ISSN: 2473-4901
v11 n6392

Virtual, Augmented, and Extended Reality in Higher Education: Trends, Applications, Impacts

Tan Gürpinar
Tan.Gurpinar@qu.edu

Sana Quadri
Sana.Quadri@qu.edu

Shizhen (Jasper) Jia
Shizhen.Jia@qu.edu

Luis Sa-Couto
Luis.SaCouto@qu.edu

Guido Lang
Guido.Lang@qu.edu

Business Analytics & Information Systems
School of Business, Quinnipiac University
275 Hamden, CT, USA

Abstract

As extended reality (XR) technologies — encompassing virtual reality (VR), augmented reality (AR), and mixed reality (MR) — gain prominence across various industries, academic institutions face the task of preparing students for careers in this evolving field. XR-related programs and initiatives have emerged to meet the growing demand for professionals skilled in immersive technologies, but the question arises: how do these programs deliver added value compared to existing educational offerings? This study investigates the current state of XR integration in higher education, focusing on universities with AACSB-accredited business schools in the United States, and examines the similarities and differences across institutions. Drawing from a comprehensive sample of 547 U.S.-based institutions, this research assesses the landscape of XR-related academic offerings. By analyzing curricula, initiatives, and applications, we identify the extent of overlap between programs and consider relevant disciplines such as computer science, design, business, health sciences, and engineering. Our findings indicate that approximately 43% of higher education institutions integrate XR technologies across diverse academic programs, often in conjunction with fields such as AI, robotics, and interactive media, to align with evolving industry demands. This analysis provides concrete guidance for institutions aiming to launch or refine XR curricula by identifying current trends, disciplinary contexts, and skill emphasis. By understanding the commonalities and distinctions between XR and related fields, educators can tailor offerings to equip students with the skills needed to thrive in the immersive technology sector. Furthermore, this research serves as a resource for institutions seeking to bridge the gap between traditional educational models and the dynamic world of XR.

Keywords: Extended Reality, Virtual Reality, Augmented Reality, Digital Learning, Immersive Technologies, Higher Education Innovation

ISSN: 2473-4901
v11 n6392

Virtual, Augmented, and Extended Reality in Higher Education: Trends, Applications, Impacts

Tan Gürpinar, Sana Quadri, Shizhen (Jasper) Jia, Luis Sa-Couto and Guido Lang

1. INTRODUCTION

Extended reality (XR), including virtual reality (VR), augmented reality (AR), and mixed reality (MR), has rapidly evolved from a niche innovation to a set of mature technologies with demonstrable value across different domains, such as healthcare, education, architecture, and business (Rauschnabel et al., 2022). Rather than supplementing existing workflows, XR is increasingly integrated into core professional practices, facilitating new modes of spatial visualization, embodied interaction, and remote collaboration (Zhou et al., 2025). As XR technologies become more accessible and technically robust, their adoption is prompting substantial shifts in how knowledge is produced, experienced, and transferred within both industry and academic contexts.

The growing relevance of XR has created a pressing need for educational institutions to prepare students for the emerging demands of the immersive technology sector (Burke et al., 2025; Khlaif et al., 2024; Küpeli & Gürpinar, 2023). While industries increasingly look to XR to improve services and operations, many universities are only beginning to explore how to integrate XR meaningfully into their curricula (El Dandachi et al., 2023). There is, however, an urgent challenge: institutions must not only adopt new technologies but also design programs that cultivate the technical, creative, and interdisciplinary skills required to build, deploy, and manage XR applications effectively (Düdder et al., 2021; Karamitsos et al., 2024; Mentzer et al., 2025).

Despite growing awareness of XR's importance, a significant gap exists between recognizing its potential and knowing how to embed it within higher education. Universities face key questions:
(1) *What domains of knowledge and skill sets are most frequently emphasized in XR-related curricula across higher education institutions?*
(2) *How do academic programs integrate and balance the technical, creative, and ethical dimensions of XR within course structures?*
(3) *To what extent do current XR course offerings reflect the interdisciplinary nature of the field, how are cross-departmental collaborations facilitated?*

This paper seeks to map and analyze the current landscape of XR-related academic offerings in U.S. higher education, with a focus on institutions accredited by the AACSB. By systematically reviewing course offerings, program structures, and curricular emphasis across a representative sample of 547 U.S. universities, we aim to provide insights into how institutions are equipping students with XR-relevant competencies. Our research identifies trends, shared themes, and points of divergence across programs, offering input for universities seeking to expand or refine their XR initiatives. As demand for professionals with XR-related skills accelerates — reflected in industry job postings, research collaborations, and startup activities — academic institutions face the opportunity to position themselves as leaders in immersive technology education. This paper contributes to that effort by offering a structured analysis of current practices and by highlighting areas where academic innovation can help bridge the gap between traditional learning models and the demands of the fast-evolving XR sector. In the following sections, we present the scientific and industry context, describe our methodology, and share key findings as well as recommendations to support the development of robust XR education pathways.

2. SCIENTIFIC BACKGROUND

XR technologies offer new modalities for experiential and immersive learning, prompting institutions to rethink traditional models of instruction (Rauschnabel et al., 2022). This section reviews the current landscape of XR integration in higher education, situating it within broader pedagogical and institutional transformations. The adoption of XR technologies in higher education is a complex process that requires aligning technological innovations with institutional objectives (El Dandachi et al., 2023). Institutions are increasingly viewing XR not only as a tool for fostering innovation and enhancing student engagement, but also as a strategically aligned initiative that advances research, interdisciplinary collaboration, and workforce development (Mentzer et al., 2025). Strategic alignment refers to the extent to which XR initiatives are integrated into an institution's broader mission – such as enhancing digital infrastructure, promoting cross-disciplinary learning, and addressing evolving industry

ISSN: 2473-4901
v11 n6392

demands. A study by Huang & Hew (2021) found that higher education institutions with strong leadership and a clear vision for technology integration were more successful in aligning XR projects with their strategic objectives. Successful XR integration, therefore, requires active participation from leadership to create an environment that supports innovation, experimentation, and long-term sustainability.
Industry trends offer important context for understanding which domains of knowledge and skill sets should be emphasized in XR-related curricula. An analysis of XR-related job advertisements by Verma et al. (2021) revealed that employers consistently seek competencies in areas such as user interface (UI) and user experience (UX) design, 3D asset creation, real-time graphics rendering, and technological foundations as well as system architectures. These technical and creative skill sets reflect the interdisciplinary demands of XR development, where design thinking, programming proficiency, and visual storytelling converge. While not drawn directly from educational institutions, this study provides a relevant benchmark against which academic offerings can be evaluated, particularly with regard to their responsiveness to workforce needs.

For XR to be successfully integrated into university curricula, faculty and staff must develop a diverse set of competencies, which are essential to ensuring effective use and application. Following Tusher et al. (2024), these competencies extend beyond technical expertise and should include the following:

- **Pedagogical Competence**: Faculty must be equipped to design and implement XR-based learning modules that meet educational objectives. This includes the ability to integrate immersive experiences with traditional teaching methods, ensuring a seamless learning process.
- **Technological Proficiency**: While XR adoption requires specialized technical knowledge, faculty and staff also need to be familiar with the basic infrastructure, software, and hardware involved in XR applications. Collaboration with IT departments and external partners often plays a key role in addressing these needs.
- **Organizational Strategy**: Business schools need to develop and communicate a strategic vision for XR implementation that aligns with broader academic and institutional goals. This vision should include plans for faculty development, infrastructure investments, and long-term sustainability of XR initiatives.
- **Ethical and Equity Awareness**: As XR technologies have the potential to enhance educational experiences, it is critical to ensure affordability and accessibility to all students, including those with disabilities. Ethical concerns surrounding privacy, data security, and the potential for addiction must also be considered.

Finally, and addressing our third research question, the interdisciplinary nature of XR is increasingly emphasized in both literature and institutional practice. Studies from Radianti et al. (2020) highlight that XR curricula often merge elements from computer science, design, psychology, and subject-specific domains (e.g. medicine, architecture or marketing), underscoring the need for cross-disciplinary fluency. Institutional initiatives further reflect this trend. For example, Yale University's Blended Reality Applied Research Project brings together faculty from engineering, arts, the humanities, and library sciences to co-develop XR applications (CCAM, 2025). Similarly, the University of Michigan’s XR Initiative fosters collaboration across departments including education, nursing, design, and computer science, offering centralized support and funding for interdisciplinary XR course development (Georgieva et al., 2024). These models not only facilitate shared resource use and curricular innovation, but also highlight a broader shift in higher education toward breaking down departmental barriers in response to the transdisciplinary demands of emerging tech.

3. RESEARCH METHODOLOGY

This study investigates the extent and nature of XR integration in higher education curricula. To achieve this, a systematic search was conducted in June and July 2025 to identify XR-related course offerings across U.S. universities. The research design builds upon established methodological frameworks used in prior analyses of emerging technologies in higher education, with an emphasis on course identification, classification, and curricular analysis (see Figure 1) (Ceccucci et al., 2020; Gürpinar et al., 2025). As a starting point, the official AACSB website was queried to identify all U.S.-based institutions with AACSB-accredited business schools offering undergraduate or graduate programs. This yielded a list of 547 universities, representing a diverse and representative sample of higher education institutions across the country. The selected sample served as the basis for a comprehensive
.

ISSN: 2473-4901
v11 n6392

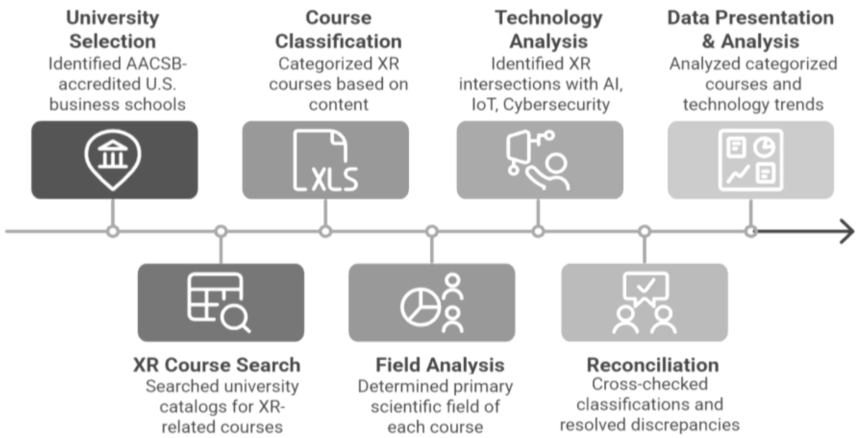

Figure 1: Research Methodology Overview

examination of XR-related course offerings and programmatic integration

Identification of XR-Related Courses

Following the identification of the institutions, the next step involved searching the websites and academic catalogs of the identified universities for courses related to XR technologies. The search term "extended reality" was used, encompassing virtual reality (VR), augmented reality (AR), and mixed reality (MR). The goal was to identify universities offering at least one course related to XR in their curricula. From this search, 236 universities were identified as offering at least one course on XR technologies. This represents approximately 43% of the total number of universities surveyed. Data such as the course title, department, school, level, and course descriptions were then collected from the universities' catalogs and websites. This data was used for subsequent analysis.

Course Classification

The courses were classified into categories based on their content and subject matter. In the first step, the authors reviewed course descriptions of the identified XR-related courses to determine the primary topics covered. A set of categories was developed from this initial review, ensuring that all relevant XR-related subjects were accounted for. Each course was then mapped to one of these iteratively established categories. If a course did not fit into any of the existing categories, a new category was created, and all authors were notified of the update. To ensure consistency, multiple authors independently reviewed samples of courses and classified them. This method is similar to the approach employed by Yang & Wen (2017) in their survey of university IS program curricula (Yang & Wen, 2017). Once all courses were independently classified, the authors reconciled their categorization through peer debriefing. If discrepancies in classification arose, the authors discussed and agreed upon the final categorization.

Field Analysis

In addition to classifying the courses, the analysis also examined the associated academic disciplines, intended learning outcomes, and course formats. This was accomplished by systematically reviewing department affiliations and course descriptions to determine the primary focus of each course. Specifically, courses were categorized based on whether they (1) focused explicitly on XR topics, (2) addressed other subject areas while incorporating XR technologies as tools, or (3) combined both approaches. This framework provided insights into the ways XR is integrated into curricula across disciplines and levels of study.

Technology Analysis

The interplay between XR and other emerging technologies was another criterium and it was analyzed how XR technologies intersect with technologies such as Artificial Intelligence (AI), Internet of Things (IoT), and Cybersecurity. This was accomplished by manually scanning course descriptions for references to these technologies, as well as relevant synonyms and related terms.
Understanding the technological intersections allowed the research team to assess how XR is positioned within the broader landscape of digital technologies.

ISSN: 2473-4901
v11 n6392

Reconciliation and Data Presentation
To ensure the accuracy and consistency of the data, a final peer review process was implemented similar to one described for the initial course categorization. Samples of the field and technology analysis were also cross-checked by multiple authors to reach consensus on items with unclear allocation. The data collected from the university catalogs were analyzed and presented using a variety of statistical and qualitative methods. Course classifications were analyzed to determine the prevalence of different XR-related topics across higher education curricula. The field analysis was used to understand how XR is integrated into various academic disciplines. Finally, the technology analysis was conducted to identify trends in how XR is being combined with other emerging technologies, providing insight into the broader direction of innovation in higher education.

4. FINDINGS AND DISCUSSION

XR-related courses are offered across a wide range of university departments and programs, as shown in Table 1. While most are hosted by departments related to Media & Film or Engineering & Computer Science, Engineering, and Media Studies, some also appear in less expected areas like Psychology, Archeology, or Nursing. A significant number of courses are also offered in a multidisciplinary format, cross-listed across several departments. A more detailed distribution of XR courses across scientific disciplines and programs can be obtained from Appendix A.

Department	Count	(%)
Media, Film & Interactive Design	252	27.6
Engineering, Computing & Technology	238	26.1
Fine Arts & Performing Arts	94	10.3
Interdisciplinary / Emerging Fields	86	9.4
Humanities & Languages	61	6.7
Education & Instructional Technology	54	5.9
Business, Management & Policy	26	2.8
Health & Biomedical Sciences	22	2.4
Social Sciences	19	2.1
Science & Math	17	1.9
Architecture & Planning	14	1.5
Multidisciplinary / University Offering	30	3.3

Table 1: Departments Offering XR Courses

The number of XR courses offered by universities varies. Most schools (311) do not offer any XR courses (Figure 3). However, 236 schools offer at least one, 142 at least two, and 16 schools offer a portfolio of more than 10 XR courses (Figure 3).

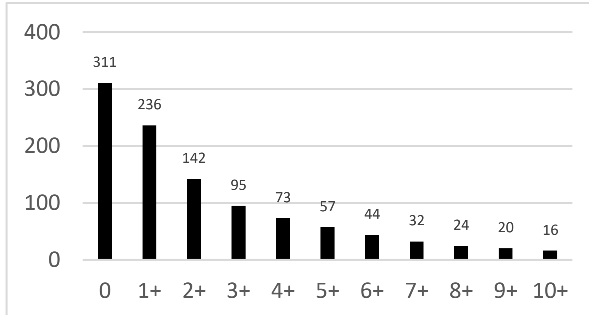

Figure 2: University's Number of XR Courses

The majority (57%) of the XR courses are offered are at the undergraduate level, 26% at the graduate level, and 17% can be taken at both the graduate and undergraduate levels.

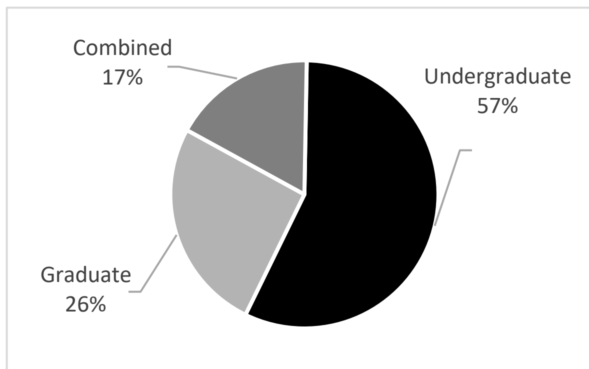

Figure 3: Academic Level of XR Courses

A greater total number of public universities offer XR courses (157 Public vs 79 Private, see Table 2). However, in looking within the university types, a slightly greater percentage of the private universities offer XR courses. 44.4% of the private universities offer at least one XR course. Whereas 42.5% of the public universities offer XR courses.

	Count	Total	Percentage
Private	79	178	44.4%
Public	157	369	42.5%

Table 2: Universities Offering XR Courses

Universities with larger undergraduate populations are generally more likely to offer XR courses. Among institutions with 25,001 to

ISSN: 2473-4901
v11 n6392

30,000 students, 68% provide at least one XR course. This figure increases to 80% for universities enrolling over 45,000 students. In contrast, smaller institutions with fewer than 5,000 undergraduates show a considerably lower participation rate, with 32% offering XR courses (see Table 3).

University Size	Count	Total	Percentage
0 - 5,000	59	186	31.7%
5,001 - 10,000	58	149	38.9%
10,001 - 15,000	28	71	39,4%
15,001 - 20,000	29	45	64,4%
20,001 - 25,000	21	35	60,0%
25,001 - 30,000	17	25	68,0%
30,001 - 35,000	12	19	63,2%
35,001 - 40,000	6	9	66,7%
40,001 - 45,000	2	3	66,7%
>45,000	4	5	80,0%

Table 3: Number of Undergraduate Students

Appendix A presents a diagram illustrating the distribution of XR course offerings across seven broad scientific fields and the departments within them. The largest share of XR courses falls under Engineering, Technology, and Mathematics, accounting for 26% of all courses. Within this field, Computer Science, Information Technology, and Engineering & Architecture programs are the most common providers. Arts, Design, and Media make up 18% of XR offerings, with Visual and Performing Arts, Emerging Media Arts, Graphic Design, Game Design, and Interior Design among the primary programs. Humanities and Social Sciences also represent 18%, including departments or programs such as Sociology, Anthropology, Literature and History, and Psychology. Communication and Journalism account for 6%, often through programs focused on teaching and learning, instructional design, and educational psychology. Natural and Life Sciences contribute 3%, with courses linked to Geology, Biology, and Archaeology. Finally, Business and Management, encompassing Innovation and Business Technology, Information Management, and Marketing, make up 3% of the XR courses.

To further understand the focus areas of current XR courses, we categorized them based on the specific thematic content and educational objectives, rather than by scientific field or department as discussed previously. Therefore, Table 4 presents thematic categories along with the number of courses assigned to each. The largest category here is Arts, Humanities & Culture, with 177 courses, reflecting a strong presence of XR in creative and cultural studies. This is followed by XR Development & Programming with 137 courses, and Communication and Journalism with 131 courses, indicating significant emphasis on both technical skills and media applications. The XR Design & User Experience category includes 112 courses, while Game Design & Interactive Media accounts for 99 courses, highlighting the importance of interactive and user-centered aspects of XR. XR Technological Foundations has 80 courses, covering the core principles behind XR technologies. Other notable categories include Specialized & Applied Topics (56) as well as Architecture, Engineering, and Built Environment (50). The category of Specialized and Applied Topics reveals how XR technologies are deeply integrated into broader ecosystems of emerging technologies. In the "Artificial Intelligence for Enterprise Program," students explore concepts like image and video recognition, natural language processing, and robotics process automation, with AR used to simulate AI workflows in business environments. Likewise, "Cyber Science Fundamentals" introduces students to a suite of technologies – including quantum computing, blockchain, and AI – to examine how they collectively shape the future of cybersecurity and data systems. Within this context, XR is explored as a medium for visualizing complex cyber systems, simulating attack scenarios, and fostering experiential understanding of abstract digital infrastructures. The course "Emerging Technologies in Digital Transformation" positions XR alongside cloud computing, IoT, drones, and digital assets, emphasizing its role in transforming business operations and user engagement. In the engineering domain, "Manufacturing Automation" explores XR through virtual environments and simulation in shared production scenarios, industrial design, prototyping, diagnostics and smart maintenance. These courses demonstrate how XR does not stand alone but interacts with a constellation of technologies, enabling immersive, applied learning that prepares students for innovation in the evolving tech landscape. In total, 913 courses were categorized across the introduced thematic areas, demonstrating the breadth and diversity of XR education offerings.

ISSN: 2473-4901
v11 n6392

Course Topic Category	Courses in Category
Arts, Humanities & Culture	177
XR Development & Programming	137
Communication, Journalism	131
XR Design & User Experience	112
Game Design & Interactive Media	99
XR Technological Foundations	80
Specialized & Applied Topics	56
Architecture, Engineering, Built	50
Education, Training, Pedagogy	44
Science & Research Applications	27
Grand Total	**913**

Table 4: XR Course Topic Categories

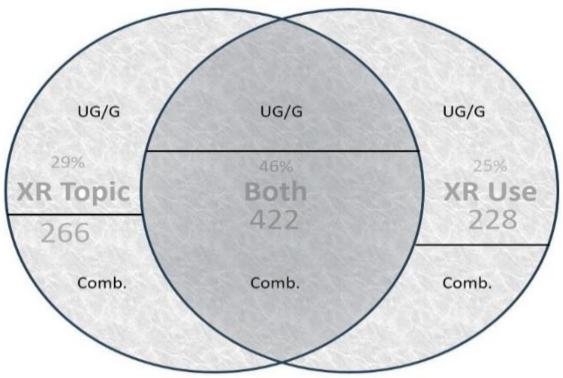

Figure 4: XR Course Distribution by Type

Regarding the nature of the XR courses offered, the analysis reveals three distinct types of course focus. A total of 266 courses are explicitly centered on XR topics, providing foundational knowledge and theory. Another 228 courses, while not primarily focused on XR, incorporate XR devices or technologies as part of their curriculum, applying XR in broader disciplinary contexts. Notably, 422 courses combine both aspects, covering XR topics in depth while also providing hands-on experience with XR devices and applications, especially in courses designed for both undergraduate and graduate student (indicated as "comb." for combined courses, see Figure 4). This blend of theoretical and practical engagement highlights the diverse approaches universities take to integrating XR education, balancing conceptual understanding with experiential learning.

Finally, the examination of detailed learning objectives from XR-related courses reveals how institutions are structuring competencies across technical, creative, ethical, and interdisciplinary dimensions. This analysis conducted in Table 5 draws from courses with comprehensive learning outcomes to illustrate the specificities of XR education and provide concrete examples for curriculum designers seeking to develop or refine their programs. The developed competency framework provides curriculum designers with a structured approach to developing comprehensive XR education programs that balance technical depth, creative application, and ethical responsibility while maintaining relevance to evolving industry demands and interdisciplinary collaboration requirements.

5. CONCLUSION

This study examines the current landscape of XR course offerings across AACSB-accredited universities in the US. Among 547 universities reviewed, larger institutions are more likely to offer XR-related courses, reflecting growing institutional capacity and student demand. The courses identified span diverse scientific fields, with a notable concentration in Technology and Engineering programs, alongside significant representation from Arts, Design, Media, Humanities, and Social Sciences. Our findings highlight how universities are beginning to address the multidimensional nature of XR education by balancing technical, creative, and applied competencies. XR courses frequently emphasize foundational knowledge and development skills, but also incorporate design, user experience, and domain-specific applications such as architecture, archeology, or production and maintenance. This distribution reflects efforts to cultivate the varied skill sets required for XR practitioners — from programming and system design to critical thinking and creative problem-solving.

Contributions

Our study confirms that XR education spans a wide array of disciplines, yet meaningful cross-disciplinary collaboration remains limited. For example, while AR applications in medical training benefit from architectural insights (e.g., spatial design, lighting), and VR simulations of archaeological sites require narrative techniques from journalism, such integration is rarely reflected in curriculum design. By mapping the departmental distribution of XR courses, this study exposes both the promise and the fragmentation of XR education across academic silos.

ISSN: 2473-4901
v11 n6392

Competency Domain	Key Learning Areas	Representative Learning Objectives
Technical Competency	1. Foundation Knowledge: System architecture, 3D modeling, data formats.	"Describe elements of typical system architecture for virtual environments (VEs)" (Naval Postgraduate School)
	2. Hardware Integration: Tracking technologies, haptic devices, display systems.	"Determine if a task may benefit from a 3DOF or 6DOF haptic device" (Northwestern State University)
	3. Systems Integration: AI integration, data strategies, converged communications.	"Learn best practice data strategies, VR/MR/AR and robotic solutions" (Virginia Tech)
Human-Centered Design and UX	1. Human factors: Perceptual modalities, sensory integration, cognition.	"Describe processes supporting human sensing of visual, auditory, haptic stimuli" (Northwestern State University)
	2. Design Documentation: User tasks, interface techniques, spatial interaction.	"Use design documentation, object-oriented software design, project management, and design iterations through user feedback" (University of Tennessee at Martin)
	3. Application Design: Use case analysis, technology matching, domain specificity.	"Identify applications benefiting from different visual displays" (Northwestern State University)
Ethical and Safety Considerations	1. Health and Safety: Cybersickness, simulator sickness, safety protocols.	"Understand health, social, privacy, and security issues and human factors that influence usability" (Augusta University)
	2. Professional ethics: Research ethics, human subjects, professional conduct	"Describe elements of professional ethics in research domain" (Northwestern State University)
Interdisciplinary Integration & Research Methods	1. Domain application: Industry contexts, military applications, interdisciplinary use.	"Use diverse interdisciplinary approaches to explore the intersection between society, culture, technology, and digital connectivity" (Norfolk State University)
	2. Research method: User studies, usability evaluation, empirical research	"Design and execute study evaluating usability of VEs" (Naval Postgraduate School)

Table 5: XR Learning Areas and Objectives

This fragmentation reflects a broader institutional challenge that our study brings into focus. Higher education institutions tend to be highly siloed, with campus units maintaining their own priorities, cultures, and budgets. Launching collaborations proves difficult because it requires cutting across existing organizational structures and sometimes developing entirely new ones. Nonetheless, leading institutions have begun to overcome these barriers through coordinated initiatives. For instance, the University of Michigan's XR Initiative supports over 40 projects across 17 of the university's 19 schools and colleges, while Yale University's Blended Reality Applied Research Project brings together faculty from engineering, arts, humanities, and library sciences.

Despite these successes, significant barriers persist including the need to align diverse departmental priorities, establish sustainable funding mechanisms, and address the lack of shared technical expertise across departments. Many XR investments remain isolated pilot projects that – while demonstrating potential – are unlikely to scale due to lack of sustainability and collaboration.

The significant number of courses combining theoretical and hands-on learning indicates a

ISSN: 2473-4901
v11 n6392

trend toward experiential education, essential for mastering immersive technologies. This pedagogical shift reflects recognition that XR enables experiential learning, where learners can practice skills in a safe, controlled environment. Medical students can rehearse clinical procedures through immersive simulations, while simulation-based learning has proven particularly effective in healthcare, engineering, and emergency response fields.

Finally, our analysis shows how XR technologies increasingly support experiential learning across disciplines. Courses in the dataset leverage tools such as 360° video to grant access to environments otherwise unreachable – such as enabling students to explore coral reefs without leaving the classroom. Others incorporate immersive storytelling and gamified elements to deepen engagement, transforming history lessons into interactive encounters with historical figures. These curricular choices reflect a shift from novelty-driven adoption toward pedagogically grounded XR use. As such, they underscore XR's potential not only to enhance learning outcomes, but also to promote inclusion, accessibility, and deeper cognitive engagement in higher education.

Limitations and Future Research

While this study provides a broad overview of XR course offerings and emerging patterns in curricular design, it also carries limitations. The data collection and analysis process were conducted manually, highlighting the need for automated methods to retrieve course information and apply large-scale AI-driven classification and analysis. Such tools would improve scalability and consistency across future studies. Additionally, our scope was limited to AACSB-accredited schools, which future work could extend to a broader range of institutions.

Future research should explore how academic programs translate XR-related competencies into curricula aligned with evolving industry demands, identifying gaps and areas for pedagogical innovation. A key challenge lies in bridging the disconnect between the technological sophistication of XR tools and the pedagogical principles necessary for effective learning – particularly as many XR developers may lack educational design expertise.

Despite promising examples, many XR initiatives remain isolated pilot projects that face significant barriers to scalability. Resource constraints continue to limit adoption, from hardware performance issues and user discomfort to accessibility challenges and integration difficulties within existing educational infrastructures. Developing high-quality XR content also requires specialized technical and instructional expertise that remains scarce in many institutions.

Periodic reassessment will be essential to track how XR education evolves in tandem with advances in technology and labor market expectations. Critical areas for future inquiry include creating more affordable and ergonomic XR devices, establishing effective instructional models tailored to immersive media, and conducting longitudinal research to evaluate XR's long-term impact on learning, employability, and professional development.

Ultimately, universities have a central role in shaping the XR talent pipeline. Doing so requires sustained cross-disciplinary collaboration, long-term investment, and a research agenda that addresses both current limitations and future opportunities in immersive education.

6. REFERENCES

Burke, D., Crompton, H., & Nickel, C. (2025). The Use of Extended Reality (XR) in Higher Education: A Systematic Review. *TechTrends.* Advance online publication. https://doi.org/10.1007/s11528-025-01092-y

CCAM (2025). Center for Collaborative Arts and Media. https://ccam.yale.edu/projects/research-blended-reality

Ceccucci, W., Jones, K., Toskin, K., & Leonard, L. (2020). Undergraduate Business Analytics and the Overlap with Information Systems Programs. *Information Systems Education Journal*, *18*(4), 22–32.

Düdder, B., Fomin, V., Gürpinar, T., Henke, M., Iqbal, M., Janavičienė, V., Matulevičius, R., Straub, N., & Wu, H. (2021). Interdisciplinary Blockchain Education: Utilizing Blockchain Technology From Various Perspectives. *Frontiers in Blockchain*, *3*(1), Article 578022. https://doi.org/10.3389/fbloc.2020.578022

El Dandachi, I., El Nemar, S., & El-Chaarani, H. (2023). XR and the Metaverse: New Opportunities in Education. In R. El Khoury & B. Alareeni (Eds.), *Contributions to Environmental Sciences & Innovative Business Technology. How the Metaverse Will*

ISSN: 2473-4901
v11 n6392

Reshape Business and Sustainability (pp. 51–61). Springer Nature Singapore. https://doi.org/10.1007/978-981-99-5126-0_6

Georgieva, M., Nelson, J., LaFosse, R., & Contis, D. (2024). XR in Higher Education: Adoption, Considerations, and Recommendations. *Educause Review*. https://er.educause.edu/articles/2024/1/xr-in-higher-education-adoption-considerations-and-recommendations

Gürpinar, T., Verma, A [Aashman], Leonard, L., Jones, K., & Ceccucci, W. (2025). Blockchain Education: Evaluating Programs, Curricula, and Integration with Emerging Technologies in Higher Education. *Information Systems Education Journal*, *23*(5), 20–29. https://doi.org/10.62273/WNRJ3445

Huang, B., & Hew, K. F. (2021). Using Gamification to Design Courses: Lessons Learned in a Three-year Design-based Study. *Educational Technology & Society*, *24*(1), 44–63.

Karamitsos, I., User, E., Al-Qadi, S., Attias, S., Belling, A., Grant, J., Gürpinar, T., & et al. (2024). Exploring the Future of the Metaverse Through - A Holistic Introduction of Virtual Worlds for Policy Makers. *INATBA Report*.

Khlaif, Z. N., Mousa, A., & Sanmugam, M. (2024). Immersive Extended Reality (XR) Technology in Engineering Education: Opportunities and Challenges. *Technology, Knowledge and Learning*, *29*(2), 803–826. https://doi.org/10.1007/s10758-023-09719-w

Küpeli, O., & Gürpinar, T. (2023). Towards a definition of the industrial metaverse applied in context of the blockchain and web3 ecosystem. *Blockchain and Cryptocurrency Conference*.

Mentzer, K., Frydenberg, M., & Li, S. (2025). Exploring VR-Enhanced Learning in Business Education: A Multi-Site Study. *Information Systems Education Journal*, *23*(5), 30–43. https://doi.org/10.62273/WOFR1838

Radianti, J., Majchrzak, T. A., Fromm, J., & Wohlgenannt, I. (2020). A systematic review of immersive virtual reality applications for higher education: Design elements, lessons learned, and research agenda. *Computers & Education*, *147*, 103778. https://doi.org/10.1016/j.compedu.2019.103778

Rauschnabel, P. A., Felix, R., Hinsch, C., Shahab, H., & Alt, F. (2022). What is XR? Towards a Framework for Augmented and Virtual Reality. Computers in Human Behavior, 133, 107289. https://doi.org/10.1016/j.chb.2022.107289.

Tusher, H. M., Mallam, S., & Nazir, S. (2024). A Systematic Review of Virtual Reality Features for Skill Training. Technology, Knowledge and Learning, 29(2), 843–878. https://doi.org/10.1007/s10758-023-09713-2

Verma, A [Amit], Purohit, P., Thornton, T., & Lamsal, K. (2021). An examination of skill requirements for Augmented Reality and Virtual Reality job advertisements. https://doi.org/10.48550/arXiv.2108.04946

Yang, S. C., & Wen, B. (2017). Toward a cybersecurity curriculum model for undergraduate business schools: A survey of AACSB-accredited institutions in the United States. Journal of Education for Business, 92(1), 1–8. https://doi.org/10.1080/08832323.2016.1261790

Zhou, D., Globa, A., & McLaughlan, R. (2025). A Systematic Review of XR, Spatial, and Physical Interaction in Remote Communication for Emotional Well-Being in Older Adults. In Q. Gao & J. Zhou (Eds.), Lecture Notes in Computer Science. Human Aspects of IT for the Aged Population (Vol. 15809, pp. 427–448). Springer Nature Switzerland. https://doi.org/10.1007/978-3-031-92707-2_28

6. REFERENCES

ISSN: 2473-4901
v11 n6392

Appendix A. Distribution of XR Courses Across Scientific Disciplines and Programs