Authors' Statements

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- Alvaro Uribe Quevedo PhD. Associate Professor, Faculty of Business and Information Technology, Ontario Tech University. Dr. Uribe Quevedo's research focuses on human factors in virtual reality, with more than 200 publications.
- David Rojas, PhD. Assistant Professor; Director Program Evaluation, Medical Education, Temerty Facutly of Medicine, University of Toronto. Dr Rojas' program of research focuses the evaluation of complex healthcare systems and accreditation processes in education, with over 30 peer reviewed publications.

We wish to confirm that there are no known conflicts of interest associated with this research and that the manuscript has been read and approved by all named authors.

FAVD Sim: Towards Designing a Forceps-Assisted Vaginal Delivery Simulator

Prototyping a custom-made 3D printed forceps-assisted vaginal delivery for computer-based simulation training, this paper explores the makerspace design of a 3D user input device for virtually practicing vaginal delivery with the goal of increasing access towards overcoming current limitations with high-end simulators that may impact morbidity and overreliance on cesarean procedures. Simulation training has shown its effectiveness throughout several fields of medical education in improving the operator's comfort with procedures, especially those conducted in high-stress environments, including obstetrics emergencies[1] . Technological advancements have enabled the incorporation of game-based strategies in higher education instruction of medicine and healthcare learning [2]. Game design and technology integration allow representation of simulated training scenarios that mirror complex "real life" situations, allowing students to practice procedures in a safe, supported and conducive learning environment.

The use of the cesarean has been increasing as an alternative to Assisted Vaginal Deliveries (AVD). However, cesarean procedures have led to an increase in morbidity among the maternal population due to the risks associated with this procedure, such as the augmented risk to experience placenta accreta spectrum disorders in future pregnancies or the risk to suffer scarring complications [3]. Encouraging the practice and training of AVD is a useful strategy to reduce the reliance on cesarean procedures and consequently, reduce the morbidity rate associated with it. The preference for the cesarean over the AVD can be attributed to the lack of training strategies for AVD procedures that require mastered skills and confidence. Previous research demonstrated that almost half of the obstetric graduated professionals do not feel competent enough to successfully perform an AVD without supervision, due to the lack of training experiences for practitioners [4], [5], [6].

Addressing the gap in training strategies, we have focused on developing a custom-made 3D printed user interface for hybrid FAVD simulator that allows obstetrics trainees to practice the procedure. The FAVD simulator consists of the custom-made user interface and a virtual reality software providing tasks that will be studied to determine its value for motor skills and confidence. Unlike high-end simulators [7], [8], which require specialized facilities, personnel, and software in addition to a high acquisition cost, or low-end computer-based simulations where mouse/keyboard or game controllers are used, our approach focuses on 3D printing and open electronics to better adapt the interactions

with proper task and instrument representation, coupled with a computer scenario running in both immersive and non-immersive virtual reality (VR) (i.e., Virtual Reality with a headset and without, respectively).

Our simulator brings together a physical interface that provides haptic feedback to the practitioner and a virtual component that provides visual feedback to the user, displaying the tasks to be performed. The design of the custom-made FAVDS has been informed by current literature [5], [9], [10] and content expert feedback. The design process has involved multiple brainstorming sessions aimed to ensure that the design properly represents the procedure in terms of visual and tactile feedback. Computer-assisted design software has been used to design the mechanism that replicates the path forceps will follow when used to deliver a baby. A combination of a serial mechanism, coupled with sensors, actuators, and mechanical constraints have been taken into account to adhere to the average newborn anthropometrics to ensure proper head and body movement is possible, while being delivered using the forceps. The sensors and actuators for tracking orientation, pressure and position are connected to an Arduino microcontroller that serializes data to a computer, thus articulating the user inputs into visual responses. For the visual feedback, Unity 2022.3 was chosen in which 3D models of the fetus and forceps tool are displayed and controlled by the physical interface to enhance the simulation experience by providing visualizations that are not possible with the physical model (e.g. What is happening inside the uterus when the tool is placed in). The scenario was used to validate the path, in addition to collecting preliminary insights pertaining to the device's usability. While additional work remains, early impressions and preliminary testing of the device have been positive. Regarding the early impressions, content experts highlighted the performance feedback strategies commending the inclusion of these metrics into the simulation experience. They also praised the fidelity of the 3D models (printed and virtual models), emphasizing its importance, as current commercial simulators often lack realism. Preliminary testing focused on the ability of the mechanism model to track the delivery path, several trials were performed with the mechanism prototype comparing the measured path (using sensors) with the real path (which was tracked using video reference as ground truth), results indicated that our prototype can track the delivery path of the baby with a margin of error of up to 6%, which is enough to generate accurate performance metrics following the methodology showcased by Bramblet et. al [5]. Furthermore, preliminary testing facilitated performance improvements through an iterative approach, including adjustment of measurements, selection of sensors and comparison with previous work.

Future work will focus on 3D printing the womb and the addition of other materials (e.g., silicone molds to simulate tissues and resistance found when delivering) to replicate FAVD. Once finalized, user testing will be conducted aiming to recruit 31 participants from the area of obstetrics and gynecology to assess usability, cognitive load, simulation value, and performance, comparing our simulator against high- and low-end simulators currently being used.

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Authors' Statements

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Fabian Gualdron. Computer Science Master's student, Ontario Tech University. Gualdron's research focuses on the development of a custom-made 3D input device for the simulation of vaginal delivery using forceps and understanding onboarding strategies for VR. Gualdron has one publication.

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Alvaro Uribe Quevedo PhD. Associate Professor, Ontario Tech University. Dr. Uribe Quevedo's research focuses on human factors in virtual reality, with more than 200 publications.

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Exploring Onboarding Strategies and Cognitive Load in Virtual Reality Games and Applications

Onboarding and tutorials should set users up for success in virtual reality (VR) regardless of expertise. This paper presents work in progress that explores how onboarding strategies impact cognitive load in VR games and serious games. The availability of virtual reality hardware has led to its adoption in applications beyond entertainment for educational purposes (Xie et al., 2021). VR devices offer audiovisual immersion and vibrotactile feedback at the consumer level. However, VR lacks significantly in terms of accessibility, presenting a mostly one-size-fits-all solution with limited customizations (e.g., interpupillary distance). This scenario is particularly concerning given that current trends in VR adoption now involve novice users who must become proficient with common virtual interactions that do not always match real-world interactions. This, in addition to the content being presented, can result in higher cognitive load, which can hinder the experience, learning, and flow (Shen & Pan, 2022).

Limitations in VR technology have sparked research into accessibility and adaptability through physical (Kartick et al., 2023), physiological (Wood et al., 2021), game mechanics, artificial intelligence (Zahabi & Abdul Razak, 2020), and custom-made user interfaces (Balderas et al., 2019). However, regardless of the adaptation, novice users face additional challenges as the technology requires them to relearn how to interact with the virtual world (Miguel-Alonso et al., 2024). For example, walking in VR is typically achieved using the joystick on the left controller; grasping objects requires using the middle finger and the grip button of either hand; controlling the camera uses the joystick on the right controller; and performing other actions requires a combination of other buttons on the controllers. While physical, physiological, and AI adaptations can alleviate gameplay and flow by ensuring smooth experiences, novice users are still required to become proficient (Khurana & Chilana, 2024).

We analyzed onboarding strategies reported in scholarly works in addition to those found in well-known VR games. From our review, we found that onboarding in most serious games and commercial games aligns closely with the three strategies for teaching presented by Long (2021). The onboarding strategies use levels of explicitness to help users familiarize themselves with tasks through the following approaches: (a) **Explain-focused tutorials** provide step-by-step instructions and are typically held within designated or labeled sections of an application; (b) **Existing knowledge-focused tutorials** guide players toward their goals without explicitly telling them the answers; and (c) **Explore-focused tutorials** allow users to discover what they can do for themselves, with minimal indication.

To further understand onboarding strategies, we analyzed six applications, including four commercial games (*Beat Saber, Half-Life: Alyx, Mirage VR,* and *Job Simulator*) and two serious games (*Premium Cuts* and *Snow Shoveling*), both of which were developed for research purposes. Six participants completed the tutorials for each application, a demographics survey, and the NASA Task Load Index (TLX)

questionnaire (Hart & Staveland, 1988). All applications scored above the ideal low (0–9/100) to medium (10–29/100) cognitive load. Five of the applications had a somewhat high cognitive load (30–49/100)—*Snow Shoveling* (31.67), *Premium Cuts* (32.5), *Beat Saber* and *Job Simulator* (36.95), and *Half-Life: Alyx* (39.45)—while one had a high cognitive load (50–79/100), namely *Mirage VR* (50). *Mirage VR, Half-Life: Alyx,* and *Snow Shoveling* were perceived to cause frustration, with *Mirage VR* requiring more effort, physical, and mental demand.

These findings align with our observations of participants struggling to paddle, reposition, and complete tasks. Similar issues were noted with other applications (except *Beat Saber*), but they were not as severe as with *Mirage VR*. Observations and feedback indicated that struggles were influenced by difficulties with specific interactions. All participants were familiar with VR games, but only one played regularly. Additionally, four participants identified as VR novices, one as intermediate, and one as advanced. Interestingly, despite their self-identified expertise, four novice players ranked their comfort and self-efficacy as moderate, while the remaining two ranked it as high.

Our preliminary results suggest that current onboarding approaches do not achieve low cognitive load. Notably, the perceived level of expertise differs from self-efficacy and comfort responses. Given that participants were familiar with VR games and had moderate to high proficiency, lower cognitive loads were expected. Future work will focus on analyzing these onboarding strategies further by collecting physical and physiological measures to better understand the role of tutorial type and VR expertise. This work aims to propose novel onboarding techniques for novices.

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Developing Inclusive Immersive Virtual Learning Environments (iVLEs) Work-in-Progress

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1.0 Overview

The use of immersive virtual learning environments (iVLEs), including serious games and virtual simulations, grew immensely during the COVID-19 pandemic as they played a significant role in facilitating remote learning during the pandemic-related-lockdowns. iVLEs allow trainees to learn from virtual simulated experiences in an interactive, engaging, and ethically safe manner. Despite the growing popularity and benefits of iVLEs, there are several issues with the currently available iVLEs including their lack of inclusivity. With respect to iVLEs and video games in general, inclusivity can be divided into two components: i) accessibility, and ii) diversity; both of which involve acknowledging the existence of people and/or groups who lack social power, prestige, or entrenched advantage, and establishing an awareness of their marginalization or exclusion based on social or physical barriers (Alozie et al, 2021). There has been very little effort placed on addressing the inclusivity of iVLEs, and access for diverse learners, particularly those with disabilities who may require accommodations to use them (Gay and Ralston, 2021).

According to the non-profit International Game Developers Association (IGDA), diversity is any dimension that can be used to differentiate groups and people from one another and may include culture, race, ethnicity, physical appearance, age, gender identity, sexual orientation, ability/disability. neurodiversity, socioeconomic, behavior, ethno-diversity, ideologies and viewpoints, education, career and roles, marital/parental status, location and geography, history, technology, and its access (IGDA, 2022). Armstrong conducted a review that examined over 160 studies on representation in media, and reports a predominance of white characters in software, books and learning tools and a significant lack of representation of people of color (Armstrong, 2021). Various inclusivity guidelines have been proposed for games and media in general. For example, the IGDA has devised the "Inclusive Game Design and Development" framework that emphasize diversity for designing and developing inclusive games and media (IGDA, 2022). Accessibility represents the features that developers design into iVLEs and video games to allow access and use of the iVLE/video games by users with a wide range of needs (ISO, 2013; Preece et al., 2019). The Game Accessibility Guidelines (GAG, 2016) were created by a collaboration between a group of game studios, specialists, and academics. Westin et al. (2018) recommend that the WCAG and GAG are used in conjunction in iVLEs/video games.

1.1 Objectives

The maxSIMhealth Group is an interdisciplinary collaborative manufacturing, design, and simulation laboratory at Ontario Tech University in Oshawa, Canada combining expertise in Health Sciences, Computer Science, Engineering, Business, and Information Technology, aiming at building community partnerships to advance health professions simulation training. A large focus within maxSIMhealth is iVLEs in the form of virtual simulations and serious games and recently we have placed emphasis on

inclusivity (diversity and accessibility) within iVLEs to better match the diversity of health professionals and patients within a diverse country such as Canada. Here, in this "work-in-progress" paper, focus is placed on diversity. More specifically, an overview of our ongoing work that will see the development of a "diversity questionnaire" that will be distributed to medical educators to gauge what features they view as important with respect to diversity. Results of the questionnaire will ultimately lead to a set of best practices for designers/developers of iVLEs to ensure diversity within any applications they develop.

2.0 Proposed Solution

Work recently begun on a literature review on diversity within iVLEs. Emphasis is being placed on avatars given their importance in medical-based iVLEs and the large number of individual attributes to consider including body shape, voice, skin/eye/hair color, clothing (e.g., culturally specific or faith-based), age, abilities (physical, cognitive, motor or social), amongst others. The results of the review will be used to devise a draft diversity questionnaire (DQ). Following the Delphi method (Cochrane, 1983), the draft DQ will be surveyed by a panel of between four and six experts (from a variety of fields including education, health care, and computer science). During each round, panel members (anonymous to each other), will be asked to evaluate an online version of the draft DQ and provide feedback regarding its questions. After each round, responses will be aggregated and shared with the panel (anonymously), providing them the opportunity to respond to the emerging data, until a consensus is reached (typically three rounds) and the final DQ is achieved. The final DQ will be distributed to medical educators) for them to complete. An analysis of the results will help determine what features and attributes should be incorporated into medical-based iVLEs (e.g., it may lead to an avatar "construction kit" to allow the trainee to customize their avatar). These results will then be incorporated into a medical-based iVLE and focus group sessions in addition to usability/user experience experiments with human participants (medical educators and trainees) will be conducted. Ultimately, this work will be summarized in a set of best-practices/recommendations that will be made freely available to guide designers and developers of medical-based iVLEs.

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Author Description

Bill Kapralos is an Associate Professor in the Game Development program, and a member of the maxSIMhealth Group at Ontario Tech University (OTU) in Oshawa, Canada. Bill's research is currently focused on immersive virtual learning environments (iVLEs) including virtual simulations, serious games and spatial sound/multimodal interactions. His work in the iVLE field began in 2006 at a time when technology was well behind where we are now and well before iVLEs became popular. His innovative work has resulted in many refereed journal and conference articles, many in very well-respected technology- and medical-based journals and conferences, including a recent article describing a method to convert a serious game into an accessible version which appears in the IEE Transactions on Games journal.

Integrating Virtual Reality Reminiscence Therapy into the dementia care programs at Alzheimer's Society of Durham

Winnie Sun, Alvaro Quevedo, Sara Elzazzar, Khadeeja Fatima, and Dana Warner

Background

As the prevalence and incidence of dementia increases, new forms of treatments are being explored to offer people with dementia (PWD) with options outside of the traditional treatment models. The introduction of reminiscence therapy through virtual reality (VR) technology combines sight, touch, sound, and events from past experiences [1]. Through this non-pharmacological approach, this intervention has the potential to assist PWD with recalling memories of their past lives, reducing episodes of depression and improving their quality of life as they age in place in their homes and communities. Our exploratory study seeks the input of PWD, caregivers, and program workers in enhancing a VRRT prototype that is being considered for integration into an existing dementia care program. Our goal is to develop educational training, resources and support to equip the caregivers related to the use of VRRT in complementary to the traditional responsive behaviour mitigation interventions, with the expected impact of supporting aging in place and promoting the quality of life for PWD and their caregivers.

Methods

This mixed methods research focuses on the use of co-designing approaches with PWD, their caregivers and program workers. It aimed to explore and understand the participants' perspectives on applying VR as an immersive approach to facilitate reminiscence therapy for PWD. A final sample of ten participants was recruited, including three PWD, three caregivers, and four program workers (ie. Registered Nurses) from the Alzheimer's Society. VR reminiscence experience was conducted through usability testing for once a week over four weeks, including assessing the user interface, system functionality and user responses.

Our study employed Meta Quest 3 VR headsets to give the participants an initial VR presentation and demonstration. The VR presentation content was tailored to introduce to participants what VR entails and its significant role in dementia care. The demonstration aimed to stimulate cognitive engagement and physical interaction within the VR space and promote reminiscence therapy through memories from pictures and audio downloaded to the VR system [2]. Participants gained familiarity with the broad spectrum of the uses of VR

as they experienced the VR environments through virtual travel to different nature scenes and engaged in stimulating activities such as painting in a 3D virtual environment. The participants were first placed in an outdoor environment where they could choose between outer space, a mountain valley, or a city landscape. Here, they were given free navigation to explore the environment they were exposed to. The participants were then guided through instructions on how to navigate to the VR reminiscence application that had been developed for the project within the Meta Quest headset. This indoor environment also had different scenes and home styles to choose from. This application involved aspects of reminiscence therapy as the participants could engage with photo albums, favourite audio and music, and videos from their past within the VR world using VR remotes or physical hands via the hand tracking method embedded in the application [3]. Lastly, the demonstration involved introducing and guiding participants through the VR reminiscence experience through usability testing, including assessing the user interface, system functionality and user responses. Each VR demonstration lasted approximately 10-15 minutes. Data collection instruments were used to gather participants' quantitative and qualitative information. Participants' demographic information and baseline caregiver burden were gathered before the VR presentation and demonstration. Participants' perspectives on the usability of VR system, their sense of presence while immersed in the VR world, and their perceptions of the VR experiences were obtained after the VR presentation and demonstration.

Results

Participants provided qualitative feedback, including (1) Understanding of Dementia Care and Service Experience; (2) Perspectives of the VR Demonstration; (3) Usability of Head Mounted Display and Hand Control; and (4) Perspective on System Usability and Immersive Presence. Our study findings revealed that people with dementia and their caregivers reported Increased self-reported self-efficacy in the technology use of VRRT overtime . There were also reported changes in Behavioral and Psychological Symptoms of Dementia as indicated by PWD and their caregivers as a result of engaging in VRRT (ie. increased engagement; Improved affect; improved daytime wakefulness). Positive impacts on caregiving abilities (ie. such as reduced stress, anxiety, anger/frustration) were reported by caregivers since the use of VRRT and technology skills training supported with educational resources. Perceived satisfaction with VRRT was reported by participants and their caregivers as they indicated that it is highly likely they will recommend this program to others.

Conclusion

When developing new therapies, it is critical to include the perspectives of the potential end users through participatory co-designing. Our study achieved this by engaging PWD,

caregivers, and program workers through exploratory co- designing and usability testing of VRRT. Utilizing co-designing approaches enhances the trust and collaboration between the study participants and the researchers, which is vital for our study as we seek to introduce VR into the existing dementia care programs and services.

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Affiliation (institutional, industry, independent, etc.):

Ontario Tech University and Alzheimer’s Society of Durham Region

Description of selected research, publications, and presentations:

This mixed methods research (funded by Centre for Aging and Brain Health Innovation CABHI) focuses on the use of co-designing approaches with people with dementia (PWD), their caregivers and program workers at Alzheimer’s Society of Durham Region. It aimed to explore and understand the participants' perspectives on applying virtual reality (VR) as an immersive approach to facilitate reminiscence therapy for PWD.

Sun, W., Volletta, P., Elgazzar, S., Warner, D., Peddar, S., Theodorou, A., & Quevedo, A. Integrating Virtual Reality Reminiscence Therapy into Dementia Care: An Exploratory Study. Institute of Electrical and Electronics Engineers. DOI: 10.1109/SeGAH61285.2024.10639596

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