# Advancing Pedagogical Innovation:

# Educational Supplemental XR Module Guide

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**Abstract.** This study explores best practices for developing and implementing eXtended Reality (XR) modules in higher education, emphasizing sustainable, scalable, and pedagogically aligned approaches. Drawing on a multi-phase initiative led by Virginia Tech's XR Community of Practice (XR CoP), the research combines data from a campus-wide survey (N = 232) and faculty/staff focus groups (N = 14). While 44.59% of respondents expressed interest in XR integration, despite over half (51.29%) of respondents having never used immersive technology in educational settings and 19.7% facilitating rate – highlighting a significant adoption gap driven by institutional, technical, and pedagogical barriers. Successful implementations were marked by clear instructional objectives, strategic planning, and interdisciplinary collaboration. Key challenges include limited access to pre-built content (16.72%), technical usability issues (16.48%), and digital accessibility concerns (12.09%). Recommendations emphasize prioritizing modular XR development, building cross-campus partnerships, supporting faculty through collaborative frameworks, and balancing high- and low-fidelity solutions based on learning goals and available resources. Future stages will include a case study examining the feasibility of outsourcing XR development through the creation of a supplemental module for Environmental Health & Safety (EHS) portable fire extinguisher training. This phase will assess the outsourcing process, project management responsibilities, and stakeholder coordination. Once developed, the module will be used to evaluate its impact on learner performance and self-efficacy. Overall, this work contributes to the growing discourse on immersive learning by proposing practical frameworks for XR adoption in diverse academic settings.

**Keywords**: eXtended Reality, Higher Education, Technology Adoption

# 1 Introduction

Higher education stands at a crossroads, facing pressure to transform traditional pedagogical approaches. The demands of Industry 4.0 and the expectations of digitally native Generation Z and Alpha students necessitate a shift toward more immersive and interactive learning experiences (Seemiller & Grace, 2017; Rothman, 2022). The modern workforce increasingly requires graduates with advanced digital competencies to excel in the "Jobs of Tomorrow" (World Economic Forum, 2020), challenging institutions to bridge the gap between academic instruction and professional readiness.

eXtended Reality (XR), an umbrella term encompassing virtual reality (VR), augmented reality (AR), and mixed reality (MR), emerges as a promising solution to these challenges. XR technologies offer unique capabilities for enhancing learning outcomes, particularly in fields requiring spatial understanding, hands-on practice, or exposure to otherwise inaccessible environments (Radianti et al., 2020; Aguayo & Eames, 2023). The increasing availability of commercially accessible head-mounted displays (HMDs) has significantly lowered technical barriers to entry (Jensen & Konradsen, 2018), with experts anticipating widespread classroom integration of VR technology in the coming years (Adams Becker et al., 2017).

Despite this potential, XR remains underutilized in higher education. This underutilization may stem from several systematic barriers, but one of the major challenges is creating XR content that meaningfully aligns with educational objectives (Jensen & Konradsen, 2018). Educators often lack the technical expertise, development resources, or pedagogical frameworks needed for effective XR implementation (Makransky & Petersen, 2021). Moreover, while complete digital twin replacements of traditional courses may seem appealing, research suggests that supplemental XR tools offer a more practical, sustainable, and effective approach to technology integration (Hamilton et al., 2021; Lee et al., 2025). This blended approach allows institutions to maintain proven pedagogical methods while strategically incorporating XR to enhance engagement, promote active learning, and bridge specific pedagogical gaps (Bower et al., 2017).

Drawing on a case study from the XR Community of Practice (XR CoP) at Virginia Tech (VT), an R1 research institution, this research identifies effective strategies for XR module development and integration into curricula. The previous phase, Phase I of the XR CoP initiative, aimed to understand the top-down and bottom-up needs of XR utilization and to identify gaps in general XR knowledge and university-wide resources. This report encompasses Phase II and III. More specifically, Phase II aims to determine the current state of XR at VT and to map the development lifecycle of XR projects at the university; while Phase III aims to establish a framework for systematic XR adoption with future efforts aimed at validating the efficacy of XR development for enhanced educational experiences.

## 2 Objectives

This research aims to identify best practices for developing XR modules in higher education, specifically by focusing on effective processes utilized at Virginia Tech (VT). It aims to identify and evaluate processes that support the creation of modular XR content that aligns with existing curricula. The objective is to generate a set of evidence-based, actionable recommendations for institutions planning to integrate XR technologies. Emphasis is placed on cost-efficiency, scalability, and pedagogical effectiveness. The study contributes to the academic discourse on XR in education by proposing sustainable development frameworks that balance instructional goals, technical feasibility, and institutional resources.

## 3 Methods

A mixed-methods approach was employed to understand the current state of XR applications across the VT Blacksburg campus. This study explored two primary components: a campus-wide survey and focus group sessions. The campus-wide survey collected a total of 371 responses (with N = 232 completions) exploring the use cases across institutions (i.e., types of experiences, tools, and methods used). The participant sample consisted of 125 Males, 93 Females, 2 identified as Non-binary, and 11 as Other with one who preferred not to identify. Of those 232 participants, when asked "Which group do you belong to?" seventy-six (n = 76) participants identified themselves as Undergraduate Students, seventy-eight (n = 78) Graduate Students, sixty-one (n = 61) faculty, and seventeen (n = 17) Staff. Participants' college affiliation representation is shown in Figure 1.

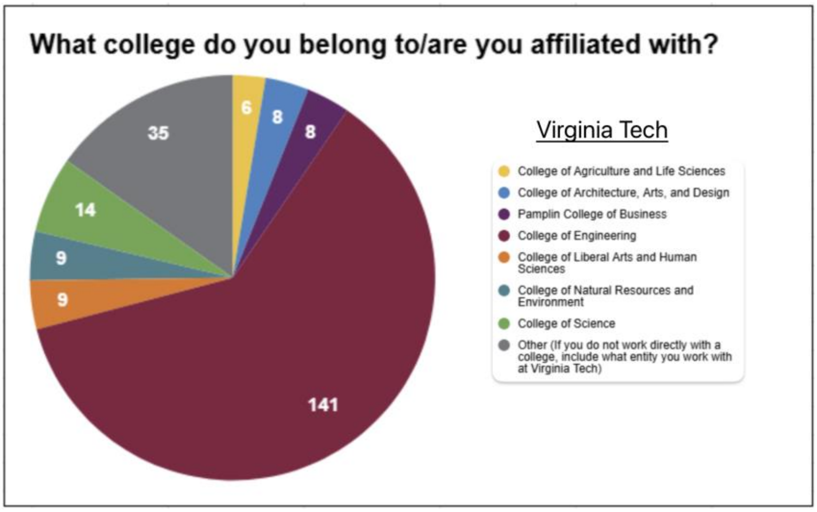


**Fig. 1.** Virginia Tech Blacksburg 'Campus-wide Survey' participants' college affiliation.

Additionally, for the focus group, a total of fourteen (N = 14) subject matter experts (SMEs) were recruited across multiple colleges, as shown in Table 1. A total of two focus group sessions were conducted, including 6 participants (n = 6) in Session 1, and 8 participants (n = 8) in Session 2. Focus group sessions aimed to better understand SMEs' previous XR development experiences in creating academic-based XR content. While students' perspectives on XR development are valuable, focus groups were exclusive to faculty and staff, as educators are ultimately responsible for the curricula which entails designing and implementing XR content in alignment with course objectives and institutional policies.

**Table 1.** Focus group participants' institutional department affiliation and roles.

| Department | Role |
|---|---|
| **Veterinary Medicine** | Associate Professor of Practice |
| **Interior Design** | Assistant Professor |
| **Computer Science** | Professor; HCI Deputy Director |
| **Food Sciences & Technology** | Assistant Professor |
| **Sustainable Biomaterials** | Assistant Professor of Practice |
| **Industrial & Systems Eng.** | Professor |
| **General Chemistry** | Lab Manager |
| **General Engineering** | Director |
| **Undergraduate Education** | Assistant Vice Provost |
| **Construction Engineering & Management** | Adjunct Professor; EHS Health & Safety Training Coordinator |
| **University Library** | Assistant Director; Executive Director |

All qualitative data were secured on a hard drive only accessible by the research team. Prior to analysis, personal identifiers were removed. Audio recordings were extracted from the hard drive and transcribed, and open-ended responses were coded using Microsoft Excel using question-specific keywords to establish thematic frequency patterns. This study received approval from the Virginia Tech Institutional Review Board (IRB #24-1356).

## 3.1 Procedure

The campus-wide survey was distributed through community listservs and the Canvas platform using QuestionPro. The comprehensive survey gathered data across five key domains: introduction, demographic, branching, XR development, XR user questions, ranking resources, interest/concerns of implementing XR, and further interest.

The survey employed multiple-choice questions with "Select all that apply" options to capture comprehensive data on participants' experiences and perspectives regarding XR technology in higher education. The survey began with *Introduction* and *Demographic* sections (7 questions) such as participants' roles, college/department affiliations, race, gender, and roles while the *Branching* section (1 question) assessed participants' involvement with XR in higher education settings. The *XR Development* section (14 questions) of the survey extracted timelines, specific development tools utilized, and resource allocation patterns. The *XR User Question* section (2 questions) focused on their experiences using immersive technology. *Ranking Resources* section (2 questions) asked to rank importance for XR development and implementation, and the *Interest/Concerns of Implementing XR* section (3 questions) assessed their interest level, motivation, and barriers. Lastly, the *Further Interest* section (2 questions) asked participants to indicate if they are interested in engaging in extended research activities. The survey consisted of 32 total questions, took approximately 8 - 10 minutes to complete, and included instructions for compensation upon completion; the instrument can be seen in Appendix A.

Focus group sessions were conducted in a hybrid format using Zoom, with each session lasting approximately 60-minutes. The focus group protocol/questions can be seen in Appendix B. Focus group solicitations were sent out to the XR CoP listserv (~29 members) to recruit SMEs. The semi-structured protocol began with a 10-minute introduction where participants shared their name, role, and previous XR experience. This was followed by a guided discussion exploring participants' visions for education and classroom evolution over the next 5 years, concerns about XR usage in classrooms, and reflections on previous XR experiences including successes and challenges. Throughout the sessions, participants delved into XR implementation experiences, perceived barriers and opportunities, and strategies for pedagogical integration. An interactive Canva slide deck facilitated engagement across both in-person and virtual participants, and all sessions were audio-recorded with participant consent for transcription and analysis. Participation was strictly voluntary without compensation.

# 4 Results

## 4.1 Campus-wide Survey

Based on survey responses, several concerns and barriers were identified regarding the adoption of immersive technologies in educational settings. When asked, "What is your involvement with immersive technology in a higher education setting?", the majority indicated they had never used immersive technology in such settings (51.29%, n = 119). Additionally, 28.45% (n = 66) reported having only been users of immersive technology, while 20.26% (n = 47) had participated in its development, either through commissioning, building, or facilitating development processes.

Regarding experience with facilitating immersive technology in classroom settings, a minority of respondents (19.70%, n = 13) reported direct experience. The vast majority (80.30%, n = 53) indicated they had no prior experience facilitating immersive technologies for educational purposes. Among those who had facilitated immersive technology experiences, prominent challenges identified included "technical issues" (18.68%, n = 17), "usability and UX of the tool" (16.48%, n = 15), and "evaluating the effectiveness of the tool" (15.38%, n = 14). Despite the overall low rate of facilitation experience, there was substantial enthusiasm among respondents in favor of the integration of XR technologies into curricula, as shown in Figure 2.

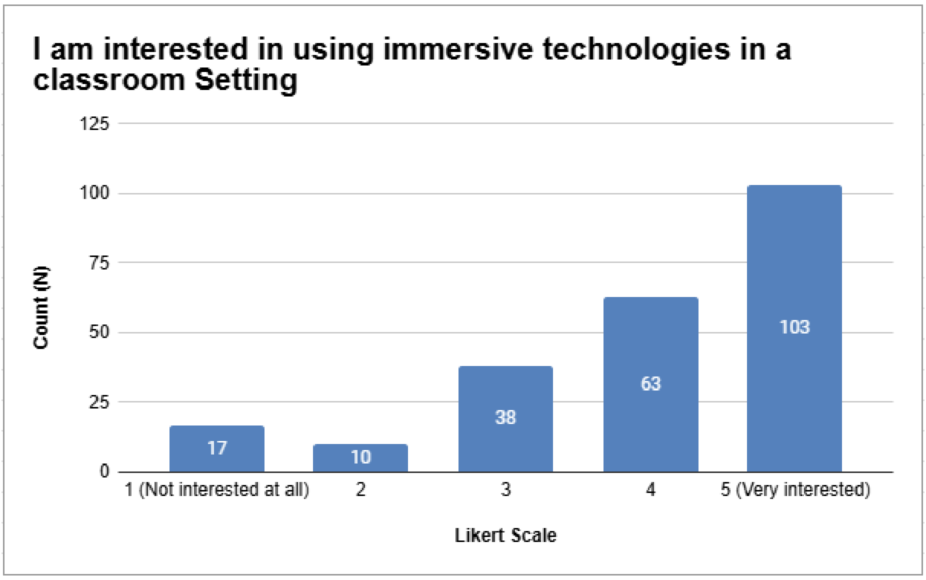


**Fig. 2.** VT SME Faculty & Staff interest in using XR tools in curricula.

In terms of device familiarity, VR HMDs were the most frequently used devices, with 60.40% (n = 61) of respondents having prior experience. AR glasses had been used by a smaller proportion of respondents (18.81%, n = 19), while the remaining respondents indicated familiarity with 'Other' types of devices (e.g., computers, mobile devices, MR). Additional findings on the types of resources and tools used for XR module development are shown below in Table 2.

**Table 2.** Resources and tools used for XR module development

| Question | Answer Choices | % | n |
|---|---|---|---|
| **How long did the development process take from design to implementation?** | *1-3 months* | 14.93 | 10 |
| | *3-6 months* | 17.91 | 12 |
| | *6-12 months* | 29.85 | 20 |
| | *Longer than 12 months* | 13.43 | 9 |
| | *Ongoing* | 23.88 | 16 |
| | | ***Total*** | **67** |
| **What type of immersive technology development tools were used?** | *Unity* | 37.8 | 31 |
| | *Unreal Engine* | 14.63 | 12 |
| | *Mozilla Hubs* | 6.1 | 5 |
| | *ARKit and ARCore* | 4.88 | 4 |
| | *Blender* | 10.98 | 9 |
| | *Maya* | 7.32 | 6 |
| | *Other* | 18.29 | 15 |
| | | ***Total*** | **82** |
| **What resources were used to develop the immersive activity/activities?** | *ARIES* | 11.11 | 7 |
| | *Department Development Team* | 11.11 | 7 |
| | *Third-party Developers* | 6.35 | 4 |
| | *VT Library* | 6.35 | 4 |
| | *Student Workers* | 44.44 | 28 |
| | *Other* | 20.63 | 13 |
| | | ***Total*** | **63** |
| **For what specific activity was the immersive technology/technologies intended?** | *Classroom/education* | 33.05 | 39 |
| | *Research* | 33.05 | 39 |
| | *Recruitment* | 5.93 | 7 |
| | *Performance/Recreation* | 22.88 | 27 |
| | *Productivity/Communication* | 4.24 | 5 |
| | *Other* | 0.85 | 1 |
| | | ***Total*** | **118** |

## 4.2 Focus Groups

Based on the thematic analysis of focus group discussions, participants consistently emphasized that XR implementation should be driven by clear pedagogical goals rather than technological novelty. As one participant noted, "XR implementation must be driven by clear pedagogical goals and demonstrable improvement over existing methods." The analysis also revealed a strong emphasis on collaborative frameworks (11 responses), particularly focusing on cross-disciplinary cooperation (2 responses), instructional design expertise (3 responses), technical support (2 responses), and faculty engagement (4 responses). Strategic planning considerations (6 responses), while mentioned less frequently, emerged as crucial for successful implementation. Participants highlighted the importance of creating specific scenario-based applications (2 responses), piloting small-scale projects (1 response), and focusing on module scalability (2 responses).

**Pedagogical Transformation & Tools**

Results indicated a significant shift toward more experiential, active, and project-based learning, accompanied by an increased emphasis on formative assessment due to advancements in AI and technology. Participants suggested exploring alternative technologies, such as WebXR and tablet-based VR, to enhance accessibility and cost-effectiveness.

**SME Recommendations**

SMEs indicated that high-fidelity simulations for specific applications, particularly in safety training, proved especially effective. However, they emphasized the necessity of careful planning, clearly defined instructional objectives, and thorough preparation to fully realize the effectiveness of the developed module. XR experiences conducted without these essential components frequently resulted in disorganized and uncomfortable participant experiences, consequently increasing the likelihood of simulation sickness.

**Development Barrier & Pain Points**

The rapidly evolving technological landscape posed challenges for long-term planning, while software compatibility and sustainability remained ongoing concerns. SMEs reported limited expertise in instructional design for XR, coupled with a lack of clear pedagogical frameworks for integration. Scalability issues for group activities and collaborative learning, along with administrative barriers such as software licensing and data privacy, further complicated implementation efforts. Additionally, concerns emerged regarding user discomfort and motion sickness.

## 5 Discussion

The findings from this study provide valuable insights into the current state of XR implementation in higher education, particularly highlighting the challenges and opportunities in developing and integrating XR content into academic curricula at an R1 institution (i.e., Virginia Tech's Blacksburg campus).

**Current State of XR Adoption and Usage Patterns**

The survey results indicate a significant gap between interest and opportunity to implement XR within higher education. The majority of the participants indicated they are interested in using immersive technologies in a classroom setting (44.59%; n = 103) despite over half (51.29%; n = 119) of respondents having never used immersive technology in educational settings. This finding aligns with the broader challenge of technology integration in education, suggesting a need for more systematic approaches to XR implementation. The relatively low facilitation rate (19.70%) further emphasizes the existing gap between XR's potential and its actual deployment in educational contexts.

**Barriers and Implementation Challenges**

Our findings reveal multiple layers of challenges in XR adoption. The identified barriers span technical, pedagogical, and resource-related dimensions. First, the limitation of pre-built materials (16.72%; n = 125) represents a significant barrier, highlighting the need for more readily available educational XR content. Second, usability issues (16.48%; n = 15) and digital accessibility concerns (12.09%; n = 11) emerged as notable obstacles, suggesting the importance of considering human-centered design principles in XR development. Third, focus group participants emphasized the critical role of frameworks (11 responses) and strategic planning (6 responses), indicating that successful XR implementation requires cross-disciplinary collaboration.

**Pedagogical Integration and Transformation**

The thematic analysis of focus group discussions revealed a strong emphasis on pedagogical considerations. The frequent mention of key terms such as "learning" (7 responses), "assessment" (5 responses), and "objectives" (3 responses) underscores the importance of aligning XR implementation with educational goals. This aligns and supports a previously mentioned SME recommendation that "XR implementation must be driven by clear pedagogical goals and demonstrable improvement over existing methods."

**XR Implementation Recommendations**

Based on our findings, we propose several recommendations for institutions seeking to develop course-specific XR modules. First, focus on creating discipline-specific scenario-based supplemental applications and pilot small-scale projects before scaling up. Secondly, it is recommended to have high-fidelity applications for the most realistic experience but also recommend considering low-fidelity supplemental modules, focusing on core concepts, which will be “better” in educational settings where you can create more modules that increase student learning outcomes and engagement while reducing development effort, cost, and time. Third, strengthen collaborative frameworks by incorporating instructional design expertise and technical support in the XR development cycle. Fourth, consider developing and providing alternate modes of immersive experiences such as tablet- or computer-based VR to increase accessibility and reduce cost. Fifth, given the emphasis on formative assessment and the shift toward experiential learning, develop specific evaluation metrics for XR-enhanced learning experiences to justify adoption. Next, you can choose to outsource the XR module development to create a viable product in a short period of time, but it requires significant project management (i.e., coordination and communication between stakeholders) to effectively create an XR module that aligns with course objectives and compliances. It should be noted, ownership and usage of the developed content should be discussed. Lastly, if possible, it is recommended to develop module templates internally that align with institutional teaching practices and policies. This approach promotes sustainability, accessibility, and consistent branding, while ensuring the templates can be easily accessed, distributed, and adapted across a variety of disciplinary use cases.

**Limitations and Future Research**

While this study offers valuable insights, several limitations should be acknowledged. The research is ongoing and currently in Phase III of the XR CoP initiative. As part of future efforts, an External XR Development Guideline will be produced, featuring a case study on the outsourcing of a supplemental XR training tool for Environmental Health and Safety Portable Fire Extinguisher (EHS PFE) training. This case study will highlight the use of an iterative development process and will evaluate the tool’s effectiveness in terms of performance and self-efficacy. Following this, its impact on learning outcomes will be assessed more comprehensively.

Future research should also examine the internal development process for XR modules, identifying key barriers and offering practical recommendations. Additionally, longitudinal studies are necessary to evaluate the long-term effects of XR tools on both learning outcomes and pedagogical transformation.

## 6 Conclusion

This study advances the understanding of XR development in higher education by providing actionable recommendations for institutions planning to integrate XR technologies. Through comprehensive survey data and focus group analyses, it reveals a significant gap between interest (44.59%) and actual involvement in XR development (20.26%) or use (28.45%). This adoption gap stems from interconnected challenges, including pedagogical misalignment, technical barriers, and insufficient institutional support. Findings suggest that supplemental XR modules—rather than full-scale digital twin replacements—present more practical and sustainable solutions. Successful implementations were marked by strategic planning and clear learning objectives, yet challenges such as limited pre-built materials (16.72%), usability issues (16.48%), and accessibility concerns (12.09%) persist. Institutions are encouraged to prioritize modular content, foster cross-campus collaboration, develop faculty support structures, and adopt scalable solutions tailored to instructional goals and budget constraints.

Looking ahead, the XR Community of Practice (XR CoP) at Virginia Tech will evaluate externally developed XR tools through a case study on an outsourced Environmental Health & Safety Portable Fire Extinguisher (EHS PFE) training module. This pilot will assess the module's impact on learner performance and self-efficacy. Future research should focus on long-term sustainability strategies and institutional readiness to support broader XR adoption. These efforts aim to bridge the gap between XR's educational potential and its real-world implementation by establishing comprehensive, scalable guidelines for XR integration across diverse academic contexts.

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**Disclosure of Interests.** The authors have no competing interests to declare that are relevant to the content of this article.

# Appendix A

**Introduction**

1. Which group do you belong to?
   a. Virginia Tech Undergraduate Student
   b. Virginia Tech Graduate Student
   c. Virginia Tech Faculty
   d. Virginia Tech Staff
   e. None of the above
2. Are you a distanced learning? (are taking on or more classes virtually through Zoom or other video conferencing)
   a. Yes
   b. No

**Branching**

3. What is your involvement with immersive technology in a higher education setting?(Immersive technologies refer to virtual reality (VR), augmented reality (AR), extended reality (XR), virtual environments)
   a. Have been involved in the development of an immersive technology (commissioned, built, or somehow involved in facilitating development)
   b. Have only been a user of immersive technology
   c. Have never used immersive technology in higher education

**XR Development**

4. For what specific activity was the immersive technology/technologies intended?
   a. Classroom/education activity
   b. Research
   c. Recruitment
   d. Performance/Recreation
   e. Productivity/Communication
   f. Other
5. *Please a short description of the immersive technology projects (i.e. specific functionalities, goals of the project)*
6. What colleges/programs/departments were these immersive technologies developed for?
   a. College of Agriculture and Life Sciences
   b. College of Architecture, Arts, and Design
   c. Pamplin College of Business
   d. College of Engineering
   e. College of Liberal Arts and Human Sciences
   f. College of Natural Resources and Environment
   g. College of Science
   h. Other (program/department)
7. What resources were used to develop the immersive activity/activities?
   a. ARIES
   b. Department development team
   c. Third party developers
   d. VT Library
   e. Student workers
   f. Other
8. What type of immersive technology development tools were used?
   a. Unity

   b. Unreal Engine
   c. Mozilla Hubs
   d. ARKit and ARCore
   e. Blender
   f. Maya
   g. Other
9. What immersive technology hardware was used?
   a. Dedicated XR-capable computer
   b. VR Headset
   c. AR Glasses
   d. Mixed Reality Headset
   e. AR-Capable Smartphones
   f. External Motion Tracking Systems
   g. Additional Trackers
   h. Other
10. How did students/users access the immersive technology?
    a. Personal equipment
    b. Long term borrowed equipment
    c. Temporarily borrowed equipment
    d. Other
11. How long did the development process take from design to implementation? (Multi-select if applicable to multiple projects)
    a. 1-3 months
    b. 3-6 months
    c. 6-12 months
    d. Longer than 12 months
    e. One or more projects are ongoing
12. How do you perceive the success of the XR activity development project/projects in meeting project goals?
    a. 1 (did not meet goals)
    b. 2
    c. 3
    d. 4
    e. 5 (met all goals)
13. Were you ever involved with facilitating an immersive tool in higher education? (Teaching with the tool, helping others use the experience at an event)
    a. Yes
    b. No
14. What challenges did you encounter facilitating the immersive technology experience?
    a. Usability and user experience of the tool
    b. Evaluating the effectiveness of the tool
    c. Technical issues
    d. Maintenance issues
    e. Student/user adoption
    f. Limited hardware
    g. Physical accessibility
    h. Digital accessibility
    i. Integration with existing activities
    j. Other
15. Please briefly describe experiences facilitating immersive technology activities (specific activities/challenges)
16. Are you interested in being contacted for follow up questions on your XR development project?
    a. Yes
    b. No

17. Have you also been a user of immersive technologies in higher education? (i.e. classroom, remote learning)
    a. Yes
    b. No

**XR User Questions**

18. As an end user, I thought the immersive technology capabilities met my requirements.
    a. 1 (did not meet)
    b. 2
    c. 3
    d. 4
    e. 5
    f. 6
    g. 7 (met all)
19. As an end user, I thought the immersive technology was easy to use.
    a. 1 (not easy)
    b. 2
    c. 3
    d. 4
    e. 5
    f. 6
    g. 7 (easy)

**Ranking Resources**

20. Please consider what support you believe to be most important for immersive technology development for higher education.Rank the following types of support (you do not need to rank an item you don't consider important)
    a. Pedagogical training (for effective tool integration) __________
    b. Immersive tech expert collaboration __________
    c. Assessment/evaluation methods __________
    d. Tech support (for troubleshooting and maintenance) __________
    e. Funding (for immersive tool research/development) __________
    f. Development software access __________
    g. Hardware access (i.e. VR headsets, AR mobile phones) __________
    h. Immersive tech developers __________
    i. Training for development skills __________
    j. Usability/User experience testing __________
    k. Student/user training (for immersive tech adoption) __________
21. What other resources/support for immersive technology development do you consider important? (N/A if fully covered by previous ranking question

**Interest/concerns of Implementing XR**

22. Please rate how much you agree with the following statements (1 being 'Do not agree'; 5 'being Agree')
    a. I am interested in using immersive technologies in a classroom setting
    b. I am interested in using immersive technologies for research
    c. I am interested in using immersive technologies for recruitment (i.e. recruitment for different majors/colleges at Virginia Tech)
    d. I believe immersive technologies can enhance the teaching experience.
    e. I believe immersive technologies can improve student engagement and motivation while learning

23. What are your concerns or barriers when considering the adoption of immersive technologies in education? (Select all that apply)
    a. Cost of implementation
    b. Lack of technical expertise
    c. Lack of access to necessary equipment
    d. Concerns about privacy and data security
    e. Limited immersive content/pre-built materials available
    f. Resistance to change from students or professors
    g. Other
24. What are motivations you consider with the adoption of immersive technologies
    a. Increased engagement
    b. Active learning
    c. Simulating the real world
    d. Accessibility
    e. Competitive advantage (over other programs or schools)
    f. Research opportunities
    g. Accommodating large numbers of students/users
    h. Other

**Demographic**

25. Which category best describes you?
    a. White (Eg: German, Irish, English, Italian, Polish, French
    b. Hispanic, Latino or Spanish origin (Eg: Mexican or Mexican American, Puerto Rican, Cuban, Salvadoran, Dominican, Colombian)
    c. Black or African American (Eg: African American, Jamaican, Haitian, Nigerian, Ethiopian, Somalian)
    d. Asian (Eg: Chinese, Filipino, Asian Indian, Vietnamese, Korean, Japanese)
    e. American Indian or Alaska Native(Eg: Navajo nation, Blackfeet tribe, Mayan, Aztec, Native Village or Barrow Inupiat Traditional Government, Nome Eskimo Community)
    f. Middle Eastern or North African (Eg: Lebanese, Iranian, Egyptian, Syrian, Moroccan, Algerian
    g. Native Hawaiian or Other Pacific Islander (Eg: Native Hawaiian, Samoan, Chamorro, Tongan, Fijian)
    h. Other/Prefer Not to Say
26. What is your sexual orientation?
    a. Asexual
    b. Bisexual
    c. Gay
    d. Heterosexual or straight
    e. Lesbian
    f. Pansexual
    g. Queer
    h. Other/Prefer Not to Say
27. How do you identify your gender?
    a. Man
    b. Non-binary
    c. Woman
    d. Other/Prefer Not to Say
28. What college do you belong to/are you affiliated with?
    a. College of Agriculture and Life Sciences
    b. College of Architecture, Arts, and Design
    c. Pamplin College of Business
    d. College of Engineering
    e. College of Liberal Arts and Human Sciences

  f. College of Natural Resources and Environment
  g. College of Science
  h. Other (If you do not work directly with a college, include what entity you work with at Virginia Tech)

29. What department do you belong to/are you affiliated with?

**Further Interest**

30. Are you interested in participating in a focus group on immersive technology use at Virginia Tech?
    a. Yes
    b. No
31. Would like to be entered in the raffle (Selected participants will receive $50)?
    a. Yes
    b. No

# Appendix B

**Introduction (5 min).**

Hello, and welcome to the Technology-Enhances Learning & Online Strategies (TLOS) XR Community of Practice Focus Group. My name is Tony Lee, an M.S. Human Factors & Systems Engineering graduate research assistant supporting this initiative. This session is part of Virginia Tech's Phase III XR CoP, which aims to establish a framework for systematic eXtended Reality adoption at Virginia Tech.

**Objectives of the Phase III is:**

- Identify a system structure for integrating XR into teaching and learning activities;
- Explore a use case XR implementation in teaching and learning.
- Disseminate best practices and find university stakeholders.

We encourage you to share your experiences and opinions, regardless of your level of familiarity with XR and immersive technologies. During this session we will be recording audio and notes.

**Icebreaker (5 min).**

- Share your name, department/role, and any previous experiences with XR (whether through research projects and/or class activities).
- Does anyone have anything they would like to say before we get started?

**Review of XR Integration Document (30 min)**

- Envisioning the Future
  - How do you envision education and classrooms evolving in the next 5 years?
- Barriers & Challenges
  - What are some concerns you have about XR usage in classrooms?
- Based on your previous experiences, what worked well and what didn't?

- Active Stakeholders
  - Active stakeholders are those who are the ultimate users of the system.
- Passive Stakeholders
  - Passive stakeholders are those who are responsible for creating a system.
- Who else should be involved as active or passive stakeholders in XR implementation? If any?

**Faculty Needs**

- What are some specific stakeholder needs?
- Are there any liability issues to consider? How do you think faculty or staff could be held liable, what should VT do to protect you?
- Do you have sufficient access to XR hardware and software right now? How do you envision this type of access?
- What kind of training or support do you need to successfully integrate XR into your curriculum?
- What are some ethical concerns (e.g., data privacy and security) related to XR technology? How would you recommend solving this issue?
- Are there financial barriers that need to be addressed? How should faculty get the funding for developments? External tend to be more expensive but quick and quality and Internal may be cheaper but takes longer.
- What barriers exist in terms of approvals, such as approved vendor payment processes, etc.?
- What should be considered or what is the threshold when measuring the success of XR implementation?

**HFE-UX (20 min)**

Review the XR EHS Portable Fire Extinguisher Module

- Do you have any specific feedback on what could be improved?
- How do you think XR can benefit your curriculum?
- Do you prefer Fully Digital Twin vs. Supplemental Tool?
- Can you provide examples of what you would like to create using XR?
- How frequently would you use the developed XR module?

**Closing Remarks (5 min)**

- Any Questions?

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