The Inclusive Campus of the Future: Diversity, Equity, and Inclusion, Extended Reality, and Student Success in Minority-Serving Institutions

A Landscape Literature Review

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Introduction

This landscape review takes as its starting point that very few four-year colleges and universities in the United States, the largest XR market in the world for education, reflect the diversity of the communities they serve, locally or nationally. (The Business Research Company 2022) That holds for the student populations and, to an even greater extent, the faculty. A recent study by McKinsey & Company estimated that it might take as many as 70 years to achieve equity for student populations and *one thousand years* for faculty populations to reflect the diversity of the United States in general. (Ellsworth, 2022) That shocking statistic points to the fact that something must be done. There is no single way to solve this profoundly systemic challenge of increasing inclusiveness in higher education. But the general belief in the importance of inclusiveness in higher education may be reflected in the fact that over 90% of colleges and universities in the United States have invested in DEI (Diversity Equity and Inclusion) administrators and strategies. (Ellsworth, 2022) However, emerging educational landscapes based on immersive digital technologies might help us uncover new pathways beyond inclusion and enhance the sense of "belonging" on virtual campuses. (Nunn, 2021) These digital technologies currently include VR (Virtual Reality), AR (Augmented Reality), and MR (Mixed Reality), which fall under the broader term of XR (Extended Reality). This review will explore ideas and best practices in using XR to support and enhance college and university diversity, equity, and inclusion efforts, particularly as these practices may affect minority-serving institutions, their students, and faculty members. In addition, the review seeks examples of how the 21st-century skills known as the "4C's" (Creativity, Critical Thinking, Collaboration, and Communication) can be engaged to support diversity, equity, and inclusion strategies.

The review also looks at how XR technologies and the idea of the metaverse developed over time, often in parallel with developments in early career preparation, STEM (Science, Technology, Engineering, and Mathematics) education, empathy building, and student success in higher education and beyond into careers. There are several examples of how the literature on XR and diversity, equity, and inclusion in higher education reflected changes in tech industries through the introduction of hardware and software innovations. (Wingfield 2014)

Finally, the landscape review has informed the development of the related conference/workshop on "The Inclusive Campus of the Future: DEI, XR, and Student Success in Minority-Serving Institutions" held at FIU (Florida International University) in Miami on December 4-6, 2022. (Gebelein et al. 2022)

Likewise, the work on the December event has revealed multiple new directions for the research that supplement what was discovered through the ongoing landscape review. When considered together, the landscape review and the conference/workshop present one of the most comprehensive and multi-dimensional explorations of the possibilities for an immersive digital experience in higher education designed to support student success by including diverse participants and viewpoints in minority communities.

Background

The review grew from a first-year experience module at FIU (Florida International University) called COMMUNITY VR (Virtual Reality). The project invited teams of four first-year students into a virtual Everglades environment to build a structure that keeps participants above the virtually rising water. After the experience, students reflect upon how they communicated, collaborated, thought critically about their challenges, and responded creatively within the environment. This virtual world supplied essential parallels to the university experience itself. It started us thinking about how similar experiences might scale up to become part of a much larger environment of digital university learning experiences in VR. With many institutions engaged in creating what we will loosely call a new educational "metaverse," we looked to find ways to include more diverse voices in this area of study, inclusive opinions in conversations about learning, and more equitable opportunities for participation in technologically enhanced learning environments. The metaverse offers unlimited potential for students to get to know one another, develop greater empathy for the diversity of backgrounds they will meet in college, and enable a more grounded understanding of the human condition. We must acknowledge and remove personal and collective biases, preparing students for a world supported by XR technology.

COMMUNITY VR was developed in partnership with EDUCAUSE and HP as part of a larger research initiative led by Yale University and including Syracuse University, MIT (Massachusetts Institute of Technology), Harvard University, Dartmouth College, Hamilton College, Gallaudet University and Case Western University called "Campus of the Future: 3D Technologies in Academe." Writing about the initiative, Dr. Jeffery Pomerantz named five critical findings about XR in the classroom. (Pomerantz, 2018) These include 1) the ability of students to explore enhanced virtual "superpowers" that help them conceptualize their own identities and capacities within this unfamiliar environment; 2) the interrelation of intellectual and physiological reactions to create new learning opportunities; 3) the ability of XR to make accessible deeply immersive experiential learning experiences and open up otherwise inaccessible teaching and learning contexts; 4) the opportunities for skill-building and individual practice; and 5) the ability to scale up otherwise high-cost real-world education experiences across space and time.

While exploring this complex and dynamic landscape, the focus has been on the broadly ranging and varied contexts in which XR technologies are being deployed in projects in higher education. Explorations of related projects in K-12 and post-graduate career and reskilling environments augmented our research on higher education. In some cases, XR has been used to untangle issues related to DEI (Diversity, Equity, and Inclusion), particularly as they explore the concept of empathy or the humanization of the other. In other examples, there is evidence of the impact of XR projects on minority students and Minority-Serving Institutions. These two more prominent features of the landscape supply the background to highlight examples of the early college experience, pedagogy, 21st-century skills, and career readiness before trying to summarize where we are today.

This literature survey has made it clear that there are still significant gaps between the diverse research areas involved in creating a sense of belonging in an immersive, digital learning environment in higher education, particularly in the context of minority-serving institutions.

Definitions

Since the technologies referenced in this review are constantly evolving, we have developed definitions for the technological terminology we use in this report.

- **Extended Reality (XR)**: This is the condition in which our current reality is experienced and extends from an entirely analog "real" experience to include new forms of experience by any digital means. Extended Reality touches the user lightly when one engages a 3D printed model or object or even sees the world through Augmented or Mixed Reality glasses or devices. The extension of reality becomes more profound when one enters a room with a fully immersive iCAVE (integrated Computer Augmented Virtual Environment) or is wearing a VR headset.
- **3D Printing**: 3D printing uses additive technologies to create objects from three-dimensional digital models by precisely building up layers of material in a 3D printer. 3D printers are used in various STEM, arts, and design contexts within higher education to promote teaching and research.
- **Augmented Reality (AR)**: This is the layering of digital information over real-world experiences. It often involves using glasses, goggles, phones, or tablets that allow the user to see the world around them as they visualize layers of information and 3D objects that augment their experience by floating in the space around them. Augmented Reality has enormous potential for educational research and teaching that is still untapped and undeveloped.
- **Mixed Reality (MR)**: Like Augmented Reality, MR layers digital information over an experience of the real world. However, Mixed Reality is more interactive and tends to mix engaging details, models, and images with real-world experiences that blur the lines between what is real and what is digitally created. The definition of MR is dynamic, as it is one of the fastest-growing areas of XR. (Speicher et al, 2019)
- **Integrated Computer Augmented Virtual Environment (iCAVE): An iCAVE is an immersive physical space often surrounded by computer screens.** Users wear glasses or goggles that allow their movement to be tracked within the space and for the area to appear as a 3D environment. Multiple users can experience the space together and will recognize themselves within the space.
- **Virtual Reality (VR):** Virtual Reality involves the complete immersion into a digitally produced space through a headset that fits over the head and covers the eyes to block out any incoming senses. VR headsets may also be used with holdable and wearable hardware that provide users with sensations in their hands, torso, and other body parts. In addition, VR headsets often allow users to see the real-world environment around them through cameras outside the headset.

Methodology

The literature review began with projects that address the question from the broadest perspective on XR and the metaverse. We then narrowed and deepened the exploration into more specific areas of interest. Next, we examined these areas' literature and explored projects undertaken in higher educational settings.

Since little, if any, research has been conducted on this landscape review, we parceled out eleven territories for investigation, each of which helped us review broader areas of study that offer insights into our more specific inquiry. These research areas included, from more general to specific:

- Extended Reality
- Diversity, Equity, and Inclusion
- Minority Serving Institutions
- Education and the Metaverse
- Diversity, Equity, and Inclusion and Extended Reality
- Extended Reality and Minority Serving Institutions
- Diversity, Equity, and Inclusion and Minority Serving Institutions
- Diversity, Equity, and Inclusion and Learning
- Learning and Extended Reality
- Diversity, Equity, and Inclusion and Extended Reality and Minority Serving Institutions
- Diversity, Equity, and Inclusion and Learning and Extended Reality.

After establishing the broad territories for investigation above and our research on the works that addressed these, we followed a research method by Choi et al. involving a series of keywords for online libraries and research databases. (Choi 2021) These keywords raised our certainty that we had found as much relevant research as possible around more specific combinations of topics. In the example below, we created a keyword search to find articles on higher education in the United States that mentioned 21st-century skills, DEI, and Extended Reality.

("21 c skills" OR "21st century skills" OR "21 century skills" OR "twenty-first century skills" OR "21c skills") AND ("educate" OR "education" OR "educational" OR "educating" OR "distance education" OR "distance learning" OR "train" OR "training" OR "lecture" OR "lecturing" OR "pedagogy" OR "pedagogical" OR "learn" OR "learning" OR "teach" OR "teaching" OR "instruct" OR "instruction" OR "instructing" OR "edutainment" OR "university" OR "universities" OR "higher education" OR "tertiary sector" OR "tertiary education") AND ("diversity" OR "equity" OR "inclusion") AND ("US" OR "USA" OR "United States of America") AND ("virtual world" OR "virtual life" OR "virtual space" OR "virtual environment" OR "virtual reality" OR "virtual community" OR "virtual inhabited world" OR "inhabited space" OR "second life" OR "active world" OR "avatar" OR "virtual immersive world" OR "Multi user virtual environment" OR "MUVE") AND ("higher-ed" OR "higher ed" OR "higher education" OR "college" or "university") AND "critical thinking" AND "creativity" AND "communication" AND "collaboration"

With the increase in the number of studies on the metaverse, technology in higher education, and Diversity, Equity, and Inclusion, our current bibliography attempts to be as comprehensive as possible. Yet, with this methodological approach, we aim not only to trace the enormous areas of study that undergird this work but also to point to new and exciting areas of research that connect multiple diverse subjects that coalesce to address the issues at hand.

1985–1999 and the Exuberant Beginnings of Extended Reality

At the broadest level, we explored XR through the immersive experience called the "metaverse," defined as a "collective virtual space, created by the convergence of virtually enhanced physical and digital reality." (Gupta 2022) Experts predict that by 2026, 25% of the global population will spend at least one hour per day in the metaverse "for work, shopping, education, social media, and

entertainment." (Gupta 2022) The metaverse is included under the rubric "Expand Immersive Experiences" as the number one of Gartner's top-three "Hype Cycle" technological trends for 2022. (Perri 2022). Explorations of the utopian possibilities of the metaverse (Baszucki 2021, Lee 2021) and its dystopian counterparts (Weinberg 2021) led to broad studies highlighting the complexities of building immersive worlds that reflect the interdisciplinarity of the reality around us. (Rawat et al. 2023)

The term Virtual Reality (VR), a term for such fully immersive experiences, was coined by Jarod Lanier. (Lanier 1988, Conn et al 1989) At nearly the same time in the late 1980s and early 1990s, the term "metaverse" was developed by Neal Stephenson in his 1992 Sci-fi novel *Snow Crash.* (Stephenson, 2003). The imaginative fervor of this early moment revealed connections between technology and education and questions about the role of identity, equity, inclusion, and belonging in virtual worlds. Lanier mentions the potential of "Virtual Reality rooms at universities that students can do projects in," noting the potential of these rooms to be educational and entertaining. (Lanier 1988) In a similar vein, Stephenson's "Metaverse" was first described through what he calls "The Street," which is "the Broadway, the Champs Elysees" of the metaverse. (Stephenson, 2003, p. 29) Stephenson envisions "The Street" in his "Metaverse" as having millions of people inhabiting it. He organizes their movement through virtual space and time and constructs places where users cloaked in their virtual identities experience more enticing events than those they find in the real world. With this structure for his "Metaverse," Stephenson laid down the fertile soil from which contemporary questions of community building, identity, and inclusion in VR have since grown but are first being explored together by this research.

In the 1990s, studies of extended reality grew in computer science programs within top universities. By 1991, early explorations at Columbia's Computer Graphics and User Interfaces Laboratory in AR explored ways to augment information on structural building systems, building construction methods, and even college campuses. (Feiner 1996) The challenges posed by the various technologies and their relative relationships between reality and virtuality led researchers out of the University of Toronto to create a continuum in 1994 dubbed "Mixed Reality" that distinguished gradations between completely immersive virtual environments and the natural world without digital interfaces. (Milgram et al. 1994) There was recognition during this period that while VR held great promise for experiential education, educational professionals needed to assume more prominent roles in the research around and construction of educational experiences. (Helsel 1992).

The decade of the 1990s began with sufficient miniaturization of electronics, the development of computer graphics, and the maturation of computer simulation to allow VR technologies to become attainable for broadened research efforts and experimentation. In his seminal work *Virtual Reality* from 1991, Howard Rheingold puts his finger on a confluence of many of the topics taken up in our current study. He notes that this new technological interface will enable us to redefine concepts as "identity, community, and reality," allowing us to redefine our "most intimate and heretofore most stable personal characteristics." Rheingold italicized for emphasis the fact that VR would help us *"decide what we as humans ought to become."* (Rheingold 1991, Tavani 1997) Vanessa Paz Dennon and Professor Robert C. Branch reinforced this idea by saying that given the "sensorial feedback" provided by VR, interdisciplinary teams of instructional designers, subject matter experts, end users, computer experts, ergonomic specialists, and artists" should be involved in the creation of experiential educational settings in these immersive environments. (Dennon et al. 1995)

Interdisciplinary researchers interested in the frontiers of medical practice were some of the first professional and educational groups to think about the possibilities of VR for improving the patient experience and the training of medical doctors. For over two decades, starting in 1992, the conference Medicine Meets Virtual Reality brought physicians, educators, scientists, and engineers together to explore how innovations in computing and electronic communications would impact medicine. The conference proceedings from 2001 are particularly noteworthy for the range of papers presented, including those on the creation of virtual anatomy labs, using VR for surgical training, treating the fear of public speaking and acrophobia, and teaching special populations how to cope with crises like the aftermath of an earthquake. (Westwood, 2001).

This period, however, was buffeted by a confluence of other populist forces, including the excitement around the first websites in 1991, the 1996 introduction of the "Hotmail" email system, and the development in 1995 of the idea for a new "Virtual University" Initiative out of the Western Governors founded in 1997 called Western Governors University. Instead of focusing on immersive three-dimensional experiences, this strategic focus explored the potential cost-saving in online content and programs as an alternative to traditional face-to-face educational environments. (Privateer 1999) As researchers have noted, these online models of education did little or nothing to exchange the familiar "information-storage-based learning" with anything more experiential and "real." (Privateer 1999)

The 2000s and New Possibilities for XR

For much of the first decade of the 2000s, the literature on VR focused on the potential impact of the internet on universities. And the decade ended with the rise of the Massive Open Online Courses (MOOCs), popularized between 2007 and 2010. (Guttenplan 2010) To collect sentiments around digital initiatives related to higher education, The Pew Research Center embarked on its first study of this type in 2012. The study revealed a wide variety of opinions on whether this digital direction pointed to positive or negative implications for the digital university. (Anderson et al. 2012) For example, several participants in the study felt that future digital universities would best serve those without the means (and privilege) to afford an on-campus educational experience. Their bullishness on the future of digital experiences anticipated Facebook's 2014 purchase (for $2 billion) of the small start-up Oculus VR, creator of the Oculus Rift VR headset. Envisioning global education on a vast scale was part of the draw as Facebook founder Mark Zuckerberg asked stakeholders to imagine, among other things, "studying in a classroom of students and teachers all over the world." (Wingfield 2014) However, there were some exceptions in the speculative area of AR, recorded in 2005. Using phones and handheld computers, these included experiments with art displays at the Bauhaus University, explorations of construction and preservation at Columbia University's Graduate School of Architecture, Planning, and Preservation, self-guided walking tours using GPS (Global Positioning Systems) at Arizona State University, and explorations in "context aware computing" at the MIT Media Lab.

Nonny de la Pena and the Development of Immersive Journalism

In 2006, journalist, documentary filmmaker, and entrepreneur Nonny de la Peña, with her intern Palmer Luckey, who went on to found Oculus, developed her first VR headset, which soon evolved into the headset she created to support her essential early immersive VR experience, *Hunger in Los Angeles*. (Bradley 2018) de la Peña's approach to VR was grounded in her interests in immersive journalism, or the "production of news in a form in which people can gain first-person experiences of the events or situation described in news stories." (de la Peña et al. 2010) This notion of using VR to amplify first-hand

experiences pointed quickly to using the technology to extend human empathy and understand more profoundly what others are feeling and experiencing around them. In her often-viewed TED Talk, de la Peña terms the quality of VR to affect human emotions a "duality of presence," which she notes allows her to "tap into these feelings of empathy." (de la Peña 2015) With this observation, de la Peña further propelled the exciting debate on empathy, which had significant implications for society and how students are taught in immersive VR environments. Innovators, public intellectuals, and scholars weighed in on whether storytelling through VR experiences can foment long-term empathy development and changed behaviors in users (and students) or whether the immersive experiences, while powerful, are ultimately unlikely to change behavior or result in the development of empathy.

Empathy Machine?

An early and influential promoter of VR as a powerful empathy-building tool was the entrepreneur and VR artist Chris Milk, who enthusiastically argued in his 2015 TED Talk that immersive experiences offered through VR were themselves the "ultimate empathy machines." (Milk 2015) With the rise of commercially available headsets, other immersive experiences followed. These included *Clouds over Sidra* (2015) by Chris Milk and Gabo Aurora, *The Displaced* (2015), *and* the *New York Times's* first foray into 360 immersive video journalism created by Ben C. Solomon and Imraan Ismail. (Milk et al. 2015, Silverstein 2015) Both examples focus on displaced people, their experiences, and conditions. Other early examples include *Becoming Homeless* (2017), developed out of Stanford University's Virtual Human Interaction Lab by Toby Asher, and *1000 Cut Journey,* a project led by Dr. Courtney Cogburn from Columbia University with the Virtual Human Interaction Lab team, which was a "virtual shoes" experience exploring racism. (Asher et al 2018, Cogburn et al 2018)

However, the question is whether these types of immersive XR environments could ultimately be learning environments, as Milk and others attested early on, or whether they supplied immersive spectacles and up-close three-dimensional experiences that ultimately did not result in long-term learning. An interdisciplinary team of researchers from France and Great Britain led by the doctoral student Phillipe Bertrand followed Milk's reasoning with a series of immersive experiments exploring empathy development as a skill. They optimistically concluded that their work on VR could "offer educators insights into different strategies that could be adopted to help learners to develop skills for building a world of tolerance and mutual understanding." (Bertrand et al. 2018) This led to further experiments in Medical Schools, like the one at the University of South Carolina, where medical professors investigated, without conclusion, whether VR could keep empathy among medical students for their patients from fading over their period of education. (Horn 2019) Through her doctoral work under Jeremy Bailenson at Stanford, Fernanda Herrera confirmed that any virtual reality experience designed to inform a greater understanding of the "imagine-self" or "imagine-others" provided an essential contribution to the development of empathy. (Herrera 2020)

Some scholars doubted immersive XR as reliable training grounds for empathy. In exploring empathy between designers for people with disabilities and their clients, Cynthia Bennett and Daniela Rosner in the Department of Human Centered Design and Engineering proposed that empathy-building techniques might allow further distance—and a diminished sense of empathy—for the individuals in need. Without using this example, they questioned whether an immersive experience might desensitize viewers rather than make them more empathetic to a particular situation. (Bennett et al. 2019) Another suggestion that VR may need buttressing to help build empathy comes from an international team led

by Sue Dean, Faculty of Health, University of Technology in Sidney, Australia, focused on nursing education. Dean and her team take the stance that the successful enhancement of empathy for a patient's condition must come not from the VR experience but from the state of mind the student is in when they undergo the VR experience. She says that "what matters most in simulations using virtual reality is how the student exits the experience and if they leave knowing just what patients 'like that' feel, or whether they leave with humility and curiosity." (Dean et al. 2020) In other words, the ability of the immersive VR experience to grow empathy in a nursing student is almost entirely dependent upon the way the instructors have contextualized the experience and prepared the student. Without this, there is little or nothing intrinsic to VR that will help a learner better understand empathy. Perhaps the most damning critique of VR as a tool for enhancing empathy comes from Lisa Nakamura, the Gwendolyn Calvert Baker Collegiate Professor of American Culture at the University of Michigan, Ann Arbor. In her dismissal of VR as an "Empathy Machine," Nakamura states that the idea itself "is part and parcel of Big Tech's attempt to rebrand VR as a curative for the digital industries' recently scrutinized contributions to exacerbating class inequality, violating users' privacy, and amplifying far-right fascist racism and sexism." She suggests that "we must be deeply critical of VR's claims for radical newness, for they have appeared many times during the internet's history." (Nakamura 2020)

XR in Higher Education: The Landscape in 2015

In 2015, just a few months after Chris Milk gave his hugely popular TED talk enthusiastically heralding VR as an Empathy Machine, the innovator and serial entrepreneur Michael Bodekaer gave what has turned out to be an equally popular TEDxCERN talk on Reimagining Education. In that talk, Bodekaer posits that the most significant challenges facing humanity are those with solutions to be found through scientific research. We rely on, he says, university students to come up with "great innovation to help us solve all these challenges." Bodekaer explains that studies have shown that a virtual lab that replicates real-world laboratory conditions in VR with faculty mentoring and coaching is a more effective learning environment for students and teachers than a real-world university laboratory. (Bodeker 2015)

Also in 2015, when Milk, Bodekaer, and de la Peña promoted the use of VR through their TED talks, Case Western Reserve University, in partnership with Microsoft, launched a Mixed Reality (MR) version of the second-year anatomy lab in the School of Medicine. In this lab, students and their professors view through Microsoft HoloLens glasses detailed anatomical models in the space before them. In the eighth year of the digital anatomy course, studies of the learning outcomes have shown no statistically significant difference between students working in MR and those who study physical cadavers. (Stojanovska et al 2020) Other early adopters include the Medical Virtual Reality Group in the Institute for Creative Technologies at the University of Southern California, where they developed simulations for wearable VR to be used in clinical settings, and the Marlboro College Graduate Center, where Jane Wilde worked with her students on assignments in Minecraft. (Abrosimova 2014, NMC 2015) On the subject of inclusion and VR environment, Wilde notes that in game-based learning environments, the "playing field is leveled – a player's gender, weight, race don't have to interfere with their acceptance by other players. You are judged by your actions." (Abrosimova 2014) While Wilde speculates that VR has a leveling impact on identity in the higher education space, Silvia Hurtado and a team of researchers are exploring the impact on higher education of "racial salience," or the number of times individuals think about their membership in what they consider to be their racial group. (Hurtado et al. 2015) While not yet connected to the notion of XR, Hurtado and her colleagues point out that understanding "how race is salient in students' lives is the first step in enabling educators to work toward dis-mantling racial

divides in personal and public life, and to work together to help students achieve their dreams and aspirations with competencies that will be important in an increasingly diverse workplace." By connecting the work of Wilde and Hurtado et al., we see that the goal to provide higher educational environments that help students acquire workplace competencies as it dismantles racial divides on campus points to future research that links student success with XR and DEI initiatives.

Horizon Reports: EDUCAUSE, The New Media Consortium, and Trends for XR and Higher Education

Arguably the most significant and consistent chronicler of the use of XR in higher education has come from the *Horizon Reports* that have been continuously produced from 2005 to the present in partnership with or by the team at EDUCAUSE. These reports track the most significant technology trends for higher education. The 2005 report did not mention VR, but as noted above, it predicted AR would be on the horizon for campuses by 2010. (Horizon Report 2005) Facebook's purchase of Oculus VR in 2014 shifted the XR playing field, so it's not surprising that the 2015 *Horizon Report* is the first to mention VR using wearable headsets, even noting that "YouVisit has adapted over 1000 college tours so they can be viewed on Oculus Rift headsets." (NMC Horizon Report 2015) By 2016, *Horizon Report* authors were convinced that XR, primarily VR, AR, and maker spaces, would be widely used on campuses in two to three years. In the 2016 *Horizon Report*, the most significant university projects using AR and VR were in medical and nursing school training. These included the creation of the Augmentarium, now known as the Maryland Blended Reality Center, at the University of Maryland (Augmentarium, n.d.), Boise State's use of Oculus Rift headsets to train nursing students to administer catheters (Wood 2012), Case Western Reserve University's partnership with Microsoft HoloLens for anatomy courses, and North Carolina State University's work with Google Cardboard for instruction related to laboratories and field investigations. (NMC Horizon Report 2016).

Authors of the 2017 Horizon Report noted changes in the document's structure that now included critical curricular, financial, and other contextual challenges to implementing innovative technologies. (NMC Horizon Report 2017). In this new report, a special note was made of Ryerson University's inroads in including VR in its architectural design curriculum in ways that allowed students to immerse themselves within the designs they have created using Yulio, a VR plug-in for computer-aided design programs. (NMC Horizon Report 2017, Da Silva 2016) Another exciting advance at the time was the haptic experiment out of Stanford University called Wolverine. This wearable device simulated "the grasping of rigid objects in a virtual reality interface" and, in so doing, started to address one of the most critical challenges of VR, the ability not only to see but experience touch. (Choi et al. 2016, NMC Horizon Report 2017)

The 2018 *Horizon Report* is the first of these reports to list its authors and use the term XR (Extended Reality) to mean the combination of "virtual, augmented, and mixed reality" in educational spaces and the first to lay out the prospect of MR (Mixed Reality) on the four- to the five-year horizon as an "emerging environment" developing "at the intersection of virtual and physical realities." (Becker 2018). The report pulls AR back into the conversation by including a vital study by Dan Munnerley and an interdisciplinary team of Australian researchers. (Munnerley 2014) Findings from the report point to the idea that AR doesn't represent a technology revolution in education but rather an enrichment of current practices that has the potential to allow any space, in and outside the classroom, into an opportunity for an enhanced learning environment. (Munnerley 2014) Another significant advancement in XR and learning noted in this report was developing a teacher training VR experience at the University of

Buffalo. Designed to help educators develop mechanisms for handling challenging situations in the classroom, this VR experience was called a “flight simulator” for teachers. (Anzalone 2017) The project was particularly significant at the time because it “incorporates elements of MR, instructional design and technologies, artificial intelligence, and learning analytics.” (Becker 2018)

As referenced in the 2018 *Horizon Report,* events proved to be a critical year for EDUCAUSE literature exploring the introduction and proliferation of XR technologies in higher education. Magic Leap, the Oculus Go, the Lenovo Mirage Solo, HP’s Reverb HMD (Head Mounted Display), and the HTC Vive filled the XR landscape with potential. (Craig et al. 2018 August 22) Most noteworthy for their vision and understanding of the educational context were articles produced by pioneers in XR in higher education and co-founders of the collaborative Digital Bodies, Emory Craig, Director of eLearning and Instructional Technology at the College of New Rochelle, and Maya Georgieva, Director of Digital Learning at The New School EDUCAUSE Review. Their influential work, which started in the middle of the decade, explored the transformations that XR technologies promised for higher education and the ethical challenges many of them brought. (Emory et al. 2018 August 22, Emory et al. 2018 April 10) These transformations include, as would be expected from early adoption trends, immersive role-play environments focused on “nursing, medical, and science education.” (Emory et al. 2018 August 22) Likewise, the authors see a significant development in students producing experiences in XR as labs have increasingly unrestricted access. (Emory et al. 2018 August 22)

Georgieva and Craig were also among the first to collect, examine, and propose possible ethical questions that could arise from XR. In these articles, their focus was mainly on issues of “access, privacy, consent, and harassment," with the underlying belief that XR had the potential to “counter our tendency to stereotype by race or gender through having people virtually embody the experience of others.” (Emory et al. 2018 April 10) Likewise, they supplied some of the first warnings that “Fake News” could lead to future “Fake Realities” in VR that could further disrupt and confuse real and fictional experiences. (Emory et al. 2018 April 10) The ethical questions raised by Emory and Georgieva through Digital Bodies point clearly toward a future in which there is a need to build trust in an XR environment, like the need to trust an educational setting, to feel a sense of belonging in that environment that is requisite for student success. They were also essential to that present moment, when, according to results from the 2018 VR/AR in Research and Education Survey, 78% of educational institutions surveyed were testing or deploying AR and VR for their students and researchers. (Collins et al. 2019) The ethical challenges would certainly need more attention.

21st Century Skills

The current emphasis on 21st Century Skills in educational curricula has its roots in early 1980s corporate, academic, governmental, and other agencies; all of which directed research to ascertain and categorize major scholastic and life skills as well as essential competencies they concluded were desirable and in demand for present-day and next generation jobs. Before this movement, the worldwide standard of knowledge was based on content delivery with teacher-centric practices and overall information accumulation in all subject areas, but not necessarily a higher-level application of accumulated knowledge, critical thinking, or mental scrutiny of the content acquired (Care 2016). In response to differing workforce demands, the United States Secretary of Education, T.H. Bell, created the National Commission on Excellence in Education to research the quality of education in 1981. Two years later, in 1983, the commission’s report emerged with the significant finding and goal of targeted

educational reform focused on creating a learning society. The chief objective of this learning society was to create lifelong learners who find educational opportunities at work, at home, and throughout a person's lifetime.

Several other vital events aided the evolution and popularity of 21st-century skills in education and the workforce. One such effort was that of Henry Jenkins, who published a white paper, "Confronting the Challenges of a Participatory Culture: Media Education for the 21st Century" (2006) which addressed three concerns and recommendations for policy and pedagogical interventions regarding *the participation gap; the transparency problem, and the ethics challenge.* The white paper concluded that participatory opportunities in educational spaces, such as peer-to-peer learning, self-directed play-based pedagogy, and constructive simulation environments, could foster specific social skills and cultural competencies. (Jenkins et al. 2006)

Another such effort was "The Partnership for 21st Century Skills (P21)," published in 2016. This collaborative document not only highlighted the inclusion of the 4 Cs into the educational curriculum but also added nine key subjects into the 21st-century themes of government and civics, history, geography, science, economics, math, arts, world languages, English, and reading. The authors had detailed teaching guidance and suggested critical support systems for educational reform to ensure student mastery of 21st-century skills to produce career-ready individuals. (P21 2016)

Creating lifelong learners in a university setting established the need for a curriculum that would assist all students in their educational success and life skills, including but not limited to financial organization, self-care, time and stress management, relationship building, career planning, and global citizenship. (Majid 2012, Andrade 2016, Knotek 2019) In addition to these life skills, colleges, and universities needed to provide their first-year students with skills that would be transferable to any field, scalable, and remain relevant as technology evolved at an ever-faster pace. This fluid and flexible mindset grew to become the 21st-century skills which include the 4 C's: creativity, collaboration, critical thinking, and communication, (Stauffer 2022) all of which would collectively aid students in processing, managing, and being able to synthesize information into meaningful and actionable outcomes. (Dwyer 2014)

Pedagogical structures to support such different learning approaches challenged traditional teaching methods. As a result, many universities were, and some still need to be, more willing to embrace pedagogies that now characterize 21st-century skills and teaching techniques. However, a growing body of research clearly shows a relationship between students learning creativity, collaboration, critical thinking, and communication (the 4 C's) and performance effectiveness at the university level. (Limna et al 2022, Chalkiadaki 2018, Supena 2021)

Virtual Reality, Pedagogy, and 21st-century skills

Virtual reality (VR) can enhance students' 21st-century skills, such as critical thinking, problem-solving, creativity, collaboration, communication, and digital literacy. It can provide an immersive learning experience that allows students to explore and interact with information from a first-person point of view (POV) perspective, which is meaningful, engaging, and unique. Virtual reality also allows students to take virtual field trips, experience simulations, and engage in a safe and collaborative space for learning activities. Additionally, virtual reality can help to bridge the gap between theory and practice, encouraging students to apply their knowledge in a more hands-on and engaging way.

Based on this, VR can positively impact evolving constructivist pedagogy. Virtual reality can be used to create immersive learning environments that allow students to explore and interact within a simulated environment; this can enable them to gain a deeper understanding of the subject matter because they are engaging with the content first-hand in a way that is personalized to their own experience and consumption of the content. When a user is in such an immersive space, they are also given control over (parts of) their learning environment, and research shows that such control may contribute to the creation of the lifelong learner. (Johnson-Glenberg 2018) Finally, this personalization of content engagement leads to greater intellectual aptitude and application of the learned material rather than material that is memorized or passively received.

A growing body of research indicates the impact of COVID and the consequent reliance on distance learning that underscored the need for 21st-century skills, particularly regarding communication and the use of immersive technologies. (Alsubaie 2022, Abdullah et al. 2022) This is an essential avenue for ongoing and future research on diversity, equity, and inclusion in and beyond the pandemic.

XR and DEI

Conversations about Diversity, Equity, and Inclusion and XR increased in prominence at the end of the decade of the 2010s. Starting with a 2016 "Call to Action" for greater diversity in the IT workforce, (Woo et al. 2016) by the end of the decade, the call was for colleges and universities to consider the diversity of the "'new majority learner,' who is older, is more likely to be balancing work and family with college and has vastly different needs from those of a traditional aged student." (Bryan et al. 2019) The results of the 2019 Pew Research Center survey of experts on the next 50 years of digital life also found an increased interest in diversity. (Stansberry et al. 2019) While not yet explicitly pulling together AR/VR and DEI in higher education, participants predicted that technologies would support a variety of voices and uses in society and higher education.

Literature on XR and DEI came into focus in 2021 with a series of five well-crafted and insightful reports by Ellysse Dick, the policy analyst at the Information Technology and Innovation Foundation. Dick, who is, as of this writing, a Reality Labs Policy manager for Meta, investigated many areas of DEI and XR in industry and dedicated the fourth of the five publications to the promise of immersive learning in education. (Dick 2021, August) In this piece, Dick notes that XR is particularly well-suited to supply immersive high-risk, high-cost explorations often found in medical education and soft-skills training in negotiation and communication. (Dick 2021, August) Other examples include training for technical skills, mainly using emerging technologies. Finally, and somewhat less convincingly, Dick points out that XR offers opportunities to avoid "Zoom fatigue" associated with long hours working together in research groups. Dick pulls together examples of higher ed XR explorations that range from those made by NASA to describe a rocket launch to an Arctic exploration of climate change by Arizona State and even a humanities-based course about immersive storytelling at Hamilton College. (Dick 2021, August) In closing, Dick argues for the equitable adoption of XR technologies, pointing to the financial challenges that educational institutions face in purchasing the hardware, developing faculty, staff, and student expertise, and managing content creation.

Dick lays the groundwork for the questions of trust and belonging in virtual spaces for higher education by asking the questions more broadly of the XR across all types of use cases. She outlined her finding in a three-part series of articles that appeared in June 2021 on the "Current and Potential uses of AR/VR for Equity and Inclusion," "Risks and Challenges for Inclusive and Equitable Immersive Experiences," and

"Principals and Policies to Unlock the Potential of AR/VR for Equity and Inclusion." (Dick 2021 Current, Dick 2021 Risks, Dick 2021 Findings)

In the most positive and forward-looking articles in this series on the current and potential uses of XR to support DEI, Dick provides key takeaways that focus on access and the immersive qualities of the experiences. She points out that the technology may reduce barriers for marginalized groups and underserved communities, particularly those with physical or cognitive disabilities, who may benefit from XR as an assistive technology. She notes that the immersive quality of XR affords new training opportunities, particularly in education and law enforcement, and the networked nature of XR will afford access to experiences despite physical distances. Dick argues that further research is needed to understand better the efficacy of XR for empathy and bias training. (Dick 2021 Current)

In her article on risks and challenges related to XR, Dick gets to the heart of many of the questions posed in the Inclusive Campus of the Future conference held at Florida International University in December of 2022. (Dick 2021 Risks, Stuart et al. 2022) She sees that underserved and marginalized communities face many "risks and challenges that discourage them from using AR/VR technologies." These include data privacy and trust issues related to the immersive environment and the physical spaces and labs where XR technology is used. Likewise, Dick points out that offline biases, stereotypes, and discriminatory behavior found in the real world often occur in the immersive environments of XR. Dick suggests that developers and organizations that engage XR might overcome some of these challenges by offering a wide range of options for users related to their safety, privacy, and online identities through the creation of personalized avatars. Finally, the author suggests that accessibility challenges remain for those using the XR hardware and that the technology today presents barriers related to "broadband connection, affordability, or digital literacy gaps." (Dick 2021 Risks)

In the third article in the series, the author focuses on recommendations related to policies that would support equity and inclusion in XR. She points out that setting a solid foundation for inclusion in XR will accelerate its adoption. These foundations and the policies created to support inclusion must include diverse voices in the discussions. She argues that there needs to be greater clarity in "how and when existing accessibility, anti-discrimination, and privacy laws apply to AR/VR solutions" and calls on governments to invest in such efforts. (Dick 2021 Principles, Fineman et al. 2018) Finally, Dick underscores the importance of governments working with industry and stakeholder communities, like universities, to develop standards and guidelines for using XR. In this work, she predicts more recent efforts by industry to drive standards and policies for immersive experiences. For example, the IEEE (Institute of Electrical and Electronics Engineers) Standards Association has named several areas needing immediate policy attention. These include "user identity and credentialing, privacy, openness, ethics, accessibility, and user safety." (IEEE SA 2022, Gulhane et al. 2019)

In May of 2021, just as Dick's series of articles was on the verge of appearing, Dr. Danielle Marie Olson submitted her MIT Ph.D. on "Social Modeling in Computational Simulations: Racial and Ethnic Representations in Videogames and Virtual Reality Systems" to her thesis advisor, D. Fox Harrell, Professor of Digital Media and Artificial Intelligence in MIT's Department of Electrical Engineering and Computer Science. (Olson 2021) Olson was building upon work she did for her MIT Master's Thesis, for which she created and tested a VR narrative game called *Passage Home VR,* through which she explored how to "meaningfully engage players from a wide range of identity backgrounds in transformational virtual storytelling experiences." (Olson 2019) Olson explores in *Passage Home VR* how "individuals cope

with racial discrimination" within the VR environment by using a new computational model of racial and ethnic socialization (RES). In her dissertation, Olson broadens the number of test users for *Passage Home VR* and exposes "statistically significant relationships between participants' RES experiences, colorblind racial attitudes, and ethnic identity development with their game experiences and narrative interpretations." (Olson 2021) She also examines video games and uses screenshots from individual scenes that depict one or more of the four themes she has identified as related to RES practice. Through a brilliant and fascinating analysis, Olson categorizes examples for the ways they promote the "cultural endorsement of the mainstream," encourage the "promotion of mistrust" of racial differences, show individuals who demonstrate "alertness to discrimination and preparation for bias," or depict people of color exhibiting "cultural pride and legacy appreciation," which she then maps against other variables, to show the complexity of responses to VR environments.

Olson concludes her dissertation by commenting that race and ethnicity are too complex to be depicted by "a brown-colored avatar or strings of text that contains vernacular associated with a particular culture." (Olson 2021) She highlights the need for computer scientists and XR designers to work closely with social scientists who study race and ethnicity. The design of immersive experiences with race and ethnicity carefully integrated is essential because, as her studies revealed, an individual brings "their racial socialization, ethnic identity development, and racial attitudes into virtual space." (Olson 2021) This is particularly important to note since, on the other hand, immersive XR experiences also, according to Olson's research, have the power to affect individuals' "beliefs, attitudes, and behaviors related to race and identity." (Olson 2021)

Olson hoped that her work would encourage the designers and creators of immersive XR experiences to be more intentional in their approach to XR design from the pre-design phases through to the final product as, in each step of the way, they attempt to be "more intentional and conscious about how they portray race and ethnicity and model social phenomena in their simulations." (Olson 2021) Ultimately, Olson sees immersive XR experiences as a "tool for positive social change which resists, rather than reinforces, the racist ideologies that are prevalent in computational simulations today." (Olson 2021)

Olson's powerful graduate work completed under her advisor Dr. D. Fox Harrell, and her rallying cry to resist rather than reinforce racist ideologies became a motivating force behind our interest in exploring how higher education provides fertile ground for rethinking what inclusion means. We were interested in the diversity of voices engaged in creating course content and models of use cases for inclusive immersive XR growing out of faculty research. To the best of our knowledge, no research group or individual scholar has yet brought together multidisciplinary voices to explore higher education and its potential to create new modalities of learning by being intentional about its support of student success, particularly in the unique contexts of minority-serving institutions.

To address these questions and their many complexities and nuances, we created a conference and workshop held from December 4-6, 2022, at Florida International University called "The Inclusive Campus of the Future: Diversity, Equity, and Inclusion, Extended Reality, and Student Success in Minority-Serving Institutions, supported by a grant from the Alfred P. Sloan Foundation and a sponsorship from HP.

Insights from The Inclusive Campus of the Future Conference

There were many and multiple insights into the Inclusive Campus that arose from the keynote addresses and the panel discussions. These have been captured and made public on the website of FIU's Immersive Learning in Extended Reality Lab, where video recordings of the conference are available to the public. References within this section point back to the website, where the appropriate videos may be found. (Gebelein et al. 2022) For this review the keynote addresses, which set the intellectual direction for the conference, will be reviewed here.

Dr. Emilia Yang: As the opening keynote, Emilia Yang, artist and Assistant Professor at the Stamps School of Arts and Design at the University of Michigan, expressed her interest in "designing innovative projects for social, racial and gender justice with Latin American, LatinX, indigenous, and Black communities, as well as building bridges between academia and community organizers." (Gebelein et al. 2022) After noting the problematic of talking about "minority communities," suggesting that we should find another term than minority, and describing her AR-based memorial project at the Museo de la Memoria Contra la Impunidad (Museum of Memory against Impunity) in Nicaragua, she highlights the importance of what she termed Justice, Equity, Diversity, Inclusion, and Belonging (JEDI-B) as we address forms of "exploitation, marginalization coded biases, and cultural dominance that are embedded in the Tech industry driven by profit making." (Gebelein et al. 2022) She proposes asking ourselves how we understand digital colonialism and how we heal and transform through technology. These communities have been most impacted, and how we ethically support the creation of "plural and diverse narratives."

In her talk entitled "Story, Code, Ethics, and Identity: Designing Inclusion in the Metaverse," Maya Georgieva, Senior Director of The New School's Innovation Center—XR, VR, AI, and Quantum Innovation Labs, led conference participants on a journey from her first experience of public and collective awareness with the fall of the Berlin wall to her visions for the future of XR to include immersive sound, smell, and touch environments. Georgieva described her foundational work in developing XR in academic settings and her efforts to engage students as creators of XR environments, thereby repositioning them to think of themselves as more than just consumers of the new media. When addressing inclusion, however, she pointed out that the prominence of sight in the development of immersive XR, like other biases, has meant that other forms of immersion have been left unexplored but point to areas in which accessibility to immersive XR could grow. Finally, she argued that marginalized communities must be brought into the design process if they are to have social, cultural, and societal benefits. (Gebelein et al. 2022)

Kylie Pepler, artist and Professor of Informatics and Education at the Donald Bren School of Information and Computer Science, then spoke about "Designing XR for Equity and Learning." As a learning scientist, Dr. Pepler is particularly interested in how learning happens in everyday environments. To explore this, she has developed three themes that help her negotiate the learning environment and the need to instill 21C skills critical to career growth. The first of these is to question materials and their embedded biases. Dr. Pepler argues that every material and object is approached with implicit biases based on class, race, gender, or a combination of these and other ways of seeing. These must be understood, mainly when things appear in XR as translations of things in the real world. The second principle is a focus on collaboration. Dr. Pepler argues that the best learning occurs when collaboration is part of social environments. Therefore, ensuring that environments are truly collaborative is critical, especially in XR, which she notes, tends to be a singular and not collective endeavor. She also notes that learning environments allow students to construct their learning environments. Therefore things must be rough and break and let for students to be part of the solution. And finally, the third principle is to be aware of

the power of storytelling. She uses the example of the history of science to supply samples of counter-storytelling as ways to reveal rarely heard narratives or lack primacy. Dr. Pepler ends her talk by discussing empathy as a design process in which the designer successfully understands the client's needs. At the same time, the designer is fully aware of their abilities and skills to achieve the desired effect. Far from standing in another's shoes, the concept of successfully making something for and with someone else is, as Dr. Pepler argues, one of the best ways to develop empathy in a learning environment.

Martin Stier, HP, the Global Head of People Organization, spoke about "Equity and Innovation in the Future of Higher Ed with HP." Mr. Stier's opening statement was a provocation. He posited that if he were an academic participating in this conference and listening to someone from industry (like him), he would want to know what the company "really believes, what do they stand for, what are they trying to accomplish...and what are their contributions to society." (Gebelein et al. 2022) In his talk, he explained how HP is trying to improve its internal culture of inclusiveness and belonging to support a more equitable corporate structure. Stier outlined ambitious 2030 goals that included achieving 50/50 gender equity in the company at the director level and above (they are 50% to goal now), having more than 30% women working in technical areas and engineering (they are now 75% to goal). Another important goal has been to double the number of Black and African American executives by 2025 from a 2020 baseline. They are 25% toward the goal. Stier positioned HP's search for a corporate culture of inclusion and belonging as a parallel endeavor to that of many of those from institutions in attendance at the conference and stressed their interest in building relationships that help use technology and innovation to achieve mutual goals.

The conference's closing keynote was provided by Dr. Nafeesa Owens, Assistant Director for STEM Education and Workforce and Senior Policy Advisory at the White House OSTP (Office of Science and Technology Policy). Dr. Owens noted that equity is the cornerstone of the administration. As Owens said, the federal government is looking for "equity of opportunity, equity of resources, and equity of outcomes for all Americans." She commented that the mandate of OSTP has been "to harness the power of science and technology to make life better, safer, and fairer for all Americans." OSTP's "The Time is Now" initiative, for example, supported equity and technology as it "highlighted the importance of building educational and career bridges and onramps ensuring people of all backgrounds can encounter healthy environments, that they are encouraged to stay on that path and to thrive in a career in STEM or innovation." (Gebelein et al. 2022) She also pointed to the MSI (Minority Serving Institutions) Strategic Plan found in the massive 2022 Chips and Science Act, which aimed to expand existing funding opportunities, enhance solicitations to incentivize partnerships with MSIs (Minority Serving Institutions), and offer planning grants and training programs to improve effective grant proposals. (Gebelein, et al. 2022, H. R. 4346 2022) As she closed her comments, Dr. Owens turned to a more personal perspective. She pointed out that it is critically important to consider the family network that supports student education. Wrap-around services and empathy are essential. She encourages educators, particularly in minority-serving institutions, to understand and support the complexity of the pathways students need to take for success.

Conclusion

In conclusion, the literature review highlights the use of Extended Reality (XR), including AR and VR, in the tech industry and academia over the past 40 years. The findings show that there is a growing

landscape of literature surrounding this topic but that this project may very well be the first of its kind to look at all these critical factors together as part of a complex synthetic whole that correlates with student success and STEM (Science, Technology, Engineering, and Mathematics) education. This review exposes, however, correlations between the advancements in technology industries and the adoption of technology in higher education, including, where possible, Minority-Serving Institutions like FIU. Despite the advances in XR technologies, there needs to be more research available on the multiple connections between XR, STEM learning, and Diversity, Equity, Inclusion, and Belonging initiatives.

The need for further research in this area becomes apparent as the review highlights the growth in literature on the connection between XR and student success, particularly at Minority-Serving Institutions. To support students' success and increase their sense of belonging in the university, it is essential to understand how immersive XR technologies can foster a positive learning environment that is inclusive and fair for all students.

The review highlights the importance of future research in this area, as the future of higher education and the workforce depends on the preparation and success of students, particularly those from Minority-Serving Institutions. By exploring how immersive XR technologies can support student success and increase their sense of belonging in the university, we can ensure that students enter the workforce with a clearer understanding of their skills, identities, and interests, their relationship to technological environments that support life-long learning and lead them to the most fulfilling lives and careers possible. If we learned anything from holding the conference before finalizing the landscape review, there are many moving parts to an inclusive campus today or in the future. The conference keynote takeaways of the importance of co-creation, emotional connection, sensorial completeness, collaboration, sympathetic industry partnerships, and advances in governmental policies to support access to XR technologies, expertise, and user frameworks are all works in progress. The landscape of the literature and actions reveal that we are dealing with complexly intertwined topics. Our goal is to support learning environments that foster immersive experiences that bring to all their users a sense of justice, equity, diversity, inclusion — and belonging.

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