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## Metaverse in higher education institutions: Drivers and effects

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# Metaverse in higher education institutions: Drivers and effects

## Abstract

*Higher education institutions (HEIs) are becoming “metaversities” and taking their physical campuses into a virtual online world. This article provides a detailed analysis and description of higher education institutions’ adoption of key underlying metaverse technologies such as virtual meeting space, virtual reality, augmented reality, mixed reality and digital twins. We analyze multiple case studies of ten HEIs that have incorporated metaverse in their teaching, learning and extra-curricular activities. We have developed seven propositions, which describe some driving forces that potentially exert pressures on higher education institutions to adopt the metaverse and the effects of the metaverse on student engagement and academic performance.*

**Keywords:** digital twins; metaverse; metaversities; student engagement; virtual reality

## 1. Introduction

An increasing number of higher education institutions (HEIs) are becoming “metaversities” and taking their physical campuses into a virtual online world, often called the “metaverse” (Kshetri, 2022b; Kshetri et al., 2022). One such initiative launched by Meta, the parent company of Facebook, and virtual reality (VR) company VictoryXR involves ten U.S. HEIs (VictoryXR, 2022). These HEIs are creating 3D online replicas, also called digital twins, of their campuses that are updated live as people and items move through the real-world spaces.

Some classes are already taking place in the metaverse. VictoryXR has announced plans to build and operate 100 digital twin campuses by 2023, which allow for a group setting with live instructors and real-time class interactions (Whitford, 2022)). One metaversity builder, New Mexico State University, is planning to offer degrees in which students can take all their classes in VR from 2027 (Asiedu, 2022)

A large body of research has suggested that students that are engaged with their studies have a higher probability of success (Fredricks, Blumenfeld, & Paris, 2004; Kahu 2013). Despite the fact that many of the key elements of student engagement such as active learning, peer collaboration, and student-faculty interaction do not require face-to-face instruction, Paulsen et

al. (2020) have warned that we should not assume that the nature and level of student engagement are the same across various course delivery modalities. While some research has been conducted examining the role of virtual technologies such as simulation and VR in teaching and learning activities (Wayne et al., 2006), in little research have scholars examined how the metaverse and its key underlying technologies potentially facilitate student engagement and learning. Recently researchers have emphasized the importance of studying the role and impact of various modes of delivery on student engagement (Kahu 2013).

Another research gap concerns the factors that drive the diffusion of the metaverse among HEIs. While prior researchers have noted that the environment and characteristics of the adopting organization affect the diffusion pattern of a technology (Chwelos et al. 2001; O'Neil et al. 1998), no research has been conducted to examine how these factors may affect the diffusion, adoption and the implementation of the metaverse among HEIS. This research gap is concerning because the metaverse is viewed as a revolution in the digital world (Vogue Business, 2021).

The goal of this paper is to fill gaps in the sparse literature on the metaverse in HEIs and help relevant stakeholders (e.g., decision makers in HEIs and national policy makers) take timely and informed decisions. Specifically, it examines the following research questions: RQ1) What factors are driving the diffusion of the metaverse in HEIs?; RQ2) How does the metaverse affect student engagement and academic performance?

The article is organized as follows. We first discuss some background, concepts and facts related to the metaverse in HEIs and enabling technologies. It is followed by the literature review section, which summarizes previous literatures on student engagement and learning outcomes, factors affecting the diffusion of a technology and the roles of technologies in teaching and learning to provide a clear rationale for the current research in the light of what has been done

before. Then we discuss how the multiple case study method has been applied. Next, we develop propositions that highlight some driving forces that potentially exert pressures on HEIs to adopt the metaverse and the effects on student engagement and academic performance. In the discussion and implications section, we offer a commentary concerning some of the driving forces that will propel HEIs to evolve to metaversities, highlight how technological and infrastructural developments affect the ability to realize such potential and delve into some practical challenges. In the conclusion section, we summarize the main ideas of the paper and discuss the opportunities offered by key metaverse technologies to HEIs as well as the most salient barriers that can prevent HEIs from using the metaverse.

## **2. Metaverse in HEIs and enabling technologies: Some background, concepts and facts**

In this section, we describe the metaverse and focus on some of the key underlying metaverse technologies that are being used in HEIs. First, what exactly is the metaverse? A simple way to look at the metaverse is that it is the current Internet's "enhanced and upgraded" version (absnews.com 2022). Different technology companies, media commentators, journalists and technology writers have different ideas regarding the way the Internet should improve. They thus have their own ways of defining, classifying and characterizing the metaverse and expressing what is significant about this innovation.

Among defining features of the metaverse that have been proposed are: (1) three-dimensional (3D) VR and augmented reality (AR) applications that can create an immersive and illusionary environment and simulate the real world, (2) a decentralized functioning economy based on blockchain and cryptocurrencies, (3) interoperability to allow users to navigate across platforms and take digital identity and assets with them, (4) digital avatars representing users,

and (5) real-time synchronous communication (Alexander, Jihadi & Parker, 2022; Gallagher & Forman 2021; labsnews.com, 2022; Kshetri, 2022c; Marr, 2022; Moore, 2021).

Often, many of these features are irrelevant and redundant for tasks and purposes for which the metaverse is used. Moreover, technical and practical challenges currently prevent the incorporation of some features in metaverse solutions. For instance, technologies have not yet sufficiently developed to address the problem of cross-platform interoperability in various metaverses. In the context of this paper, there is the lack of the interoperability of different universities' virtual teaching spaces. There is thus the question of whether virtual teaching spaces can be called "the metaverse" due to a siloed environment of virtual classes. (Thomas, 2022). Thus, diverse types of metaverses exist to serve different user groups and needs.

VR involves a simulated environment or experience, which could be similar to or different from the real world. In AR, with the help of sensors and algorithms, the computer determines the position and orientation of a camera. Then 3D graphics are made available from the camera's viewpoint and computer-generated images are superimposed into a user's view of the real world (Bardi, 2019). In addition to augmenting the physical world, mixed reality (MR) also incorporates the ability to interact with digital renderings (Balistreri, 2022). An important aspect of MR is that it can facilitate a lifelike interaction between users and digital items. For instance, Microsoft's HoloLens 2 headset can be operated with hand gestures and voice commands (World Economic Forum, 2021b).

A digital twin campus is an exact counterpart (or twin) of a physical campus. Sensors can be connected on various assets in the physical campus to collect different types of data, which are mapped onto the virtual model. A main benefit that it allows for a group setting with live instructors and real-time class interactions. The participants feel as if they are in the same space

in a campus classroom (Grubbs, 2022). VictoryXR uses Google Earth imagery, institutional photos and floor plans to construct a digital twin of an HEI's physical campus. The company has stated that it also replicates windows, bricks and other features in the real campus buildings (CoinYuppie, 2022).

Universities need to create assets such as cadaver 3D models that meet the learning goals. They can also add video elements, and voice. These assets are loaded into the authoring tool using text, media, and interactions in order to create learning content, lessons and courses. Custom scripts are then written so that the project can be played on VR headset, computer or other platforms (Barto, 2021).

### **3. Literature review**

In this section, we focus on three key points. First, as noted, new insights can be gained by extending the existing research on student engagement and learning outcomes in the context of the metaverse. Second, a review of the literature on technology diffusion can help identify what we know so far and highlight new perspectives about the diffusion of a new technology in HEIs. Third, the existing research on the roles of technologies in teaching and learning activities can provide the foundation for studying how the metaverse can facilitate such activities. This literature review is thus organized around the following three themes: a) Student engagement and learning outcomes; b) Factors affecting the diffusion of a technology, and c) The roles of technologies in teaching and learning .

#### **Student engagement and learning outcomes**

Engagement plays a crucial role in achieving positive academic outcomes as well as avoiding negative outcomes such as drop out (Fredricks, Blumenfeld, & Paris, 2004). Behavioural engagement is linked to participation. This component of engagement includes involvement in academic, social and extracurricular activities (Fredricks, Blumenfeld, & Paris, 2004).

Emotional engagement deals with internal psychosocial process and entails students' attitudes and feeling towards and reactions to instructors, classmates, academics, and school. This type of engagement is expected to create ties to an institution and influence students' willingness to do the work (Fredricks, Blumenfeld, & Paris, 2004; Kahu, 2013). Finally, cognitive engagement is related to investment of mental energy and effort that are needed to understand complex ideas and master difficult skills (Fredricks, Blumenfeld, & Paris, 2004).

Among key outcomes of engagement include student wellbeing and satisfaction (Landers 2014). This means that more engaged students tend to have a higher academic performance. However, potential intervention measure that may help to improve academic performance can also be targeted at the antecedent of engagement (Schlenker et al., 2013). For instance, curriculum design that includes games can enhance engagement (Landers 2014).

### **Factors affecting the diffusion of a technology**

Theoretical and empirical evidence suggests that the diffusion pattern of a technology is influenced by the environment, characteristics of the adopting organization, and characteristics of the technology (Chwelos et al. 2001; O'Neil et al. 1998). For instance, Chwelos et al. (2001) found that external pressure and perceived benefits of the technology influenced Electronic Data Interchange (EDI) adoption among organizations. Prior researchers have also noted that organisational characteristics such as size and the economic sector that they belong to affect their technology adoption decisions (Dholakia and Kshetri 2004; Kshetri and Dholakia, 2002).

Rogers (1962, 1995) identified several characteristics of a technology that influence its diffusion rate. They include relative advantage (benefits over the previous technology),

compatibility (with existing beliefs, experience and needs), complexity (of installing, using), observability (by others of current users and uses of the technology) and trialability (the ability to try before formally adopting). In addition to the dimensions proposed by Rogers (1962), Tornatzky and Klein (1982) identified five additional dimensions: cost, communicability, divisibility, profitability, and social approval.

### **The roles of technologies in teaching and learning**

Prior researchers have suggested that the use of technology as an instructional tool enhances learning and educational outcomes of students (Geban, Askar & Ozkan, 1992; Gonzalez-Bueno, 1998; Schecker, 1998; Hanna & de Nooy, 2003). Rockman et al. (1997, 1998, 2000) reported that laptop use strengthens the utilization of effective learning strategies. For instance, students in classrooms that have their own laptops are reported to spend more time in collaborative work and doing homework and exhibit a higher level of participation in project-based instruction compared to their non-laptop counterparts. The quality and length of writings also increase if the students have their own laptops. Such students can also direct their own learning and more readily engage in problem solving and critical thinking (Gulek & Demirtas, 2005).

Researchers have also observed that virtual technologies offer several benefits to HEIs. For medical students, the advantages of virtual teaching include the ease of accessibility and flexibility of medical resources (Murdock et al, 2020; Wilcha 2020). HEIs are reported to be working to further develop virtual resources in order to improve student engagement and interactivity (Wilcha 2020). In the U.K. anatomy education has moved away from the use of cadavers to virtual lectures and virtual cadavers (Wilcha 2020).

The incorporation of virtual technologies such as simulation and VR can enhance engagement and learning. Wayne et al. (2006) engaged postgraduate year 2 residents in a



deliberate practice that involved high-fidelity simulations of clinical events in order to develop and test skills in a mastery learning program of advanced cardiac life support (ACLS). The participants were reported to enjoy training, evaluation, and feedback in the simulated environment, which also led to a significant improvement in performance . All participants met or exceeded the mastery competency standard.

These technologies can create scenarios that are impossible or impractical to create in the real world. An inpatient psychiatric built in Second Life allowed users to virtually experience hallucinations, which increased their understanding visual and auditory dimensions of hallucinations (Yellowlees & Cook, 2006)

#### **4. Methods**

In this paper, we build theory from multiple cases (Eisenhardt & Graebner, 2007; Kshetri, 2016). We selected only cases for which sufficient information could be obtained from secondary and archival resources. Prior research has noted that archival data is among a variety of recognized data sources for case studies (Eisenhardt & Graebner, 2007).

Empirical materials in this study also included unpublished internal archives and documentation related to the incorporation of the metaverse in teaching, learning and other activities and how these activities were impacted. They also included information obtained from personal communications with technology vendors and entrepreneurs working with the universities to develop metaverse-based academic programs.

Following Eisenhardt (1989), we selected ten cases. In order to select the cases, we combined two approaches: extreme method, and diverse method (Seawright & Gerring, 2008). More specifically, our process started with extreme case method and evolved over time in order to implement different requirements and recommendations.

In the extreme case method, cases with extreme values on the independent (X= HEI characteristics) or dependent variable (Y= Adoption of the metaverse by an HEI) of interest are selected (Seawright & Gerring, 2008). The cases we selected are extreme in the sense that they are among the earliest metaverse adopters. In particular, prior researchers have suggested that best practices models are good candidates for case research (Eisenhardt, 1989).

If researchers have some idea about other factors that might affect Y (the outcome of interest), other case selection methods can be pursued (Seawright & Gerring, 2008). We utilize a diverse case method to select HEIs deploying the metaverse. A key goal is to achieve a maximum possible variance along relevant dimensions (Seawright & Gerring, 2008). The idea in this method is to select cases to represent full ranges of values characterizing X, Y, or some relationships between them (Seawright & Gerring, 2008).

In order to achieve diversity, we selected cases by using different combinations of the following two factors: a) size of the HEI; b) the purpose of the metaverse (case number in square brackets []). Table 1 presents classification of cases. We explain the rationale below:

#### **Size of the HEI (the vertical axis)**

Prior research has suggested that firm size is an important determinant of a firm's ICT adoption ((Dholakia and Kshetri, 2004). The costs of educational resources are affected by scale-related factors. A smaller scale of operation results in a higher costs per credit hour or per student (Brinkman, 1989).

#### **The purpose of the metaverse (the horizontal axis)**

The metaverse is emerging as a versatile technology which can be used in a variety of activities to facilitate teaching-learning activities. We selected universities that have used the metaverse for a narrow purpose of delivering course content as well as those that have used the metaverse

in facilitating interaction, especially of the extracurricular type. The rationale for this combination is the Importance of motivating contexts, such as peer interactions among students, which can be both intra-curricular and extra-curricular (Havnes, 2008). That is, students' learning activities go beyond curriculum-based learning.

<b>Table 1 here</b>
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#### **4.1. Ensuring accuracy and quality of data**

We made efforts to ensure the accuracy and quality of information. We assessed data's internal consistency. As suggested by prior researchers (e.g., Kshetri, 2018a), we evaluated different data items for the same point in time. Additionally, the same data items have been analyzed for different points in time. We illustrate this for the Case Western Reserve University. In Fall 2014, Case Western Reserve and Cleveland Clinic started collaboration with Microsoft. Microsoft's AR device the HoloLens was not publicly launched then (Case Western Reserve University 2016). In a ground-breaking ceremony held in Fall 2015 to begin the construction of a new Health Education Campus, which was scheduled to open in summer 2019, the university announced a plan to use HoloLens for lessons in anatomy and other subjects (CWRU and Cleveland Clinic 2015). The mixed-reality app HoloAnatomy developed by that Case Western Reserve University and Cleveland Clinic was introduced in spring 2016 (*The Daily*, 2016). In Fall 2016, medical students in the Case Western Reserve University were using Microsoft HoloLens headsets to enhance their education. In January 2017, a top-rated Sunday morning news program CBS Sunday Morning had aired a program featuring the university's first-year medical students using the headset. The program was filmed in October 2016 (*The Daily*, 2021). During the COVID-19 pandemic in Spring 2020 semester, the students were offered the HoloAnatomy course remotely. More than 90 students were reported to participate in the remote class simultaneously through HoloLens (*The Daily*, 2020).

The reputation and trustworthiness of the source as well as content of data are important. We mainly relied on information from reputable third parties. We also corroborated data and information from multiple sources. Timeliness and currency of the data are of equal importance. We followed the latest news items related to the cases chosen. In addition, we also visited the websites of the relevant HEIs for up-to-date data and information.

#### **4.2. Patternmatching theory and data**

Prior researchers have suggested that theory and data need to be “patternmatched” and propositions need to be consistent with the selected cases (Eisenhardt & Graebner, 2007). To this end, Table 2 and Figure 1 provide a visual theory summary. They explain how the framework developed can be applied to understand driving forces in the adoption of the metaverse in HEIs and effects on student engagement and academic performance. In Table 3, we have presented views of by experiencers, implementers and developers involved with metaversities. They have been mapped to corresponding propositions.

<b>Figure 1, Table 2 and Table 3 here</b>
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### **5. The metaverse in HEIs: Driving forces and effects on student engagement and academic performance.**

#### **Environment facing an HEI**

As noted above environment facing an organization is a key determinant of a technology (Chwelos et al. 2001; O’Neil et al. 1998).

#### **Pressure to attract younger generations**

Proponents of dependency theory contend that organizations are embedded within larger inter-organizational networks, which generate formal and informal pressures (Pfeffer 1981). Such networks drive organizations’ input, output, as well as beliefs, norms and traditions (Kimberly 1981). Customers are a key component of such networks. For instance, Zhu & Sarkis (2007)

found that pressure from customers was a key factor in manufacturers' adoption of innovative environmental practices such as green supply chain.

Prior researchers have noted a change in the nature the higher education market due to the forces of demand and supply. The student is viewed as a customer with the ability to pay instead of a knowledge seeker. HEIs are increasingly functioning as competitive enterprises and facing intense pressure to create value and focus their efforts and funds on activities increase value for their customers (Pathak & Pathak, 2010).

Most of HEIs' current and near-future customers are children and young adults, who are the dominant populations in well-known metaverses, which are in the gaming sector. About half of Roblox players are under 13 and 66% are under 16 (Kshetri, 2022a). Likewise, two-thirds of the metaverse-based game Fortnite's players in 2021 were young adults. Compared with older generations, this demographic is more experience-driven (Harrison, 2022) and sees interesting and exciting learning opportunities in the metaverse (*Morning Consult*, 2022).

HEIs are using the metaverse to attract them. Southwestern Oregon Community College's leaders think that its metaversity will increase enrollment (Koenig, 2022). This is because higher proportions of younger generations, such as Generation Z, grew up with VR technologies (Harrison, 2022). A study found that 50% of children who experienced swimming with whales wearing a VR headset thought that the experience was real (VHIL, 2020).

Younger generations show a higher level of interest and involvement in the metaverse. In a survey conducted in the U.S. in March 2022, 64% of Gen Z respondents were interested in having a digital avatar and 56% were interested in attending a music event in the metaverse. The proportions were 28% and 25% for baby boomers (Teale, 2022).

As noted above, compatibility is a key technology dimension affecting the diffusion rate (Rogers, 1962, 1995). The metaverse has a high degree of compatibility with the lifestyle of younger generations. Unique experience provided by metaverse technologies, such as VR, is thus appealing to younger generations and can become a key tool to attract them to universities. The above discussion suggests the following.

*P<sub>1</sub>: In order to attract younger generations, HEIs are likely to face pressures to adopt metaverse technologies.*

### **Pressure to increase accessibility for remote students**

Big gaps exist in higher education between rural and urban areas. In 2015, 18% of men and 20% of women 25 and older living in rural areas of the U.S. had earned at least a bachelor's degree compared with 32% and 33%, respectively, in urban areas (pnpi.org 2021).

Metaverse technologies can close this gap by making educational resources accessible to remote students. South Dakota State University expects that its metaversity will help reach the state's rural students (Koenig, 2022). Relative advantage (benefits over the previous technology or face-to-face classes) (Rogers, 1962, 1995) of the metaverse is higher for remote students. The above leads to the following:

*P<sub>2</sub>: In order to attract rural students that require a long commuting time, HEIs are likely to face pressures to adopt metaverse technologies.*

### **Characteristics of an HEI**

As noted above, characteristics of the organization influence the smallholders' adoption decision of a new technology (Chwelos et al. 2001; Kshetri and Dholakia, 2002; O'Neil et al. 1998). The evaluation of a technology in terms of the various dimensions identified by prior researchers (e.g., Rogers 1962, 1995; Tornatzky and Klein, 1982)) differs from organization to organization (Kshetri and Dholakia, 2002). For instance, the relative advantage of the metaverse,

that is, its benefits over the previous technology and hence the adoption rate varies with HEIs and the nature of academic programs.

### **Pressure to reduce instructional costs**

As noted earlier, a technology adoption decision is tightly linked to characteristics of the adopting organization (Chwelos et al. 2001; O'Neil et al. 1998). One such characteristic of an HEI concerns instructional costs. Costs such as those associated with installing technological solutions and maintaining or administering them are important in determining adoption decisions (Tornatzky and Klein, 1982). The costs are compared with alternative solutions.

Various disciplines differ in instructional costs per student credit hour. Such costs are higher for disciplines that rely heavily on laboratory courses (Brinkman, 1989). The costs of personnel, space, and equipment make laboratory teaching costly (Pope and Anderson, 2000). For instance, building a cadaver laboratory costs several million dollars (Skarredghost, 2021), which requires a lot of space and safety measures to meet various regulations. While cadavers could be donated, medical schools are required to pay for preparation, maintenance and burial. These costs are especially prohibitive for developing nations. In addition, since donations of cadavers are less common in many countries, they mostly rely on unclaimed bodies for dissection (Gholipour, 2019). Another option is a simulated synthetic cadaver. The costs of synthetic cadavers range between \$60,000 (for anatomical models without moving parts) and \$100,000 (for models that mimic a human body such as fluctuating respiration, blood pressure and heartbeat) (Weisberger, 2017).

Studies conducted more than two decades ago noted that the costs of laboratory equipment can be significantly reduced by using of special software on desktop computers (Pope and Anderson, 2000). More-effective metaverse-based learning tool are currently available at

low costs. For instance, the VR version of cadavers cost less than \$30,000 with 20 headsets and licenses (Grubbs, 2021).

An additional benefit of virtual cadavers is that they do not degrade and are easy to maintain. They will not wear out. Some medical schools are creating mixed reality environments to teach anatomy and other classes. Case Western Reserve University's "state-of-the-future" building involves hololens and mixed reality environments. It plans to discontinue traditional cadaver-filled laboratories used for anatomy classes. Instead, medical students with HoloLens headsets can see the body's organs and systems. For instance, a hologram of the digestive system involves labels on organs such as the stomach, gall bladder, and liver (<https://case.edu/hololens/>). The relative advantage of virtual cadavers, that is benefits over the alternative options (1962, 1995) such as human or synthetic cadaver is thus high for medical schools. Thus, we propose:

*P<sub>3</sub>: If already developed metaverse-based solutions exist, HEIs are more likely to adopt such solutions in disciplines and subjects that have higher instructional costs than those that have lower instructional costs.*

### **Resource constraints**

HEIs are facing budget constraints and lack access to resources necessary for learning (Stokes, 2021). The metaverse can help them overcome such constraints. HEIs that are facing resource constraint thus tend to evaluate the metaverse more favorably in terms of costs (Tornatzky and Klein, 1982) and relative advantage (Rogers, 1962, 1995). For example, Nashville, Tennessee-based Fisk University has not purchased cadavers due to high costs and maintenance challenges.

A virtual cadaver lab has made scientific learning affordable at Fisk University (Fisk University, 2021). The university is enhancing its pre-med program with virtual reality cadavers (<https://www.youtube.com/watch?v=VF6BhJDeWtg>), which are a more affordable alternative. It is proposed:

*P<sub>4</sub>: If already developed metaverse-based solutions exist, HEIs facing resource constraints*



*are more likely to adopt such solutions compared to those that do not face such constraints.*

## **Effects on student engagement and learning outcomes**

### **Key metaverse features**

VR-based storytelling is being used in a variety of ways in some of the HEIs to facilitate student learning. Especially VR and AR are viewed as effective learning tools due to their visual appeal. In Fisk University's planned in-person history courses, students visit historically significant locations wearing virtual reality headsets (Fisk University, 2021). They include the Montgomery Bus Boycott; the Edmund Pettus Bridge in Selma, Alabama; the Lorraine Motel in Memphis, Tennessee; and the National Mall in Washington.

VR-based storytelling can be viewed as a kind of digital storytelling, which uses digital technologies to communicate using photography, videos and games (Michalski, 2014; Nesteruk, 2014; Pritchard & Symon, 2014). Prior research has indicated that visual elements of storytelling increase student engagement (Taylor et al., 2018). Especially digital storytelling techniques with visual elements are found to improve student attention, facilitate students' understanding of complex phenomena and engage students in critical thinking (Taylor et al., 2018).

VR-based storytelling is likely to exhibit superior performance in terms of these indicators. For instance, citing research on this topic, Global Action Against Mass Atrocity Crimes, which provides a platform for the prevention of crimes against humanity, noted that VR-based storytelling is more effective than storytelling in the 2D or traditional format to facilitate a positive shift in users' human rights attitudes (gaamac.org, 2021). A similar effect can be observed in VR-based storytelling used in Fisk University's in-person history courses, which is expected to enhance what is referred to as emotional engagement (Fredricks, Blumenfeld, & Paris, 2004; Kahu, 2013).

Digital storytelling may involve representations in various modes such as linguistic, auditory, visual, and spatial (Istemic Starcic et al., 2016). In chemistry classes, VR allows visualization of how atoms are arranged in a protein to help pharmaceutical drug research using 3D visual, and spatial modes of representations.

Key activities associated with behavioral engagement include time-on-task in the classroom and active participation in class activities (Fredricks, 2013). Metaverse-based learning activities encourage such activities. For instance, in Stanford University's metaverse-based class COMM166/266: Virtual Humans, the students themselves also create virtual space in VR (CoinYuppie, 2021).

Virtual training provides an effective means of visually demonstrating concepts with step-by-step instructions to illustrate tasks. They provide opportunities for learning by doing. Immersion in games can increase engagement in learning activities (Purdy, 2022).

Atlanta's Morehouse College has piloted a metaversity that involves courses in world history, biology and chemistry. The college found that virtual reality classes increased student satisfaction, engagement and achievement compared to traditional and online formats and increased students' academic performance (Ed, 2022). For instance, the VR world history class had a 10% increase in students' GPAs compared with the same class taught via Zoom and face-to-face the year before (D'Agostino, 2022). The above discussion leads to the following proposition

*P<sub>5</sub>: Compared to non-metaverse digital technologies, the metaverse's features such as better visualization and more opportunity for active participation would lead to increased student engagement and academic performance.*

#### **Enabling experimentation with hard-to-create phenomena**

Prior researchers have also noted the important role of the metaverse in facilitating active and experiential learning by incorporating other effective educational approaches and integrating

simulations, AR/VR and game-based learning (Sandrone 2022). Studies conducted in the past two decades across several disciplines have indicated that metaverse teaching activities lead to an improvement in performance and satisfaction levels (Sandrone 2022).

The metaverse-based tools are especially valuable in contexts and situations where learning in real-world environments is risky. Some examples include chemical experiments, complex surgeries and flying airplanes. Practices play a key role in the mastery of many important skills (Guskey and Anderman, 2013). Practices in a real-life setting are not feasible in such contexts.

In such cases, special equipment, such as VR headsets, software and special gloves for haptic responses, can create immersive simulations of real environments (Great Performers Academy, 2022). Learners feel as though the digital world is real (Price et al., 2021).

In Fisk University's VR lab, a human heart can be pulled out from a cadaver's chest cavity. It creates the sense that students can feel the weight of the heart in their hands and examine it. They can enlarge it. The class sees and touches the ventricle walls. Students can compare different hearts to understand the results of health decisions that humans made when they were alive. They engage in discussion and agree on the correct diagnosis (D'Agostino, 2022). VR allows the students to see the anatomy and practice procedures without putting any risk to the patient (Suliman, 2022).

The virtual worlds of simulation games and VR make it possible to develop situated understanding (Shaffer et al., 2005). Note that contexts and constraints involved in the production of knowledge are taken into account in situated knowledge. The situated knowledge thus has additional value beyond a theoretical sense since the cognitive processes involved in the

knowledge is also influenced. Based on above discussion, the following proposition is presented:

*P<sub>6</sub>: Key underlying metaverse technologies make it possible to experiment with hard-to-create phenomena, which would lead to increased student engagement and academic performance*

### **Making virtual interactions more like real ones**

The internet performs well for sending emails, spreadsheets and PDFs from one device to another to be reviewed or modified independently and asynchronously. It was not built for person-to-person type live and interactive experiences, especially with many participants (Ball, 2022). Likewise, virtual spaces such as Zoom mostly allow a single conversation. In physical events, participants can move fluidly from one conversation to another.

Some universities are using metaverse technologies to overcome limitations of the internet and video meeting tools (Larsen, 2022). Metaverse-related technologies bridge the gap between real-life and virtual interactions by allowing people to interact more naturally.

Professors and students at the University of Chicago and the University of Pennsylvania use virtual meeting space Gather, which mimics features of real-life interactions. Its features include an avatar in a 2D map, built-in games, multimedia materials such as video recording and whiteboards and proximity-based video-conferencing (VC) in an informal environment. The VC features function only when avatars are in close proximity. Users can also share documents and direct messaging (Zhao & McClure 2022).

Users create avatars and navigate a virtual map that represents the physical environment, such as a building. The proximity chat feature make users feel that they are running into other students and professors in the hall. Users see and hear video and audio feeds of participants close to them. When they move away, the sounds cannot be heard and the video disappears. Unlike on

Zoom, users aren't forced to be in a single conversation. They can move fluidly between conversations as speakers or listeners (Larsen, 2022).

The University of Pennsylvania's computer and information science department used Gather to recreate Levine Hall, which is home to the department. The virtual building's layout mimics classrooms, laboratories, elevators, stairwells and other features of Levine Hall (Lee, 2020). The student-run hub of technological innovation, Weiss Tech House, has also been recreated virtually (Truong, 2020).

The Gather space accommodates 200 students and supports multiple conversations simultaneously. There are six virtual spaces that correspond to the building's six floors. Small groups can branch off into subgroups to work on tasks or engage in conversation (Truong, 2020).

Students that display cognitive engagement may stay after school and are interested in planning, monitoring, and assessing their understanding and performance and sharing their learning with classmates (Parsons et al., 2014). Virtual spaces such as Zoom do not provide a conducive environment for after school activities. Compared to Zoom, the Gather space thus allows more opportunities for cognitive engagement.

Prior research has noted that emotional engagement such as a sense of connectedness and feeling towards an institution and influence students' willingness to do the work (Fredricks, Blumenfeld, & Paris, 2004; Kahu, 2013). HEIs involved in the metaverse are incorporating several features to develop such connectedness. For instance, VictoryXR has claimed that it uses "a hyper-realistic model", which involves placing landscaping elements such as trees, walkways, and other features in the location of the actual real-world campus (victoryxr.co,

2022). Such features can enhance the potential for shared meaning and help universities increase students' emotional engagement. The preceding discussion can be summarized as:

*P<sub>7</sub>: Compared to non-metaverse technologies, the metaverse reduces the gap between the real world and the virtual world, which leads to increased student engagement and academic performance.*

## **6. Discussion and implications**

This article provided an overview of key factors driving the adoption of the metaverse among HEIs. Student engagement is widely recognised as a critical element of student learning (Kahu 2013). The above discussion provides an overview of the roles of the metaverse in enhancing student engagement. Due primarily to the newness of this phenomenon, little research has been conducted to investigate the use of the metaverse in HEIs. This research has provided insights into how the metaverse affects student engagement and academic performance.

Let us look at the research questions that we wanted to address. Regarding RQ1, HEIs are adopting the metaverse to facilitate student learning, which has become critical to attract the younger demographic. Since most of the current users of the metaverse are children and young adults, the HEIs' metaverse programs are mainly targeted at this group. This research THUR adds a generational dimension to the scholarly conversation in the use of technology to enhance learning and educational outcomes (Geban, Askar & Ozkan, 1992; Gonzalez-Bueno, 1998; Schecker, 1998; Hanna & de Nooy, 2003; Rockman et al. 1997, 1998, 2000). The metaverse-based academic programs can also attract students from remote areas. HEIs are more likely to adopt metaverse-based solutions in disciplines and subjects that have higher instructional costs, especially those facing budget constraints.

As to RQ2, the above discussion has made it clear that the features and capabilities of the metaverse's such as better visualization and more opportunity for active participation, possibility

to experiment with hard-to-create phenomena, reduced gap between the real world and the virtual world can lead to a higher student engagement and academic performance.

Prior research has indicated that appropriate antecedent strategies can lead to a higher student achievement as measured by engagement (Harbour et al., 2015) . One such strategy involves providing class-wide and individual opportunities to respond (OTR), which can be an academic question, prompt, or task presented to elicit active student response (Kern & Clemens, 2007). The task related to OTR could be drastically different in the metaverse-based learning. For instance, as noted above, in some metaverse-based courses, the students themselves create virtual space in VR (CoinYuppie, 2021).

Prior researchers have suggested that students in HEIs learn more than what the curriculum prescribes or instructors express in the learning goals (Chickering 1969; Havnes, 2008). A key learning mechanism is peer learning, which is defined as “the acquisition of knowledge and skill through active helping and supporting among status equals or matched companions” (Topping, 2005, p.631). As noted earlier, peer interaction among students can be both intra-curricular and extra-curricular (Havnes, 2008). Compared to Zoom, the metaverse-based tools such as Gather Town allow more extra-curricular peer interaction and hence facilitate engagement and learning.

Among issues that require consideration are mastery and appropriation of curriculum materials (Wertsch 1998). Mastery is related to competence that can be demonstrated. Appropriation involves “taking something that belongs to others and making it one’s own” (Wertsch 1998, 53). While peer learning can also facilitate mastery learning, a more important role of this approach is likely to be in students’ appropriation of the curriculum. When students are not under the instructor’s supervision or control and the activities are not part of an

assessment, students are freer to express themselves. In this way, peer learning can help build social communities in which learning is one of the key outcomes. It is also possible for students to appropriate a version of the course content that is not related to the learning goals (Havnes, 2008). Students frequently discuss about the assignments, and the appropriateness of curricular activities. Students also become a part of social networks that become important when they transform themselves from learners, to professionals and as members of society (Havnes, 2008). By facilitating interaction with faculty and peers, the metaverse-based tools such as Gather Town help in the appropriation of the curriculum.

Researchers have noted that the mechanisms contributing to students' engagement have not yet been clearly articulated (Kahu 2013). In this regard, this study provides an understanding of such mechanisms in the context of the metaverse-based learning.

### **6.1. Practical challenges**

The metaverse provides several benefits compared to both face-to-face learning methods and those relying on non-metaverse technologies. However, the implementation of the metaverse in HEIs involves a number of practical challenges. As noted above, the reduction in the costs to deliver some courses is a major motivation for the adoption of the metaverse in some HEIs. However, licenses for virtual reality content, construction of digital twin campuses, virtual reality headsets and other investment expenses do add costs for universities (Pimentel et al., 2022). A metaverse course license can cost universities at least \$20,000, and could go as high as \$100,000 for a digital twin campus. VictoryXR also charges a yearly subscription fee of \$200 per student to access its metaverse (Whitford, 2022). Additional costs are incurred for virtual reality headsets. While Meta is providing a limited number of its virtual reality headsets – the Meta Quest 2 – for free for metaversities launched by Meta and VictoryXR, that is only a few of what may be needed (Bohanon, 2022; Kshetri, 2022b). The low-end 128GB version of the



Meta Quest 2 headset costs \$399.99. Managing and maintaining a large number of headsets, including keeping them fully charged (Jensen, 2022), involves additional operational costs and time. HEIs also need to spend significant time and resources to provide training to faculty to deliver metaverse courses (D'Augustino, 2022). Even more time will be required to deliver metaverse courses, many of which will need all-new digital materials (Pimentel et al., 2022).

The metaverse can also expose students to inappropriate content and nefarious actors such as predators. For instance, Roblox has launched Roblox Education (<https://education.roblox.com/>), which aims to bring 3D, interactive, virtual environments into classroom. Its metaverse involves user-generated content and an in-game chat feature. This means that students can easily be exposed to inappropriate content such as profanity, drugs/alcohol (D'Augustino, 2022) and sexual content (Dickson, 2021). Jason Kelley, associate director of digital strategy at the Electronic Frontier Foundation, a non-profit championing user privacy noted that a company like Meta “is not going to go out of its way to create a more stringent privacy policy,” (Swaak, 2022a).

Some have raised significant concerns about biases and stereotypes affecting learning in the metaverse. People in the metaverse may be represented with avatars. It was reported that when historically Black institution Morehouse first launched its metaversity, a professor refused to join the effort because they were concerned that the avatars failed to correctly represent students and faculty. at the. VictoryXR needed to significantly improve the avatars to convince the hesitant professor to join the project. The university’s administrators think that the avatars need more improvement (D'Augustino, 2022).

Most educators do not have the capability to create their own metaverse teaching materials (Pimentel et al., 2022), which can involve merging videos, still images and audio with text and interactivity elements into an immersive online experience (Barto, 2021). If metaverse based learning materials are not readily available, teaching and learning of topics using this technology thus are not easy.

The metaverse could be incompatible with the current educational system, which has been arguably commodified and needs to be divided into distinct, measurable quantities and assessed. It is also important for the processes of education to become “capable of being monitored, audited and evaluated” (Hussey & Smith, 2002). Traditional methods of teaching such as lecturing are no longer used. The teacher just plays the role of a facilitator. The metaverse also requires significant modification in the assessment and monitoring processes (Guerro Vall, 2022). HEIs thus face adaptation challenges to the new metaverse environment: Teaching and learning in the metaverse would require drastic changes in pedagogic and cultural aspects such as roles of teachers and students. For instance, students are not just a recipient of contents. They actively participate games and other activities and play a more leading role.

The lack of access to advanced telecommunications infrastructures in rural areas could also hinder the adoption of the metaverse among HEIs. Many metaverse applications require access to advanced infrastructure such as high-speed 5G networks to ensure high bandwidth and data transmission rate with low latency. For instance, T-Mobile has installed 5G network in the Fisk University campus, which has enhanced students’ experience with metaverse courses (Skarredghost, 2021). Rural areas lack such infrastructures. For instance, 97% of the population living in urban areas had access to a high-speed, fixed service compared to 65% in rural areas and 60% in tribal lands (World Economic Forum 2021a).

## 6.2. Future research implications

Before concluding, we suggest several fruitful future research avenues. While various features of the metaverse discussed in this article have attracted some universities, it also has aspects that discourage some universities from adopting this technology for teaching and learning. Jacob H. Rooksby, dean of the Gonzaga University School of Law noted: "[The reason] vendor partners "are interested in this is [because] they're interested in you, students. They're interested in what you see, do, think, feel, say, etc.. [People and their data] "are the product. That's kind of lurking in the background of all of these contracts." (Swaak, 2022b)

Technologies' use in learning have been associated with not only positive outcomes such as capability to direct their own learning and engage in problem solving and critical thinking (Gulek & Demirtas, 2005) , but also negative outcomes such as distraction and social isolation (Al-Jarf, 2021). A potentially negative effect of the incorporation of the metaverse in learning is that it amplifies effects of various biases. It is important to note that biases are common in the textbooks of history, science and other subjects, which can influence how students understand certain events and topics (Gupta & Gupta, 2015). Films have more powerful impacts than textbooks in molding how students view and understand certain issues and the world around them (Scheiner-Fisher & Russell, 2012; D'Augustino, 2022). Metaverse content has the potential to be even more influential (D'Augustino, 2022). For instance, VR is likely to provide an even deeper impact on how students view certain issues (D'Augustino, 2022). In future research scholars also need to compare the effects of biases that result from using the metaverse with such effects resulted from the use of textbooks and films.

The metaverse-based learning materials have some very intriguing features that cannot be found in other settings. In Fisk University's VR lab, additional features, such as surgical procedures and comparative learning between humans and animals, can be added over time (Fisk

University 2021). Thus, the VR lab performs better in divisibility dimension, which is related to a potential user's ability to select the features they want and the time of use and pays accordingly (Zaltman et al. 1984). Researchers should thus examine metaverse technologies used in HEIs in terms of key technology dimensions and compare them with non-metaverse settings.

## **7. Concluding comments**

Many HEIs have jumped into the metaverse bandwagon. The adoption decisions of the metaverse in the HEIs examined in this paper are driven by diverse motivations. Some view that it is a key tool to attract a young demographic and students from remote areas. Metaverse technologies are more effective in closing the rural-urban gap compared to face-to-face learning. Since the metaverse can mimic various features in the physical campus, students can learn on their own with no need of commuting. In some HEIs, the metaverse is deployed as a cost cutting tool. The channel provides a low-cost learning alternative in some settings and thus makes educational resources affordable.

It is also important to keep in mind some of the drawbacks of the metaverse. For instance, biases' effects can be even more powerful in rich media environments. Overall, to maximize the benefits of the metaverse for teaching and learning, universities – and their students – will have to wrestle with protecting users' privacy, training teachers and the level of national investment in broadband networks.

### **Compliance with Ethical Standards:**

Disclosure of potential conflicts of interest: There are no conflicts of interest.

Research involving human participants and/or animals: Not applicable for this research

Informed consent: Not applicable for this research

**Table 1: Selection of cases**

Purpose Size	Facilitating extracurricular interaction	Delivering course content
Big	<p style="text-align: center;">I</p> <ul style="list-style-type: none"> <li>• University of Chicago: 17,834 (univstats.com 2022) [1]</li> <li>• The University of Pennsylvania: 30,688 (Forbes. 2022). [2]</li> </ul>	<p style="text-align: center;">II</p> <ul style="list-style-type: none"> <li>• Stanford university 17937 (Autumn Quarter, 2021) (stanford.edu. 2022) [4]</li> <li>• Case Western Reserve University: Enrollment (fall 2021): 12,069 (Case Western Reserve University. 2022) [5]</li> <li>• Arizona State University: 77,881 (fall 2021) (ASU, ND) [6]</li> </ul>
Small	<p style="text-align: center;">III</p> <ul style="list-style-type: none"> <li>• Whitman College (total undergraduate enrollment of 1,360 (fall 2020), (USNEWS, 2022a) [3]</li> </ul>	<p style="text-align: center;">IV</p> <ul style="list-style-type: none"> <li>• Morehouse College: 2,152 (fall 2020) (USNEWS, 2022b) [7]</li> <li>• Fisk University 879 (fall 2020) (USNEWS, 2022c), [8]</li> <li>• Southwestern Oregon Community College: 2,157 (USNEWS, 2022d) [9]</li> <li>• South Dakota State University: 9,976 (fall 2020) (USNEWS, 2022e) [10]</li> </ul>

**Table 2: The metaverse in HEIs: Driving forces and effects on student engagement and academic performance**

Independent variable (IV )	Explanation	Examples [Case No.]
<b>Environment facing an HEI</b>		
Pressure to attract younger generations (P <sub>1</sub> )	Dependency theory: pressure from customer drives the adoption of a technology (Pfeffer 1981; Zhu & Sarkis 2007). Younger generations see interesting and exciting learning opportunities in the metaverse: influence HEIs to adopt the metaverse.	Southwestern Oregon Community College [9]
Pressure to increase accessibility for remote students (P <sub>2</sub> )	Relative advantage (benefits over the previous technology or face-to-face classes) (Rogers, 1962, 1995) of the metaverse is higher for remote students.	South Dakota State University [10]
<b>Characteristics of an HEI</b>		
Pressure to reduce instructional costs(P <sub>3</sub> )	Costs are important in determining technology adoption decisions (Tornatzky and Klein, 1982). The relative advantage of virtual cadavers is high for medical schools due to high instructional costs per student credit hour (Brinkman, 1989; Pope and Anderson, 2000).	Case Western Reserve University [5]
Resource constraints (P <sub>4</sub> )	HEIs facing resource constraint evaluate the metaverse more favorably in terms of costs (Tornatzky and Klein, 1982) and relative advantage (Rogers, 1962, 1995).	Fisk University [8]
<b>Effects on student engagement and learning outcomes</b>		
Key metaverse features (P <sub>5</sub> )	VR-based storytelling, a kind of digital storytelling involves visual elements, which increase student engagement (Taylor et al., 2018; Michalski, 2014; Nesteruk, 2014; Pritchard & Symon, 2014). Key activities associated with behavioral engagement (Fredricks, 2013): the metaverse performs well.	Stanford University’s metaverse-based class COMM166/266 [4] Fisk University [8] Morehouse College [7] Arizona State University [6]
Enabling experimentation with hard-to-create phenomena (P <sub>6</sub> )	The metaverse-based tools provide opportunities for practices, which play a key role in the mastery of many important skills (Guskey and Anderman, 2013), especially important When earning in real-world environments is risky.	Fisk University [8]
Making virtual interactions more like real ones (P <sub>7</sub> )	Students that display cognitive engagement may stay after school and plan, monitor, and assess their understanding and performance and share their learning with classmates (Parsons et al., 2014). Metaverse such as the Gather space allows such opportunities. Incorporation of real-world campus features can increase emotional engagement and influence students’ willingness to do the work (Fredricks, Blumenfeld, & Paris, 2004; Kahu, 2013).	Whitman College [3] University of Chicago [1] University of Pennsylvania [2]

**Table 3: Views of and statements by experiencers, implementers and developers**

Experiencer, implementer or developer	Statement	Case no. and related proposition
Juli Dunn, senior associate dean of students, Whitman College (Whitman College 2021)	"This summer was a blast. We hosted it [Summer Fly-In] in Gather Town, which gave us some different options in terms of games, interactivity and building community."	P <sub>7</sub>
Steve Grubbs, VictoryXR CEO	"The Fortnite generation is descending upon colleges now. What they know is a social, synchronous, group experience" (Drozdowski, 2022).	P <sub>1</sub>
	"We're a construction company in the Metaverse, and our team is replicating every window, every brick of the real world. With fast progress, we could complete this task in eight to 12 weeks." (Mug.News, 2022)	P <sub>7</sub>
Muhsinah Morris, chemistry professor and metaverse program director at Morehouse	"In our [metaverse] courses ... we saw attendance rates go up, we saw engagement increase, we saw achievement increase."	P <sub>5</sub>
	"My students are more receptive to learning hard-to-grasp subject matter. You can't see molecules, but in my virtual reality classroom where I taught advanced inorganic chemistry, you can. You can actually build three-dimensional representations of molecules ... The learning tends to happen faster. They go on to the real situation faster." (D'Agostino, 2022).	P <sub>6</sub>
Annie Hale, executive director of the EdPlus Action Lab at Arizona State University,	"When students reported they felt as though they were present in the VR story, we saw a positive correlation between engagement and lab scores".	P <sub>5</sub>
Kendrick Brown, Provost and Senior Vice President of Academic Affairs at Morehouse College	If we can bring Black people and people of color into this space as creators, contributors and learners — not just as consumers — then we have an opportunity for authorship and authenticity in a way that otherwise doesn't happen." (Shimalla, 2022)	P <sub>5</sub>
Nikki Wise, First-year medical student, Case Western Reserve University	"I went in 100 percent thinking it [Microsoft HoloLens] would be a fun day, but that it was gonna be gimmicky. I walked out of it having learned things that I hadn't appreciated, either in the cadaver course or in our lectures. ..It gives you more angles, and it gives you that 3-D sense while maintaining your ability to approach it from any direction, which you don't have with a cadaver and you really don't have in a textbook" (The Daily, 2021).	P <sub>6</sub>
Tahj Henry Jackson, Morehouse student	"It's a whole new experience, and you're meeting and experiencing things first-hand, such as the Underground Railroad" (Lee, 2022).	P <sub>6</sub>

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