Heds FR
Haute école de santé Fribourg
Hochschule für Gesundheit Freiburg

Haute école d'ingénierie et d'architecture Fribourg
Hochschule für Technik und Architektur Freiburg

HumanTech
Technology for
Human Wellbeing Institute

Réalité virtuelle et augmentée: comment enrichir son cours avec l'apprentissage immersif?

Jean-Michel Vasse, HEdS-FR
Elena Mugellini, HEIA-FR
Quentin Meteier, HEIA-FR

16.05.2023

UNI FR
UNIVERSITÉ DE FRIBOURG
UNIVERSITÄT FREIBURG

Hes·so
Haute Ecole Spécialisée de Suisse occidentale
Fachhochschule Westschweiz
University of Applied Sciences and Arts Western Switzerland

PRESENTATION OF SPEAKERS

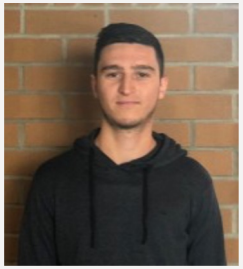
Jean-Michel Vasse

Lecturer UAS at HedS-FR

Elena Mugellini

Professor in Computer Science at HEIA-FR

Head of HumanTech Institute



Quentin Meteier

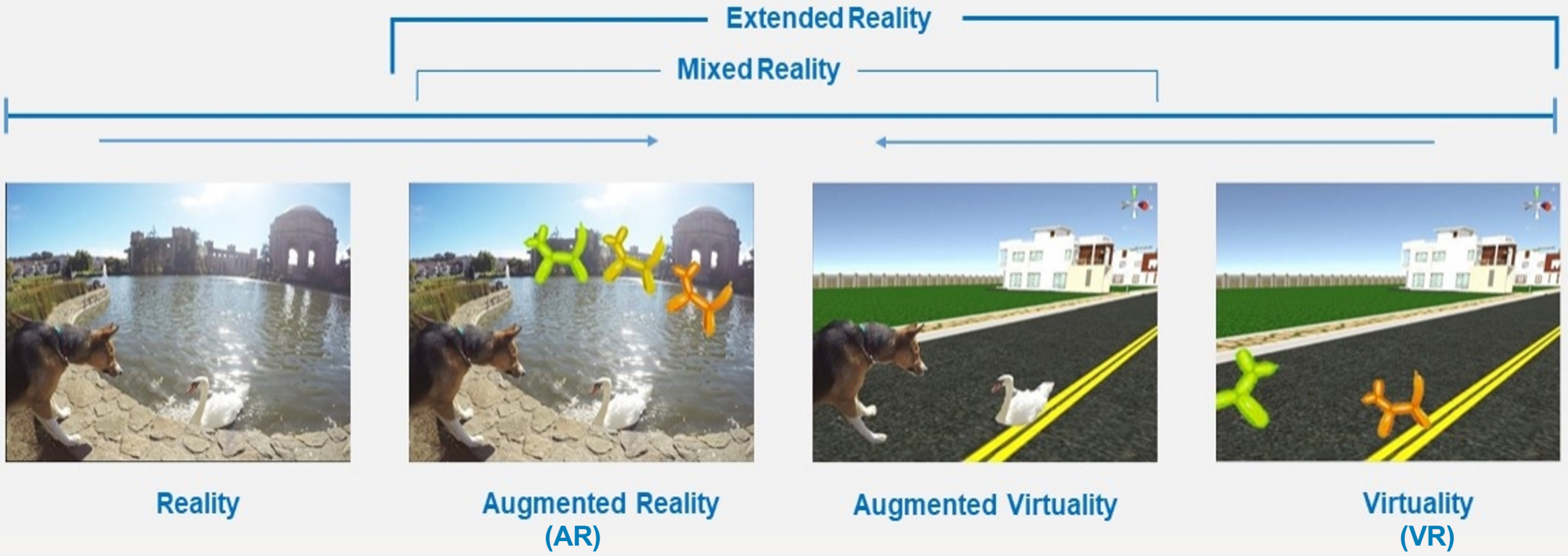
Post-doc in Computer Science at HumanTech Institute

IMMERSIVE TECHNOLOGIES

Definition: Immersive technologies are **digital technologies** that create a **sense of presence** and **immersion** in a virtual environment, typically through the use of virtual reality (VR), augmented reality (AR), and mixed reality (MR) technologies.

These technologies aim to simulate a realistic environment or **experience that engages** the user's senses and perception, creating a feeling of being fully immersed in a digital world.

REALITY-VIRTUALITY CONTINUUM



P. Milgram, H. Takemura, A. Utsumi, and F. Kishino, "Augmented reality: a class of displays on the reality-virtuality continuum," in Telemanipulator and Telepresence Technologies, H. Das, Ed., vol. 2351, International Society for Optics and Photonics. SPIE, 1995, pp. 282– 292.

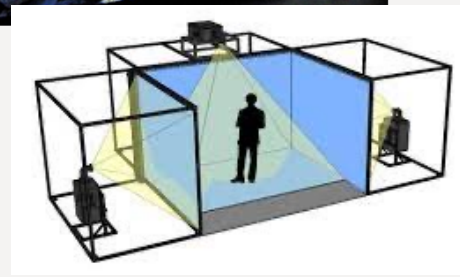
IMMERSIVE TECHNOLOGIES

Wearable Head Mounted Display (VR / AR)

Meta Quest 2

Microsoft Hololens 2

Very Large Screen, CAVE - (VR)



Hand-held device - (AR)

WHY IMMERSIVE TECHNOLOGY IN ACADEMIC EDUCATION?

Support different learning

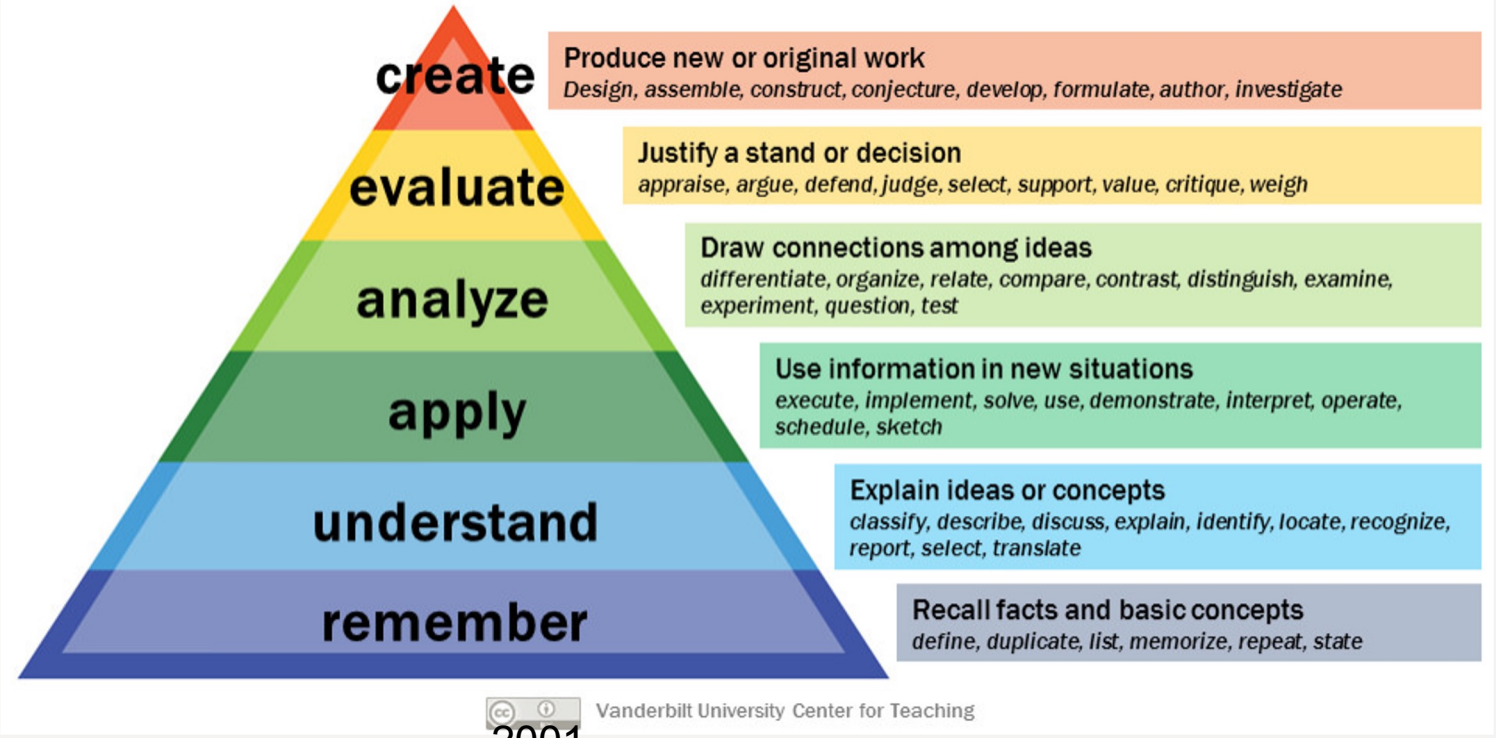
- Vocational learning
- Experiential learning or learning by doing
- Situated learning - faster transfer rate from theory to practice

→ **knowledge must be taught in context and not in the abstract!**

Benefits

- Increased student engagement
- Deeper subject understanding and longer retention
- Increased student success
- Increased rate of transfer
- Development of lifelong skills

"REVISED" BLOOM'S TAXONOMY



2001

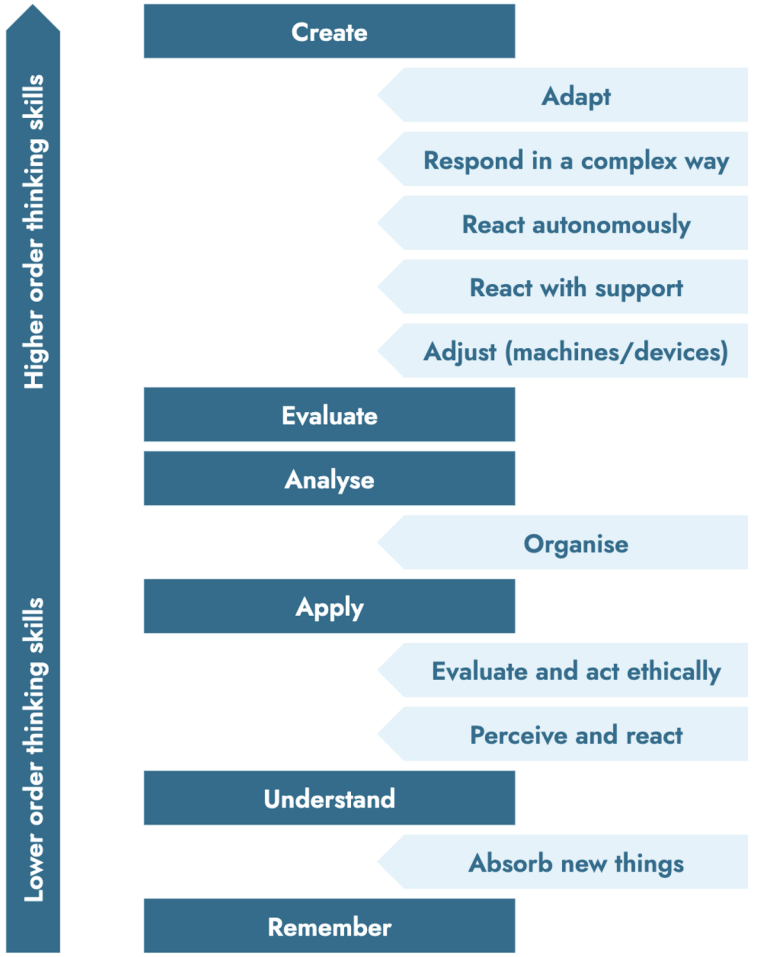
https://cft.vanderbilt.edu/guides-sub-pages/blooms-taxonomy/

Extension of Revised Bloom's Taxonomy

Extension of Revised Bloom's taxonomy for immersive technology learning

Affective Learning Objectives

- designed to change an individual's attitude, choices, and relationships



Goertz, Lutz; Hagenhofer, Thomas; Fehling, Christian Dominic: Planning the Use of Augmented and Virtual Reality for Vocational Education and Training: A Practical Guide. Bonn, 2021

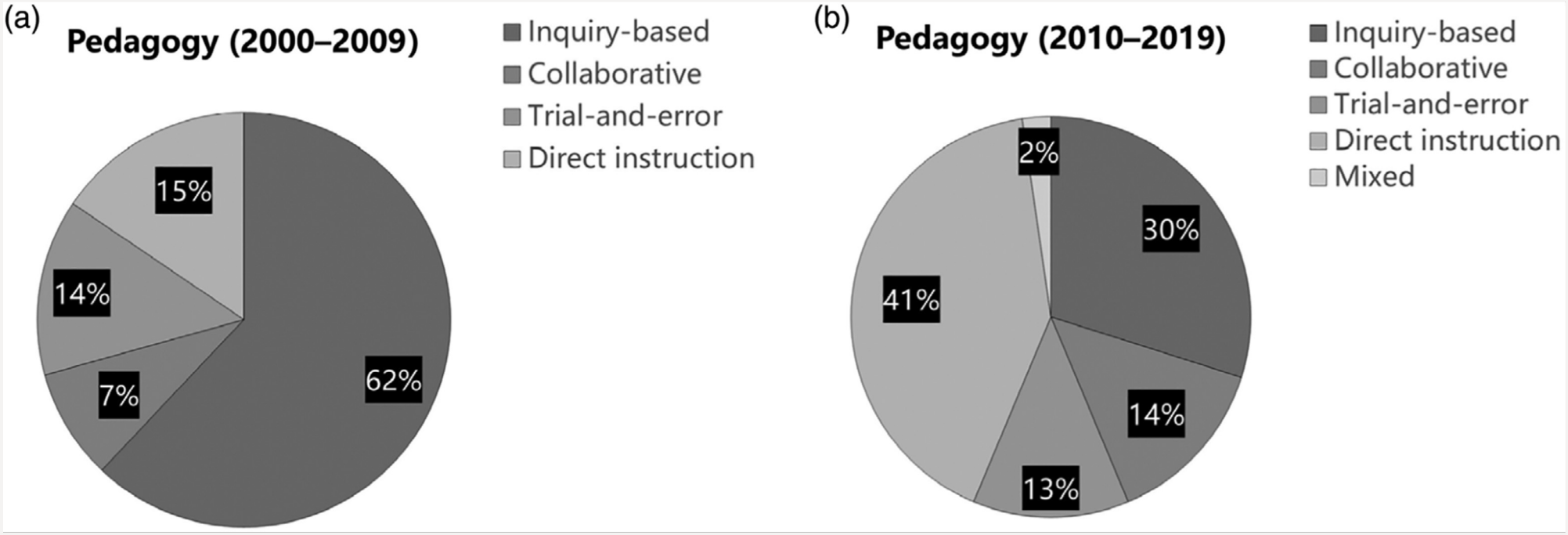
VIRTUAL REALITY IN HIGHER EDUCATION IN THE LAST 20 YEARS - I

TABLE 2 Number of publications by disciplinary field and school setting

Discipline	Elementary	Middle school	High school	K-12 mixed[a]	Higher Ed	Total
Basic science	5	4	10	2	16	37
Social science	10	5	1	0	21	37
Mathematics	3	2	0	0	1	6
Language	2	1	1	1	8	13
Health and medicine	6	4	3	1	32	46
Engineering	0	1	0	0	14	15
Other[b]	1	0	1	0	1	3
Total	27	17	16	4	93	157

H.Luo, G. Li, Q. Feng, Y. Yang, M. Zuo. "Virtual reality in K-12 and higher education: A systematic review of the literature from 2000 to 2019", Journal of Computer Assisted Learning, Wildey, 2021. DOI: 10.1111/jcal.12538

VIRTUAL REALITY IN HIGHER EDUCATION IN THE LAST 20 YEARS - II



H.Luo, G. Li, Q. Feng, Y. Yang, M. Zuo. "Virtual reality in K-12 and higher education: A systematic review of the literature from 2000 to 2019", Journal of Computer Assisted Learning, Wildey, 2021. DOI: 10.1111/jcal.12538

IMMERSIVE TECHNOLOGY PARADOXES

Is this true?

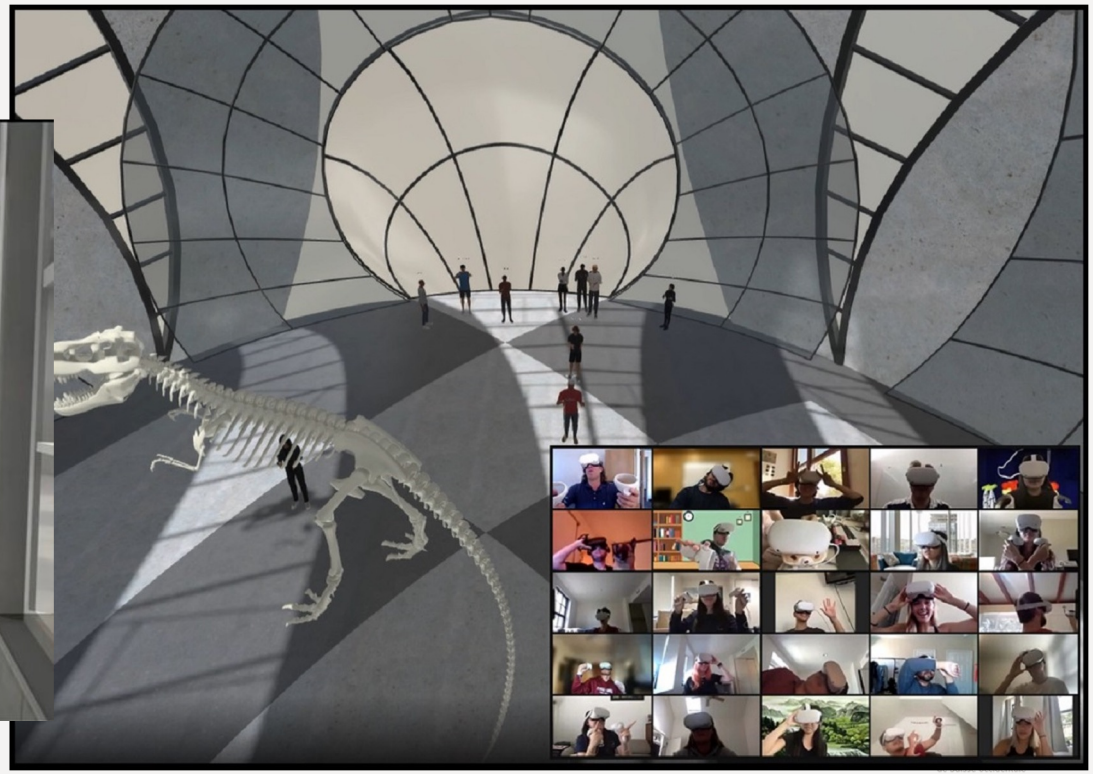
immersion = f (fidelity)

→ engagement = f (immersion)

→ learning = f (engagement)

VIRTUAL PEOPLE CLASS @ STANFORD UNIVERSITY

Since 2021 - 200 students doing classes into a virtual classroom



https://www.youtube.com/watch?v=gOLI_OIV3nc

TEACHING-LEARNING SCENARIOS

Some examples

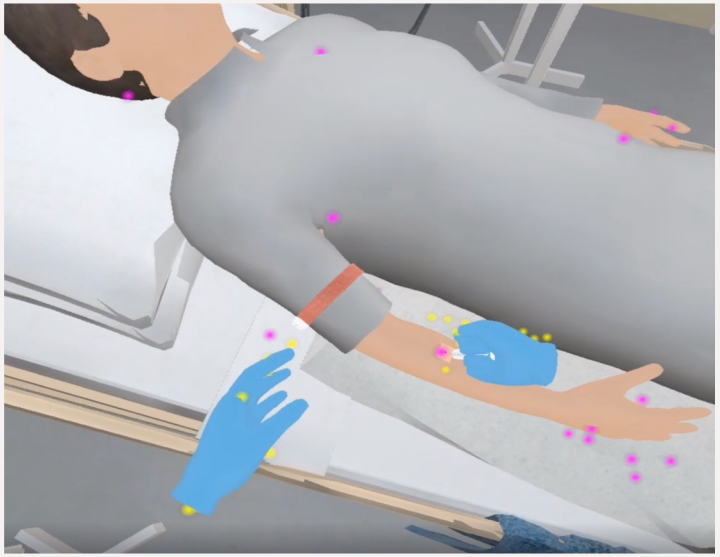
- Motor skills learning
- Dealing with unfamiliar situations
- Safety and accident prevention
- Interaction with machines
- Acquisition of professional competencies
- Understand complex concepts/physical phenomena
- Assistance systems
- Learning self-reflection
- …

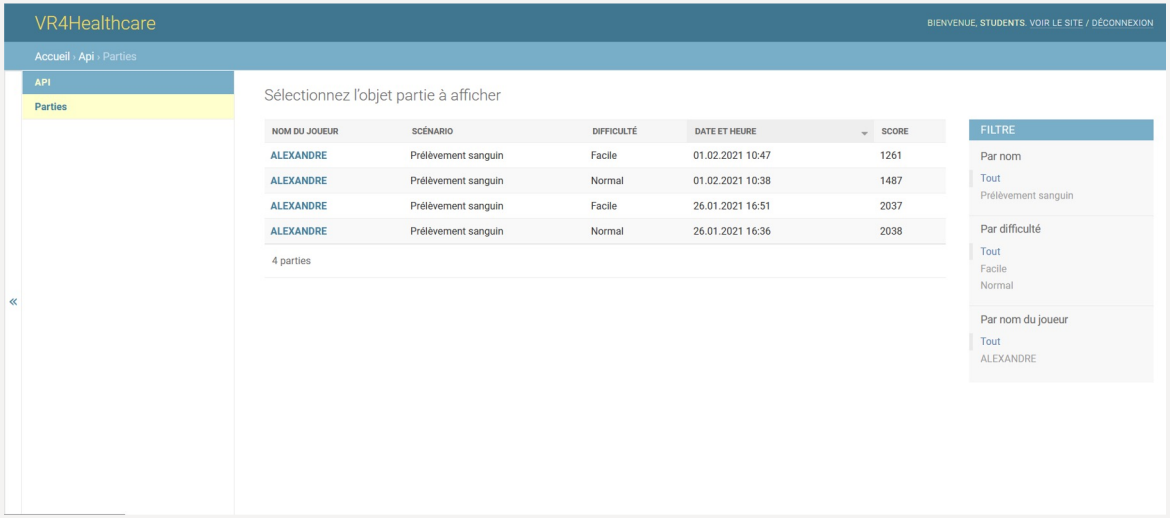
SOME EXAMPLES: VR FOR ACQUISITION OF PROFESSIONAL COMPETENCIES

Target: nursing student

Objective: Asepsis - Learning a basic nursing skill

- Gamified scenario: ranking with points according to successful and unsuccessful steps (with student's name)





Youtube video

SOME EXAMPLES: VR FOR UNDERSTAND COMPLEX CONCEPTS & DEALING WITH UNFAMILIAR SITUATIONS

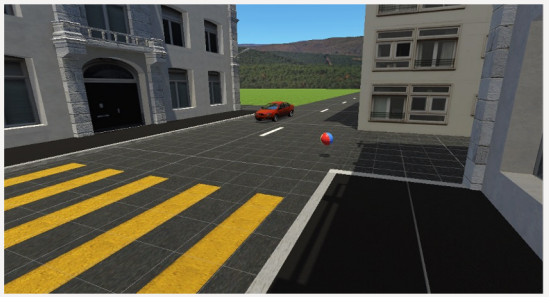
Target: Young people (12-18 years old) with intellectual disabilities (ID)

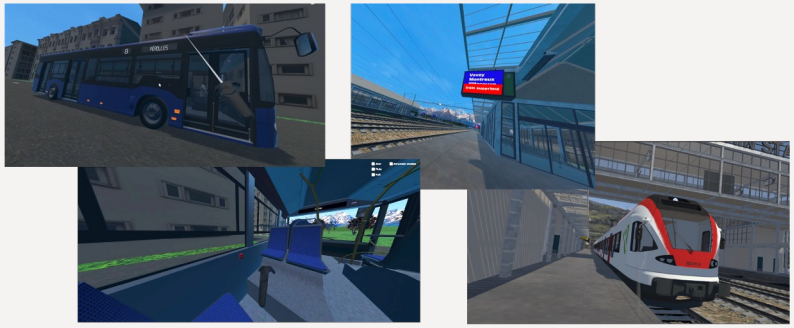
Problematic: Train to perform several complex daily tasks

- regularly
- while being accompanied by one or more supervisors
- situations difficult to reproduce systematically in the real world

Objective: Use of virtual reality (VR)

- to allow the simulation of these learning situations
- to perform learning exercises with teenagers with ID
- to customize each scenario for the students' learning objectives





Youtube video

SOME EXAMPLES: VR FOR SAFETY AND ACCIDENT PREVENTION

Target: Restaurant workers

Objective: Health, safety and hygiene in the Kitchen

- Learning good practices through hands-on practice, without risk, and in autonomy

- 4 training scenarios
  - #1: Storing dangerous products in the retention bins
  - #2: Carrying a load
  - #3: Opening an oven
  - #4: Fryer fire

Youtube video

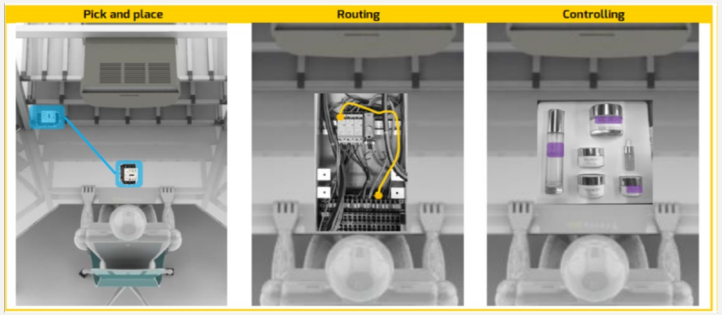
SOME EXAMPLES: AR FOR ASSISTANCE SYSTEMS

Target: People with cognitive disabilities
Objective: Smart assembly assistant

- Track hands from RGB streams using Deep Learning
- Track operations in order to avoid errors
- Project informations directly on assembly table

Schematic view of the system

- **Benefits**
- Self-learning of the operator, manager does not need to supervise constantly, also reduces stress
- Prevent assembly error
- Reduce workload of «managers »
  in order to let them better assist individuals



Types of assistance

Youtube video

A MORE IN DEPTH EXAMPLE: EYE TRACKING & METACOGNITION IN NURSING EDUCATION - I

A practical use case

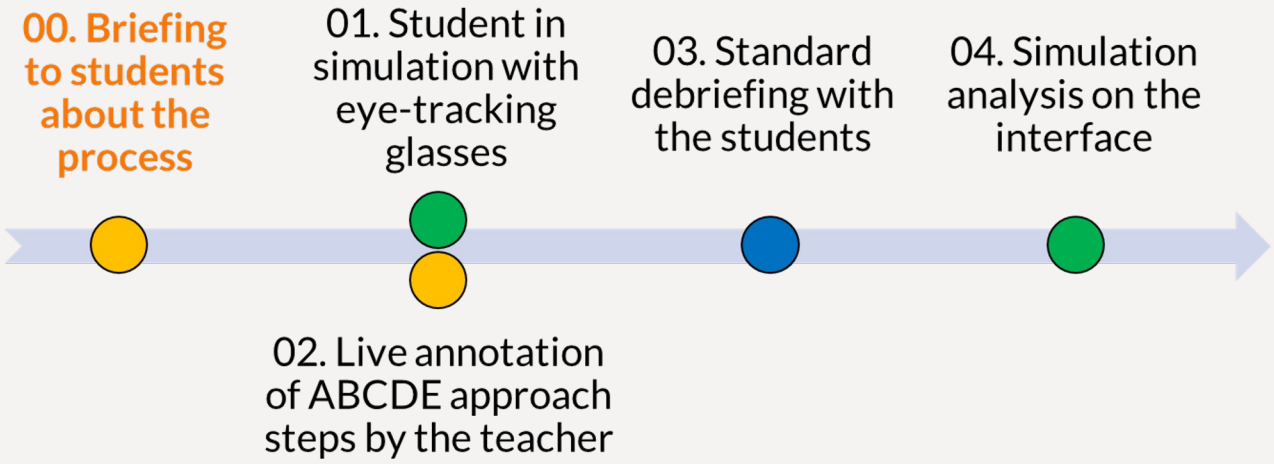
- In nursing, **simulation** has become an essential tool to develop **clinical reasoning**/judgement and decision-making.

- In the School of Health Science in Fribourg, a clinical reasoning technique using a systematic approach to assess and treat the patient's Airway, Breathing, Circulation, Disability, and Exposure (**ABCDE**) has been developed.

Goal : improve the application of this **systematic ABCDE approach** throughout the students' curriculum through a better understanding of their metacognition, thanks to **eye-tracking** in a simulation.

A MORE IN DEPTH EXAMPLE: EYE TRACKING & METACOGNITION IN NURSING EDUCATION - II

The Pedagogical Process



Pupil Invisible glasses

Equipping the student with the **eye tracking glasses** + calibration

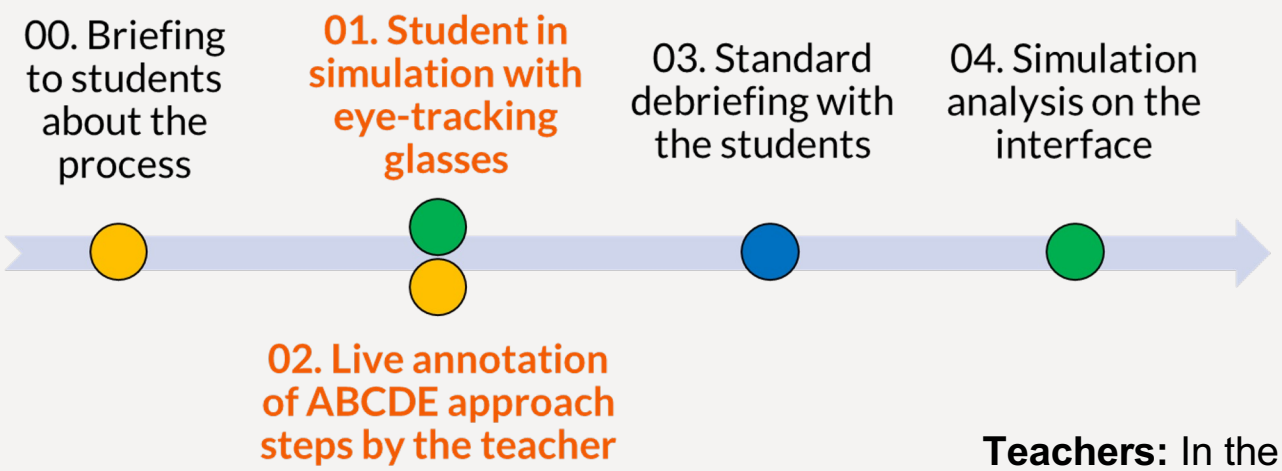
Teacher Student Both

UNI FR
UNIVERSITÉ DE FRIBOURG
UNIVERSITÄT FREIBURG

Hes·so
Haute Ecole Spécialisée de Suisse occidentale
Fachhochschule Westschweiz
of Applied Sciences and Arts Western Switzerland

A MORE IN DEPTH EXAMPLE: EYE TRACKING & METACOGNITION IN NURSING EDUCATION - III

The Pedagogical Process

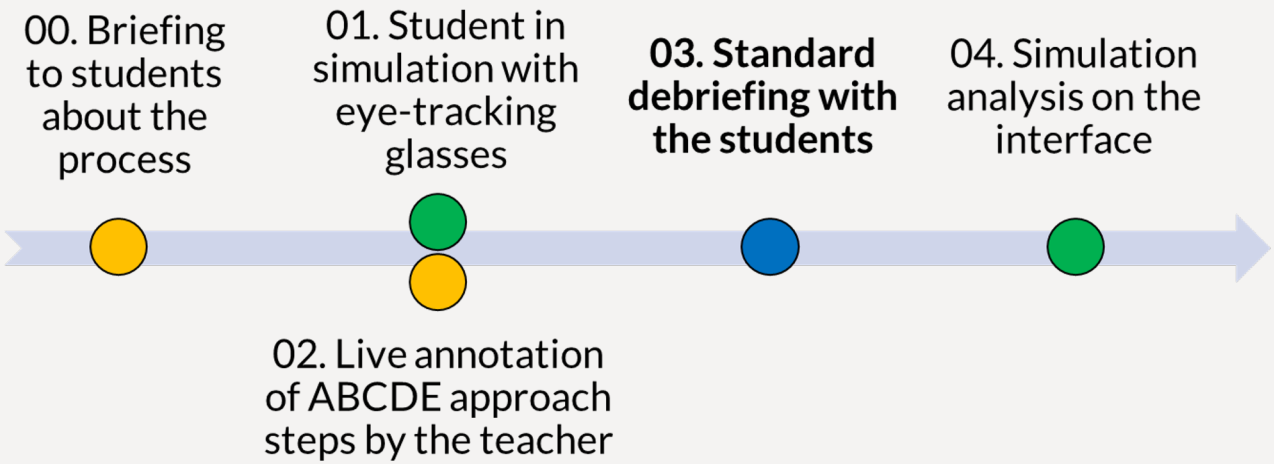


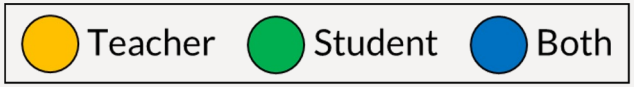
Students: perform care and clinical reasoning through the ABCDE's systematic approach

Teachers: In the video control room, **annotating** the beginning/end of each ABCDE phase

A MORE IN DEPTH EXAMPLE: EYE TRACKING & METACOGNITION IN NURSING EDUCATION - IV

The Pedagogical Process





A MORE IN DEPTH EXAMPLE: EYE TRACKING & METACOGNITION IN NURSING EDUCATION - V

The Pedagogical Process

00. Briefing to students about the process

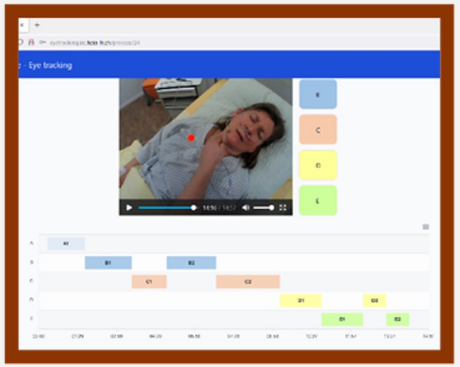
01. Student in simulation with eye-tracking glasses

02. Live annotation of ABCDE approach steps by the teacher

03. Standard debriefing with the students

04. Simulation analysis on the interface

Teacher | Student | Both



- Self evaluation
- Annotation of steps
- Analysis with AOIs
- Comparison with teacher's annotations
- Metacognition
- Self evaluation

METACOGNITION - DEFINITION

Metacognition refers to the ability to monitor and regulate one's own thinking processes. This includes the ability:

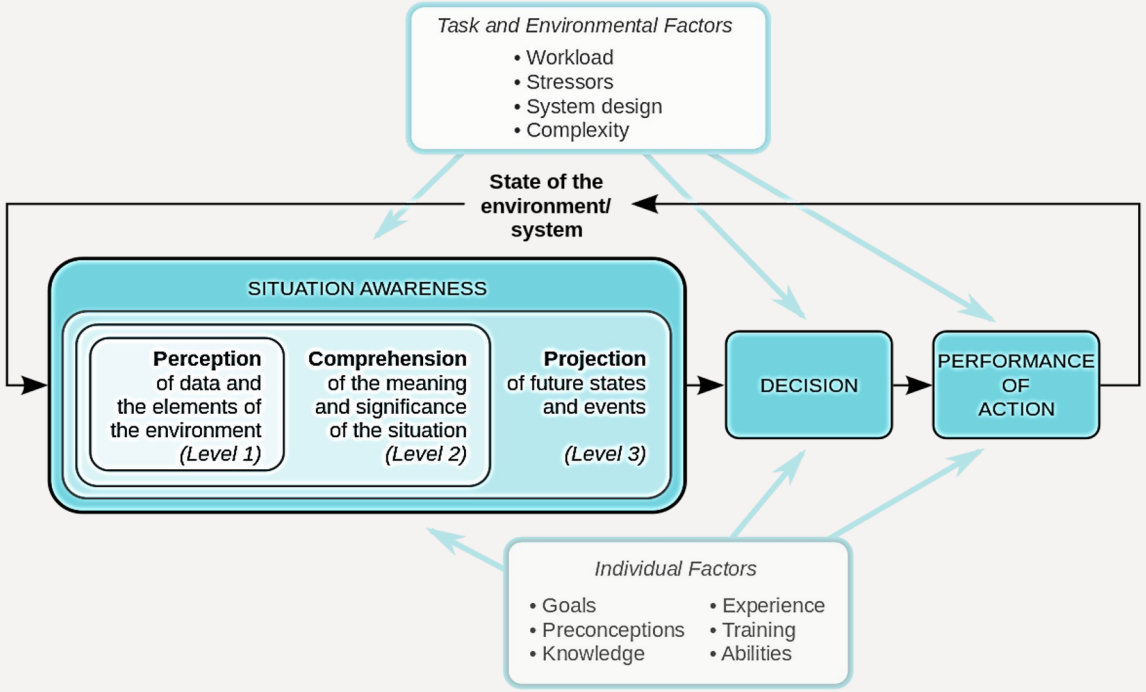
- to plan,
- set goals,
- evaluate progress,
- and adjust strategies as needed in order to achieve desired outcomes.

Metacognition is often considered a key component of successful learning and problem solving.

Flavell, J. H. (1979). Metacognition and cognitive monitoring: A new area of cognitive–developmental inquiry. American Psychologist, 34(10), 906-911.

SITUATION AWARENESS (SA) - DEFINITION

"the **perception** of elements of the environment in a volume of time and space, the **understanding** of their meanings, and the **projection** of their state into the near future".



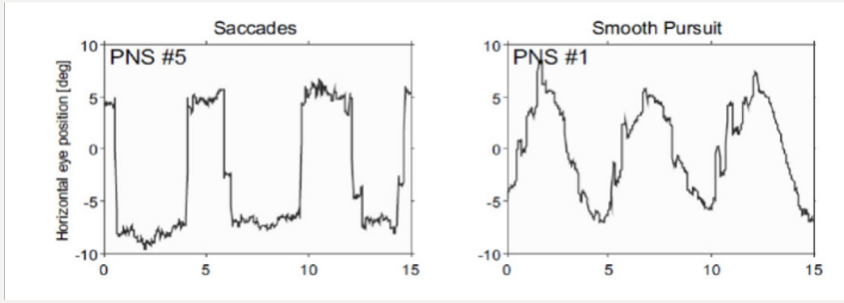
Endsley, M.R. (1995). Toward a Theory of Situation Awareness in Dynamic Systems. Human Factors: The Journal of Human Factors and Ergonomics Society, 37, 32 - 64.

EYE MOVEMENTS - THEORY

Eye movements can be classified into three discrete movement motifs [3, 4] :

- **Saccade** = a quick, simultaneous movement of both eyes between two or more phases of fixation in the same direction [3]. Shift the focus of the eyes abruptly (typically in 20–100 ms)
- **Fixation** = longer periods (0.2–0.6 s) of steady focus on an object
- **Smooth pursuit** = continuous movements of the eye to track a moving object.

Example of saccadic movements [1]



Saccadic movements vs. Smooth pursuit movements [2]

[1] Simon Viktória. A face is scanned by saccadic movements of the observer's eye. 2009.
[2] Caroline Schraa-Tam et al. « An fMRI study on smooth pursuit and fixation suppression of the optokinetic reflex using similar visual stimulation ». In : Experimental brain research. Experimentelle Hirnforschung
[3] Findlay J, Walker R. Human saccadic eye movements. Scholarpedia. 2012 Jul 27;7(7):5095.
[4] Rayner K, Castelhano M. Eye movements. Scholarpedia. 2007 Oct 9;2(10):3649.

EYE TRACKING - HARDWARE

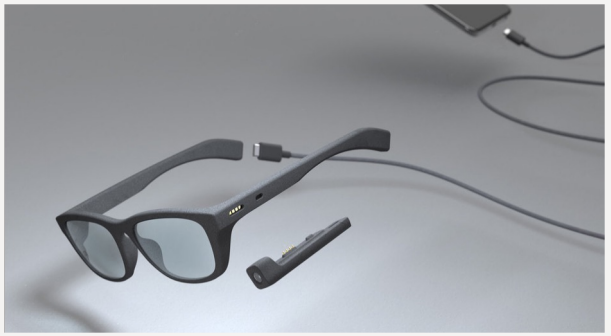
Remote eye-tracker

Tobii Pro Spark

EyeTech (Neurospec)

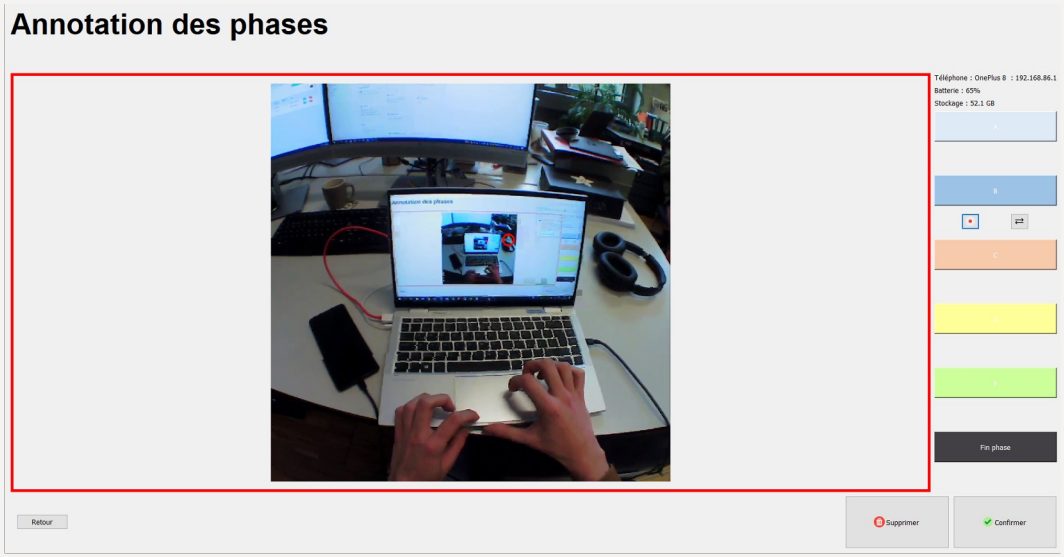
Eye-tracking glasses (Wearable)

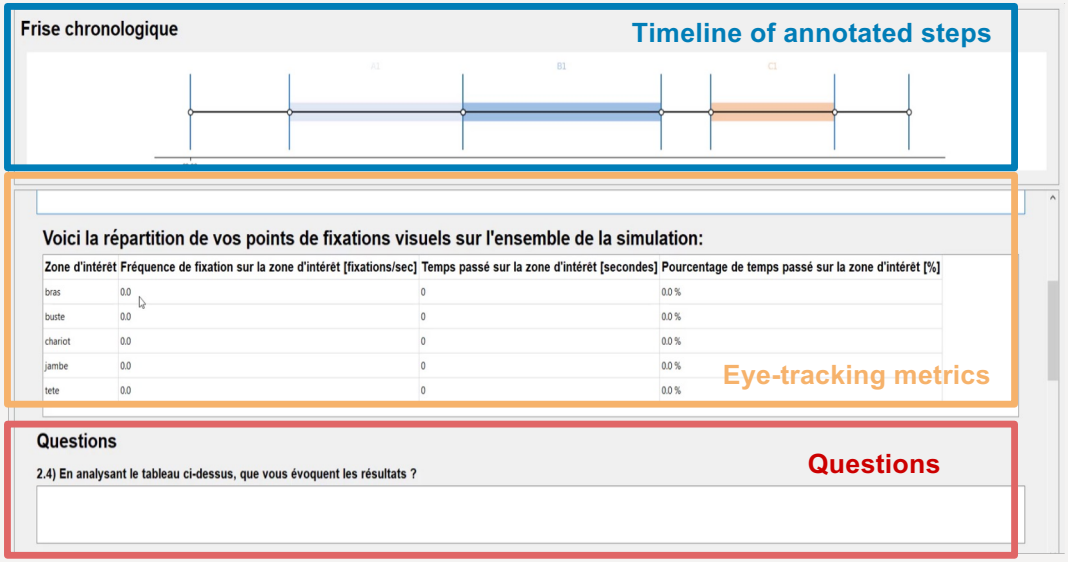
Tobii Pro Glasses 3



Pupil Invisible

EYE-TRACKING : EDUCATION INNOVATION IN NURSING - INTERFACE V1





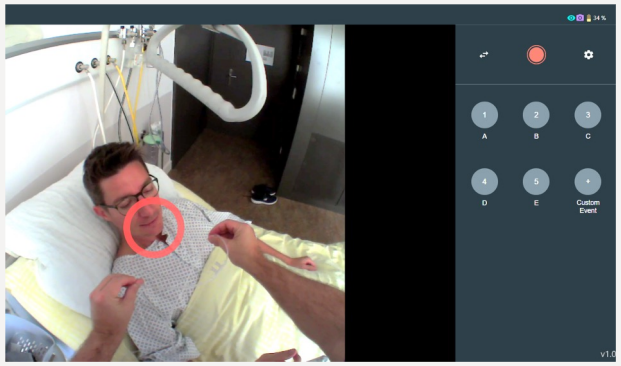
During the simulation:

Streaming of the student's vision with gaze overlay and annotation of steps by the teacher on the interface

After the simulation:

Student work in autonomy: Review and annotate own simulation (with gaze overlay), answer questions that prompt him/her to reflect on his/her metacognitive process

EYE-TRACKING : EDUCATION INNOVATION IN NURSING - INTERFACE V2



During the simulation

After the simulation

USER EVALUATION : PRELIMINARY RESULTS

Session 1 : 19 students participated - first version of the interface (v1)

Results

Self-made questionnaire (5-points Likert scales, subjective data)

+	**UX/UI**	Glasses : easy to use (4.73) and non-invasive (4.33) Interface (4.47) and instructions/video tutorial (4.8) clear and easy to use
+	**Learning**	Better identification of elements for their patient's nursing (4.33) and cognitive reasoning (4.33), enhanced learning thanks to eye-tracking (4.2) Positive change for their next intervention (4.46)
-		The annotation of the ABCDE approach phases (4) The accuracy of the eye-tracking metrics (3.66)

Short French version of the User Experience Questionnaire

Pragmatic quality : **1.72/3**
Hedonic quality : **2.32/3**
Overall : **2.02/3**

User experience of the process considered as ***excellent*** regarding the benchmark set by the authors' questionnaire.

These preliminary results are encouraging for the further development of this innovative pedagogical process in Switzerland.

Session 2 : 15 students, 14 are currently analysing their simulation on the redesigned web interface (v2)

Martin Schrepp, Andreas Hinderks, and Jörg Thomaschewski. 2017. Design and Evaluation of a Short Version of the User Experience Questionnaire (UEQ-S). Int. J. Interact. Multim. Artif. Intell. 4 (2017), 103–108.

CONCLUSION

Take aways

- Immersive technology can contribute to support learning (engagement, retention, transfer rate, etc.)
- Immersive technology is not a magic box!
- It is a tool and not an end!
- The magic comes from the "users" and not the computer scientists!

→ Interdisciplinarity is essential!

If you enjoyed this seminar, don't miss next episode! 😃: **3rd of November 2023**

- https://www.unifr.ch/digitalskills/fr/teacher/course.html?cid=2631

Heds FR
Haute école de santé Fribourg
Hochschule für Gesundheit Freiburg

Haute école d'ingénierie et d'architecture Fribourg
Hochschule für Technik und Architektur Freiburg

HumanTech
Technology for
Human Wellbeing Institute

Thank you for attending!

Haute école de santé Fribourg
Hochschule für Gesundheit Freiburg
Route des Arsenaux 16a
1700 Fribourg/Freiburg

T. 026 429 60 00
heds@hefr.ch
www.heds-fr.ch

HumanTech Institute
Haute école d'ingénierie et d'architecture Fribourg
Boulevard de Pérolles 80
1700 Fribourg/Freiburg

T. 026 429 66 11
www.heia-fr.ch
humantech.institute

UNI FR
UNIVERSITÉ DE FRIBOURG
UNIVERSITÄT FREIBURG

Hes·so
Haute Ecole Spécialisée de Suisse occidentale
Fachhochschule Westschweiz
University of Applied Sciences and Arts Western Switzerland

CONTACT INFORMATION AND LINKS TO THE VIDEOS

Contact Information

- Elena Mugellini – elena.mugellini@hefr.ch
- Quentin Meteier - quentin.meteier@hefr.ch
- Jean-Michel Vasse – jean-michel.vasse@hefr.ch

Links to the videos

- **Asepsis** - https://www.youtube.com/watch?v=N-p04aGw7vw&list=PLlWFApYKGnDfyA6_KduTMug7tVAS4TOLr&index=4
- **Young people with intellectual disabilities** https://www.youtube.com/watch?v=8C3Hjya2S_I&list=PLlWFApYKGnDcVxhsi2V6-PPUYasFHysre
- **Hygiene and security in the kitchen** https://www.youtube.com/watch?v=CkatyBltsyM&list=PLlWFApYKGnDeyKRORiG-31qY7lxGKtUTN&index=1