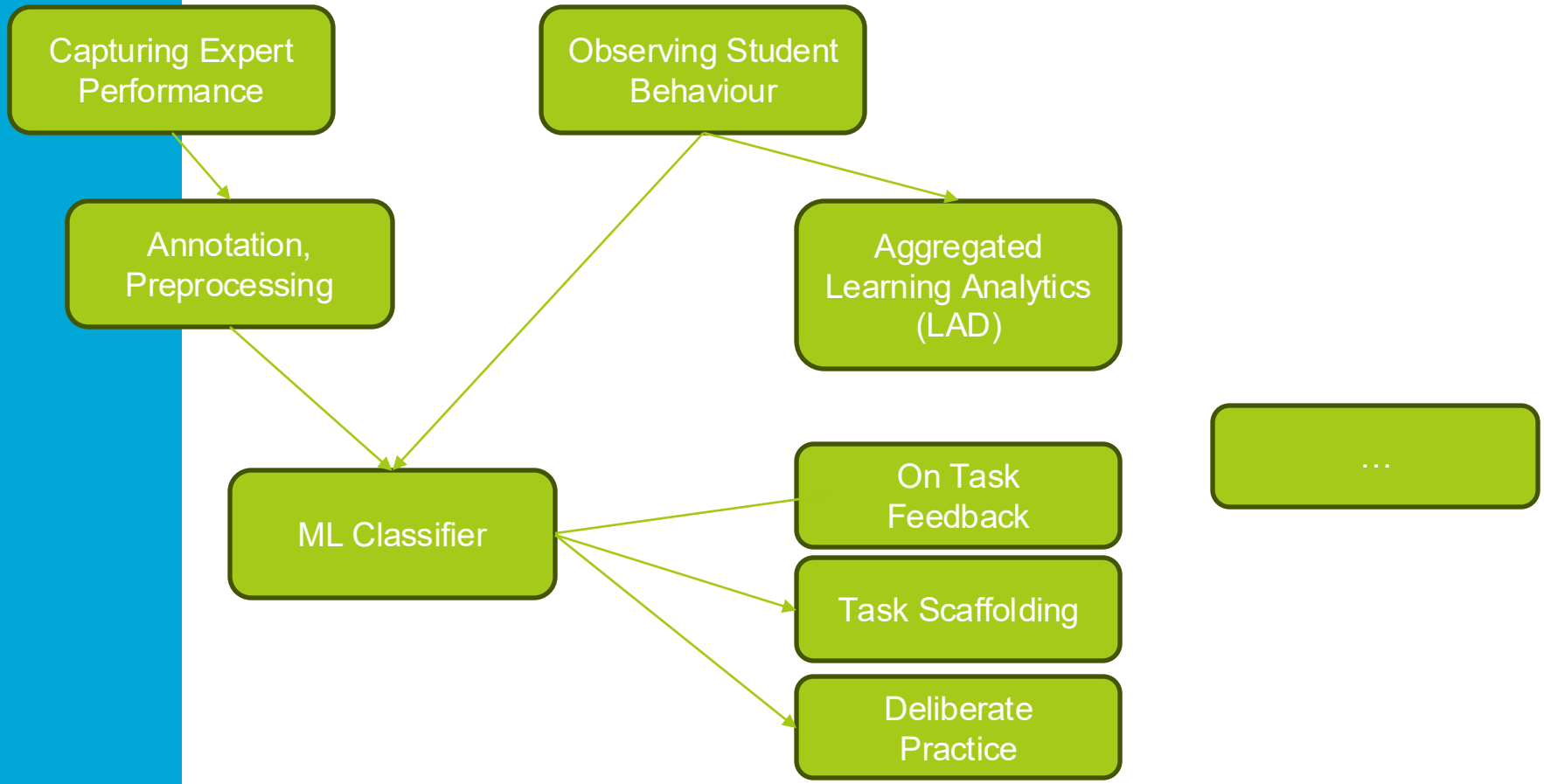
- For giving instruction and feedback

Expert Performance

Practice



TU Delft


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

TU Delft

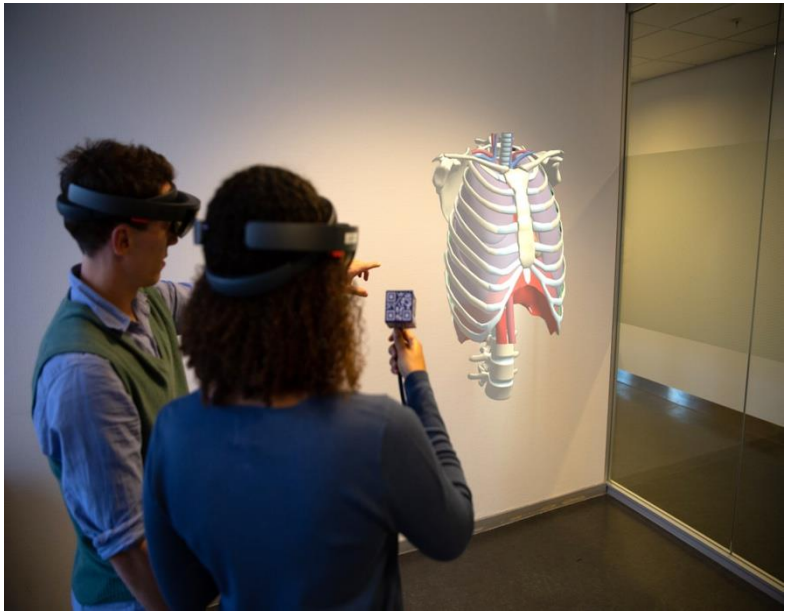
#3 Structuring Collaboration in VR

TU Delft

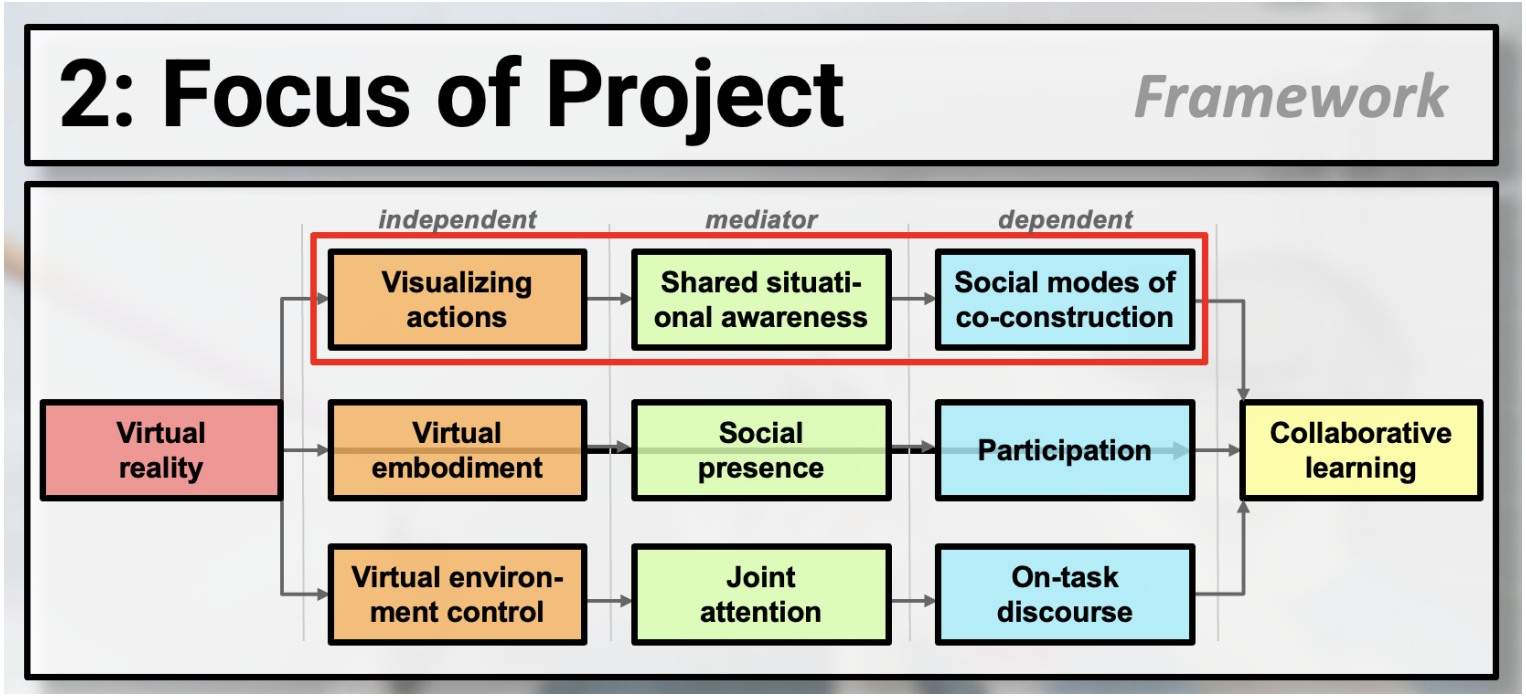
Collaboration in AR

- 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

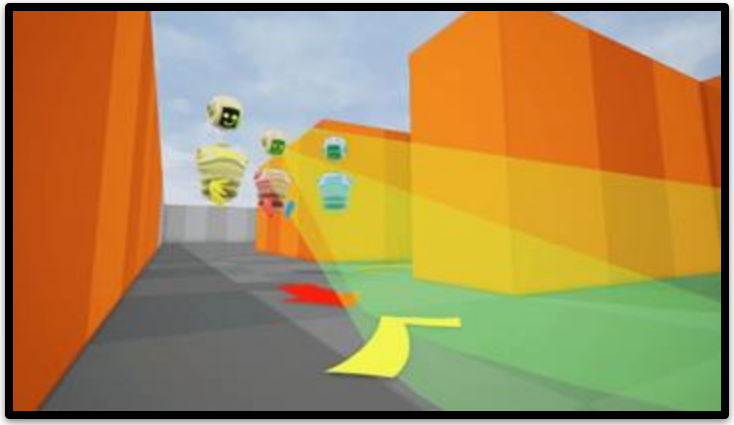


Collaboration in VR



3: Experiment

Visualization of actions



Visualization of actions

1: Vision cones

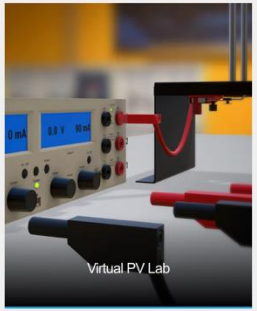
- Visualization of a user's view
- Others can see what is (and isn't) inside a user's vision
- Does knowing what your group members are (and aren't) looking at create a higher level of shared situational awareness and transactivity?

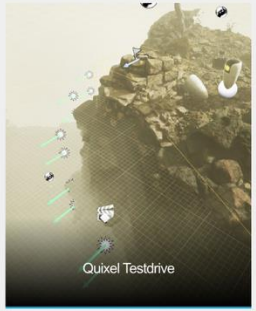
2: Highlighting / pinging

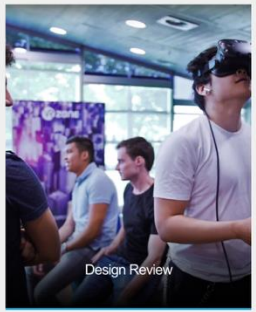
- Ability to highlight anything considered a point of interest
- Used (at will) to attract the attention of other users
- Does the ability to point out any elements of interest at will, both from far away and up close, create a higher level of shared situational awareness and transactivity?

TU Delft

Thanks







TUDelft Home Collecties Bezoek & gebruik Support Over de Library Actuele thema's NL EN

About VR4VET

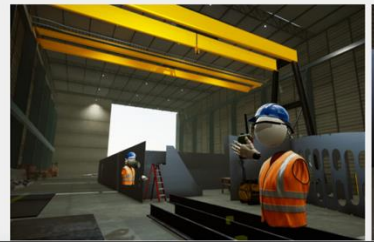
Virtual Reality for Vocational Education and Training – VR4VET – is a project funded by the European Union's Erasmus Plus program, grant agreement 2021-1-NO01-KA220-VET-000028033.

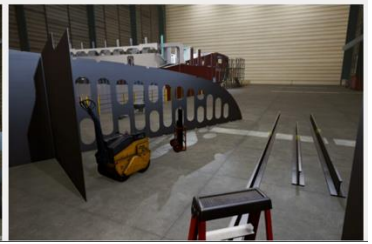
VR Maritime

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."

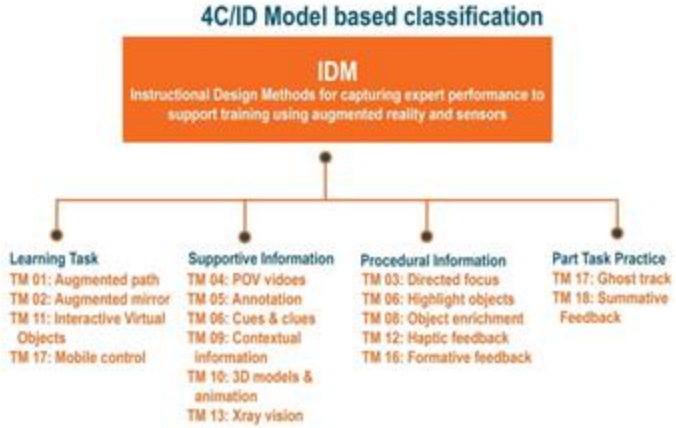




Conclusion and Discussion

- 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



TU Delft

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