The COVID-19 pandemic has compelled educators to rapidly transition to online learning methods. This shift is particularly challenging for instructors whose courses involve hands-on laboratory instruction. In his research, Dr Dominik May, an Assistant Professor in the Engineering Education Transformations Institute at the University of Georgia, has been focusing on online laboratories and Cross-Reality learning spaces in engineering education for over a decade. Collaborating with researchers from the international community of engineering education research, Dr May has been involved in the digital instructional design of and respective educational research on courses for mechanical, electrical, biological, civil and computer engineers. His work provides an environment for collaborative engineering lab work for students irrespective of their physical location.

Thirdly, he investigates virtual experimentation activities designed to develop a fundamental understanding of cognitive and affective factors that influence the students’ learning experience in Cross-Reality learning spaces, again particularly during online laboratory-based instruction.

Dr May believes that “face-to-face instruction and online instruction should never be seen as ‘either-or’ things, but it is important to examine, define, and combine the strengths of both worlds for the overall learning experience”. His studies and work from other researchers in the field have shown that hands-on experimentation activities often focus on developing knowledge and procedural skills rather than the development of competencies to solve workplace problems. Furthermore, they require and promote different skills and competencies when compared with virtual experimentation activities. Both hands-on and virtual experimentation learning activities, however, can be combined according to their individual strengths and intended learning outcomes for a particular lab activity. Moreover, they can be tailored to the preferences or needs of the individual student, as well as the school’s infrastructure and resources.

LABORATORIES AS A TEACHING AND LEARNING ENVIRONMENT
Dr May describes how the use of laboratories as a teaching and learning environment has been an essential part of science and engineering education at universities since the very beginning of higher education in engineering. Laboratories have a crucial role in both research-oriented and application-based study programs. He notes that to exploit the full potential of laboratories as a teaching and learning location, however, there must be a specific competence-oriented approach to learning in laboratories if the mere reproduction of specialist knowledge and skills is to be avoided. While research-based learning is the central paradigm of laboratory teaching, genuine competence development is essential to promote students’ employability in science and industry.

CROSS-REALITY
Online or Cross-Reality laboratories encompass all types of digitally or online-supported teaching learning laboratories. Cross-Reality labs employ emerging technologies, including augmented reality, virtual reality, and mixed or merged reality. Augmented reality labs can involve, for example, experimental setups that use augmented reality to display real-time data such as temperature or pressure directly on the test device. Cross-Reality technologies involve 3D models and simulations, using physical, virtual, and immersive platforms and offer particular innovation potential for engineering education. Dr May’s research consists in comparing real, remotely accessible and virtual instrumentation, specifically in the context of STEM education, and examining their impact on learning and communication practices and sociotechnical issues.

THE EAGER PROJECT
One of Dr May’s foremost engineering education research projects is EAGER: Investigating the rapid transition from face-to-face to exclusively online engineering laboratory classes in an Electrical and Computer Engineering program, which is funded by the US National Science Foundation (award #2023282). This project examines the impact of using only online laboratory modules in an engineering laboratory course beyond COVID-19. Current work involves exploring the rapid switch from face-to-face experimentation to online laboratories from three different perspectives: the perspective of students taking Electrical Engineering and Computer Engineering program, which included working from home. They commented that working from home also allowed personal health benefits of in-person labs. These included participating in the campus experience, feeling more hands-on as they were immersed in the lab environment, and getting more practice with the equipment. On the other hand, the students found that the online labs meant that they spent more time commuting and were able to work at their own pace and with respect to their own learning needs. Online labs also prepared them for future digital working environments, including working from home. They commented that working from home also allowed personal health.

Student interviews revealed several benefits of in-person labs. These included participating in the campus experience, feeling more hands-on as they were immersed in the lab environment, and getting more practice with the equipment. On the other hand, the students found that the online labs meant that they spent more time commuting and were able to work at their own pace and with respect to their own learning needs. Online labs also prepared them for future digital working environments, including working from home. They commented that working from home also allowed personal health benefits.

Hands-on experimentation activities often focus on developing knowledge and procedural skills, rather than the development of competencies to solve workplace problems.
Behind the Research

Dr Dominik May focuses on online laboratories and Cross-Reality learning spaces in engineering education.

The researchers advise instructors to study the interface’s quirks and be prepared to spend a significant amount of time helping students deal with them. Compared with physical labs, online labs require more formal, intentional means of student collaboration. At the beginning of the course, instructors are advised to discuss what effective real-world teamwork looks like, together with the roles involved, as this can help students build teamwork skills. Students need access to their instructors for help with the lab activities and interface. Online labs should be structured to maximise students’ ability to receive help from the instructional team. Following these guidelines can provide an environment for collaborative engineering lab work for students irrespective of their physical location. However, fostering social interaction and collaboration in online lab environments remains challenging due to still existing technical constraints. It is of vital importance for future educational development and research in this field to include social interaction in online labs to avoid losing this very important part of the overall learning experience.

INTERNATIONAL COLLABORATION

Dr May collaborates with colleagues within the University of Georgia as well as researchers from the international community. For instance, for a recent excavation research, such as the International Association of Online Engineering and the American Society for Engineering Education, Dr May has been involved in the digital instructional design of courses for electrical, biological, civil and computer engineering students. His work has led to the creation of the Engineering Education Transformation Institute’s (EETI) Innovative Teaching Lab Group at the University of Georgia.

The future of engineering education

Dr May’s research addresses a critical requirement that has been exemplified during the COVID-19 global health crisis with the rapid transition to online learning. Nonetheless, looking beyond this crucial application, Cross-Reality learning spaces promise a lasting impact of the future of engineering education, and respective educational research is vital to actively shape this future.

References


Personal Response

What is the most important piece of advice that you would give to instructors using Cross-Reality learning spaces?

“I would like to advise instructors to embrace the opportunities the new technologies offer to your teaching and the classroom with an open mind. This might require stepping outside of your current comfort zone, but it will be absolutely rewarding. Secondly, introduce new approaches and technologies with respect to the course goals and the intended learning outcomes. Don’t use online labs as an end in itself, but only if they help you reach your goals. And finally, maybe the most important one; be patient with the technology, the students, and yourself. New approaches might not work at first but will improve over time, which is normal. However, students are typically very patient as long as you are transparent about your goals, your strategies and even potential failures.”

Reference: