Metaverse in dental hygiene education: Are we prepared for the future?

Vanessa Vuong[1], **Nazlee Sharmin**, PhD, MEd,[2] and **Ava K Chow**, PhD[3]

[1]Dental hygiene student, Mike Petryk School of Dentistry, Faculty of Medicine & Dentistry, College of Health Sciences, University of Alberta, Edmonton, Canada

[2]Associate teaching professor, Mike Petryk School of Dentistry, Faculty of Medicine & Dentistry, College of Health Sciences, University of Alberta, Edmonton, Canada

[3]Associate professor, Mike Petryk School of Dentistry, Faculty of Medicine & Dentistry, College of Health Sciences, University of Alberta, Edmonton, Canada

Corresponding author: Ava K Chow, PhD
Associate Professor
Mike Petryk School of Dentistry
Faculty of Medicine and Dentistry
College of Health Sciences
7-020H Katz Group Centre
University of Alberta
Edmonton, AB T6G 2E1
Email: akchow@ualberta.ca

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ABSTRACT

Introduction: Metaverse technologies can revolutionize students' learning experiences by offering an immersive and interactive environment. Our study explored the perception and readiness of dental hygiene students and faculty towards adopting metaverse technologies for teaching and learning. **Description of case:** A descriptive study was conducted to explore dental hygiene student and faculty behavioral intention and willingness to accept the incorporation of metaverse into teaching and learning. Twenty-five students and 15 faculty responded to the survey, and students showed higher acceptance of metaverse technologies than faculty members. **Discussion:** The application of metaverse is not yet widespread in education. Concerns about cost and technical proficiency may have caused hesitation among faculty participants, resulting in a disconnect between faculty and student willingness to accept this technology. **Conclusion:** Though only one institution was polled, our study identified gaps in student and faculty perceptions, which can be helpful for other institutions in the planning and implementation of metaverse technologies.

Keywords: dental education; education; educational techniques; interactive learning; learning; teaching

CDHA Research Agenda category: capacity building of the profession

INTRODUCTION

As technology continues to evolve, the metaverse is making its way into diverse fields, with medical, dental, and other health professional education at the forefront. This immersive virtual space can revolutionize students' learning experiences by creating an interactive, collaborative, and safe environment for training.

Although the term 'metaverse' was coined in 1992 and became popularized in 2022, many are unfamiliar with what 'metaverse' actually means and what it can do.[1,2] 'Metaverse' was first used in Nile Stephenson's novel 'Snow Crash' to describe a 3D virtual setting where real and virtual characters could interact.[2,3] In the present day, the metaverse can be described as a graphics-rich virtual space where people can learn, socialize, play, shop, and party.[1] The technologies that contribute to the metaverse include augmented reality, virtual reality, mixed reality, internet of things, 5G, blockchain, cloud computing, digital twins, and artificial intelligence.[4]

In their metaverse roadmap, the Acceleration Studies Foundation proposed the metaverse as a connection point between the real world and virtual reality and suggested four types of metaverse divided by two axes: augmentation *vs.* simulation and intimate *vs.* external.[5] The augmentation *vs.* simulation axis defines whether the experience is physical or virtual. The intimate *vs.* external axis divides applications based on their focus on the user's inner or surrounding world.[5,6] The axes divide metaverse applications into four types:

1. *Augmented Reality:* Improves the physical world by incorporating location-aware systems and interfaces that process information about our everyday perceptions of the

world. This technology is widely applied in smartphones, education, augmented reality books, and games like Pokemon Go.[5,7]

2. *Lifelogging*: Technologies in this category capture and share experiences and information with others, with Facebook and Instagram being well-known examples.[5]

3. *Mirror world:* Technologies for this group capture the real world as it is but provide information about the external world using GPS technology. Google Maps is an excellent example of a mirror world. [5,7]

4. *Virtual reality:* Refers to a virtual world built with digital data based on activities between avatars (a digital representation of the user). Second Life is an example of this type of metaverse.[5,7]

In simple terms, the metaverse is an extension of the internet that allows users to interact with each other and their surrounding environments.[8] Metaverse has immense potential in dental and medical education, providing life-like simulations and collaborative environments. In medicine, the benefit of using metaverse for training purposes has been well-recognized.[9,10] Virtual and augmented reality-based tools are gradually becoming popular in dental and medical training.[11,12] Dental students using a virtual dental clinic (VDC) showed significantly higher scores on the qualification test than those not exposed to VDC.[13] Metaverse can potentially teach clinical skills involving interprofessional collaboration, patient interactions, and communication. Second Life, for example, offers a platform for small group interactions to practice communication, patient

education, teamwork, and skills that are difficult to practice in traditional classroom settings.[14, 15] Rodriguez-Florido et al.[16] evaluated the feasibility of multi-user immersive virtual reality technology as an educational tool in medicine and reported that the technological complexity of such resources is no barrier to medical teaching.

Metaverse can be beneficial for dental and medical students and experienced clinicians to practice fine motor skills. The use of haptic gloves can take the metaverse experience of dental students to the next level, allowing them to feel virtual objects. Students can safely practice suturing or giving nerve blocks in a simulated virtual environment and can receive immediate feedback for needle point insertion.[8,11,17]A schematic presentation of the metaverse is shown in Figure 1.

There is a growing global interest in integrating technology into higher education, spanning from basic eLearning platforms to advanced applications like the metaverse. The necessity of this digital transformation was accelerated by the COVID-19 pandemic. However, the incorporation and acceptance of cutting-edge technologies like metaverse are influenced by faculty and students' understanding of the technology, effort expectancy, behavioral intention, self-efficacy, enjoyment, and immersion.[18] In a recent study, Chauhan et al.[19] assessed the knowledge, understanding, and awareness of dental students and professionals regarding the application of metaverse in dental practice. Although the results showed a general optimism among respondents towards the metaverse, it revealed that 48% of the 328 participants reported having a low knowledge of the metaverse.[19] Identified bottlenecks for adopting metaverse were equipment costs, network security, privacy issues, usability, accessibility, and expertise.[19] However, lack of knowledge and

perceived limitations do not always relate to a lack of readiness, and studies focusing on dental hygiene students towards adopting metaverse as a teaching tool are scarce. In this context, we conducted a study to explore the perception and readiness of dental hygiene students and faculty towards adopting metaverse technologies into teaching and learning. Our research questions are:

1. What are the attitudes of dental hygiene (DH) students toward incorporating metaverse as a learning tool?
2. What are the attitudes of the faculty members toward incorporating metaverse as a teaching tool?

DESCRIPTION OF THE CASE

A descriptive study design, aiming to describe a population, situation, or phenomenon without identifying the underlying cause, was chosen for this research.[20,21] The study design was approved by the University of Alberta Research Ethics Board 2 (Pro00127392). The validated Unified Theory of Acceptance and Use of Technology 2 (UTAUT2) survey,[22] with a 7-point Likert scale, was adapted to explore DH student and faculty behavioral intention and willingness to accept the incorporation of metaverse technologies into teaching and learning. DH students from 2nd to 4th year and the faculty members of the Mike Petryk School of Dentistry were invited to participate in the anonymous online survey. Descriptive statistics (e.g., median, percentage) were performed using Microsoft Excel. The significance of the difference between DH students and faculty perception was analyzed using the Kruskal Wallis test.[23] Cronbach's alpha was calculated using Microsoft Excel to assess the internal consistency of the UTAUT2.

RESULTS

The UTAUT2 survey yielded 25 responses from DH students and 15 from faculty members. The survey had an overall Cronbach's alpha of 0.973, which is considered excellent. The Cronbach's alpha for the constructs of performance expectancy, social influence, hedonic motivation and attitude also showed excellent reliability, while the constructs of effort expectancy, facilitating conditions, habit, behavioral intention, and actual use behavior showed good reliability. (Table 1)

Overall, the DH students showed higher acceptance of metaverse technologies compared to faculty members. Analysis using Kruskal-Wallis tests showed that students and faculty differed significantly in all questions that represented the key constructs of performance expectancy and facilitating conditions. The analysis also revealed that students expected that educational metaverse technologies would be easy to adopt compared to faculty members, with significant differences in 3 of the 4 questions in the construct. Students also anticipated that they were more likely to use the technology for their education, compared with faculty members, in 3 of the 4 questions in the construct. (Table 1)

DISCUSSION

The application of the metaverse opens immense possibilities in dental education. Salloum et al.[24] describe the metaverse as equivalent to an educational ecosystem integrating various academic materials, applications, and simulation technologies. We conducted a study to explore the perception and willingness of DH students and faculty members to accept the metaverse technologies for teaching and learning.

The findings reveal disparities in the acceptance and perceived utility of metaverse technologies between DH students and faculty members. Notably, students believed that the metaverse would be more useful (performance expectancy construct), easier to use (effort expectancy construct) and that they had the resources to utilize the technology (facilitating conditions construct) when compared to faculty members. There are also marked differences between students and faculty in the constructs of habit and actual use behaviour, with students predicting that they would be more likely to regularly use the technology as part of their education.

This gap in perceptions on metaverse technologies may be at least in part due to demographic differences between students and faculty. According to Venkatesh et al.,[22] the UTAUT2 constructs are moderated by factors such as age, gender, and experience. While demographic information was not explicitly collected, admission statistics indicate that the DH students are generally young adults. This difference between faculty and students may represent a generational gap with students being digital natives who may more readily integrate new technologies and tools into their learning repertoire. Faculty members may have less familiarity with these technologies and may consequently have reservations about the application and effectiveness of the metaverse in education, particularly as it would involve significant amounts of time and effort to implement these tools for teaching. These findings are somewhat aligned with Chauhan et al.,[19] who reported study participants were enthusiastic to embrace the technology, but also identified concerns regarding cost, technical proficiency, privacy, and data security, which would be of concern to faculty, but likely less so for students who would not be responsible for shouldering these burdens.

Social influence has been shown to impact the adoption of technology and innovations.[25,26] The scores for questions related to social influence were low for students and faculty, with no significant differences among the groups. This suggests that external pressures did not play a major role in impacting the attitudes of the study participants and implies that the acceptance of the metaverse technologies is primarily driven by individual perceptions and experiences, rather than external, social pressures.

Specifically examining dental hygiene student and faculty acceptance of technology is important as previous studies have shown that there are disciplinary differences in the acceptance and use of technologies in higher education.[27] However, we recognize that the findings of our study are based on one institute with a small number of study participants. The UTAUT2 is also self-reported. Though the survey was anonymous, social desirability bias may impact the results. Besides these limitations, our study has successfully identified the gap and disconnect between faculty and student willingness to accept metaverse. However, behavioral intention is not the same as actual behavior use, and a more nuanced investigation may be necessary before implementing a resource intensive tool, which may present challenges with uptake.

PRACTICE IMPLICATIONS

- Metaverse technologies can revolutionize students' learning experiences
- Dental Hygiene students have a higher acceptance of metaverse technologies than the faculty members.

CONFLICTS OF INTEREST

The authors of this study have declared no conflict of interest.

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Figures and Tables

Figure 1: A schematic representation of the metaverse.

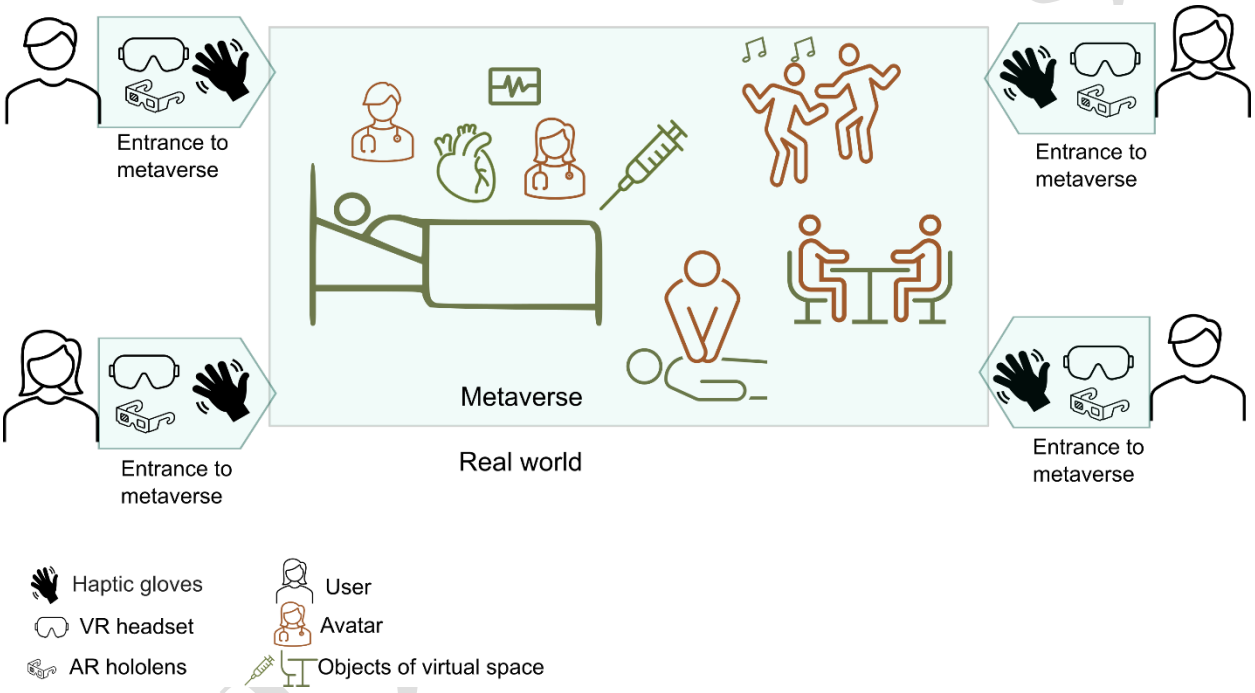

Table 1. Attitudes of students and faculty towards metaverse use. The UTAUT2 is scored on a 7-point Likert scale with 1 indicating strong disagreement and 7 indicating strong agreement. Values are median (IQR). Cronbach's alpha is shown below each construct. Cronbach's alpha for the instrument is α= 0.973 * indicates p<0.05, ** indicates p<0.01 according to Kruskal-Wallis test.

CONSTRUCT	QUESTION	MEDIAN		KRUSKAL-WALLIS
		Instructors (n=15)	DH Student (n=25)	P
Performance expectancy (α=0.974)	The metaverse will be useful in my teaching/learning.	3 (2-4)	5 (4-5)	0.00155**
	The metaverse will help me teach/learn more efficiently.	3 (2-4)	5 (5-5)	0.00562**
	Metaverse technologies can improve my teaching/learning productivity.	3 (2-4)	5 (4-6)	0.00864**
Effort expectancy (α=0.88)	I feel learning how to use metaverse technology for education will be easy.	3 (3-4.5)	5 (3-6)	0.09449
	It is easy for me to become skillful at using metaverse technologies for teaching/learning.	3 (2-5)	5 (4-5)	0.00477**
	Metaverse technology for education will be easy to use.	3 (2-4.5)	4 (3-5)	0.14922
	With the help of metaverse technology, I will be able to teach/learn proficiently.	3 (2-4)	5 (4-6)	0.00995**
Social influence (α=0.913)	People who are important to me think I should be using metaverse technology for teaching/learning.	2 (1-4)	3 (2-5)	0.32673
	There are individuals who influence my behavior who recommend that I use metaverse technology for education.	2 (1-3)	3 (1-5)	0.37793
	People whose opinions that I value prefer me to teach/learn using metaverse technology.	2 (1-2.5)	3 (2-4)	0.3799
Facilitating conditions (α=0.822)	I have access to the resources necessary to teach/learn in the metaverse.	2 (1-2.5)	4 (3-6)	0.00085**
	I have all the information I need to teach/learn in the metaverse.	1(1-2)	3 (2-5)	0.01628**
	Metaverse technology is compatible with other technology I use.	3.5 (1.5-4)	5 (4-5)	0.02422*
	I can get assistance from others if I am having trouble with my metaverse teaching/learning techniques.	3 (1.5-4)	5 (4-6)	0.00105**
Hedonic motivation (α=0.949)	Teaching/learning through the metaverse will be a fun experience.	4 (3-5.5)	6 (4-7)	0.06949
	Teaching/learning through the metaverse will be an enjoyable experience.	4 (2.5-5.5)	6 (4-6)	0.05504

	Teaching/learning through the metaverse will be a rewarding experience.	4 (2.5-5)	5 (4-6)	0.09363
Habit (α=0.828)	Teaching/learning through the metaverse can become a habit.	4 (3-5)	6 (5-6)	0.01118*
	I can become addicted to teaching/learning through the metaverse.	2 (1.5-4)	5 (3-5)	0.07243
	It can become necessary for me to use the metaverse to teach/learn.	4 (3-4)	5 (4-5)	0.02462*
Behavioral intention (α=0.851)	Future teaching/learning will continue to utilize metaverse technology.	4 (4-5)	5 (4-6)	0.01975*
	As a part of my daily life, I will always seek to use metaverse technology as a means of teaching/learning.	3 (1-4)	3 (2-5)	0.66917
	I plan to continue to use metaverse technology on a regular basis to teach/learn.	3 (1-4)	4 (3-5)	0.25113
Actual use behavior (α=0.869)	It is a pleasure to use metaverse technology to teach/learn.	3 (1-3)	4 (3-5)	0.04875*
	I will actively use metaverse technology to teach/learn.	3 (1.5-4)	4 (3-5)	0.12742
	I would recommend metaverse technology to others for teaching/learning.	3 (2-4)	5 (4-5)	0.02107*
	As a student/teacher, I am confident in my ability to use metaverse technology.	2 (1-3.5)	4 (3-5)	0.02069*
Attitude (α=0.944)	As a learner/teacher, I would be in favor of using the metaverse for education.	4 (1.5-4.5)	5 (3-5)	0.14381
	Using metaverse technology for education can provide valuable services.	4 (2.5-4.5)	5 (4-6)	0.06069
	Teaching/learning with metaverse technology can be a rewarding experience.	4 (3-4.5)	5 (4-6)	0.06493