XR for Teaching and Learning: Year 2 of the EDUCAUSE/HP Campus of the Future Project

EXECUTIVE SUMMARY

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Key Findings

- **XR technologies are being used to achieve learning goals across domains.** Whether we are talking about Bloom and colleagues' original trio of educational activity domains—the cognitive (knowledge), psychomotor (skills), and affective (attitudes)—or the revised quartet—factual, conceptual, procedural, and metacognitive—we find that XR technologies contribute to learning gains and produce changes in all domains, though not necessarily all equally.
- **Effective pedagogical uses of XR technologies fall into one of three large categories:** (1) Supporting skills-based and competency-based teaching and learning, such as nursing education, where students gain practice by repeating tasks. (2) Expanding the range of activities with which a learner can gain hands-on experience—for example, by enabling the user to interact with electrons and electromagnetic fields. In this way, XR enables some subjects traditionally taught as abstract knowledge, using flat media such as illustrations or videos, to be taught as skills-based. (3) Experimenting by providing new functionality and enabling new forms of interaction. For example, by using simulations of materials or tools not easily available in the physical world, learners can explore the bounds of what is possible in both their discipline and with the XR technology itself.
- **Integration of XR into curricula faces two major challenges: time and skills.** Students need sufficient time to engage deeply with the technology and with the problem-solving enabled by it. But engaging with XR technology requires that students possess some technical skills, and gaining these skills also takes time. A single academic term may not be sufficient for students to both scale the learning curve of XR technology and also cover the subject matter of the course. Institutional support is needed to ensure that students have the time to gain the skills necessary for effective pedagogical use of XR.
- **The adoption of XR in teaching has two major requirements: the technology must fit into instructors' existing practices, and the cost cannot be significantly higher than that of the alternatives already in use.** First, many disciplines have existing accreditation standards, curricula, and even instructional methods, and the use of XR hardware or applications must fit into such existing ways of doing things. Second, cost might be calculated not simply in terms of money but also in terms of the time required to scale the learning curve, or however the instructor perceives cost.

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- **The effectiveness of XR technologies for achieving learning goals is influenced by several factors: fidelity, ease of use, novelty, time-on-task, and the spirit of experimentation.** Fidelity: The more realistic an XR simulation is, and the more it supports the “embodiment” of the user, the more valuable it is as a teaching tool, particularly for skills-based learning. Ease of use: An XR technology must be easy to use for both the instructor and the student. This is partially achieved through increasing standardization of interfaces and functionality. Novelty: XR technology must enable pedagogy that is not available through existing instructional methods. Time-on-task: Like other technologies for blended learning, XR promotes increased engagement for students interacting with educational materials. Spirit of experimentation: Like other developing technologies, XR promotes self-directed learning. But this requires that instructors and the institution as a whole provide students with the freedom, flexibility, and resources to engage deeply with the technology.

Recommendations

For Instructors

- **Provide time for students to engage with XR and the subject matter.** For XR to be pedagogically meaningful in teaching and learning, students must have sufficient time to both scale the learning curve of the technology and engage with the learning material. It can be difficult to make this kind of time available, however, in the context of a course or across the curriculum. Hackathons hosted by institutions of higher education have been effective in providing students with the time and resources to engage deeply with a topic through the use of XR technology.
- **Integrate XR into courses that fulfill the institution’s general education requirements.** For XR to be pedagogically meaningful in teaching and learning, students must have sufficient time to engage deeply with the technology and with the problem-solving enabled by it. Integrating XR into an institution’s general education curriculum, perhaps as part of the larger theme of technology literacy and/or into a first-year experience course, is an effective method for introducing students to XR technology.
- **Provide support to students.** XR, like any new technology, has a learning curve. Students will need to scale that learning curve in order to use XR effectively, but there really is not a lot of time for this curve-scaling in a typical academic term. Instructors need to know how to use XR themselves in order to support students in their use of XR. Instructors should also bring in student support from other campus units, such as centers for teaching and learning.
- **Let students experiment.** XR is a new technology, and both developers and users are still discovering its affordances and boundaries. As with many new teaching tools, there is not yet a set of best practices for deploying XR for teaching and learning. Even as students are learning how to use XR, they may also be developing something new and pushing the bounds of their chosen field. Of course, it is challenging to assess student learning when the student—and often the instructor—is experimenting. The important question in this context is whether XR technology is being used thoughtfully in the context of the field.

For Institutions

- **Provide support to the campus community.** Students and instructors alike will need to learn to use XR technology. Students may be using it in the context of a course or an assignment and therefore have a short timeline for learning. Instructors may have a longer timeline, but they need more in-depth information as they integrate XR into their courses or assignments. Different service models will be appropriate for these different use cases, and some combination will probably be necessary, offered by collaborations between one or more campus units, such as IT units and centers for teaching and learning. Workshops on various specific XR tools, limited in scope and offered frequently, may be useful for both students and instructors. Classroom support may help instructors in their deployment of XR in their courses and provide students with more in-depth training than the instructor is able to provide. Train-the-trainer models may be effective for instructors: one instructor learns about and integrates a technology into a course and then helps colleagues to do the same.
- **Provide space for users to engage with XR technology.** For members of the campus community to be able to experiment with and learn to use XR technology, that technology must be freely available—for example, in a campus lab or a makerspace. Providing public access to XR has staffing implications, as the staff in the space must be able to support users with the technology. Likewise, the space must be staffed or monitored constantly to ensure the security of the hardware. That said, simple access is one of the most important factors influencing the effectiveness of XR for learning.
- **Encourage capacity-building.** Like many campus technologies, XR will be used across fields and by all types of institution-affiliated users. Supporting these diverse users and use cases will require staff from across campus units. Instructional designers will need to learn how to use and support the technology, while IT staff will need to learn how to support teaching and learning with it. Knowledge-sharing across campus units and traditional institutional silos will be critical. Creating cross-institutional working groups and building capacity within individual campus units will both be important for supporting XR technology on campus.
- **Participate in community-building.** Many institutions are adopting XR technology for teaching and learning, but often this process is entirely internal to the institution. There is a great need for support and information sharing across institutions concerning uses and practices for XR in teaching and learning and to enable the sharing of XR tools and content. The EDUCAUSE XR (Extended Reality) Community Group promotes discussion and support regarding these and other issues. Institutions should encourage instructors and staff involved with XR technology on campus to participate in this and other formal and informal interest groups.

For Future Research

- **More research is needed on the pedagogical impact of XR.** A body of research exists about the use of VR and AR for teaching and learning, but much of that literature focuses on the use of a specific technology for teaching a specific topic or in a specific course. This study was broader in scope than much previous research, spanning multiple technologies, topics, and institutions. But while this study provides a wide-angle view of the current state of the art and starts to map out a research agenda, that research agenda must be taken up by the XR community as a whole.

- **Intervention studies are needed.** Two types of intervention studies are particularly relevant for studying the effectiveness of XR technology for learning, and these study designs are not mutually exclusive. Pre–post studies will enable researchers to identify the impacts of XR technology on students. Trial studies will enable researchers to compare the effectiveness of an XR technology with that of a non-XR option. This is especially the case in fields where XR tools are competing, so to speak, with existing teaching methods—for example, simulations using XR versus those using manikins or standardized patient–actors in nursing education.

For Technology Development

- **Develop easier-to-use development platforms.** Several repositories of XR objects and experiences exist, as do several XR development platforms. It is relatively easy to download an educational XR application and use it as is. Likewise, it is relatively easy for a developer with knowledge of a development platform to develop a new XR application. What is not yet easy is for someone who is not a developer to develop a new XR application. There is great demand among instructors for exactly this functionality—the ability to develop custom XR applications for specific fields, courses, and use cases. For XR to be widely adopted in higher education, it will need to become easier to customize and serve in developing course-specific materials.
- **Contribute XR applications to repositories of learning objects.** Several repositories of open educational resources (OER) exist, such as **MERLOT** and **Waymaker**. These repositories provide a platform for instructors to share materials that they have created and to find materials shared by others. While there is demand among instructors for custom XR applications, some of this demand arises from a lack of sharing: given a choice, some instructors would probably rather not develop XR applications themselves. If more XR applications were shared via such repositories, they would no doubt be used as much as other forms of OER.
- **Work with game designers.** Realism and authenticity are critical in XR simulations, particularly in fields where education and training are skills-based. This is not a call to “gamify” skills-based education. Rather, this is a call to work with developers who have experience designing realistic simulated environments. The gaming industry has been developing ever-more realistic graphics for VR and AR games for years.
- **Build instructional scaffolding into applications.** Again, this is a call to work with game designers, as the gaming industry also has long experience at building key performance indicators into games, to track and promote player progression. Educational applications need to do the same, that is, track student progress and promote student success. Just as KPIs are different in different games, so too should they be different in different educational applications, based on standard rubrics and assessment tools in different fields.

Learning More

Access the full report about XR for teaching and learning on the research hub at https://www.educause.edu/hp-xr-2.