A Framework for Choosing, Using, and Designing XR Applications for Post-pandemic Learning (Jan. 5, 2022)

The three sets of best practices outlined in Tables 2, 3 and 4 make up a framework to guide instructors and developers in providing equitable opportunities for using XR as a tool for learning and knowledge sharing during and after the pandemic.

Best Practices for Choosing XR Learning Applications for Post-pandemic Learning

Topic	Best Practice
Pedagogical Design	Choose an XR application that • facilitates achievement of preset learning outcomes, • enhances but does not replace other modes of learning, and • aligns with the most recent teaching and learning research related to the specific student group.
Accessibility	Choose a technology with accessibility features that provide multiple means of engagement in order to support the needs of learners with diverse abilities. Provide alternative modes of learning when this is not possible.
Accessible technology	Choose XR applications that can be accessed on smart phones, tablets, and personal computers.
Costs	Minimize costs for both instructors and students. Use free technology when possible.
Connectivity	Avoid XR technologies that require large downloads and if possible, select a tool that can be used offline.
Support	Choose XR applications with reliable, effective support for students and instructors
Segmentation/ Self-direction	Choose an XR application that facilitates segmentation allowing learning to be divided into short chunks or, when chunking is not possible, facilitates a student-directed learning experience.
Level of Immersion	Choose less immersive XR technologies when they will provide an equally effective learning experience that fulfills learning outcomes.
Ease of Use	Minimize distractions and frustration by choosing XR technologies that are reliable and easy to use with clear navigational cues.
Repetition	Choose a technology that will facilitate repetition of the learning experience
Effectiveness	Choose an XR application that allows for monitoring and revision as needed to ensure ongoing achievement of learning outcomes.
Privacy	Determine what information will be collected by the technology, how it will be used, where it will be stored, how this may impact your learners, and whether it aligns with the policies of your institution.

(Long and Tsinakos, 2022, unpublished paper under peer review)

Best Practices for Using XR Learning Applications for Post-pandemic Learning

Topic	Best Practice
Pedagogical Design	Use the XR technology in a way that • facilitates achievement of preset learning outcomes, • enhances but does not replace other modes of learning, and • aligns with the most recent teaching and learning research related to the specific student group.
Accessibility	Use available accessibility features fully to maximize opportunities to engage with the learning activity. Provide alternative modes of learning when a fully accessible experience is not possible.
Accessible Technology	Ensure students have the option of accessing the learning using smart phones, tablets, and personal computers.
Supplement	Offer the XR learning application as one of several representations of the learning material. Use it to enhance but not replace other modes of learning.
Preparation	Provide learners with plenty of time to become familiar with the technology prior to the learning experience.
Pretraining	Familiarize students with key concepts and navigational cues beforehand.
Support	Provide learners with reliable, effective support throughout the learning experience.
Segmentation/ Self-direction	If the application does not already do so, divide XR learning into short chunks, interspersing these with breaks, generative activities, formative assessment, and/or opportunities to repeat or review the learning. Where segmentation is not possible, provide learning experiences that are student-directed with plenty of time for student-initiated breaks, review, and/or repetition.
Distractions	Minimize distractions and interruptions from outside sources that can prevent learners from fully engaging in the learning activity.
Repetition	Encourage repetition of the XR learning experience, especially more immersive experiences that tend to have a higher cognitive load.
Effectiveness	Evaluate the XR experience regularly to ensure ongoing achievement of learning outcomes. Revise applications as necessary.
Privacy	Use applications in ways that will minimize collection and sharing of personal information and align with the policies of your institution.

(Long and Tsinakos, 2022, unpublished paper under peer review)

Best Practices for Designing XR Learning Applications for Post-pandemic Learning

Topic	Best Practice
Pedagogical Design	Design an XR application that • allows educators to adapt the material and revise as needed in order to ensure achievement of preset learning outcomes in their unique setting, • is intended to enhance but not replace other modes of learning, and

	• aligns with the most recent teaching and learning research related to the specific student group.
Accessibility	Incorporate accessibility features into the design to support the needs of learners with diverse abilities. Provide multiple means of engagement. When this is not possible, ensure that alternate forms of learning are also made available.
Accessible Technology	Design XR applications that can be accessed on smart phones, tablets, and personal computers.
Cost	Minimize costs for both instructors and learners. Create tools that can be offered for free, when possible.
Connectivity	Avoid designing XR applications that require large downloads. If possible, design a tool that can be used offline.
Level of Immersion	Design less immersive XR applications when they will provide an equally effective learning experience that fulfills learning outcomes.
Simplify the experience	Avoid extraneous use of text and audio to minimize distractions and decrease cognitive load.
Ease of Use	Minimize frustration by designing XR applications that are easy to use. Ensure that technical support is reliable and easy to access. Build in effective navigational cues.
Segmentation/ Self-direction	Where possible, design XR learning that is presented in short chunks interspersed with breaks, generative activities, formative assessment, and/or opportunities to repeat or review the learning. Where segmentation is not possible, design learning experiences that are student-directed.
Signaling	Incorporate features that highlight key learning concepts to signal their importance to students.
Repetition	Design XR applications that encourage repetition, especially with more immersive experiences that tend to increase cognitive load.
Minimize distractions	Design the XR application to minimize distractions and interruptions allowing learners to fully engage in the learning activity.
Monitor Effectiveness	Evaluate the design of the XR application throughout the development process to ensure ongoing achievement of learning outcomes. Revise as needed
Privacy	Design XR applications that do not collect, store, or share personal information.

(Long and Tsinakos, 2022, unpublished paper under peer review)