Extended reality in lab education? – a webinar recap

On Thursday, November 20th, Present-day Practicals hosted its second webinar:

🌼 eXtended Reality (XR) in lab education 🌼

The webinar explored how immersive technologies—Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR), collectively referred to as XR—are evolving from futuristic concepts to practical tools in higher education.

The webinar was presented by **Dr. Lars de Vreugd** from UMC Utrecht (UMCU) and **Karolien Van den Bergh** from University Colleges Leuven-Limburg (UCLL), Belgium, who shared both some theoretical background and two concrete case studies on implementing XR in medical and biological lab training.

The webinar provided the audience with both inspiration and practical insights, addressing the question: **Why, when, and how can you use XR for your education?**

Flow of this webinar

The webinar provided an introduction to XR, specific implementations, and insights into recent research findings;

1. **eXtended Reality (XR) overview**
    - **Defining XR:** The session began by providing a definition of XR as an umbrella term that covers the spectrum from the real world to the fully virtual world, going from Mixed Reality (MR), to Augmented Reality (AR), to Virtual Reality (VR).
    - **The CAMIL Model:** The presenters introduced one of the existing theoretical models to understand learning with XR, emphasizing three key characteristics that can add to XR users' learning: **Immersion** (the vividness of the system), **Interactivity** (the actions the system allows), and **Presence** (the feeling of 'being there'). These characteristics, the speakers argued, are difficult to fully understand by hearing about XR. They are best understood by actually experiencing XR yourself.
2. **Implementations of XR @ UMCU & UCLL:** several use cases were presented to demonstrate how XR is used to teach complex, high-stakes lab skills safely and efficiently:

- **Case study 1: sterile working in cell culture (UMCU):** This example showcased how XR can support students when preparing for the stringent environment of a cell culture lab. The VR scenario allowed students to practice **sterile techniques** and understand complex **flow cabinets** without consuming costly reagents or risking contamination.
- **Case study 2: operating a cutting-edge laboratory automate (UCLL):** This scenario, known as **VR-Digilab**, was designed for Medical Laboratory Technology students preparing for internships. The VR environment enabled students to **operate a high-tech lab automate**—an expensive and complex machine—in a zero-risk setting. The key takeaway was that this learning system:
    - Is **interactive and safe**, removing the fear of making mistakes (promoting self-regulation and self-efficacy).
    - Gives a **realistic idea** of how the automate works, boosting student interest, motivation, and perceived usefulness.

Interaction with the international audience

Following the examples, the participants moved into breakout rooms to **reflect, weigh the pros and cons, and discuss feasibility;**

1. How can XR be implemented in your (lab) education?
2. Which learning processes can or cannot be supported using XR?
3. What challenges do you see for integrating XR in your institution?
4. What else is required to realise XR implementation in lab education?

Key audience feedback after the breakout room

The breakout room discussions were highly productive, focusing on the practical implementation, potential benefits, and significant obstacles to integrating XR into (lab) education.

In summary, the benefits of XR;

1. Implementation and learning processes supported by XR

Participants identified two key areas where XR would immediately enhance the quality of teaching: **safety and preparation**.

- **Safety and Confidence:** Multiple groups noted that many students feel **intimidated** by lab work due to the fear of making mistakes ("laboratory anxiety is really a 'thing' in many labs").
    - **Solution:** VR provides a **safe environment** where students can experiment freely, make errors, and learn from them without real-world consequences or consuming resources. This allows them to be **inquisitive** and understand *why* certain steps are important and what the consequences of mistakes are.
- **Scalability and Access:** For institutions with **large student groups**, it is often impossible to let all students handle all experiments or use expensive equipment.
    - **Solution:** XR provides **scaleability**, ensuring every student can practice the complete experiment and gain essential skills, thereby adding to the overall quality of teaching.
- **Inclusivity and Accessibility:** VR can create inclusive experiences that are otherwise inaccessible.
    - **Examples:** It can support **neurodivergent students** who might be overwhelmed in a busy physical lab, or provide alternatives for students with **physical accessibility challenges** (e.g., virtually "climbing a mountain" for an ecology assignment).

The shared reflections acknowledged that while XR can offer powerful benefits (e.g., repeatability, safety), it also presents potential challenges related to cognitive load, learning how to use the technology, and the need for clear instructions.

The audience also identified several practical and research-based challenges that need to be addressed for successful XR implementation. Funding and time resources were cited as the main obstacles. Participants requested guidelines and insight into the funding and development process. Concerns were raised about the time of the development process, the maintenance and replacement of headsets. The possibility of using or copying existing applications from other institutions (like the examples shared by UMCU and UCLL) where discussed.

Lars indicated: *“There are multiple national initiatives (e.g. DUTCH, XR-Community) which actually stimulate openly sharing, for example, existing XR-simulations. In one of our ongoing research projects, we collaborate with the University of Twente to explore if OK-ready can be beneficial for their students. Openly sharing existing applications makes a lot of sense I feel, although sharing is not always that easy due to different types of headsets*

etc."

Current research and findings: Insights from UMCU and UCLL

The research presented by the UMCU and UCLL teams focused on measuring the efficacy and usability of their XR applications, yielding several key insights:

- **Self-Efficacy and motivation:** The findings suggested that the XR learning system **can boost students' interest and motivation**. By removing the **fear of making mistakes and making them more self-confident**, the VR-tool Digilab, for instance, successfully stimulated **self-regulation and self-efficacy** among students preparing for internships to operate on complex diagnostic lab automates. XR applications can also help **calibrate students' self-efficacy.** UMCU students' self-efficacy decreased after using XR (VR-sterile application), indicating that students potentially overestimated themselves before XR use.
- In addition, while the interactive and immersive nature of Digilab was beneficial, the research highlighted the importance of managing **cognitive load**. To ensure high and content related **usability** and prevent motion sickness, guidance (like a coach or refreshing course) is crucial, and instructions should not solely rely on instructional boards *within* the XR environment, as this can delay the experience. **Usability** was also an important factor within the UMCU study's results, where usability influenced self-efficacy, presence, and perceived Usefulness. Students' capability to handle XR seems to be key.

- Students are convinced by the added value of the VR-tool Digilab at UCLL and recommend it to other students**,** as it successfully **integrates practical skills and theoretical knowledge** and provides a **realistic idea** of complex machine operation before high-stakes internships. Likewise, UMCU students' **perceived usefulness** of VR-Sterile was high, indicating that they see the potential of XR in supporting their learning.

Key take-home messages

The webinar provided practical guidance on ways of integrating and increasing the use of Extended Reality, based on both the presented research and the audience's real-world concerns:

- **Prioritize safety and confidence:** Utilize XR to create a **safe, risk-free environment** where students can freely **make mistakes and learn from them**. This directly addresses the high level of **"laboratory anxiety"** many students experience and is particularly beneficial for large groups or complex, high-stakes procedures.
- **Leverage for scale and access:** View XR as a potential solution for **scalability and inclusivity**. It can provide students with high-quality, hands-on practice, regardless of group size, equipment availability, or physical accessibility limitations (e.g., virtual field trips, accessible practice for diverse learners).
- **Focus on the didactic value:** The decision to use XR must be driven by **pedagogical goals**, complementing or replacing traditional methods by facilitating practice that is (for example) too risky, time-consuming, or expensive to perform repeatedly in a physical lab.
- **Address resource management:** Be realistic about the main barriers: **funding and time resources**. Institutions must seek strategic planning and collaborative opportunities to address the costs of development, hardware, and maintenance.
- **Mind the experience:** For XR to be effective, factors like **usability** and managing **cognitive load** (through clear instructions and tutorials) can relate to student interest and motivation, and eventually student learning.

Wrap-up – enroll for the next webinars and/or a LabBuddy session!

The webinar concluded with a **wrap-up by the organizers** and an invite to enroll for upcoming webinars in the Present-day Practicals series and a special LabBuddy session.

➢ Refocusing labs: from cookbook to open inquiry	Tue 02/12/'25
➢ Fostering sustainability in lab education	Tue 13/01/'26
➢ Artificial intelligence in lab education	Thu 29/01/'26
➢ LabBuddy* session: Enhancing lab education	Thu 19/03/'26

Register here for the Present-day Practicals series => Webinar series 25/26 and/or

Sign up for our special LabBuddy* session => Enhancing lab education with LabBuddy

See you soon!

On behalf of the organizers

** LabBuddy provides an e-learning solution to support students in preparing before the start of the practical work, while working in the lab or field, and to guide them during the processing of their results after the practical work. Visit our website for more information, https://www.labbuddy.net/.*

Q&A and sharing information

See chat of this webinar for the complete overview (participants only) - Webinar 2: Extended reality in lab education | Meeting Chat | Microsoft Teams

Audience question: Do you have more information on specific applications, such as the "Aggressive Patient example" which is highly relevant for pharmacy education, where aggression is a significant issue. Lars shared a link to the DialogueTrainer

Response Lars: There is some information here: DialogueTrainer, that's the program in which the simulation is available. The study/development I was talking about (comparing Immersive VR with 360 degree VR in terms of effect on both learing and emotions) is in early phase, so feel free to get in touch if you're interested!

Supporting students with lab anxiety: An audience member shared a relevant research article on the topic: The Use of Virtual Reality in a Chemistry Lab and Its Impact on Stud...

XR lab for chemistry education: An audience member developed a VR lab for first year chemistry students and implemented it into the classroom to address the challenge of lab anxiety. They shared the following poster link: Immersive VR Chemistry Labs

Example application: An audience member from the building system engineering field shared a link to their own application video, demonstrating how they **implemented interactable systems** (via hand-tracking/controller) in VR to increase **motivation and involvement** compared to 2D-3D PC apps: YouTube video: CXBKjxlkcOc.

Community building: There's a Dutch community on XR - in case you want to join this community you can have a look via this link https://community-xr.npuls.nl/