Exploring Immersive Reality: Case Studies From a North American University

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Abstract
Higher education institutions are increasingly utilizing immersive technology to support interdisciplinary research, teaching, and student development. For instance, Arizona State and Pennsylvania State have established virtual reality (VR) spaces on their campuses to support interdisciplinary research, the integration of VR into teaching, and VR development spaces for students. These spaces provide opportunities for students, faculty, and researchers to explore subjects in new, immersive ways and to experiment with cutting-edge technologies. For example, immersive virtual reality (I-VR) in particular creates a computer-generated, multi-sensory, 3D environment that can be accessed through devices such as head-mounted displays (HMDs), headphones, and controllers and/or haptic gloves (Freina and Ott 2015; Murcia-López and Steed 2016), and has been employed in educational contexts including astronomy, biology, business, engineering, and history. These immersive experiences enable students to interact with the content in a way that simulates real-life scenarios, manipulating objects and exploring environments that would be impossible or impractical to do in real life (Bailenson, 2018; Slater and Wilbur, 1997). The present study features vignettes that illustrate how faculty at a North American university are utilizing immersive technology in their teaching and research endeavors. These vignettes form a critical component of our larger initiative to expand immersive spaces for faculty across the university. The study highlights faculty perspectives, challenges, and requirements when integrating immersive technology such as VR and augmented reality (AR) into their courses. By exploring how higher education instructors are currently utilizing or are seeking to use VR/AR, the study provides a comprehensive understanding of how this technology can be incorporated into higher education.

Keywords: Higher Education, Virtual Reality, Augmented Reality, VR, AR

Introduction

Immersive technologies like virtual reality (VR) and augmented reality (AR) are gaining traction in higher education (Radianti et al., 2020) for their potential to bridge the gap between curriculum and practical skills needed in students' respective fields of study. These environments essentially merge the physical world with the virtual by using devices that project virtual spaces and objects into a real space. VR in particular affords the ability to be situated in various settings which can put the learner in scenarios and environments where they can discover, interact, collaborate, problem-solve in a relevant context. AR enhances the real world through the projection of virtual objects. As immersive technology integration gains momentum (European Commission, 2019; Office of Education Technology, 2017), there is tremendous promise for VR to positively influence teaching and learning outcomes (European Commission, 2019; Freeman et al., 2019). However, best practices for effectively incorporating immersive tools like VR and AR into higher education are still emerging. There is a pressing need to explore faculty development models that provide pedagogical guidance, technical support, and hands-on experimentation with integrating extended realities across diverse disciplines.

Procedure

The main objective of this study was to explore the extent to which faculty have integrated VR/AR technology in their courses. Specifically, it sought to answer: (1) *To what extent have faculty at the university implemented VR/AR technology?*; (2) *What is the purpose/reason for using or interest in VR/AR?*; (3) *What challenges and barriers did faculty encounter?*; (4) *What were student responses to VR/AR?*; (5) *What support services are they looking for?* To answer these questions, a survey was deployed and data was collected from faculty who have already engaged in VR/AR integration and/or participated in communities of practice or professional development offered at the campus. The data was used to inform decisions surrounding the creation of dedicated spaces and services to enhance faculty awareness and use of immersive technology.

The survey was composed of questions aimed at identifying academic programs in which the faculty had integrated or expressed interest in integrating VR/AR technology, as well as identifying the types of activities they created or hoped to create using the technology. Additionally, the survey aimed to identify spaces and services faculty sought assistance from, uncovered challenges encountered by faculty and students, and described student reactions to the experiences. Lastly, the survey gathered feedback to help identify what services would help faculty in the future. To achieve these objectives, QuestionPro survey software was utilized to create a survey of 19 questions for faculty who utilized VR/AR in their courses and 12 questions to faculty who are interested in these technologies. The survey was emailed to 97 faculty who were identified from a professional development list of participants from various VR/AR workshops and communities of practice.

Findings

The main objective of this survey was to explore the extent to which faculty have integrated VR/AR technology in their courses. This involved identifying academic programs in which the faculty had integrated or expressed interest in integrating VR/AR technology, as well as the types of activities they had created or hoped to create using the technology.

Background Statistics

Of the 97 faculty who were sent the survey, 29 responded and 22 completed the survey, resulting in a completion rate of 75.86%. Of the total number of respondents, 12 implemented VR/AR, and 17 did not. Of the 12 implementers, only 8 completed the survey. The non-implementers can be grouped into interested and not interested (table 2). Of the interested group, 9 completed the survey.

Among faculty who did not implement VR/AR but expressed interest, 8 indicated that if they developed a VR/AR activity, it would be for undergraduate students while 1 faculty member answered that it would be for graduate students. Surprisingly, 4 of the interested faculty indicated that they already engaged with some VR/AR spaces at the university.

Overall, respondents came from a diverse pool of academic disciplines (table 1) with notable representations from communication (3 faculty) and computer science (2 faculty). The remaining respondents came from various other fields. It is encouraging to see a range of disciplines spanning creative arts to hard sciences exploring the integration of VR/AR technology into their teaching practices.

Faculty Group	Department Affiliation	Frequency
Implementers	Communication	1
	Computer Science	2
	Interior design	1
	Nuclear Engineering	1
	Communication: Journalism	1
	Not disclosed	1
	Geography	1
Interested	Architecture	1
	Not disclosed	1
	Consumer Studies	1
	Geosciences	1
	Chemistry	1
	School of Performing Arts	1
	Communication	1

Veterinary Medicine	1
History	1

Table 1: Department groupings of respondents.

Faculty Who Implemented VR/AR

VR/AR Technology Used

It was found that among VR/AR implementers that 5 utilized virtual reality, while 1 used augmented reality, and 2 faculty utilized both. Looking more closely, the immersive technologies that were applied include 360 videos and 360 images, VR head-mounted displays (HMDs), AR apps, and one implementer used a cave automatic virtual environment (CAVE).

Purpose of Using VR/AR

When asked about the purpose for integrating VR/AR technology, 4 respondents indicated that they used the technology for student-created VR/AR experiences, while the other respondents' VR/AR experiences were instructor-created. The student-created activities served various purposes, such as research credit, app development, and 360 video storytelling creation. For example, computer science students in a Fall 2022 capstone course developed an AR app called *Sculpture Park*, where users could add 3D models to the campus Drillfield. In contrast, a course in the School of Communication had students create a VR simulation for research credit.

Some of the instructor-created activities leveraged the VR affordance of immersing students in environments that are otherwise inaccessible, unsafe, or impractical to visit or experience in real life. For example, using the CAVE space, nuclear engineering students safely explored a nuclear reactor core and checked the amount of fission neutrons and power at different sections. The geography respondent used 360 images to create virtual fieldtrips, allowing students to immerse in various landscapes such as Southern Beech and New Zealand where students can learn more about the glacial features by interacting with hotspots embedded in the environment. The goal was to bring students to landscapes that they would otherwise be less likely to ever visit. Although less 'immersive' as compared to HMD or CAVE VR systems, interior design students experienced various classroom designs and design elements by scanning a QR code that linked them to a virtual image on their cellphones. Then they used their phones to rotate the view of the room in 360 degrees. The objective was to provide feedback on classroom designs that impact learning for students who identify as neurodiverse. Students in journalism created their own stories by shooting video, then editing it in Adobe Premiere where they could add motion graphics and other text to their stories. Afterwards, they reviewed their work using the HTC Vive. These applications of VR/AR represent a wide range of uses across disciplines.

Implementers of VR/AR indicated that the process from planning to implementation took 1-3 months for 50% of the respondents, while 37.5% it took 3-6 months, and 12.5% took 6-12 months. None of the respondents indicated that it took over a year, which isn't surprising since there wasn't development of a VR (HMD) immersive experience that requires time-intensive development.

Faculty Challenges

Because four of the activities involved student-created VR/AR, the challenges identified from the faculty responses to this question seemed to center a bit on both faculty and student challenges (table 2) for developing and implementing VR/AR. For instance, it was noted by both the School of Communication and the journalism program that there was a lack of student experience using VR development tools such as Unity. Journalism stated that they would like to have more of a plug and play ability to make it easier for students to work in. Further, they also noted that they are looking into eye tracking in future implementations of the activity that will assist in the analysis of students' work. Computer science students who had to develop an AR product as their capstone project, the challenges centered on overall integration between a physical system and immersive environment. A respondent from an unidentified program indicated that they encountered no challenges, while the geography respondent specified that they could not access Captivate software and lacked the knowledge to know how to publish a Captivate product. The nuclear engineering respondent seemed to struggle with space and capabilities for what they were trying to accomplish.

Challenge/barrier	Program
Student lack development skills using immersive technology	Communication
Student lack of knowledge using Unity	Journalism
Overall integration	Computer science
UX design	Computer science
Lack software skills/knowledge (faculty)	Geography
Need more facilities provide immersive capabilities	Nuclear engineering

Table 2: Faculty challenges and barriers.

Services and Spaces Used

The immersive spaces used (table 3) varied among the respondents with 4 respondents indicating that they used their department VR/AR space, 2 used the library immersive studio, while another indicated that they used a third-party vendor app. One used an AR app, while in the 'other' category, respondents specified the use of an open-source platform, and 1 other used the CAVE space. Those who used a department space came from computer science, the School of Communication, journalism, and interior design.

A few of the respondents indicated that they used more than one space. For instance, the interior design respondent utilized a department space as well as an AR app and the communication respondent utilized their department space as well as a third-party vendor.

The geography respondent used the library studio and an open-source platform. The 3 respondents in the 'other' category specified the use of the CAVE space, an open-source platform, and the other indicated it was the capstone course which involved students creating an AR app.

Space	Frequency	% of Total
Library studio	2	18.18%
Department Studio	4	36.36%
Third-party vendor	1	9.09%
AR app	1	9.09%
Other	3	27.27%

Table 3: Immersive spaces used.

As a follow up question for those who used non-department spaces such as the library studio implementers were asked what specific services they sought from these spaces. These respondents noted that they used tracking and 3D audio, consultation, use of equipment, and collaboration. A respondent from computer science indicated that they collaborated with a member of the library studio to help with development using Unity, AR Foundation, and XCode.

Student Challenges

When asked about student challenges (table 4), the responses generally referenced student access to the VR/AR technology, although other notable challenges related to accessibility, navigating the VR environment, and technical issues. Both access to VR/AR technology as well as technical issues each shared 33.33% of the identified challenges with accessibility and navigating the environment each constituting 16.67% of the identified challenges for students. Computer science specifically noted UX design as a challenge for their students and sought help with the library studio.

Challenge/barrier	% of Total
Access to VR/AR technology	33.33%
Navigating the VR/AR environment	16.67%
Accessibility	16.67%
Technical issues	33.33%

Table 4: Student challenges and barriers.

There are studies that indicate that VR technology can cause motion sickness, particularly to new users and access to the technology (Makransky & Mayer, 2022). To address this issue, surveyed faculty offered alternatives such as having those students watch their peers in the immersive environments, while other faculty had their students watch videos instead of engaging with the technology.

In all except 1 case, respondents indicated that they had students who either could not participate or did not want to participate in the VR/AR activity. These respondents (table 5) indicated that they offered alternative activities for those who chose not to participate or could not participate due to accessibility. With nearly 60%, watching other students engage in an immersive activity was the most common alternative. The single respondent who selected 'other', noted that all their students participated in the VR/AR activity.

Alternative Activity	% of Total
Watched videos	28.57%
Watched other students engage in VR/AR	57.14%
Other	14.29%

Table 5: Alternative activities.

How Students Accessed the Activities

37% of the respondents indicated that their students accessed the immersive activity using their own personal equipment, while 12.5% used the Institute for Creativity, Arts, and Technology (ICAT) space. The other 50% used department studios and the CAVE.

Assessment

The survey also looked at how faculty approached assessment and found that 50% had no assessment tied to the VR/AR activity while 25% of students received an assessment after the VR/AR activity and 12.5% had assessment embedded in the VR/AR environment. These results aren't surprising because over half of the respondents indicated that the activity was student created rather than instructor created.

Student Reactions

Figure 1: A word cloud listing the student reactions.

Overall, the reactions from the student users were positive with various sentiments describing the students as *interested, engaged,* and *motivated*, *happy, enthusiastic* (interior design), *impressed* and *interested*, and *excited*. Specifically, the interior design respondent said students were enthusiastic, adding that the experience allowed students to observe a "*complete visual of designs including colors and textures, relationship to space to design elements, and orientation to the room*." Another respondent noted that students' interest in becoming involved in his/her research activities increased. The geography respondent has tested it with participants as it is in early development, but the participants were excited. A respondent who observed that students were interested also mentioned that the content of the simulation may not be memorable because it was a prototype. Student reactions were all based on what the faculty member observed during the process.

Future Support

When asked about the likelihood the respondent would use VR/AR again (table 6), 87.5% of the faculty who implemented VR/AR indicated that they were likely to highly likely to use the technology again, while one respondent indicated that they were highly unlikely, although this respondent also indicated that they do not have the technical expertise and that user friendly software is critical for them to use it again.

Likelihood	% of Total
Very likely	50%
Likely	37.5%
Not likely	0%
Very not likely	12.5%

Table 6: Likelihood to use VR/AR again.

Suggestions for future support that would help respondents next time include the establishment of more facilities with ability for high performance computing in immersive environments (nuclear engineering), professional development (geography) on incorporating VR/AR, as well as understanding available software for creating VR experiences, where and how to access it, how to go about content capture, and overall workflow process that includes how to post immersive experiences to a server. Offering user friendly software was suggested by two respondents with one going on to suggest a more plug and play ability for development. Another recommended bringing in graphics design students to assist with UX design.

Interested Faculty

Reasons for Faculty Interest in VR/AR Integration

The first question in the survey asked if the respondent implemented VR/AR. For those who answered in the negative, a follow up question asking if they were still interested in using VR/AR was given. 9 faculty indicated that they were still interested in using the technology, while 5 others responded as not interested, and 3 more indicated they were but never completed the survey. The following is a summary of the 9 who completed the survey.

According to the interested faculty group, the primary motivation for incorporating VR/AR technology is to prepare students for their future, which is noted by 3 faculty members. Other reasons for using VR/AR technology align with some common uses of VR/AR currently reflected in the literature. For example, experiencing environments that are not feasible in the real world such as simulations of various architectures or Earth science fieldtrips where students can view the impacts of large-scale surface mine and folds and faults on Earth. The veterinary medicine respondent indicated that they would use it to help students practice spay and neuter procedures in a simulated environment before practicing on a real animal. Respondents in the creative arts indicated that they are interested in using VR/AR for activities such as students developing multimedia storytelling to add another dimension to the story while another respondent in theater indicated they could use it for artistic creation and distance communication.

Program(s)	Reasons to Utilize VR/AR
Architecture	Simulate environments in architecture
Undisclosed	Uses virtual worlds
Consumer studies	Prepare students for work lives
Geosciences	Virtual Earth science field trip
Chemistry	It is a new innovation
Theater arts, performing arts, Center for Communicating Science	Useful for teaching and learning. Need to incorporate to advance students in the field.

Communication (journalism)	Storytelling. Expose students to the technology since it is being used in new outlets. Students can create simple projects.
Veterinary medicine	Teaching tools
History	Unsure but curious how to integrate

Table 7: Reasons for wanting to utilize VR/AR.

The respondents who noted that they were not sure exactly what activity or topic they would want to use VR/AR in, indicated that they see value in the technologies and want to use it for teaching and learning. The history respondent wasn't sure how the technologies could be used in their field but indicated that it could possibly help students understand the history of technology better. A similar response from the chemistry, architecture, and consumer studies respondents who noted that they were unsure about how to incorporate VR/AR into their courses. This also echoes some sentiments from the implementer group who wanted to understand more about the application of VR/AR in their respective fields.

Types of Services Interested Faculty Sought

When asked what types of services they would need to move forward with effectively incorporating VR/AR technologies into their courses, each respondent indicated the need for technological support. Specifically, they specifically noted a "lack of knowledge" of the technologies, which appears to be a common theme. All respondents except for two mentioned pedagogical assistance as a service they would need. Some specified that they want to learn how to effectively incorporate the technology into their course, while the VR/AR design and development were other services noted by 6 of the faculty respondents. Having a dedicated space for VR/AR was another commonly referenced service noted by 5 faculty with some specifically mentioning space for multiple students (including one with over 100 students) to engage and space for the design and development of VR/AR activities. 4 of the interested faculty described the need for technological and pedagogical services as well as design, development, and a dedicated space with the tools and resources needed to support them throughout the process.

Spaces Interested Faculty Used

Surprisingly, 40% of interested faculty indicated that they have interacted with VR/AR spaces on campus, 60% indicated that they have not interacted with these spaces. Figure 2 breaks down the different spaces interested faculty have reached out to.

When asked if they would use a dedicated immersive technology space for faculty, 66.67%, or 6 respondents said that they would use it while 33.33%, or 3 respondents were unsure. The unsure group may be apprehensive due to the challenges and barriers they identified, such as having a lack of time or lack of knowledge of the technology.

Challenges Interested Faculty Encountered

There were several challenges identified by the faculty respondents with the most mentioned challenge being the lack of knowledge. This includes not knowing the technology, who to partner with, where to start, what is possible, and how it can be used in their courses.

Other notable challenges include the cost, availability, and accessibility of the technologies for students, as well as the lack of support available to assist with incorporating the technology into their teaching. One respondent expressed concern about the structure of control and power---who gets to use the technology and space. In veterinary medicine, limited options for anatomy--citing challenges with primary funding, getting community support, knowing what technologies exist, knowing how to make different systems such as VR and haptic work together, and integrating into a "curriculum that is already full." They further noted that there was a lot of interest in using VR/AR in their program, but the referenced challenges are a barrier that would need to be addressed. Based on these responses, it appears that there is interest, however not knowing the technology and how to use it nor where to go for support seems to resonate across respondents.

Future Support

When asked about the support and resources they would need to successfully integrate VR/AR into their courses, the respondents made several suggestions. The architecture respondent noted that they want to understand best practices for integrating VR/AR into architecture project development. The geosciences respondent stated that they are very unfamiliar with VR/AR and suggested some training program to get started and counts towards professional development that would be like a workshop for faculty to develop VR/AR that can be reviewed by peer faculty. The veterinary medicine respondent suggests that it would be helpful to know who can work on VR/AR projects, for example providing experiential learning opportunities for student workers with skills related to VR/AR development as well as possible funding options in this area of support would be beneficial. Further, they want to know what technologies exist and how to make them work together (e.g., VR with haptic).

Discussion

It is important to note that the faculty who were surveyed were from a list of faculty who participated in various professional development workshops and communities of practice on XR technology, therefore not every instructor across campus who implemented or are interested in VR/AR were surveyed. However, among the audience who were surveyed, it appears that faculty are in the early stages of VR/AR integration with most indicating that they have a lack of knowledge of not only the technology, but what it can and cannot be used for. It was surprising to see that there was broad representation of faculty respondents from various fields, from performing arts to the liberal arts, and the hard sciences. Such broad faculty interest in VR/AR can potentially lead to cross-disciplinary collaboration and innovation, creative applications of VR/AR including interdisciplinary opportunities for students, and create opportunities for students to use and develop with the technology. Moreover, knowing that a diverse pool of faculty have interest in VR/AR can help those working in faculty development bring to life the potentiality that VR/AR can offer in the classroom, from enhancing teaching and learning to preparing students for the workforce and beyond. However, there are some challenges and barriers that need to be addressed for any wider adoption to take place or for any scaling up of VR/AR spaces and services.

The spaces used by all respondents reflect use of spaces from across campus. The fact that nearly half of the respondents utilized their department VR/AR space for development indicates that some departments already have some infrastructure and capacity for VR/AR and faculty are making use of it, whether it be for student-created or instructor-created experiences. They also utilized the development services of existing VR/AR spaces while interested faculty noted the need for various types of support throughout the planning through integration process.

The types of activities the implementing respondents described vary across levels of immersive technology being used. For example, interior design using 360 images that students access using their phones, while journalism is having students create 360 videos to engage in storytelling then review those stories in VR using a head-mounted display. This reflects the fact that faculty are making use of the extant spaces, services, and expertise. Although, there is a need for more spaces, technologies, expertise, and services as denoted by numerous respondents.

Over 66% of interested faculty indicated that they would be interested in a dedicated space for faculty to engage with VR/AR. In order to support faculty, finding ways to enhance their knowledge of VR/AR including: an understanding of what technologies and tools are out there and how they are being used in the respective fields, providing instructional design services to help them identify topics or activities that are appropriate for VR/AR use, and allowing them to also work with those with development skill sets, can address some of the challenges and barriers identified from this data. Aside from instructional design assistance, someone who can set up, maintain, troubleshoot various VR setups (manage an immersive studio) as well as someone with development experience in Unity who could lead students developers would be a few invaluable resources that can have a meaningful impact and help facilitate faculty adoption on a broader scale.

Conclusion and Implications

As virtual reality (VR) and augmented reality (AR) technologies continue rapid development, higher education institutions should strategically explore potential applications and implications (Johnson et al., 2016). Though not yet ubiquitous, adoption of immersive technologies will likely accelerate (Radianti et al., 2020). Early investigation by faculty innovators, researchers, and instructional design teams can uncover effective practices and identify infrastructure needs for wider deployment (Southgate et al., 2019). This proactive inquiry will allow universities to make informed investments to support pedagogical uses of VR/AR and prepare students with relevant future-focused skills.

The present study aims to identify current exploration of VR/AR among faculty at our institution. Surveying early adopters across academic programs provides insight into intended use cases, integration approaches, benefits, and pain points. While limited to those already expressing interest, initial findings will inform expanded efforts to gauge readiness among broader faculty and student populations. Developing dedicated VR/AR creation facilities and support services tailored to uncovered needs can progress institutional capacity for educational applications of these emerging technologies.

In anticipation of a world where immersive technology affects our everyday life, universities have an obligation to ready students for professional contexts transformed by these technologies. This study serves as the starting point of a broader effort to explore VR/AR technology in the context of higher education. Future efforts will expand to student perceptions, as well as the creation of a VR space dedicated to faculty and supported in the areas identified in this study.

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