The Surrogate Avatar Experience (SuAvE) as an Integrated System in the Hybridization of Higher Education

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Abstract

Hybrid learning demand, especially in a post-pandemic context, has reshaped higher education, demanding new approaches to the pedagogy of instruction and to the integration of advanced technologies. Hybrid learning, which combines face-to-face and virtual learning activities, offers flexibility but also presents challenges, particularly in replicating the embodied experiences of traditional classrooms. This thesis explores the Surrogate Avatar Experience (SuAvE) as a socio-technical system designed to enhance hybrid learning environments by enabling remote students to engage with physical classroom settings more fully through a Surrogate Avatar volunteer. SuAvE aims to address the lack of embodiment—a key issue in virtual and hybrid learning—by allowing students to experience the interactions in the physical environment remotely.

Employing a constructivist grounded theory approach, the research co-constructs methodology with participants and the researcher, allowing theories to emerge organically from qualitative data gathered through interviews and iterative SuAvE implementations. The study is structured in two parts: a holistic examination of SuAvE's integration into higher education and a focused analysis of additional factors influencing its implementation. The research aims to determine SuAvE's capacity to overcome the challenges of hybrid learning, particularly in fostering embodied experiences that are often diminished in virtual settings.

The discussion will analyze SuAvE as an integrated system in educational contexts, assessing its potential to bridge the gap between physical and virtual learning experiences. It specifically assesses 4 observed themes, where it is identified to be a technology utilized in facilitating relational spaces in social and collaborative learning classrooms. It will identify key challenges observed with technological and accessory devices, as well as motivational factors to increase participation. These themes will be used to determine the future scope of SuAvE, considering its broader implications for the digitalization of education and its role in creating more inclusive, interactive, and effective learning environments in higher education and beyond.

Table of Contents

List of Figures

List of Tables

Glossary

Term	Definition
Avatar	Signifies object or person that acts as a stand-in for another person within a physical environment and can be controlled or given a direction on behalf of a person.
Surrogate Avatar	A volunteer that is attending the physical environment on behalf of the remote participant. The Surrogate Avatar assumes the responsibility of physically representing a remote participant who attends virtually and requires physical embodiment.
Remote Participant	A person who is remotely located; located away from the environment.
Embodiment in Learning	The physical experiences that contribute to the learning process, such as face-to-face interactions, gestures, spatial awareness and the physical presence of instructors and peers.
Planes of Learning	The virtual plane through a personal device and a video-teleconferencing platform. The physical plane is in the physical environment.

Chapter 1: Introduction to the Study

1.1. Positionality of the Research

According to the National Center for Education Statistics, 54% of students in higher education were enrolled in distance learning courses in 2023 (National Center for Education Statistics, 2023). Furthermore, these statistics also showcase that students of minority groups enroll in distance education at higher rates. Since the COVID-19 pandemic, there has been a shift in learning styles and methods of delivering learning material to adjust for the pandemic's impact on education and other public sectors.

Hybrid learning emerged as a flexible and innovative educational approach that combined face-to-face instruction with virtual learning activities. As technology advances in academia, digital tools become more integrated into educational settings to accommodate hybrid learning and societal shifts toward digital connectivity (Haleem et al., 2022). The standard implementation of hybrid learning typically involves a blend of online and face-to-face learning modules using technological tools. These tools include a learning management system (LMS) to provide content such as lecture slides and additional reading material, a video-conferencing platform to navigate attendance in the physical environment for remote users and audio-visual equipment to allow for communication between the classroom environment and remote participants. Combining these technologies to deliver educational material allows for fluidity and self-directed learning through student convenience and capacity. The face-to-face sessions are predominantly utilized for activities that benefit direct interaction, such as discussion groups, collaborative projects and hands-on demonstrations.

While the pedagogy of instruction in higher education predominantly supports traditional learning implementations centered around in-person lectures and standardized assessments, standard hybrid learning aims to create a dynamic learning environment to support student success and promote more profound learning outcomes related to participation in courses and retention of information while in a virtual environment. The flexibility of hybrid learning allows educational institutions to cater to a broader range of students, accommodating various learning styles and preferences (Chen & Chiou, 2014). This flexibility can lead to increased engagement and retention rates in education, as students have greater control over their learning pace and environment. Furthermore, hybrid learning fosters the development of digital literacy and technological skills, which has become essential as education institutions and workplace environments shift to a knowledge-driven economy. Overall, this approach to education enhances accommodations for diverse learning preferences and schedules of students and professors and goes beyond the confinements of traditional classrooms.

However, hybrid learning poses differing implementation challenges, especially with regard to education. First and foremost are technical issues, such as unreliable internet connectivity or unfamiliarity with digital tools. The hybridization of learning is impacted by the degree of comfort and proficiency in utilizing technology for educational purposes. With the demand for hybrid learning activities, there is a demand for hybrid learning technologies for students and educators to familiarize themselves with to allow for the development of better-mediated tools.

Even with limitations of knowledge and comfort in utilizing hybrid learning technologies and tools, there is a disconnection with maintaining consistent engagement and interaction in both online and physical settings. To navigate these digital and physical presences, educators are

also responsible for coordinating the web-conferencing platform tools, finding new methods of accommodation and interacting with students on separate platforms. These hybrid learning technologies are essential to facilitate these modules' interaction and content delivery. Learning management systems, video-conferencing platforms, and other collaborative tools play pivotal roles in supporting the bridge between the physical and virtual planes of learning. These technologies aim to promote interactive learning experiences. However, these tools must still be effectively harnessed by educators, who are already adapting their teaching practices to accommodate technological advances in the classroom. For this reason, many educators worldwide acknowledge the struggle to implement hybrid learning technologies and their respective practices. Furthermore, hybrid learning technologies do not yet address an observed lack of embodiment in education (Rodríguez-Jiménez & García-Merino, 2017).

The concept of embodiment in learning refers to the physical experiences that contribute to the learning process, such as face-to-face interactions, gestures, spatial awareness and the physical presence of instructors and peers. These physical experiences play a crucial role in the learning process, as they facilitate spontaneous interaction, convey non-verbal cues, and create a sense of physical presence that can contribute to a cohesive learning environment. However, there is a notable challenge in replicating this type of experience in hybrid learning environments, as virtual learners are not physically in the classroom (Rodríguez-Jiménez & García-Merino, 2017). The digital interactions conducted through screens and mediated by technology can diminish the experiences of spontaneous interaction, body language and facial expressions by the presence of a physical person in a specific location that can contribute to a cohesive learning environment (Greenhalgh-Spencer, 2013). Moreover, the lack of embodiment in hybrid learning environments can impact social dynamics and collaborative learning

experiences, which has been linked to belonging in the classroom and an increased observation of participation.

Social and collaborative learning are integral to hybrid learning classrooms, emphasizing peer interaction, knowledge sharing, and collective problem-solving (Sidgi, 2022). The interactions through embodiment influence students' perception and engagement with their peers and professors, while perception influences in educational settings are discussed in more detail in Section 2.4 (Jusslin et al., 2022). Educators and institutions worldwide implementing hybrid learning models must consider strategies to mitigate the lack of embodiment. Numerous studies have shown the implementation of telepresence robotic avatars to address this lack of embodiment, considering the increase in the digitalization of educational practices (Gleason & Greenhow, 2017; Lei et al., 2022; Wernbacher et al., 2022). However, there exist technical limitations regarding design as it impacts resource allocation, the physical environment, and the ease of use in experience for the remote user (Tsui & Yanco, 2013).

1.2. Intention of Research

This thesis prompts the thorough investigation of the Surrogate Avatar Experience as a socio-technical system for use in academia. SuAvE enables individuals to interact with physical learning environments remotely, potentially addressing the lack of embodiment in hybrid learning. The research aims to determine the scope of SuAvE implementation in higher education and addresses its capacity to overcome the challenges of hybrid learning, particularly in fostering embodied experiences that are often diminished in virtual settings.

Using a constructivist grounded theory approach, the primary research co-constructs methodology with participants and the primary researcher, allowing theories to emerge from the

qualitative data gathered from interviews following interactive and iterative processes of SuAvE implementations. The methodology, which is divided into two main sections, follows a holistic approach of SuAvE implementations, and a more focused approach on additional influencing factors in the SuAvE implementation from prompted questions regarding the overall capacity of integration determined from the holistic approach. A thematic approach to the discussion will analyze SuAvE as an integrated system in education, and an exploration of the future scope of SuAvE is developed.

1.3. Novelty of Research

This thesis presents a novel exploration to addressing the lack of physical embodiment in hybrid learning spaces. As outlined in Chapter 2, hybrid learning is an inclusive educational approach that offers numerous benefits to students. However, it also poses challenges related to students' sense of integration within physical classroom experiences, and the impacts that has on participation and retention in the classroom. The Surrogate Avatar Experience (SuAvE) represents the inaugural socio-technical methodology designed to bridge the virtual and physical dimensions of learning. This study aims to investigate the various dynamics involved in its implementation, marking it as the first of its kind in this field. Prior investigations into this subject were solely conducted by the primary researcher and their supervisor (Bruce, 2024; Sonnilal et al., 2024; Sonnilal & Bruce, 2024).

There are several methodologies that could be considered for the development of novel research that each offer different strengths related to the industry and direction of the project. Grounded theory offers distinct advantages over other research methodologies, particularly when exploring new or complex social phenomena. It is particularly well-suited for the scope of this thesis as it allows the research to be open-ended and exploratory in approach to gather new

insights and theories. Furthermore, this type of theory is focused on the interactions of the participants within the research environment, and allows for project iterations based on themes and insights that arise. These methods are beneficial for SuAvE, where understand the complex interplay of virtual and physical learning environments require fluidity. The choice of grounded theory as the framework for methodology is further discussed in Chapter 2.6, The Use of Grounded Theory for Hybrid Learning Examination.

Chapter 2: Literature Review

The current thesis study embarks on implementing the Surrogate Avatar Experience as a socio-technical telepresence system in hybrid education. As the novelty of the chosen implementation methodology has yet to be previously explored in this context, the literature review is structured around the core themes pertinent to the scope of the thesis. The literature review is organized thematically and compromises vital areas fundamental to the examination within the research. These themes include: educational environments, the hybridization of learning modalities, technology incorporated into hybrid learning related to embodiment, perception influences, and the use of grounded theory, each representing a different aspect of the topic. Reviewing the literature in this manner provides a comprehensive understanding of the existing knowledge base, identifying other methods and gaps the current study seeks to address. Additionally, the review will discuss similar projects within the same scope, highlighting methodologies and findings to contextualize the present research within the broader academic discourse but also through the potential impact of the SuAvE study. This literature review covers much of the relevant background information and implications that will aid in understanding the scope of SuAvE as an integrated system as pertaining to this thesis.

2.1. Educational Environments

The educational environment encompasses a variety of elements that are collectively the setting in which learning occurs. This section of the literature review emphasizes three aspects of the educational environment about the scope of the thesis: learning styles, pedagogy of instruction, and the point at which they intersect. Learning styles in education recognize how students process and retain information differently. Teaching strategies are methods and approaches employed by educators to deliver content and facilitate learning that are a useful interaction related to the three environmental aspects/ The intersection of these approaches builds the educational environment outside the physical institution's scope and the technological infrastructure's scope.

2.1.1. Learning Styles Within Education

The concept of "learning style" denotes the different methods of learning and processing new information, used as a framework for discussing approaches to educational practices (Romanelli et al., 2009). First introduced in 1987, Neil Fleming designed the VARK model to address preferences for processing educational information in learning (Fleming, 2006) . VARK is an acronym for the four classifications of learners: visual, auditory, reading/writing, and kinesthetic/tactile. In the educational field of Science, Technology, Engineering, and Math (STEM) specifically, a review of different learning styles was conducted by Kulturel-Konak, that determined gender differences in learning styles were observed when evaluating different executions attributed to learning styles (Kulturel-Konak et al., 2011). Using the VARK model, the review concurred that preferential differences in STEM-specific classes indicated that most female students preferred multimodal learning styles, with a combination of visual, auditory, and reading/writing – compared to only one-third of male students. Meanwhile, male students

preferred kinesthetic and auditory learning independently of each other. Understanding these learning styles is important about implementing pedagogy of instruction within educational environments. This remains true in other contexts as well regarding VARK as a framework in pedagogical approaches, but this central environment of STEM is best for the application of SuAvE. A brief literature review of the VARK model is essential for understanding the role embodiment plays within physical learning spaces and highlights preferential learning. With the intention of SuAvE to bridge the gaps that hybrid-learning do not address in providing physical experiences, learning styles are an aspect of consideration. While VARK is not the only model available for discussing learning styles, it was chosen as a framework to guide the avenues explored in the methodology due to its foundational work within the topic of learning styles.

2.1.2. Pedagogy of Instruction

The pedagogy of instruction encompasses the methods and strategies employed by educators to facilitate learning and promote student engagement. It is rooted in various educational theories and practices to create an effective learning environment tailored to the diverse needs of students (Kind & Chan, 2019). A pedagogy of instruction is essential for several reasons. Strategies support providing a structured approach to teaching to meet systemic educational objectives, applying effective teaching strategies, and encouraging student engagement. As such, there is no one set methodology of pedagogical approaches; instead, various methods are incorporated into teaching practices related to different learning preferences (Burke & Lehane, 2023). While there are many different pedagogical approaches, the selected approach depends on each teacher regarding what they believe is the most beneficial about the courses they teach related to student outcomes.

2.1.3. Intersection of Teaching Instruction and Learning Styles

The intersection of the pedagogy of instruction and learning styles is essential in creating effective educational environments that accommodate the diverse ways students learn. Utilizing the VARK model, the pedagogical strategies enable educators to design student-catered lessons. In a comprehensive review conducted by Hussain, methods for pedagogical approaches related to VARK were organized (Hussain, 2017). Regarding visualization learners that benefit most from observation, pedagogical implications suggest using visual aids, including colour coordination, graphic material and drawings in lesson content. Regarding auditory learners that acquire knowledge through listening, pedagogical implications encourage the use of discussion groups and projects, and lecture recordings to encourage auditory sharing of information. Reading reading/writing learners who acquire knowledge through the repetition of words, pedagogical implications encourage the use of secondary readings incorporated into lecture content. Lastly, concerning kinesthetic learners who benefit most from hands-on activities, pedagogical implications suggest incorporating hands-on activities and simulations in active learning environments. The alignment of the VARK learning styles model into the pedagogy of instruction enables an environment of learning that benefits multiple ways of processing information and is essential about implications within digital learning environments (Moazeni & Pourmohammadi, 2013).

2.2. Hybridization of Learning

With a background in the general implementations of pedagogy of instruction and learning styles pertaining to the educational environment, the scope of this thesis specifically emphasizes the hybridization of learning in a post-pandemic educational setting of higher education.

2.2.1. Hybrid Learning at a Glance

The hybridization of learning, also commonly referred to as blended learning, has multiple definitions framed around the “mixed mode of instruction, formally combining traditional face-to-face instruction and pure online learning”(Olapiriyakul & Scher, 2006). While often used interchangeably due to the common pedagogical approach of combining in-person classroom instruction and virtual instruction, this type of learning aims to integrate different learning to maximize student participation and retention (O’Byrne & Pytash, 2015). However, the semantic differences between blended learning and hybrid learning suggest that blended learning is a category of learning while incorporating technology, and hybrid learning is a specification of the execution of the implementation of simultaneously content delivery in various learning environments (Shevtsov, 2021). Blended learning is the overarching pedagogical approach of incorporating digital technologies and online tools in physical educational spaces. However, blended learning focuses on the interchangeability of these elements, where some aspects of instruction will require attendance in an in-person classroom environment, and some can be conducted asynchronously or synchronously in a virtual environment (Shevtsov, 2021). Meanwhile, hybrid learning specifically emphasizes synchronous lessons that occur in the virtual and in-person environment, allowing an instructor to prescribe the teaching modality to students.

2.2.2. Benefits of Hybrid Learning

Hybrid learning offers numerous benefits to enhance the educational experience for learners and educators alike. One of the primary advantages is its flexibility, which allows students to interact with course requirements at their own pace and accommodates learners who are balancing other aspects of life such as work, family, and health (Maneotis & Warren, 2024).

This mode of study also supports personalized studies, which allows students to select the VARK model that best supports their learning style the best. Hybrid learning is also considered a more accessible delivery of education for students who cannot physically travel to campuses (Barker, 2015).

Studies on understanding the perspective of undergraduate and graduate students and their relationship to hybrid learning have also been conducted by different researchers. In a study focused on a cohort of mixed undergraduate and graduate students, Ali utilized a mixed-methods approach of interviews and surveys to gather data about the students who were familiar with hybrid learning (Ali, 2019). In this, most students indicated a positive view of hybrid learning methods, where 35% of students agreed, and 65% of students strongly agreed that hybrid learning was advantageous for students who need to study remotely for various reasons.

Similarly, Snart analyzes applications of hybrid learning in the classroom by studying exemplars of undergraduate and graduate courses that have implemented those implementations in the classroom (Snart, 2010). By analyzing different student experiences obtained from interviews and surveys, it was concluded that undergraduate and graduate students generally prefer the method of hybridization in learning as it enables them to more easily balance academic, professional, financial and social environments while satisfying educational requirements.

2.2.3. Difficulties With Hybrid Learning Implementations

Despite the numerous benefits of hybrid learning, it presents several challenges that impact its effectiveness. In a systematic literature review conducted by Raes et al, 47 studies were analyzed that indicated pedagogical and technical challenges experienced (Raes et al.,

2020). These include a lack of equal access to technology and reliable internet that would primarily impact students from underrepresented and underprivileged backgrounds. Additionally, student engagement and motivation have been challenging to maintain on behalf of the professors and have emphasized a requirement to adjust pedagogical approaches. Overcoming this challenge requires integrating various teaching methods and can impact effective communication and collaboration between students and instructors across different platforms.

In the study previously investigated by Abdelrahman and Irby, even with acknowledging the benefits of hybrid learning, interviewed educators recognize that the quality of education is impacted by the lack of face-to-face interactions in the learning environment (Abdelrahman & Irby, 2016). Furthermore, in a series conducted regarding 39 leaders and teachers, it was concluded that implementations of hybrid learning within educational settings rely heavily on educators to utilize digital tools and modify traditional course material and assessments, which has been an adjustment to faculties, educators, and learners alike (Dikilitas & Rambla, 2022).

Concerning VARK, a comparative case study was conducted to determine the influence of learning styles within in-person, hybrid, and fully online learning (Ansari, 2023). By implementing and studying the models developed, it was determined that students in hybrid learning environments were more negatively impacted by cultural and societal factors, student motivation and engagement, resource availability, psychological and emotional factors, and self-reflection compared to their in-person peers. These factors, and overgeneralization and stereotyping can limit the capacity to accommodate student learning preferences. Furthermore, for kinesthetic learners especially, a lack of embodiment to participate in hands-on activities is not accommodated.

While factors described in this section that impact hybrid-learning may also be challenges within the physical learning environments as well, these will be strictly considered in the lens of hybrid-learning environments for the evaluation within this thesis.

2.2.4. Hybrid Learning: Pre-and-Post Pandemic

As the context of higher education changes, the access and integration of technology has changed the learning environment. Previously, online learning systems were strictly separated from traditional in-person classroom instruction. However, resulting from the COVID-19 pandemic, online learning became the only method of learning that was accessible during the mandated lockdowns. As higher education institutions began resuming traditional in-person classroom environments, the hybridization of learning was demanded by students to accommodate the diverse range of learning styles and needed accommodations that stemmed from the pandemic (Krishnan & Nagaratnam, 2023). Furthermore, there exist many external aspects of students being unable to return to full-time in-person lecture styles, such as full-time professional commitments or familial and caretaker roles.

Focal studies were conducted post-pandemic to determine if there was any impact on student's perception of the type of learning methods utilized in the classroom environment. As studied by Sulistyanto et al. through implementing a hybrid learning model that adapts the VARK learning style in elementary schools, it was determined that the independence in studying through hybrid learning has improved students' critical thinking skills but requires characteristics of VARK to allow students more freedom to engage with learning in the way they prefer (Sulistyanto et al., 2023). Similarly, Zaplaska utilized VARK as an instrument in an undergraduate engineering course to access students' learning about a post-pandemic learning environment and with emphasis on gender-based differences in STEM education (Zapalska,

2022). The research methodology was conducted through interviews and a VARK questionnaire, and the results indicated an increase in grade point average when VARK methods were introduced in hybrid learning compared to without its consideration. Males executed a better grade point average with kinetic methods of learning, whereas females executed a better grade point average with reading and verbal methods of learning. In both cases, the researchers indicated the importance of VARK methods being implemented in the instruction pedagogy for the benefit of hybrid learning in a post-pandemic world.

With consideration of the pedagogy of instruction in a post-pandemic context, educators seek to reflect on innovating teaching methods to implement in institutions due to the rise of online and hybrid learning (Parchoma et al., 2020). As such, through a series of interviews, educators commented on how the pandemic emphasized the digitalization of teaching and learning in higher education (Rapanta et al., 2021). However, there are limited group interactions and challenges with educators providing fair evaluations from the ability for students to access secondary resources when conducting examinations online compared to in-person. As such, most educators believe that for hybrid learning to occur successfully in the post-pandemic world, peer-support, self-engagement, accessibility to technology, are critical to consider in the strategic planning of pedagogical innovation.

2.2.5. Addressing the Lack of Embodiment in Hybrid Learning

While there has been an understanding of the benefits of hybrid learning methods, it is suggested that the teaching-learning process requires physical embodiment within higher education (Rodríguez-Jiménez & García-Merino, 2017). This conclusion was determined by studying experiential learning through implemented embodied experiences. From interviewing students before and after participating in the experiential learning activities, a qualitative analysis

was conducted which showcased the benefits of active learning for students' motor development and memory retention.

Regarding physical embodied experiences, a study was conducted with fourth-year University students by Foo et al., comparing in-person classmates to their strictly remote counterparts to understand the difference in the hybrid learning realm (Foo et al., 2021). In the identified areas of proficiency, participation, communication, preparation, critical thinking, and group skills, the students with physical embodied learning had a higher observed performance in a standardized scoring system. This study suggested that having a sense of belonging in a learning environment increased motivation and satisfaction for students.

In a dissertation completed by Greenhalgh-Spencer, a thorough study was conducted regarding understanding engaging and socially stimulating educational spaces in online environments (Greenhalgh-Spencer, 2013). It was determined through literature reviews and orientations with embodiment that physical embodiment is a vital missing component in current hybrid learning implementations, creating a lack of engagement in online educational spaces. Similarly to this, a design-based research approach was conducted by Raes about understanding two cases of learning: hybrid group problems and hybrid lectures (Raes et al., 2020). Quantitative data from surveys that were conducted pre-and-post hybrid environments were obtained and evaluated, where it was determined that student engagement was impacted by a lack of embodiment and thus a sense of presence and belonging. The research concluded that pedagogy for hybrid education environments should entail aspects of embodiment to increase benefits for students.

To address this lack of physical embodiment in many higher education environments, the concept of using secondary avatars to navigate physical environments has been introduced. The

concept of avatars, as well as how the implementation differs between studies conducted and is discussed in greater detail in Section 2.4 – Avatars.

2.2.6. The Importance of Copresence and Social-Presence in Hybrid Learning

When implementation in social settings occurs and is related to embodiment, the presence and connection of a human surrogate becomes a vital aspect in how students learn and the capacity to integrate into the environment. Copresence, which was proposed as a dimension of communicating with users in differing environments, is also vital to understanding implementations within hybrid learning environments as it influences mediated communication situations. In the classification of communication situations, copresence is observed differently in differing situations (Kraus & Kibsgaard, 2015). Un-mediated copresence can exist through a shared immediate environment where physical proximity is observed, which would entail co-located and immersed users. Meanwhile, mediated copresence entails a collaborative teleoperation where users are connected and immersed but from a non-shared location and do not require physical proximity. This ability to mediate copresence is required for the integration of the hybrid learning methods in the classroom.

With the increase in popularity of hybrid learning spaces, gathering information pertaining to the quality of education and student satisfaction in the implementation of online modules of learning have been studied. In an analysis conducted by Stankovska et al., students were invited to participate in surveys, where questions pertained to instructor support, student interaction and collaboration, personal relevance, authentic learning, active learning, and student autonomy (Stankovska et al., 2021). The data collected was then evaluated using the Social Presence Scale (SPRES) developed by Cobb, where social presence was defined as the perception of the environment and with others that learners experience in online environments

(Cobb, 2009). In this case, social presence is a sub-section of copresence, focusing specifically on the social aspects of shared and non-shared environments. The observation entailed a significant positive relationship between authentic learning and social presence; it was concluded that online courses need an aspect of social presence to increase interest and engagement in both measurable and implied interactions.

2.3. Technology Incorporated into Hybrid Learning Related to Embodiment

Telepresence, augmented reality (AR), and virtual reality (VR) are innovative technologies that bring embodied experiences to hybrid learning environments. Each provides distinct ways of doing so, as represented by each sub-section below.

2.3.1. Telepresence

Telepresence refers to the use of technology to enable individuals to interact from a remote location through the first-person perspective (Draper et al., 1998) . This is achieved through advanced video-conferencing tools, virtual reality (VR) and augmented reality (AR) systems to provide immersive experiences. These tools mimic human senses of hearing, seeing, and interacting with the environments in real-time from afar. Telepresence has been integrated into different fields, primarily with foreseen value in business, healthcare, and education (Goodliffe, 2023).

In the business world, telepresence systems allow participants to partake in business meetings from remote locations, which has had benefits related to cost- and time-savings (Standaert et al., 2013). In healthcare, telepresence enables remote consultations and surgeries, and access to medical expertise regardless of geographic location (Molloy et al., 2016). Telepresence has been introduced in education regarding virtual classrooms for remote and

distance learners (Heikkila, 2018). As technology continues to evolve, and concerning hybrid learning, telepresence is continuously being integrated to address the lack of embodiment and engage in co-presence in virtual environments.

2.3.2. Augmented Reality

Augmented reality refers to technology that overlays digital information and virtual objects onto the real-world environment to provide a perception of a physical reality (Al-Ansi et al., 2023). Key features of augmented reality include real-time interaction, allowing remote users to interact with both real-world and virtual elements simultaneously. Augmented reality can also provide context-specific information to enhance user experience. Applications of augmented reality include education, through interactions with 3D modelling and simulation, healthcare through medical training and patient care, and navigation, amongst other industries.

2.3.3. Virtual Reality

Virtual reality is technology that creates an immersive digital environment in a computer-generated world (Al-Ansi et al., 2023). This immersive environment, which is a simulator, allows for interaction with virtual objects to provide sensory engagement. Virtual reality is used primarily in training and simulations, such as aviation, medicine, and military, where providing a real-time livestream of the environment poses challenges. Models that are combined with virtual reality to mirror a real-world entity in the digital realm are also emerging, such as utilizing digital twins (Cooney, 2024). This future interaction can include manipulating objects, viewing real-time data, or simulating different scenarios to simulate a physical object or space.

2.3.4. Comparison Between Telepresence, Augmented Reality, and Virtual Reality

Telepresence, augmented reality, and virtual reality, aim to provide immersive experiences for remote users to enhance or alter the first-person perspective of environments. The collection of all of these interfaces is termed XR and refers to Extended Reality. Each utilizes technology, including video-conferencing software, displays and sensors to create their respective experiences. However, the three have critical differences in aims and executions. Telepresence aims to use technology to provide an experience where remote participants feel physically present in a remote location. Augmented reality could be utilized to enhance telepresence as a mediator between physical and digital worlds. Lastly, virtual reality replicates real-world experiences through the modelling of digitally immersive experiences. As related to this thesis, telepresence is the medium of focus for integration into hybrid learning environments as it is the most cost-effective and accessible of the three options and requires the least amount of specialized equipment. For this reason, familiar technology that is used to facilitate engagement is easier to incorporate for educators and students.

2.4. Avatars

"Avatars" signify any object or person that acts as a stand-in for another person within a physical environment and can be controlled or given a direction on behalf of a person (Yeonjoon Kim et al., 2015). Different mediums of avatars are implemented into telepresence environments different fields of implementation.

2.4.1. Robotic Avatars at a Glance

Robotic avatars in telepresence are an application of technology that enables remote users to project their presence into a remote location using a robot that they can control (Rezeck et al.,

2013). As such, these robots are equipped with secondary devices, such as microphones and cameras for transmitting real-time audio-visuals, amongst some aspects of mobility to navigate the surrounding areas. The applications of robotic avatars in telepresence vary based on industry and intended application, as well as in remote work, healthcare, education, exploration, and customer service.

2.4.2. Robotic Avatars in Business

Robotic avatars have begun preliminary implementations in business settings, predominantly related to meeting attendance and the capacity to partake in remote work (Standaert et al., 2013). Regarding remote work, telepresence robots aid in providing physical attendance and mobility in offices by operating a robot controlled by a personal device, and utilizes a video camera, screen, speakers and microphones to connect with the physical environment. In a case study conducted involving the interactions that the robotic avatars had with their colleagues in a traditional office setting, a Double 2 Robot was explicitly utilized. From interviews conducted following the implemented experiences, feelings of isolation for remote workers were reduced, and a sense of belonging was achieved with the ability to navigate and interact with those in a physical environment (Beno, 2018). Overall, it was considered a more beneficial implementation despite technical issues and the initial reluctant approach from colleagues in the physical environment due to unfamiliarity with the concept and technology.

2.4.3. Robotic Avatars in Healthcare

The most common industry that has utilized robotic avatars in telepresence is related to healthcare. In a study conducted during the COVID-19 pandemic, telepresence robots were implemented in the hospital to connect patients and family members who had dementia (Hung et

al., 2023). Implemented in care homes in British Columbia, Canada, interviews were conducted by a remote participant, who attended utilizing a video-conferencing platform, and were projected onto the robot's display screen. The remote participant could also see the resident who was in the room. Following interviews, a thematic analysis was conducted, where it was analyzed that telepresence robots can be utilized for data collection in the midst of infection outbreaks and crises. Participants experienced an initial reluctance experienced by participants related to the idea of operating a robot, which became reduced upon training and practicing. These interviews also indicated that telepresence robots were more engaging compared to only online methods of video-conferencing implementations. However, it was acknowledged that there were poor connections due to a lack of infrastructure, technical obstacles, and challenges with added work on staff to conduct training.

In another aspect of telepresence, telepresence robots were also implemented in a simulated healthcare facility to determine the capacity to conduct measurements and fragility with ageing populations (Leoste et al., 2024). A self-driving, two-wheeled robotic avatar was utilized, and it was equipped with a screen to display the remote user's face and upper body. The robotic avatar was also equipped with microphones, cameras, and speakers to conduct the experience. Three scenarios were implemented where the remote participants were professionals supervising trainees in their approaches to working with clients in the healthcare setting. In case 1, the trainee interviewed the patient about their medical history; in case 2, the trainee measured the patient's vitals such as blood pressure, body temperature, and weight; and in case 3, the trainee is dispatched for emergencies to assess and communicate the environment for the remote professional. Mixed responses were obtained: students found it beneficial, and professionals could supervise more trainees with these implementations. However, many negative experiences

were pointed out: the robot was challenging for people who were hard of hearing, some procedures required in-person guidance, and patients felt less security and less comfort when professionals were not physically in the room. Telepresence robots were concluded to be promising, but there are still several issues with implementation because of early development.

Similarly, in a case used for senior citizens, the robots were programmed to engage in social environments through a combination of gestures, speech, and facial expressions (McGinn et al., 2020). In this project, the final design concept involved a robot that moved using wheels and had a range of sensors to perceive its surroundings, combined with teleconferencing capabilities to engage in social interactions. However, this research project showed that there are still barriers to social interactions amongst connecting with robot avatars in the field of human-robot interaction, such as openness to the interaction with robots, and the quality of the interaction with technological limitations.

2.4.4. Robotic Avatars in Education

As related to the scope of this thesis, the implementation of robotic avatars in education is also emphasized. In a study conducted at a large public university, robot-mediated communication was implemented utilizing social robotics telepresence systems (Gleason & Greenhow, 2017). These telepresence systems utilized a screen to project the remote user, microphones for sound, and a set of wheels on the robot for movement. From this implementation in the classroom, survey data and written reflections were obtained from students who participated directly in the study. Results observed that a sense of connection between classmates using the robot was enabled through the ability to control the robotic movements and have some interaction with sound, sight, and interaction in the classroom. However, there were many limitations with the technology utilized, and nearly all participants

had issues with either audio, visuals, or robotic movement. The overall study suggested that robotic avatars implemented into educational environments can foster students' embodiment, belonging and contribution in higher education learning environments.

Telepresence robots were also implemented in another higher education campus setting, and a survey was conducted to determine the perception of campus attendees who interacted with them (Lei et al., 2022). A total of 60 respondents, which included faculty, students, and professionals, were considered for the analysis. A few key conclusions were determined: a perceived usefulness of the telepresence robots increases the likelihood of use, perceived usefulness of the telepresence robots impacts the ease of use for the user, social pressure impacts user perception about the usefulness of telepresence robots, and perceived risk affects the ease of use. In other words, there must be an observed personal appeal by the participants to utilize robotic avatars. As such, this study showed that the perception of telepresence robots impacts their use and integration by campus attendees.

Similar to these previous studies, the growing implementation of telepresence robots in education was analyzed holistically through a literature review, technology review, interviews, and focus groups (Wernbacher et al., 2022). The holistic review intended to increase awareness about the potential growing use of telepresence robots in higher education settings as a method of hybrid learning.

2.4.5. Challenges with Robotic Avatar Implementations

Despite the increasing development of telepresence robots, there are also several challenges with implementations that require addressing to function effectively (Tella & Ogbonna, 2023). One of the main challenges is pertaining to cost, as the development and

maintenance of robotic avatars for telepresence can be expensive. The robots must be designed to interact with built-form environments that have been optimized for human use, thus needing to replicate actions such as traversing stairs, operating door handles, amongst other interactions within navigating the physical environment. However, it is to be noted that these challenges with traversing physical planes is not inherent to its application, as in many environments, the robotic avatars can be set up in their set rooming environment where the interactions occur. Regardless of this, operating the robotic avatars requires user-friendly interfaces to navigate movement in the physical environment. This operation requires varying levels of technical proficiency, which can be hard to standardize. There are also several technical limitations, such as the stability of the internet, audio-visual connections, and battery life of the robotic avatars in being able to conduct experiences. Users who have utilized robotic avatars also worry about privacy and security and experience a reluctance to accept and trust participating in the experience with robotic avatars. Lastly, there is discourse on approaches to making robotic avatars seem more socially acceptable: some researchers believe that robotic avatars should be “humanized”, while others believe that the act of promoting physically human traits and characteristics can cause feelings of uneasiness.

2.4.6. Human Avatars

Human avatars have also been studied with recognition of challenges with robotic implementations, where the human surrogates replace the technological approach of using robots. Specifically for collaboration and education in smart cities, human surrogates and avatars are implemented to complete tasks that are dangerous or physically demanding, and aid in the development of the city (Hughes, 2014). There are few other literatures found about the use of human-human surrogate avatar implementations.

2.5 Perception Influences

With the implications of hybrid avatars, whether these representations are in the virtual or physical environments, there are perception implications with how these remote avatars want to be perceived, versus how those in their environment perceive them. Stereotyping, as defined by the American Psychological Association (APA), is "a set of cognitive generalizations (e.g., beliefs, expectations) about the qualities and characteristics of the members of a group or social category"(American Psychological Association, 2018b). Stereotyping occurs because of aspects related to physical characterizations of avatars, gender implications, and the sense of psychological self.

2.5.1 Physical Appearance in Education

The first influence of perception that is commonly experienced pertains to one's physical characteristics (Zebrowitz & Montepare, 2008). These are visual characteristics, such as hair, skin colour, facial features, height, and weight – many of which are impacted by gender. It has been commonly studied that gender influences on learning behaviours and interactions within the learning environment, as many physical traits are linked with gender. Gender stereotypes, outside of gender differences, have been studied to affect perception and classroom relationships, especially regarding environments where virtual learning platforms are implemented (Aguillon et al., 2020). While there are many differences of social behaviours associated with gender, as relevant to this study, male students are seen to be more outgoing and louder in the class, where they experience a tendency to ignore female contributions. This exists because of preconceived biases about the traits associated with male and female physical features. While stereotyping has been addressed in educational settings by educators and students alike, behaviours associated

with gender are still unconsciously emphasized observations obtained from many learning environments and how people in these environments are perceived (Gajda et al., 2022).

Related to a physical characteristic associated with gender, height has been determined to impact how people are treated in different environments. In a study conducted in Germany regarding learning environments, surveys were collected regarding height and school performance (Cinnirella et al., 2010). The results from the survey indicated a positive association between height and attendance in classes for male students, where taller male students attended class more frequently, and were related to better teacher recommendations. However, for female students, the results were statistically insignificant since there was no correlation or opposition to the behaviours observed and height. Related to social presence, taller male students were also perceived to have better social skills, independent of other characteristics in their home life, while this was also not observed for female students. Additionally, using data from the National Longitudinal Survey of Adolescent Health, Gorry examines academic outcomes for tall individuals (Gorry, 2017). It was similarly observed that height perceptions only affected male students, where taller students achieved higher grades and more teacher support. This was hypothesized to have occurred for various reasons, such as perceived physical attractiveness and dominance. This conclusion further supports the understanding of gender implications on learning.

2.5.2 Gender and Robotic Avatars

Regarding robotic avatars, the implication of gendered robots was studied in the literature pertaining to physical characteristics and perception implications, as many other characteristics of physical characteristics are not directly transferrable to humans based on the implemented

designs. In human-robot interactions, where a robotic avatar is used as a representation for a human, gender stereotyping is seen in several studies.

Nomaru conducted a thorough literature review regarding the current scope of gender in human-robot interactions (Nomura, 2017). Divided into six different sections of interaction effects, Nomaru analyzed studies pertaining to robot and human gender interactions, other robot and human factors, and situational factors. Regarding robot and human gender factors, in general, when pre-recorded human masculine and feminine voices were manipulated by the robot, male participants found the female robotic voice to be more credible, while female participants rated the opposite. In situational circumstances, gender stereotypes applied to robots taking on specific tasks, where male robots were preferred in security scenarios, and female robots were preferred in healthcare scenarios. In general, all implementations that Nomaru studied indicated that there was a correlation between perceived gender and how reliable or trustworthy participants felt towards them. In general conclusion, the gendering of robots by manipulation of voice and name affected how people interacted with the robot and perceived certain tasks to be completed (Nomura, 2017). These effects of these interactions could be deemed positive or negative depending on the outcome of the participant and their desired interaction with the avatar, but overall suggests that to prevent further scenarios of stereotyping, that avatars should not be gendered.

More specifically, one of the studies Nomaru reviewed was conducted by Eyssel and Hegel, where they showed pictures of robots to people, one of which had short hair, and the other that had long hair (Eyssel & Hegel, 2012). Despite not directly providing genders to the robots, most participants viewed the short-haired one as male and the long-haired one as female. When asking participants about the robots related to perception, the short-haired was perceived as

dominant and assertive compared to a long-haired robot. Concurrently, tasks that are more stereotypically male were perceived more suitable to be completed by a male robot, and female robots were instead perceived to be more suitable to complete stereotypically female tasks.

Another study of utilizing robot avatars also identified stereotypes regarding implicit gender, identified as personality characteristics (Kraus et al., 2018). In this study, robots were programmed to have specific gender traits about personality and voice. Participants in the study were invited to test a robotic assistant, and the data collected from the interactions with the robots were recorded. Male robots were perceived to be more reliable than female robots, whereas female robots were perceived to be more likeable. These human-robot interactions, related to surrogate avatars and representation address one aspect of perception of person as correlated with technology.

While there are many studies pertaining to gender stereotyping with robots, two other studies conducted hold relevance to the scope of the thesis based on the conclusions found. A large-scale study on the physicality of avatars in human-surrogate interactions indicated the influence of social facilitation, where there was a more significant observation of persuasion and connectivity when the avatar and the remote participant shared the same gender (Kim et al., 2017). Lastly, in work that was conducted to examine the difference between the use of humanoid and non-humanoid avatars, it was determined that there was a greater sense of proficiency of use for the remote participant to navigate the physical environment when utilizing the humanoid avatar (Lee et al., 2018). This is because the humanoids avatar better replicated physical tasks and perception of the environment.

2.5.3 Psychological Self

When addressing the influence of perception in interactions with others and the environment, the psychological self refers to an individual's perception and understanding of their identity (Bertocci, 1945). The psychological self impacts human behaviours and how people think, feel, and act.

One of the categories of psychological self, as it pertains to hybrid learning environments, is self-representation in avatar-mediated environments. As observed in a study conducted related to this subset, it was discovered that people will design their virtual avatars to have traits and appearances similar to themselves but are inclined to enhance personal features to appear more attractive (Messinger et al., 2019). This change to their features enhanced their extroversion and loudness in virtual environments. As such, this journal article suggests how the person is perceived in the virtual environment changes their interactions with others.

Similarly, the psychological self is also observed when referring to the current participation of students in online environments and their camera usage. As noticed during hybrid learning classrooms, students are inclined to not use their web cameras for self-identification purposes. In a multi-methods study conducted and analyzed through personal surveys, the majority of students felt more comfortable in having their cameras turned off (Farid et al., 2022). Female students associated the comfort on having their cameras turned off because of feelings of self-consciousness and concerns about their appearance compared to their male students. Furthermore, inattentiveness in online classes was more likely to occur when students had their cameras turned off.

In another study regarding the use of web cameras in virtual classroom spaces, interviews were conducted with participants who had experience on a campus where camera usage was optional in all distance and hybrid learning courses (Schwenck & Pryor, 2021). The results of the interviews were analyzed based on themes of engagement, connectedness, and future impacts. In this, participants who interacted with their cameras off felt awkward about unmuting themselves, and the lack of microphone connection combined with a lack of video connection resulted in disengagement and a lack of connection with peers. The conclusions determined that a sense of connectedness occurs when students can perceive each other, which stems from factors such as having a camera and microphone turned on for remote participants.

Even with the studies described above, the understanding of implications regarding student perception and how it influences hybrid learning technologies also needs to be further analyzed.

2.5.4 Motivational Factors

In the broader topic of perception, motivational factors are a sub-section that addresses how individuals interpret their environment and experiences. As perception is driven by personal experiences, understanding motivation allows us to comprehend why different people perceive the same situation in a varied way. The two main distinctions of these motivational characteristics are intrinsic and extrinsic factors. Intrinsic motivation refers to an internal motivation, where students engage for personal satisfaction (Morris et al., 2022). Extrinsic motivation refers to an external factor, where students participate out of necessity, or to gain a reward (Morris et al., 2022). These differing types of motivation can fall into distinct categories: autonomous motivation and controlled motivation; autonomous motivation suggests intrinsic motivation, where the participant identifies a value in the task, compared to controlled

motivation, which requires a regulator or a motivation based on introjected regulation to be present (Deci & Ryan, 2008).

2.6. The Use of Grounded Theory for Hybrid Learning Examination

As it stands in scholarly literature, there is a lack of human-human mediated hybrid learning technology, as most methods of physical embodiment for remote learners has been focused on robot and augmented reality mechanisms. Literature regarding the focus of this thesis requires the foundation to be developed, while determining if it is similar, better, or worse than the other methods of hybrid learning technologies that exist in current literature and how they compare when differing social situations invite their use.

As such, grounded theory is utilized to conduct the methodology and execution of this study. Grounded theory is a qualitative research measurement that generates theory from empirical data rather than existing literature, where analysis occurs from substantiating research, confirming and enhancing the emerging project to situate it within current knowledge and practices (Nathaniel, 2022). There are three methodological aspects of grounded theory: classical, Strassman, and constructivist (Chun Tie et al., 2019). Classical grounded theory emphasizes theories based on data without preconceived hypotheses and uses a comparative method where data collection and analysis occur simultaneously (Mediani, 2017). Straussian ground theory utilizes a structured and detailed coding process; to verify theories and refine emerging concepts (Mohajan & Mohajan, 2023). Lastly, constructivist grounded theory emphasizes the social contexts, interactions and understanding of the role of participants and researchers in the methods and data collection (Mohajan & Mohajan, 2022). For the purpose of the scope of this thesis, constructivist grounded theory was selected for working the methodology, as discussed more in Chapter 3.

After conducting the above literature review, the execution of the Surrogate Avatar Experience was developed and executed to understand its implementation and implications in higher education.

Chapter 3: Methodologies and Procedures

The materials and methods for the Surrogate Avatar Experience (SuAvE) were developed and directed using grounded theory – a technique utilized in conducting research related to generating theories and concepts rather than previous hypotheses (Chun Tie et al., 2019). While there are previously attempted concepts of different approaches to embodied learning experience for virtual and hybrid learners regarding the disconnection that remote participants face in hybrid modules, the concept of SuAvE is unique; utilizing a new approach that has not been previously completed in the same manner. The comprehensive nature of SuAvE as a concept is best conducted through this approach to build theories directly from observations and experiences of the interactions of Surrogate Avatars and their remote participants related to societal implementations.

As referred to in the literature review, this methodology was developed utilizing the constructivist grounded theory approach. Constructivist grounded theory is utilized when obtaining qualitative data for emerging concepts, especially when the researcher is directly involved in the research process (Mohajan & Mohajan, 2022). As this methodology was conducted using the researcher as an active role in the experience, it allows for the co-construction of methods and analysis by the researcher and participants. It aligns well with obtaining qualitative interview data where interactions and interpretations play a critical role in project development. This approach also allows flexibility in the experience, to engage and iterate the process of data collection actively. As the methodology is divided into two distinct sub-sections, where the second

subsection was determined based on the refinement of concepts and theories that emerged from the first data sets, constructivist grounded theory supports the methodology developed for SuAvE, as described in detail below. Overall, implementing SuAvE in the following and predominantly free-form studies allows for exploring diverse perspectives and experiences within the given context of higher education adaptations. Furthermore, the iterative approach of grounded theory allows for the continuous refinement of SuAvE implementations.

The methodology chapter of this thesis is structured into distinct sections, each containing its own set of sub-sections aimed at different approaches to the research process. These sections ensure an organization of the methods produced related to independent inquiries and questions per their respective section. By detailing the methodologies employed within each sub-section, this chapter provides a comprehensive framework regarding the different avenues of SuAvE implementations in academia.

Amongst all implementations of SuAvE, informed consent was diligently obtained from all participants involved in the project implementation, ensuring they were fully informed of the experience, their potential roles in it, and the collection of anonymized data for this thesis. Consent documentations were developed prior to methodology implementations to submit to the University of Ottawa Research Ethics Boards and obtained an Ethics Approval Certificate attached in the appendix. This obtained approval affirms that implementation of the methodology in each section ahead to ethical guidelines and standards of conduct in research involving human participants, even in a voluntary project.

3.1 General Utilization of SuAvE

The Surrogate Avatar Experience is a socio-technical approach to academia that enables individuals to interact with physical learning environments from a remote virtual environment. To organize a connection between the physical and virtual planes of learning, volunteers are asked to take on the role of either the Surrogate Avatar or the remote participant. The Surrogate Avatar assumes the responsibility of physically representing a remote participant who attends virtually and requires physical embodiment.

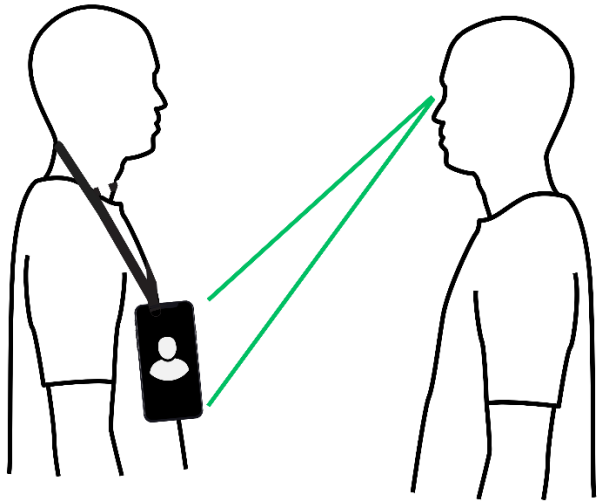
Different approaches have been taken to recruit volunteers, including the development of posters, emails to student groups, and implementations in the classroom. Informed and voluntary consent is obtained from all participants in SuAvE through an initial orientation call that introduces the purpose of SuAvE, the roles of participants, key terms, and the potential use of observations in a thesis research paper. Surrogate Avatars and their remote participants are connected through a provided Microsoft Teams link after being matched manually by the researcher based on availability of the volunteers and obtaining the consent to participate.

With the current implementation iterations, people interact with this experience from different technological standpoints when using the technology and accessories involved in the experience, leaving many slight adjustments to the set-up of SuAvE that will be addressed in their independent subsections.

At its base, the materials involved include: a device with video-conferencing capacities, a microphone, and a harness. Other alternatives include headsets or a neck harness depending on the execution of SuAvE in a certain environment. Sample schematics are depicted in Figure 2.

Figure 1

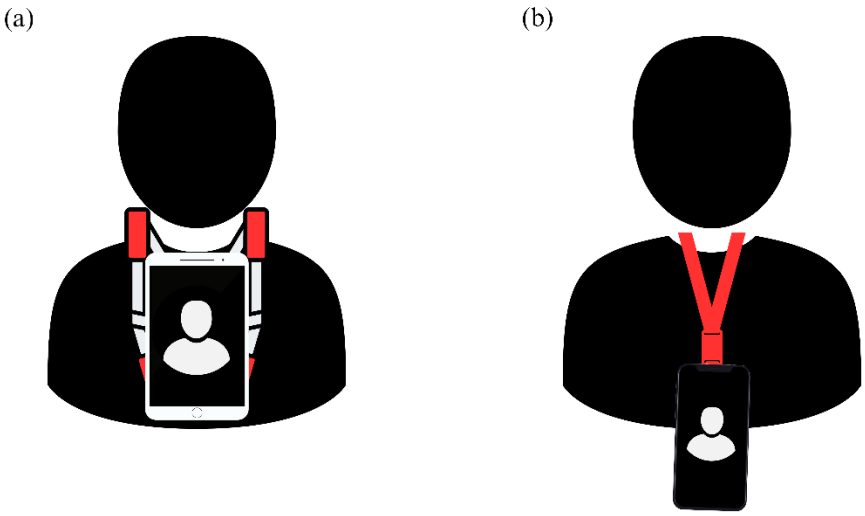
The Surrogate Avatar Experience Overview.



Note. The person on the left-side of the image is the Surrogate Avatar volunteer, who is attending a physical environment on behalf of the remote participant, who is located on the device screen that is being worn. The person on the right-side of the image is the third-party observer interacting with the remote participant through the contact area, signified by the green line.

Figure 2

First-person perspective of a third-party participant of SuAvE, showcasing the Surrogate Avatar and the remote participant on the device screen.



Note. (a) A harness, identified by the red colour, is worn by the Surrogate Avatar Volunteer to hold a personal electronic device that the remote participant is joined on, to maneuver in the physical environment in place and behalf of the remote participant. (b) A lanyard, identified by the red colour, is used for the personal electronic device that the remote participant is attending on, in the same way as described in (a).

3.2 SuAvE From A Holistic Lens

The methodology for implementation from a holistic lens, as per this section is structured into sub-sections, each exploring various avenues of implementations in educational settings. By integrating different sub-sections, the methodology provides a framework for how different approaches converge to achieve a comprehensive implementation strategy, even with different implementation scenarios.

3.2.1 Integrations in the Classroom for Students

In this section, the methodology employed for student learning is delved into with regard to the integration of SuAvE in classroom environments. These integrations seek to determine how methodology implementations can vary in relation to student-student interactions, while still depicting the intention of SuAvE in relation to physical embodiment in educational environments.

3.2.1.1 Case 1: Summer 2022 – Preliminary Implementation

In Winter 2022, the first implementation of SuAvE occurred for an embodied lecture experience at the University of Ottawa. In this case, the virtual participant was unable to attend class due to precautions regarding the COVID-19 pandemic and was looking for a method of attending class. The Surrogate Avatar volunteer, who was in the same time zone and province, was also a graduate student at the University of Ottawa who was a part of the preliminary design regarding SuAvE. As such, this preliminary trial entailed the use of a personal cellular device with video capabilities, the Zoom platform for the facilitation of video calls, and a body harness to hold the cellular device. The feedback from this trial formed the foundation of posed questions and areas for improvement within the design and implementation.

3.2.1.2 Case 2: Winter 2023 – Multidisciplinary Design Lecture Implementation

In Winter 2023, an implementation of SuAvE was conducted in an undergraduate course for an international student who was abroad for a portion of the semester and needed to interact with class content. In this implementation, the class activity involved touring a local museum to select an artifact for study. Using a personal cellular device and additional equipment that were suggested during the preliminary implementation, SuAvE was offered for this 3-hour experience. In this case, the remote participant was offered a Zoom link by the Surrogate Avatar volunteer who was both an auditing student for the class and a developer of SuAvE. As this was only the second implementation of the project, no other materials were used to conduct the interaction.

3.2.1.3 Case 3: Fall 2023 – Graduate Design Lecture Implementation

In Fall 2023, an implementation of SuAvE was conducted in a graduate course for an international student who could not physically attend a project-based class. In conjunction with an institutional policy regarding classroom attendance and participation, graduate students are required to be present in the classroom, and SuAvE was offered as a method of satisfying and being accommodating to the attendance policies in the curriculum for the remote participant.

The remote participant and Surrogate Avatar were presented with the same zoom link to connect. Prior to connecting, the remote participant and Surrogate Avatar had an opportunity to briefly meet, so that introductions would not impede the experience. In the preparatory meeting the two students discussed the experience, including the roles of both the Surrogate Avatar volunteer and the remote participant, as well as how the remote participant could engage in interactions with the physical environment through the embodiment of the Surrogate Avatar volunteer. This process was discussed, with a question-and-answer period, for approximately 30

minutes. The Surrogate Avatar utilized a personal cellular device, a pair of Bluetooth headphones, and a harness to conduct the experience, similar to that in Figure 2(a).

A summary of the 3-Cases conducted in the "Integrations in the Classroom for Students" is tabulated in Table 1.

Table 1

Summary of the 3-Cases Conducted in the "Integrations in the Classroom for Students"

	Case 1: Summer 2022 – Preliminary Implementation	**Case 2: Fall 2022 – Multidisciplinary Design Lecture Implementation**	**Case 3: Fall 2023 – Graduate Design Lecture Implementation**
Number of Students in the Classroom	50	40	20
Harness Utilized	No	No	Partially
Headset Utilized	No	Yes	Partially
Web-Conferencing Platform Used	Zoom	Zoom	Zoom
Duration of Experience	1.5-hours	3-hours	3-hours
Location of Remote Participant	Locally	Internationally (+8 hours)	Internationally (+8 hours)

3.2.2 Integration in Shared Learning and Presentations Environment

In this section, the methodology employed for shared learning and presentation environments is, with regards to the influence of peer engagement and collaboration in academia. Like in the previous section, these project integrations seek to determine how methodology implementations can vary specifically when focused on collaboration and the requirement to interact with peers and the environment rather than just the general classroom environment.

3.2.2.1 Case 1: Winter 2022 – Class Excursion Implementation

In Winter 2023, the SuAvE was implemented to undergo a class excursion for an internationally located remote student who could not physically attend a public museum in Ottawa. The course integrated a portion of an assignment related to an experience attending and observing historical artifacts in the city of Ottawa, which placed restrictions of possible participation for a student who was studying remotely. SuAvE was offered to bridge the planes of learning for this student to be able to participate in the required course requirements.

A volunteer who had an interest in the preliminary efforts of SuAvE implementations acted as the Surrogate Avatar volunteer for the internationally located remote student. The Zoom platform was used as the web-conferencing platform, where a meeting link was made external to both participants and shared with them a few moments before the introduction. Both participants were provided preliminary information about SuAvE to provide context for the experience and an explanation of how to engage with it. In this specific case, the remote participant was able to direct the Surrogate Avatar volunteer to interact with specific pieces, focusing on the artifacts and surrounding descriptions, and interacting with other in-person attendees. This implementation of SuAvE aimed to show the capacity and importance of mobility and interaction of the physical space for virtual participants. Regarding hardware, the Surrogate Avatar volunteer was directed to bring their own personal cellular device and a recommendation of a headset due to the navigation of a large public space.

3.2.2.2 Case 2: Fall 2023 – Design Day Implementation

In Fall 2023, SuAvE was implemented to undergo a tour of Design Day for a remote international attendee. Design Day is a highly anticipated research event on a university campus

that is dynamic and involves communicating and listening to students in a large, crowded space. The set-up of Design Day can entail over 40 projects being showcased between 9am-2pm, with 3-4 presenters per project. Attendance between judges, presenters, and other viewers can reach a capacity of well over 500 participants in a 2-story building. Due to this chaotic environment, hybrid sessions can rarely occur, which limits the presentation of the research to the local audience.

Using Microsoft Teams as the web-conferencing platform, the Surrogate Avatar and the remote participant connected at an agreed-upon time to account for time-zone differences. The Surrogate Avatar, situated on campus at Design Day, then walked around to the different presentation booths, explaining that they were representing a remote participant from a different country to the student presenters. The attention was then directed to the remote participant. Without discrete instructions to the booth speakers, there were a variety of reactions possible to occur. In some cases, the booth speakers would directly take control of the device that the Surrogate Avatar was using, and in other cases, the Surrogate Avatar would move the device based on their own perception of the booth or under the direction of the virtual participant. In this case, no particular hardware was controlled, and this interaction demonstrates the perception of how people interact with SuAvE without formal directions or instructions.

Table 2

Summary of the 2-Cases Conducted in the "Integrations in Shared Learning and Presentations Environment"

	Case 1: Fall 2022 – Class Excursion Implementation	Case 2: Fall 2023 – Design Day Implementation
Number of Students in the Environment	50	100-500
Harness Utilized	No	No
Headset Utilized	Yes	No
Web-Conferencing Platform Used	Zoom	Microsoft Teams
Duration of Experience	1-hours	1-hour
Location of Remote Participant	Internationally	Internationally
Opportunity for Interactions With the Physical Space	Yes	Yes

3.2.3 Integrations in Project-Based Studies

In this section, the methodology employed for integrations of SuAvE in educational environments that surrounding themselves on iterative and collaborative project development is described. Similarly to the previous sections, this specific integration seeks to determine repetitive implementations of SuAvE with the same working participants to determine how implementation circumstances can vary even when the population does not.

3.2.3.1 Case 1: Fall 2023 – 4-Session Implementation With A Capstone Group

In Fall 2023, a series of implementations of SuAvE were conducted to accommodate a group of engineering students who were working on their independent final capstone project. The capstone project is imperative to completing an undergraduate degree in the Faculty of Engineering, where capstone groups are required to have clients who interact with different

iterations of their project and provide feedback to the group and their professor. Scheduling conflicts between the client and group members were consistent, where the client of the capstone group or the group members themselves could not always physically attend meetings. SuAvE was utilized to accommodate this challenge so as to not impact the requirements of the capstone group. The overall intention in this utilization was to understand different conditions of SuAvE within the same environment with the same participants' group and alternating roles.

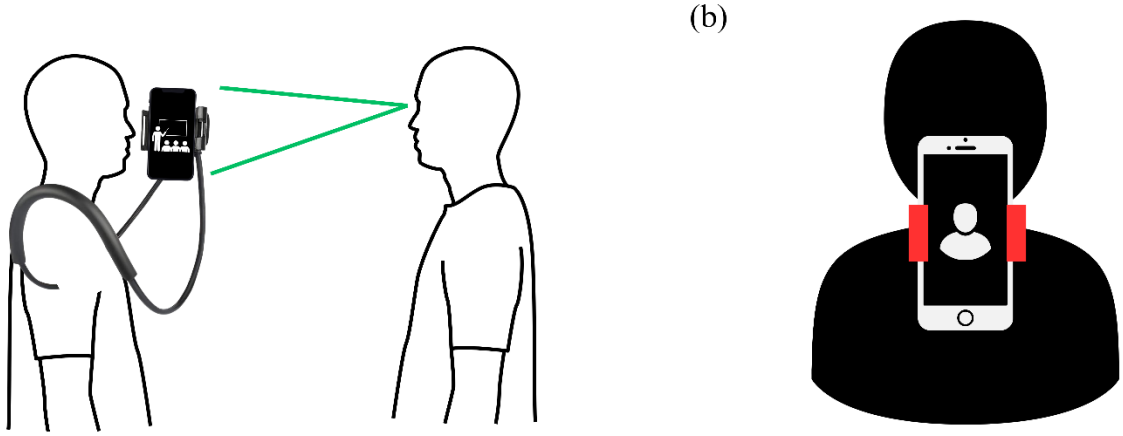
This capstone study was conducted over a 4-session period, where 4-instances were able to be trialed using SuAvE. The first three weeks of this SuAvE implementation entailed the client being the remote participant, attending through a Surrogate Avatar volunteer who was a group member. The fourth week entailed a study where multiple Surrogate Avatars represented multiple remote participants; the remote participants included the client and one of the group members. This study attempts to create similar conditions with the same participants to draw conclusions about interactions of SuAvE in learning spaces, and understand the perspectives of third-party observers in the experience.

Specifically in this trial, a neck harness was used as the accessory to prop the personal electronic device on, as depicted in Figure 3.

Figure 3

SuAvE Design utilizing a neck harness as the accessory for holding the personal electronic device.

(a) (b)



Note. (a) An overview of the implementation of SuAvE in a trial utilizing a neck harness. The person on the left-side of the image is the Surrogate Avatar volunteer, who is attending a physical environment on behalf of the remote participant. The person on the right-side of the image is the third-party observer interacting with the remote participant through the contact area, signified by the green line. (b) First-person perspective of a third-party participant of SuAvE, showcasing the Surrogate Avatar and the remote participant on the device screen. The red colour on the image indicates how the neck harness is observed from the first-person perspective.

3.2.4 Integrations in the Classroom for Professors

In this section, the methodology employed for potential implementations with professors in the classroom environment is delved into, specifically under the capacity to conduct a multiple Surrogate Avatar experience for a single remote participant. While professors can still utilize SuAvE in classroom implementations similar to any previously described methodologies, the

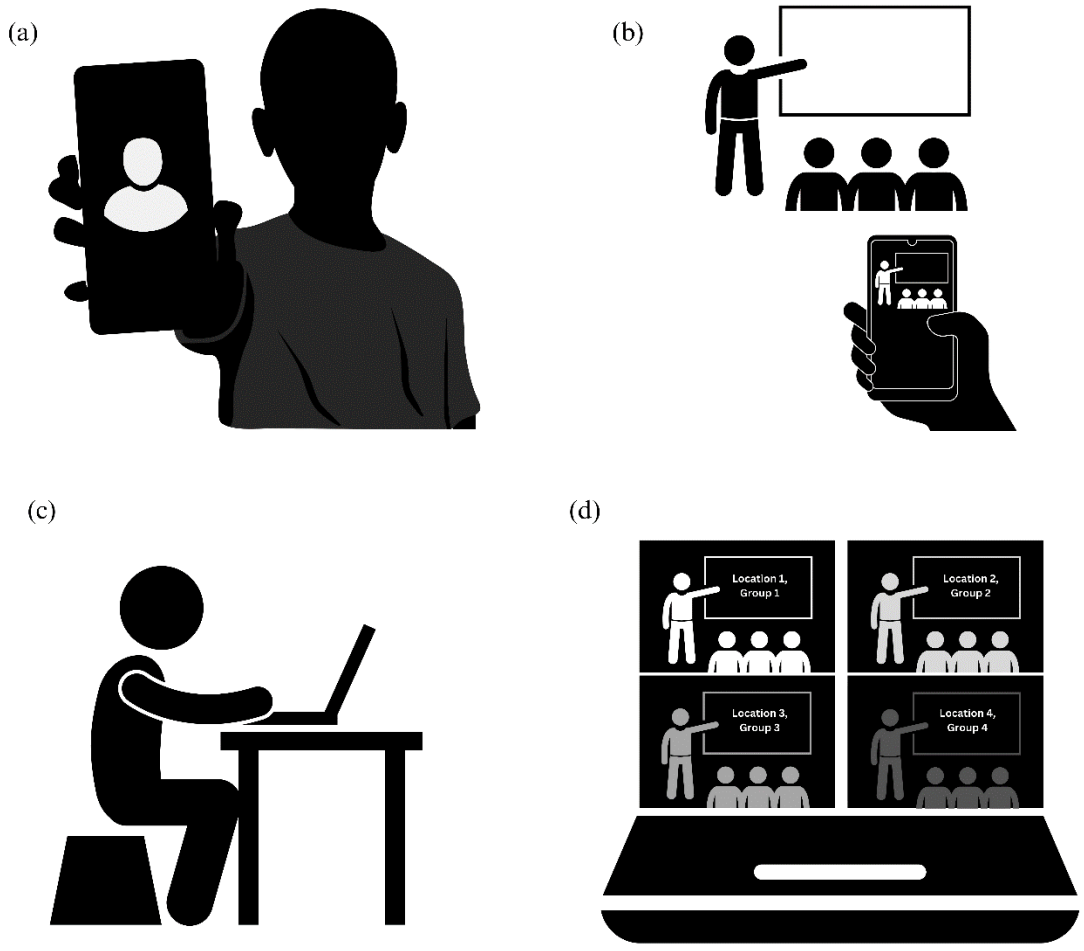
methodology in this section focuses on the capacity to interact with multiple physical environments, which was most suitable for a professor in this case.

3.2.4.1 Case 1: Fall 2022 – "Hydra"

An implementation of SuAvE in the Fall 2022 semester was conducted, where students from a mixed graduate and undergraduate class were instructed to attend different buildings on campus to participate in public presentations to their peers related to course work. Upon set-up, one person from each group was then selected as the Surrogate Avatar participant for the professor who acted as a remote participant. The remote participant could then evaluate students' presentation skills and delivery of materials to the public, alongside guiding the students in improving their presentation experience by role-playing the professorial role. With 10 groups in 10 different locations, Zoom was used as a video-conferencing platform for its capacity to manage breakout rooms, so that the remote professor could move between different physical spaces without physically being on the site of the presentations. This allowed for groups to present simultaneously to upkeep class-time productivity. The professor would not be present with every group at once but would be free to join the conversation to observe as needed. This schematic is depicted below.

Figure 4

Integrations where one remote participant can be represented by multiple Surrogate Avatars.



Note. (a) First-person perspective of the third-party participant of surrounding participants that were able to view the remote participant as shown by the Surrogate Avatar volunteer. (b) Perspective of the Surrogate Avatar volunteer, utilizing a personal device to showcase the environment to the remote participant for navigation purposes. (c) Perspective of the environment that the remote participant attends from, which is isolated and separate from the environment being showcased in (b). (d) Perspective of the remote participant and the ability to navigate many different physical environments with differing representation. Only one video feed was active at a time as facilitated by the 'Breakout Rooms' feature on the Zoom platform

3.3. Overview of Methodologies from "SuAvE From A Holistic Lens"

A summary related to each of the implementation methodologies is detailed in Table 3.

Table 3

Key details related to the difference or similarities in materials and methodology between the 4 explored implementations of SuAvE.

	Integrations in the Classroom for Students	**Integrations in Shared Learning and Presentation Environments**	**Integrations in Project-Based Studies**	**Integrations in the Classroom for Professors**
Surrogate Avatar	Student	Student	Student	Student
Remote Participant	Student	Student	Client	Professor
Number of Surrogate Avatars	1	1	1-2	10
Physical Group Size Number	Case 1: 50 Case 2: 40 Case 3: 20	Case 1: 50 Case 2: 100-500	5	100
Duration of Experience	Case 1: 1.5-hour, 1 session Case 2: 3-hours. 1 session Case 3: 3-hours, 1 session	Case 1: 1 hour, 1 session' Case 2: 1 hour, 1 session	45 min, 4 sessions	1 hour, 1 session
Headset Utilized	Case 1: None Case 2: Yes Case 3: Partially	Case 1: Yes Case 2: None	None	Partially
Harness Utilized	Case 1: Yes Case 2: None Case 3: Partially, Body Harness	Case 1: None Case 2: None	Yes, Neck Harness	None

3.4 Analyzing Influencing Factors in SuAvE

From the previous general implementations of SuAvE, there was an interest in understanding how personal implications change the experience and interaction for Surrogate Avatar volunteers, the remote participants, and bystanders. For this reason, three overarching factors were determined to conduct individual case studies, specifically regarding the implications of personal perception, gender, and technology.

3.4.1 Perception Implications:

In the case of perception, the definition by the American Psychological Association (APA) is “the process or result of becoming aware of objects, relationships, and events by means of the senses, which includes such activities as recognizing, observing, and discriminating.” (American Psychological Association, 2018a). With SuAvE being a voluntary experience, it was hypothesized that interactions could change based on the perceptions of the remote participant and their Surrogate Avatar volunteer. This was tested in two independent cases.

As noted in Chapter 2, Literature Review, there have been studies conducted about the role of perception in the representation of a remote participant, as well as how others around them will unintentionally chose to interact, especially with regard to technological implementations. In these studies, self-representation in avatar-mediated environments was observed, identifying that the personal features of the remote participants were important to their interaction with others in a virtual environment because of personal identity (Messinger et al., 2019). Using this conclusion from the study as a basis, Case 1 utilizes face covers to determine how the personal features of the Surrogate Avatar volunteer impacted the remote participant in any capacity. In a similar way, many studies were referenced in Chapter 2 that indicate the

suggestion for improved student perception through having remote participants utilizing their video camera when attending classes remotely, either in hybrid-or-virtual only learning environments (Schwenck & Pryor, 2021). As SuAvE builds upon current hybrid learning practices, this influence is to be studied through the conditions of having remote participants attend the sessions with their cameras turned on or off.

Meanwhile, Chapter 2 also studied the influence of height having a positive correlation to learning and engagement in the classroom (Cinnirella et al., 2010). Outside of educational context, height has been related to the perception of one's personality and thus the perception of characteristics such as dominance and self-esteem (Gorry, 2017). This possible influence is studied in relation to embodiment exhibited through SuAvE. It is to be noted that there are other possible physical features that could be evaluated regarding perception factors, but height was chosen out of an easier capacity to reproduce the experiment with the available resources and volunteers.

3.4.1.1 Case 1: Use of Face Cover

The initial case of perception studies was based on the appearance of the Surrogate Avatar volunteer respectively. Specifically, four situations were prepared to be trialed, which occurred over a 4-week period in a discussion group session for an undergraduate engineering course of 45 students. Volunteers were asked in advance about their interest in participating in a SuAvE implication study. First, the classroom was provided context on what SuAvE entailed, the expected behaviour and information provided in the informed consent documentation. The process of SuAvE was then explained to students in an interactive session as an example. While 13 students initially volunteered, a few students dropped out mid-experience, and thus their experiences were not recorded. The reasons for these students who originally volunteered but did

not join the experience are analyzed in the discussion. Thus, 8 students were divided into either participating remote personnel or Surrogate Avatar volunteers, after obtaining their consent to participate in the anonymous study. Remote participants were asked to participate in a separate room from the classroom on the same campus where discussion group typically occurred. Surrogate Avatar volunteers attended the discussion group classroom directly. Regarding materials provided, Surrogate Avatar volunteers were provided with a neck harness, a plain white face cover, and a portable charging pack for their personal devices, as depicted in Figure 5. Surrogate Avatar volunteers and their remote participants were asked to bring their own personal electronic devices independently. Microsoft Teams was used as the web-conferencing platform, specifically using the "Breakout Room" feature so that all participants were able to join the same meeting link.

The first case entailed the Surrogate Avatar volunteer wearing a plain white face cover, and the remote participant joining the session with their camera turned on to show their face. The second case entailed the Surrogate Avatar volunteer not wearing a face cover, while their remote participant had their camera turned on to show their face. The third case entailed the Surrogate Avatar volunteer wearing the same plain white face cover as the initial case, but in this case the remote participant had their camera turned off. Lastly, the fourth case entailed the Surrogate Avatar volunteer not wearing a face cover, and the remote participant having their camera turned on throughout the session. This is detailed in Table 4.

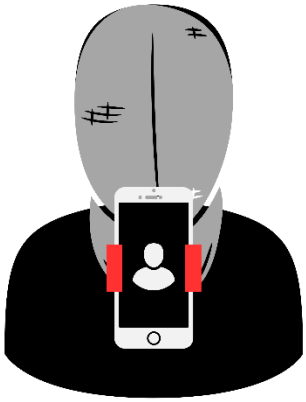
Table 4

The 4-implemeted trials of Case 1: Use of a Face Cover in SuAvE Perception Studies.

	Trial 1	**Trial 2**	**Trial 3**	**Trial 4**
Face Cover for Surrogate Avatar	Yes	No	Yes	No
Camera On for Remote Participant	Yes	Yes	No	No

Figure 5

First-person perspective of a third-party participant of SuAvE, showcasing the Surrogate Avatar volunteer wearing a face cover and the remote participant on the device screen.



Note. The red colour on the image indicates how the neck harness is observed from the first-person perspective. While the face cover is identified by the colour gray, its colour was white in the implementation, and this schematic above is differently coloured only to provide clarity.

3.4.1.2 Case 2: Device Positioning and Height

The secondary perception study was based on the influence of device positioning and height. In the general implementations of SuAvE, there was an interchange of harnesses utilized,

if any, due to the availability of materials or the progression of the project. The study investigated whether the type of harness utilized impacted either Surrogate Avatar volunteer based on their comfortability of wearing it, or whether the viewing point and camera stability may have impacted the surrounding that was being video captured for the remote participant. For this reason, Case 2 of the Perception Implication Studies was conducted through 8-alternating studies regarding the type of harness utilized, the height of the Surrogate Avatar volunteer, and height of the remote participant. This implementation occurred over a 4-week period in a discussion group session for an undergraduate engineering course of 38 students.

In the same method as Case 1, volunteers from the discussion group undergraduate class were asked in advance about their interest in participating in a SuAvE implication study and provided context on what SuAvE entailed, the expected behaviour and information provided in the informed consent documentation. The process of SuAvE was then explained to students in an interactive session as an example. In this case, those who volunteered for the role of either Surrogate Avatar or volunteer were split and connected by height in the sections of under 5 feet 2 inches and over 5 feet 3 inches. The choice of height cut-off was determined based on the height demographic of the volunteers who were chosen to volunteer in this experience, where there was a distinct difference in the height of volunteers at the 5 feet 2 inches indicator.

They were then paired up in one of 4 ways, either both volunteers being under 5 feet 2 inches or over 5 feet 3 inches. The alternate was also studied, where Surrogate Avatar volunteers that were under 5 feet 2 inches in height were paired with remote participants that were over 5 feet 3 inches – and vice versa. These pairings were conducted twice, where in one instance a neck harness was utilized, and in another, the body harness was utilized. Condition 1 entails utilizing a neck harness and is encompassed through Trials 1 to 4. Condition 2 entails utilizing a

body harness and is encompassed through Trials 5 to 8. In either condition, the remote participant was not told the type of accessory device that would be utilized to conduct the experience, to understand if there was any perceived difference. A summary of these 8 trials conducted are found in Table 5.

Regarding materials provided, Surrogate Avatar volunteers were provided with a neck or body harness depending on the trial conducted, and a portable charging pack for their personal device. Surrogate Avatar volunteers and their remote participants were asked to bring their own personal electronic devices independently. Microsoft Teams was used as the web-conferencing platform, specifically using the "Breakout Room" feature so that all participants were able to join the same meeting link.

Table 5

The 8-implemeted trials of Case 2: Device Positioning and Height in SuAvE Perception Implication Studies.

	Trial 1	**Trial 2**	**Trial 3**	**Trial 4**	**Trial 5**	**Trial 6**	**Trial 7**	**Trial 8**
Harness Utilized	Neck	Neck	Neck	Neck	Body	Body	Body	Body
Height of Surrogate Avatar	≤5'2	≥5'3	≤5'2	≥5'3	≤5'2	≥5'3	≤5'2	≥5'3
Height of Remote Participant	≤5'2	≤5'2	≥5'3	≥5'3	≤5'2	≤5'2	≥5'3	≥5'3

3.4.2 Gender Implications

Following the previous Perception Implications study, an observation that will be further discussed is the role and influence of gender in interactions. The America Psychological Association (APA) defines gender as “the attitudes, feelings, and behaviors that a given culture associates with a person's biological sex.” (American Psychological Association, 2012). In modern society, gender can be related to self-image, appearance, behaviour, expression or other factors, regardless of the sex assigned at birth. This study was conducted with cis-gendered volunteers, whose gender expression was correlated with their biological sex. This implementation was chosen to provide a framework that could be conducted over multiple sessions for the implementation due to the number of volunteers available for this study. It was hypothesized that interactions could change based on the perceptions of men and women as Surrogate Avatar volunteers and the remote participant and was trialed in Case 1.

In the 3-studies conducted pertaining to the role of gender in interactions with robot technology, per Chapter 2: Literature Review, each of the independent cases studied concluded a co-existing relationship between perceived gender expression and social interaction (Eyssel & Hegel, 2012; Kraus et al., 2018; Nomura, 2017). For this reason, this sub-section focuses on determining if the same influence gender exhibited in hybrid environments with robots is seen in hybrid environments with human Surrogate Avatar volunteers. Since it was observed by Kim, et al., shared gender between the avatar and remote participant resulted in a greater connectivity observed, it was considered as implementation conditions in the trial (Kim et al., 2017).

3.4.2.1 Case 1: Gender

One case of the gender implications studies was conducted over a 2-week period in a discussion group session for an undergraduate course. For this case, classroom volunteers were explicitly explained that their gender would be relevant to the study, but that besides gender, there would be no other identifying information would be collected. With the information shared about the specifics to SuAvE and their role in a voluntary role, informed consent was taken from the participants. As previous, remote participants were asked to participate in a separate room from the classroom on the same campus that the discussion group typically occurred in. Surrogate Avatar volunteers attended the discussion group classroom directly. In total, 4 participants were a part of this case study, so that a comparative approach could be used in analysis. This entails that the remote participant in Trial 1 and Trial 3 were the same, and the remote participant in Trial 2 and Trial 4 were the same. In the same way, the Surrogate Avatar volunteer in Trial 1 and 4 was the same volunteer, as in Trial 2 and 3 as well. Regarding materials provided, Surrogate Avatar volunteers were provided with a neck harness and a portable charging pack for their personal device. Surrogate Avatar volunteers and their remote participants were asked to bring their own personal electronic device independently, which aligns with all previous perception studies conducted. Microsoft Teams was used as the web-conferencing platform on a one-by-one link basis.

In the first and second cases of this implementation, the SuAvE participants, being the Surrogate Avatar volunteer and the remote participant, were both men and women respectively. In trial 3, the Surrogate Avatar volunteer was a woman, who was embodying the experience for a remote participant that was a man. Trial 4 was conducted in the opposite manner. A summary of these joint-embodied connections is depicted in Table 6 and illustrated in Figure 6.

Table 6

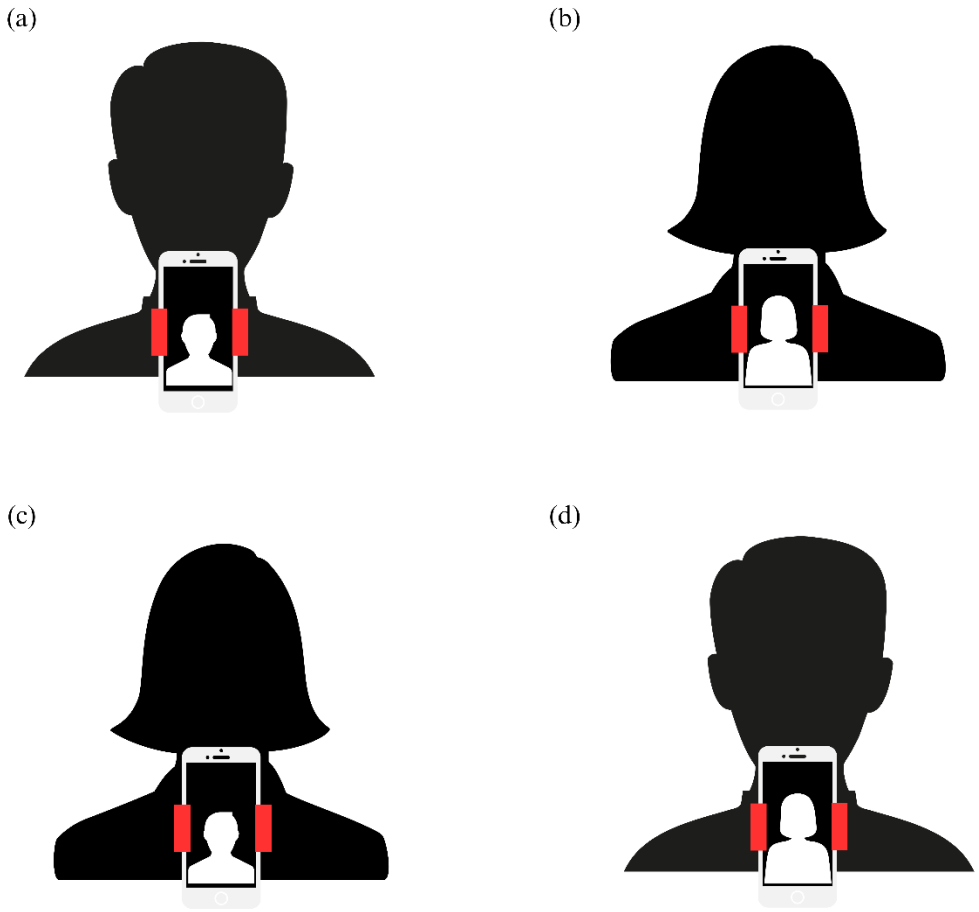
The 4-implemeted trials of Case 1: Gender in SuAvE Gender Studies.

	Trial 1	**Trial 2**	**Trial 3**	**Trial 4**
Gender of Surrogate Avatar	Man	Woman	Woman	Man
Gender of Remote Participant	Man	Woman	Man	Woman

The selection of different outlines for the men and women in each trial as in Figure 6 is intentional to depict that the remote participant in Trial 1 (a) and Trial 3 (c) are the same, as well as the remote participant in Trial 2 (b) and Trial 4 (d). In the same way, the outline for the Surrogate Avatar volunteer is the same for Trial 1 (a) and Trial 4 (d), as well as Trial 2 (b) and Trial 3 (c) as previously described.

Figure 6

Illustration of the 4-implemented trials of Case 1: Gender in SuAvE Gender Studies.



Note. (a) Gender is shared between participants, where both the Surrogate Avatar Volunteer and the remote participant are men as in Trial 1. (b) Gender is shared between participants, where both the Surrogate Avatar Volunteer and the remote participant are woman as in Trial 2. (c) Gender is different between participants, where the Surrogate Avatar Volunteer is a man, and the remote participant is a woman as in Trial 3. (d) Gender is different between participants, where the Surrogate Avatar Volunteer is a woman, and the remote participant is a man as in Trial 4.

3.4.3 Technological Implications

As SuAvE is a voluntary project, the studies conducted were based on the Surrogate Avatar volunteer utilizing their own personal cellular device, and so there are technological implications to consider. While technological challenges for each study are observed and analyzed in later sections, the intention of this case was specifically identified and draw comparisons regarding the type of personal cellular device used by the Surrogate Avatar volunteer when conducting the experience. Regarding implementation, since all participants in this case were from the same undergraduate class, and were divided into separate rooms on campus, it is noted that the internet capacity and speed is not evaluated with regards to the device, as all students utilized the same internet source for connection and video-streaming capabilities. In a similar way, the condition and capacity of the personal laptops that remote participants were joining the session on were not studied or taken note, as the focus was on the use of the cellular device in streaming the surrounding environment.

The preferences of a certain device a person will personally use is influenced by the country and generation (Nagy, 2017). In a market study obtained in the 3rd quarter of 2023, 58.59% of people in Canada owned Apple cellular devices, while 26.27% of people in Canada owned Samsung cellular devices (Laricchia, 2023). Alongside this, in 2023, Apple surpassed Samsung in becoming the world's largest smartphone manufacturer by volume (Tech HQ, 2024). Meanwhile, according to 2023 statistics, smartphone users in general wait an average of 3-4 years to upgrade their cellphones, based on the replacement cycle length patterns studied that concluded that smartphones have a longer lifespan with newer models developed (S. Knight, 2024). Even more specifically though, Apple users have noted a greater longevity of keeping their phone, where 29% of Apple users keep their phone for three or more years, compared to

21% of Android users (Orr, 2024). This statistic is contributed to Android's being more cost-effective to upgrade in shorter durations, and Apple products having a longer functionality period and strategic rollouts plans for newer devices.

3.4.3.1 Case 1: Differing Devices Capacities

With Apple and Samsung cellular devices being the majority owned by the population, they were utilized in a comparison test to understand how the quality and capacity of the technological device used can influence the experience, if any. Of the technical differences for the two device brands, the information that was pertinent to gather related to this study was the year the device was launched, the model of the device, and the video-capacity of the device based on pixel frames per second. The year the device was launched holds importance to the longevity of the device, as the previous statistics identified newer devices hold a greater longevity of usage, which is beneficial for students. The device model has differences on device features that in offers, including the number of lenses on the device, which can impact the video-capacity. Lastly, the video-capacity was determined to be of importance as related directly to this study, which involves the requirement of using video-conferencing platforms to navigate the physical space for the remote participant. In both cases, the web-conferencing platform utilized, and the duration of the experience was the same. These technical differences of the devices are summarized in the table below. While data regarding the audio capabilities of the differing devices will also be obtained, there are no specifications found online that describe the stereo support and resolution; instead, there is only an acknowledgement that all devices have stereo support and can play audios of differing formats. The only additional information pertaining to solely audio is that there is spatial audio capabilities with different accessory devices pertaining to providing a "surrounding experience". This is not studied within the scope of this project.

Table 7

The 2-implemented trials of Case 1: Differing Device Capacities in Technological Implications.

	Trial 1: Apple Cellular Device	**Trial 2: Samsung Cellular Device**
Year the Device Was Launched	2023	2023
	2022	2021
	2018	2020
Model of Device	iPhone 15	Galaxy S23
	iPhone 13	Galaxy S10E
	iPhone XS	Galaxy A15
Number of Lenses on the Device	2	4
	2	2
	2	3
Video Capacity of Device	1080 pixels at 30 frames per second	1080 pixels at 30 frames per second
	1080 pixels at 30 frames per second	1080 pixels at 30 frames per second
	1080 pixels at 30 frames per second	1080 pixels at 90 frames per second
Web-Conferencing Platform Used	Microsoft Teams	Microsoft Teams
Duration of Experience	30-minutes	30-minutes

As in all previous trials of SuAvE, volunteers were notified about the intention and methods of interaction with SuAvE in accordance with obtaining informed consent. In this case, Surrogate Avatar volunteers were additionally asked about the type of personal cellular device they owned and could utilize in the experience to determine pairings for remote participants so that the age of

devices and the year that the devices were launched did not have a great disparity for comparative purposes. Microsoft Teams was used as the web-conferencing platform for continuity with other perception studies. In this case, 2-trials were conducted simultaneously by 3-different user pairings where the age of the device utilized by the Surrogate Avatar volunteers varied between implementations due to the availability of devices and volunteers. Meanwhile, the remote participants joined the sessions on personal laptops, as the study aimed to understand the quality of the physical environment that was being interacted with. Trial 1 indicates the Surrogate Avatar volunteer utilizing an Apple cellular device, meanwhile Trial 2 indicated the Surrogate Avatar volunteer utilizing a Samsung cellular device.

Chapter 4: Observations of the Implementation

The following chapter describes the observations obtained from the implementations as described in Chapter 4. In accordance with grounded theory and the procedures utilized to conduct each case related to the implementations of SuAvE, the observations are described using qualitive methodology.

4.1 SuAvE From A Holistic Lens

This section of the thesis, in the same format as the methodology, aims to describe the observations obtained from the holistic implementation of SuAvE in educational settings. The observations, structured into their respective sub-sections, aim to allow a multifaceted view of SuAvE implementation in similar, but continuously modified, scenarios.

4.1.1 Integrations in the Classroom for Students

In this section, the observations related to student learning, with a focus on how SuAvE is integrated into classroom environments are explored. These integrations seek to examine how

student-student interactions amongst the roles of Surrogate Avatar volunteer, remote participant, and surrounding peers involved in SuAvE are interacted with in learning experiences.

4.1.1.1 Case 1: Summer 2022 – Preliminary Implementation

The preliminary implementation of SuAvE was the first real-world and non-theoretical study conducted. Emerging directly due to travel issues resulting from COVID-19, the remote participant could not to attend classes physically, and was offered SuAvE as a method of bridging the planes of learning. The remote participant explained that up to the point of the introduction of SuAvE, they attended classroom activities through a Zoom link that was set-up by the classroom professor. These virtual students would watch the lecture activity from the professor's personal laptop. Since the classroom content included collaborative learning modules, students who attended virtually were encouraged to engage directly with each other, while students who attended in-person were encouraged to engage with their peers in the physical environment. With the introduction of SuAvE, the remote participant was encouraged to communicate and collaborate with peers in the classroom through direction of the Surrogate Avatar volunteer, while the Surrogate Avatar took on a more passive approach. The remote participant explained that they were able to meet and participate with their peers more than through attending the lecture environment through the professor's device – specifically because it was identified that in virtual environments, students in their classroom were less likely to turn on their cameras and microphones to engage with others. The remote participant explained that they experienced wanting to engage more in-person, specifically by turning on their camera and their microphone – which is an action they chose not to conduct as often when attending through solely virtual platforms because of the lack of motivational factors in virtual spaces. As such, the opportunity to engage with different peers in the classroom, specifically seeing faces and hearing voices, was

a refreshing concept that provided a different experience related to the collaborative learning activities.

At this point in the project, the SuAvE study was a team-volunteer effort, where the Surrogate Avatar volunteer was one of the team members involved in the design. In this case, as there was curiosity and a lack of familiarity for surrounding peers that were interacting with SuAvE, there were instances of the Surrogate Avatar volunteer directly communicating with peers in the classroom. This made it challenging for peers to view the Surrogate Avatar volunteer as an embodiment of the remote participant, compared to viewing both participants as separate identities. For this reason, some peers did explain that there was a preference to the remote participant acting as a sole speaker in future implementations; suggesting that in the future, it would be better for the surrogate avatar volunteer to have minimal experience. Regarding the implementation specifically in this physical environment and the accessory devices utilized, a harness was implemented to hold the personal cellular device upright. However, this caused physical strain for the Surrogate Avatar volunteer, specifically in the shoulder area due to long-term wear. When this was taken off, and the Surrogate Avatar volunteer utilized no accessory device, the remote participant experienced challenges with unstable camera movements. Furthermore, surrounding peers determined that having the Surrogate Avatar volunteer hold the cellular device and navigate it was distracting and further emphasized the two participants as separate identities.

Technology also impacted the implementation in the physical environment, specifically with battery drainage of the device used, which identified the use of portable charging packs in future implementations. The choice to not use a headset resulted in some audio issues, specifically an echo-sound was experienced by the remote participant when multiple surrounding

peers were engaging with each other outside of direct engagement with SuAvE. Similar to this, the proximity of the Surrogate Avatar volunteer to the surrounding peers or professor impacted the quality and clarity of audio for the remote participant. This lack of audio control in large classrooms posed an issue in the experience, and an implementation of a headset was implemented in the following case as a result.

4.1.1.2 Case 2: Fall 2022 – Multidisciplinary Design Lecture Implementation

Following the preliminary implementation of SuAvE in Case 1, SuAvE was then implemented in a mixed undergraduate and graduate level course. In a similar circumstance as prior, the need for physical embodiment in the classroom was a result of an inability to be in the same country as the course was being taught in, due to Covid-19. For this reason, the same Surrogate Avatar volunteer as prior engaged with SuAvE in the physical environment for the remote participant. Notably in this case, there was an instance of a physical interaction with the direct environment, where the professor asked for a student volunteer to write an answer to a question written on the board. The remote participant directed the Surrogate Avatar volunteer to raise their hand to showcase their interest, have the Surrogate Avatar volunteer walk to the front of the classroom, and direct them to write the correct answer on the board. This interaction allowed for a physical embodiment that would not have been conducted through current hybrid technology platforms. The remote participant identified that this opportunity was a first for them and helped to showcase their understanding of course material in the physical classroom. Furthermore, they identified that they felt more noticed by the professor through having an in-person presentation that could raise their hand and volunteer, as they identified that the “raise hand” features on Zoom platforms were often missed by professors due to the requirement of the professor to be attentive to students in two different planes of learning.

However, there were other physical environment concerns that posed challenges in the experience. Unlike in the initial case, the remote participant and the Surrogate Avatar volunteer spoke different first-languages and were in different time zones. As a result, the communication related to direction for the Surrogate Avatar volunteer to interact with the physical environment in the way that the remote participant had described had many delays in understanding and thus action. For example, for the Surrogate Avatar volunteer to properly convey an action, there were many clarifying questions asked which became overbearing for the remote participant, and distracting for other students. For this reason, the remote participant changed from using the microphone feature for directions to using chat features. Upon asking for clarification on why this change was observed, they described that it was easier to use other language interpreters to implement directly in the chat, which saved time and effort in directing the Surrogate Avatar volunteer to interact with the environment. Furthermore, with the time zone difference of several hours, exhaustion was observed by surrounding peers by the remote participant, who ended up turning their camera and microphone off half-way through the experience. As the remote participant engaged less with SuAvE, the Surrogate Avatar volunteer also experienced decreased engagement. This was further experienced due to the duration of class occurring over a span of 3-hours with minimal breaks. Lastly, there were numerous technical problems related to internet connection, where the internet was not stable enough to hold a long-term connection on the remote participant's end. Disengagement was noticed as a result of consistent delays prolonged by internet capacity and language barriers.

Regarding the usage of accessory devices to conduct the experience, following the previous case it was decided to trial this implementation without the use of the body harness and including the use of a headset. With the use of the headset, it was identified that there were less

experienced of an echoing sound for the remote participant. While the headset made it easier for the remote participant to communicate actions to the Surrogate Avatar volunteer, it was harder for the remote participant to engage directly with the surrounding peers. Combined with the decrease of engagement of the remote participant as previously described, the headset was beneficial to decrease distractions to surrounding peers outside of experiences where collaboration and communication was encouraged. The lack of body harness had no notable differences in the SuAvE experience in this case, but that can be contributed to the lack of movement in general in the classroom during lecture content.

4.1.1.3 Case 3: Fall 2023 – Graduate Design Lecture Implementation

When utilizing SuAvE in practice for this graduate classroom, key observations involved the interaction with the physical space and its respective technological approach as measured through interviews with both the Surrogate Avatar and the remote participant. In the in-class experience, through direction of the Surrogate Avatar, the remote participant took part in team discussions in the physical plane of learning related to group work and project assessments. Furthermore, the remote participant was also able to engage with the professor in asking direct questions about course length. The remote participant would turn their camera on and interact with others around them when there was the opportunity to do so, but predominantly had their camera off otherwise. This remained true when a break occurred in the lecture, as the remote participant would leave to assume their break. This disconnect left the Surrogate Avatar in an "idle state" – a term coined to define the inactivity of utilizing a Surrogate Avatar, but where the Surrogate Avatar is still in a role of being a physical representation for someone else. This idle state causes the interaction between the Surrogate Avatar and the other participants in the physical space become overlapped between representing another person and representing

themselves. This takes away some of the aspect of physical embodiment, as after that initial point of idleness, the perceptions of others interacting with SuAvE recognize at the avatar as being a separate entity from their virtual participant, which should not be the case.

Technologically, there were challenges for the Surrogate Avatar in navigating a private voice channel with the virtual participant to understand their instruction for physical embodiment, and a public voice channel for the remote participant to interact with others around them. This required the interaction of a third device, that allowed the remote participant to send a private message about any modifications they would need without interrupting others around them in the public voice channel – which is not logistically ideal. This is because it required the Surrogate Avatar to navigate two interfaces and two information streams, in a timely manner. If connectivity issues occurred, resulting in delayed messages on the separate messaging interface, it would also cause a delay of information and activity direction. Furthermore, there were some challenges with the remote participant being able to consistently view slide content, as the video-streaming capacity of the device, the placement of the device with the harness being too low, and general internet connectivity differences that affected the legibility on the screen. Content from the slide deck of the course was accessible to the student prior to the lecture in order for the remote user to follow along with better resolution at home, and changing attention from the screen to the classroom participants only was suggested by the surrogate avatar volunteer half-way through the session to try to provide a more relatable and clear experience of physical embodiment.

Generally, the remote participant and Surrogate Avatar were content with the experience, both having acknowledged the technological and brief social challenges aforementioned. The remote participant indicated that being able to see other students in the classroom and communicate with project peers for classroom activities was a refreshing aspect of SuAvE. It was

mentioned that the group would typically meet in-person to discuss project deliverables, with the remote participant obtaining a designated role following the role-distribution conducted in class without their physical presence or participation in how the deliverables were subdivided. SuAvE allowed the remote participant to be an active participant in these discussions and develop a more foundational relationship with their peers that they had not had the opportunity to interact with in the missed sessions prior. It was identified that the capacity to direct the Surrogate Avatar in the space, such as moving closer or farther from sources in the physical classroom or interact with different peers in the classroom also made SuAvE a more interactive experience than current hybrid learning methods.

4.1.2 Integration in Shared Learning and Presentations Environment

In this section, peer engagement and collaboration as impacted by shared learning and presentations environment is observed. Building on the previous section, these observations also see to determine the impact of a differential learning space, that focuses on the requirement of relationship between students through collaborative environments to fulfill academic requirements.

4.1.2.1 Case 1: Fall 2022 – Class Excursion Implementation

The capacity for an interaction in a physical environment that not the classroom, but relevant to course learning objectives was notable regarding this implementation of SuAvE. In this opportunity, the requirement of attending a public museum in Ottawa to complete a classroom assessment was a barrier for students who were attending virtually. The Surrogate Avatar volunteer physically attended the museum, and specifically interacted with the pieces in the museum that the remote participant identified an interest in. While there was a decreased

interaction with surrounding peers, there was an increased interaction observed with the physical environment. In this, the general engagement and enthusiasm of both the Surrogate Avatar volunteer and the remote participant increased. This is because regarding physicality, the Surrogate Avatar volunteer was instructed on movements at a greater demand than in classroom specific trials. The vice versa was also observed, where the remote participant had more opportunities to ask for engagement within the physical environment. Upon asking the remote participant about anything notable about this experience, there was an explanation that the ability to direct movement of the environment through explanations of "move closer, move further, show the description, etcetera" allowed for a more thorough interaction with the environment compared to the 360-degree tour that was offered online as an accommodation to virtual participants. In instances where the remote participant had specific questions or wanted to interact with staff that had more information on certain museum pieces, the Surrogate Avatar volunteer transferred the personal cellular device to the staff to interact directly with the remote participant. This did create a disconnection of viewing the Surrogate Avatar volunteer as a physical embodiment for the remote participant, but instead as a mediator for bridging the physical and virtual environments.

This experience focused less on the ability for the remote participant to connect to peers, but a greater emphasis to connect with the physical space. For this reason, previous barriers with the accessory devices used were not as influential in the experience. As such, the headset was utilized to allow for a focus on the private audio channel between the remote participant and the Surrogate Avatar which was deemed necessary for this experience. When the remote participant was in conversations with the staff as aforementioned, the Surrogate Avatar volunteer disconnected their private audio channel using the headset to allow for a public audio channel

through the speaker on the personal cellular device. As there were more instances of the requirement of the private audio channel compared to the public audio channel, this was not a sufficient technological barrier. Furthermore, the lack of a harness allowed for an increase mobility for the capacity to direct the personal cellular device in certain spaces. Language and time zone differences also did not impede this experience due to the increased excitement about the capacity to interact with a physical environment, and less of a requirement for an understanding of language resulting from the same directional sayings being utilized. This case was one of the most notable in terms of showing the importance of physical embodiment in experiential learning.

4.1.2.2 Case 2: Fall 2023 – Design Day Implementation

The freedom of movement within SuAvE in a physical environment for a remote participant was the most notable observation of this implementation. Since the physical environment was loud and busy, having no stringent expectations for either the remote participant or the Surrogate Avatar allowed for different interactions with SuAvE not previously observed. In some interactions, the booth speakers at Design Day felt more comfortable taking the cellular device to interact with the virtual participant as it improved auditory concerns since both sides could hear the other better. For projects that had a physical component that could be interacted with, presenters familiar with their project physically demonstrated the work to the remote participant. Interactions with the remote participant were authentic and well-received based on anonymous interview responses collected in the aftermath of SuAvE, but it is to be noted that the Surrogate Avatar and the remote participant were treated as separate identities.

Intertwined with the Surrogate Avatar and the remote participant being treated as separate identities, this perception of the Surrogate Avatar and the remote participant being separate was

observed through understanding the difference in these participants and their interactions with the environment surrounding language and communication. As Design Day occurred at a bilingual institution, many presentation groups preferred presenting in the French language. In this case, the Surrogate Avatar did not speak French, but the remote participant did – so at times, the agency was given to the group presenters to interact with the remote participant directly, rather than through the Surrogate Avatar due to this language barrier. Since the Surrogate Avatar did not interact with the environment much in these instances, when presentation groups were able to present in English, the Surrogate Avatar then interacted with the projects independently from the remote participant instead of for the remote participant. This further enforced the participants behaving as separate identities. For this reason, it was observed that the Surrogate Avatar acted as more of a mobility aid rather than a physical replacement for the remote participant, which was not aligned with the project intention of creating an embodied experience. With that being identified, most presentation groups remarked that this was a more dynamic and fluid approach to presentations in a remote state as there was agency in interactions directly with the project. The remote participant also explained that the ability to direct the Surrogate Avatar to interact with projects that required an in-person demonstration from a first-person perspective rather than a third-person perspective provided a greater comprehension of project technicalities.

4.1.3 Integrations in Project-Based Studies

In this section, the observations obtained from the integration of SuAvE within educational environments is focused on through iterative and collaborative project development. These observations determine how repeated implementations of SuAvE with the same participants can lead to varying outcomes, despite a consistent population.

4.1.3.1 Case 1: Fall 2023 – 4-Session Implementation With A Capstone Group

An engineering student capstone group reached out to a graduate student from the University of Ottawa to inquire if this graduate student would be willing to be a client for their project. The client explained that they would be willing if remote accommodations were available, with SuAvE implemented to facilitate the interaction. A preliminary session explaining the context of SuAvE was conducted to obtain consent from all participants. While the concept of remote attending could have been possible without the integration of this thesis, SuAvE allowed for a more unique experiences as explained in more details below.

The first session acted as an opportunity to become familiar with SuAvE as a socio-technical tool to be used in all future capstone project meetings. The Surrogate Avatar and remote participant utilized their own Microsoft Teams meeting link to conduct the virtual connection. Based on feedback from the prior study, a neck phone holder was utilized to create a higher viewpoint for the remote participant, with only a public audio connection, entailing an open speaker and microphone in the public environment. For the first trial, the Surrogate Avatar and the remote participant were asked to interact with SuAvE as they saw best fit. In the first week, the preliminary design and implementation of the capstone project, the group did not have much to showcase in a physical environment, as their main tasks were to research background information about their project designs and begin preliminary sketches. The Surrogate Avatar explained that they interacted with the room environment as they thought would have been beneficial, including moving with the flow of conversation to show the perspective of each person talking. The remote participant explained that this was beneficial to be able to feel like they were having face-to-face interactions with each individual group member when brainstorming the outline of the project design, excluding the one acting as the Surrogate Avatar. There was an observed overlap in

instances where they were both speaking (the Surrogate Avatar and the remote participant), as this was the Surrogate Avatar's first experience with SuAvE, and they were adjusting to the differentiation of being a physical embodiment of their remote client. It was also noted that the observing participants, being the other group members, had to adjust to identifying the remote participant and the Surrogate Avatars as differing identities. This is because observing participants would attempt to interact with the Surrogate Avatar as a separate person from the remote client – which is not the intention of SuAvE in regard to seamless interaction in the environment for the remote participant. It was explained that outside this initial perception difference, having a Surrogate Avatar for remote client interactions with other group members and themselves felt more dynamic and easier to manage as an observer, as they were not required to change viewpoints or manage any technical aspects themselves.

The second session built upon the observed results from the first session, providing another student in the capstone group with the opportunity to be the remote participant. In this case, the preliminary prototype was able to be demonstrated. The Surrogate Avatar was directed by their remote participant to pick up the working parts of the prototype to interact with its design and understand the foundation of the project. The capacity to interact with the prototype design and inquire about certain connections made within the design from a first-person perspective provided the remote client with the opportunity to present feedback on the preliminary prototype to the capstone team. The remote client indicated that this was unique to other solely virtual methods of being a remote participant overseeing project designs as there was a greater interaction with the environment. As the Surrogate Avatar had previous knowledge about the prototype design, they were able to be directed to interact with specific aspects without difficulty. The observing participants, being the other group members, identified that the experience was easier to navigate

as there was the benefit of having the Surrogate Avatar aid in the remote participant's perception of the space and their physical interaction with the project. This allowed conversations to flow more authentically with the remote participant. These observations remained the same in the third session as the process did not change, and the interactions with the developing prototype were coordinated in a similar manner.

In the fourth session of the implementation of SuAvE for this capstone group, another team member was unable to physically attend the client meeting, but still wanted to be present as it was the final session. As a result, this session utilized two Surrogate Avatars representing two remote participants: the client and another team member. This was the first instance of having two SuAvE experiences ongoing in the same group, and there were some observed limitations and challenges as well as a third-party indicator observed. Of this, it included delays due to the processing of different internet connections on the ends of the remote participants. Furthermore, considering the capstone team's dynamic in presenting their final working model, there were observed cases of Surrogate Avatars interacting with each other, and the opposing remote participant – so there was a greater shared agency and collaboration rather than individual physical embodied experience. The remote participants explained that when this occurred, they were able to identify that they were not being directly addressed, but mentioned it was an unfamiliar experience to be a first-person observer in a conversation. There was one additional member of the group who acted as an observing participant, who mentioned that it was a bit overstimulating to navigate multiple Surrogate Avatars and their remote participants, especially in an environment where there was familiarity amongst all participants through multiple sessions of implementations. Despite these circumstances of navigating multiple audio and video-channels for communication, from all overall standpoint they did emphasize it was still more integrational than current hybrid practices,

and that it was beneficial considering it was the final required client call for the course and project completion.

4.1.4 Integrations in the Classroom for Professors

In this section, the application of SuAvE in classroom settings is observed, particularly with how it can be used to facilitate multiple Surrogate Avatar experiences for a single remote participant. This observation examines specifically the capacity for professors to interact with and manage various physical environments using SuAvE.

4.1.4.1 Case 1: Fall 2022 – "Hydra"

Organized through the professor and their respective course, the student groups were provided the purpose of using SuAvE in conducting multiple simultaneous project presentations that the professor could remotely attend. The selected volunteer from each student group that would act as the Surrogate Avatar was directed to use their own personal device and conduct their roleplay to 'act as the professor' as they best saw fit. As such, there were no other technological devices utilized besides personal electronic devices with video-conferencing capabilities. Students were then provided with the zoom link and a specific breakout room number to join, and then departed to their desired presentation locations on campus.

Without any prior notification, the remote professor would join breakout rooms to observe student presentations. The professor had the opportunity to participate in the physical environment in one of two ways. The first method was to observe how students interacted directly with their physical environment. The lack of notification or set-joining time meant that there was an increased likelihood of the professor being able to authentically observe students in their presentation environments without the students specifically preparing for interactions with the

professor. The second method was to watch the students directly present and ask questions. The remote participant was able to direct the Surrogate Avatar to move within the environment, either closer or father to students and their presentation material.

Although there was the benefit of navigation through multiple spaces for the remote professor, a few technological challenges were observed. From the perspective of the choice of personal device, the model of the device changed the audio-visual quality – causing some student groups to have a greater technological capacity to focus on the presentation material and surrounding environment. Furthermore, the choice of personal lines of communication, which is directly between the Surrogate Avatar and the remote participant, compared to public lines of communication, which is between the remote participant and the direct environment, changed the quality of the audio and thus the integration of a first-person perspective for the remote professor. In general, students explained that it was a unique experience and found benefit in not having isolated times to present or a requirement to observe other student presentations. Meanwhile, the experience from the perspective of the remote professor was accessibility focused, with the ability to move around quickly between groups, as there was no need for physically navigating multiple environments since it was able to be completed through the virtual space of learning.

Some students reported that there was some resistance to participation of bystanders of the experience as the crowd assumed that the streaming device was being used to record the experience and they did not want to be personally recorded and saved to a digital file. This could be contributed to the assumption of personal electronic devices being typically utilized for photo or video-capturing, compared to when a body-mounted accessory is used to place the electronic device, since there was no saved recording taken during the experiences.

4.2 Analyzing Influencing Factors in SuAvE

From the previous general implementations of SuAvE, personal implications studies were conducted to determine if they had any influence in the benefit of experience and interaction for participating members in the experience. The observations obtained from the three individual case study themes pertaining to personal perception, gender, and technology are written per their respective sections.

4.2.1 Perception Implications:

As determined in the holistic implementations of SuAvE, with SuAvE being a voluntary experience, perception of others in the learning environment, as well as how the remote participant feels to be perceived could have an influence on the experience. The observations from two perception cases of physical perception through facial features and height pertaining to the Surrogate Avatar volunteers, were observed and are described through their respective sections.

4.2.1.1 Case 1: Use of Face Cover

The perception implication studies aimed to understand if the visual appearance of the Surrogate Avatar volunteer and the remote participant had any impact on connection with surrounding peers or the physical environment.

From students who first showed interest into being a volunteer in conducting a SuAvE experience, only 29% of the course showed an interest, leaving 71% of students in the course uninterested. First, interviews with the students who did not volunteer were conducted. Of these students that did not volunteer, 30% of them explained that it was the idea of volunteering extra time without personal benefit in the classroom that seemed unappealing. One of these students

quoted the following, “I already do not want to attend class myself, so I’m not inclined to want to spend more time in the classroom than I need to or do more than I need to do to pass this class.” From the remaining 70% of students, 29% indicated that they had some interest in the experience but felt generally hesitant to participate because of unfamiliarity with the project or any similar execution. One of these interviewed students had the following to say, “I’m already a note-taker in my class, so I understand that there are benefits to having accessible learning devices. But the process of notetaking does not require me to do anything more than take notes for the class, which I would be doing regardless. Facilitating an experience that I have no experience myself in feels like a lot of pressure.” The other 41% of non-participants did not want to be interviewed.

Meanwhile, of the 29% of students in the class that did volunteer, only 39% of those students ended up participating in SuAvE. The students who removed themselves from the volunteer experience were interviewed separately. One of those students mentioned the following, “After wearing masks for years during the pandemic, I thought wearing a face cover would be no issue. But then I put it on and felt claustrophobic, and decided this experience was not for me.” Two other students that volunteered also mentioned generally that while it seemed easy enough to conduct, upon seeing all the working parts it seemed like more responsibility than they were willing to participate in.

From those who did participate in the experience, the resulting observations are written based the respective perspectives of the Surrogate Avatar volunteer, the remote participant, and the surrounding peers in overlapping scenarios. The differences of each trial specific to the pairing of face covers and camera usage were observed independently.

When Surrogate Avatar volunteers were not instructed to wear a face covering– as in Trial 2 and Trial 4, they explained that there was no physical or societal discomfort related to the

accessory materials required to be a Surrogate Avatar volunteer. While they were asked questions about SuAvE, their role, and sometimes conversation topics specific to them compared to their remote participants by surrounding peers, these Surrogate Avatar volunteers explained that it felt easier to refer topics back to the remote participants. In these cases, when posed the question “Do you feel as though you are an embodiment of the remote participant or a mediator for the remote participant?”, both Surrogate Avatar volunteers explained that they felt they were mediators for the remote participant, as they did not feel as though they were the same identity as the remote participant, but an alternate assistive identity.

Meanwhile, when Surrogate Avatars volunteers, wore the provided white face covers to hide their facial features and perceived identity – as in Trial 1 and Trial 3, they explained that the face cover they were asked to wear became uncomfortable part way through the experience. This is because it impacted their visual and auditory senses, as well as increased their facial body temperature. The Surrogate Avatar volunteers also explained that wearing the face cover felt as though it drew more attention to them due to the unfamiliarity and perceived theatrics of wearing it and resulted in many questions about the necessity of the face cover in conducting SuAvE. As in the previous case, when posed the question “Do you feel as though you are an embodiment of the remote participant or a mediator for the remote participant?”, the Surrogate Avatar volunteer who participated in Trial 1 explained that they felt like they were embodying the remote participant more. The reason they provided was that they did not feel that the facial cover represented themselves, so they felt less connected to others. Alternatively, the Surrogate Avatar volunteer from Trial 3 felt very disconnected from the experience, as neither an embodiment nor a mediator – but simply an unwanted focal point in the classroom. The reason for this is explained when talking about the trials independently. When asked if the Surrogate Avatar

volunteers would have been comfortable wearing other articles of clothing or accessories to hide aspects of their personal identity, such as hair coverings, gloves, or loose base layer clothing, they both replied that they would not, because while they are agreeing to be a physical embodiment for a remote participant, they were not open to external wear that they deemed unnecessary or uncomfortable to them personally as related to fulfilling their role. It is identified that while the Surrogate Avatar volunteers deemed that this felt unnecessary to them, it does not indicate that it is entirely unnecessary to the remote participant as related to embodied experiences. This is an observation that differs from other studies conducted that have utilized mask wearing in interaction; where as in a study conducted by Crandall, the researchers indicated that the masks had little to no affect on social interaction (Crandall et al., 2022). Some research has also pointed to masks having a positive impact related to academic performance, emotional and self-awareness, and overall inclusion (Roy, 2020).

When remote participants were instructed to attend the sessions with their camera turned on to show their facial features and perceived identity– as in Trial 1 and Trial 2, they explained that the knowledge that their surrounding peers could visually see them impacted their interest in participation and the upkeeping of their physical appearance. With the consideration that in these scenarios, remote participants were directed to also blur their background and utilize camera tracking features to place a focus on their face, the two differing remote participants explained that knowing a focus was placed on them increased their connection to the classroom activities, as their disinterest or multitasking activities would be observed by other peers. Two opinions were described by the remote participants: (1) An increase in participation due to perceived observation was beneficial to the grasping of material in lectures, but (2) the increased focus on them being integrated with a new technology placed a lot of emphasis on them and created

personal feelings of anxiousness. Both observations imply that extrinsic motivation in the form of both ‘external regulation’ and ‘introjection’ are influencing the motivation to participate in the classroom activity (Deci & Ryan, 2008).

Meanwhile, when remote participants were told to keep their cameras turned off when attending the classrooms virtually – as in Trial 3 and Trial 4, they explained that they felt less engaged with the content because of the knowledge that they were not being perceived or seen by their surrounding peers. The remote participant from Trial 4 specifically explained that they left their device for approximately 10 minutes of the experience to use the washroom without anyone noticing due to their camera being turned off, and their own choice to not turn their microphone on during the experience. The remote participant from Trial 3 did not describe this scenario but explained that there seemed to be no benefit of attending the physical environment with their camera off as it felt more distracting and had many more audio concerns of not being able to hear the professor due to proximity of their Surrogate Avatar and the professor than simply attending classroom sessions utilizing a stationary web-conferencing platform link.

Observing the surrounding participants, they explained that having the Surrogate Avatar volunteers wear face coverings posed more questions and inquisition than when the Surrogate Avatar volunteers did not wear the face covering. The use of the face coverings also resulted in several surrounding participants not wanting to interact with SuAvE due to personal feelings of the experience feeling comical or unserious due to the perceived theatrics. In general, when the remote participants had their cameras turned on, surrounding participants found it easier to communicate with them separate from the Surrogate Avatar volunteer, but felt there was no point in engaging with remote participants who had their cameras turned off.

Trial 1 independently entailed surrounding peers communicating more with the remote participants due to the barrier of connection that resulted from the Surrogate Avatar wearing a face cover. However, only 19% of surrounding peers chose to interact with the remote participants due to discomfort of the perceived theatrics previously described. This trial showed a more attentive connection to those willing to interact with SuAvE, but less comfort for the Surrogate Avatar and surrounding peers, and thus less general connections between the physical and the virtual environment. Trial 2 independently entailed surrounding peers communicating with both the Surrogate Avatar volunteers and the remote participants separately and requiring redirection to solely interact with the remote participant. However, all participants felt that this trial was the most productive in terms of integration, ease of use, and engagement, since 48% of surrounding peers chose to interact in this case. Trial 3 was described as the least engaging and beneficial trial for all participants, as surrounding peers felt no need to engage with the Surrogate Avatar volunteer because of the face covering they were wearing, and no need to engage with the remote participant due to their camera being turned off. As such, only 5% of surrounding peers were seen attempting to interact. The remote participant felt disconnected in this case, and communicated that under these circumstances, they would not use SuAvE. Lastly, Trial 4 was described as disengaging for the remote participant, and the Surrogate Avatar volunteer felt as though they were not of any use in this experience. The 11% of surrounding peers that participated were more inclined to engage with the Surrogate Avatar volunteers rather than the remote participants, and thus there was no perception of physical embodiment in this case.

Overall, utilizing no face cover for the Surrogate Avatar volunteer and having a camera turned on for the remote participant was observed in Trial 2 to be the most beneficial. Opposingly, utilizing a face cover for the Surrogate Avatar volunteer and having the camera

turned off for the remote participant was observed in Trial 3 to be the least beneficial experience. A further analysis will be conducted in Chapter 5.

4.2.1.2 Case 2: Device Positioning and Height

This case of the perception studies aimed to determine if there was an influence on perception and user experience if the personal cellular device that was being used to embody the remote participant was placed at a certain height.

Similarly to the previous case study, students who opted out of participating in SuAvE were initially interviewed, as 40% of the classroom students were interested in participating in SuAvE, however only 21% of students in the classroom participated. The perspective of having no interest in extra participatory actions deemed personally irrelevant to their own learning in the course impacted the choice of 34% of the participants who refused to participate from the beginning. As quoted by one student, “I’m already barely able to feel on top of my own academics, I don’t have the capacity to attempt to help others.”

Of the 40% of the classroom that initially volunteered, 46% of those students ended up opting out either right before the experience or during the experience. Of these, there were students who chose to participate in only one of the two harness usages. This data, while collected, was chosen to be removed from the study as a direct comparison of perception utilizing the same volunteers with differing accessory devices could not be accurately conducted and were deemed unable to be utilized since the primary focus of these studies is to understand perception through repetition of volunteers with differing accessory materials.

As such, in the actual execution of the experience, 8 trials were conducted that mixed a variety of factors including the type of harness used, the height of the Surrogate Avatar, and the

height of the remote participant. Due to the number of trials conducted and the varying factors, Condition 1 in Table 8 consists of the data collection when a neck harness was utilized, while Condition 2 in Table 9 consists of the data collection when a body harness was used. These tables are further discussed below.

Table 8

Implemented Trials for Case 2 of "Perception Studies", utilizing a neck harness as Condition 1.

Height of Remote Participant	**Height of Surrogate Avatar**	
	≤5'2	**≥5'3**
≤5'2	Trial 1: No Difference	Trial 2: Notable Difference
≥5'3	Trial 3: Notable Difference	Trial 4: No Difference

Under Condition 1, when the height of the Surrogate Avatar volunteer and the height of the remote participant were in similar ranges, as in Trials 1 and 4, there was no notable differences in their experience from the experience that the remote participant anticipated to be perceived. When interviewing participants in Trial 1, it was identified by the remote participant that the location of the device placed this student's facial location around the same height as in-person experiences, so conversing with other surrounding peers through SuAvE felt more integrated. This participant specifically emphasized that with current hybrid modules, the device location entails either a laptop placed on a desk or a large overhead surveillance camera to portrait the physical environment – where either angle disconnects the virtual and physical environments.

However, in Trials 2 and 3, where there was a height difference between the Surrogate Avatar volunteer and the remote participant, there was a perceived and notable difference

according to the remote participants. In Trial 2, where the Surrogate Avatar volunteer was taller than the remote participant, the remote participant explained that the face-to-face interactions that were being embodied through the Surrogate Avatar volunteer placed them at a different height than that in-person. As such, maintaining eye contact or looking in the surrounding environment of direct speakers felt unfamiliar despite a previous knowledge of the environment.

In this case, the remote participant, who personally identified being shorter than most of their surrounding peers, was now at an interacting viewpoint that was much taller than them. They compared this feeling to the overhead cameras in classrooms that have been commonly used to record lectures from a birds-eye viewpoint. When asked if this viewpoint changed their interaction or interpretation of SuAvE, they responded that interacting at a higher viewpoint that was not entirely disconnected from the classroom provided a greater sense of confidence in communicating with their surrounding peers. In the opposing method, Trial 3 entailed the Surrogate Avatar volunteer being shorter than the remote participant. In this case, the remote participant explained that being placed at a lower viewpoint than normally perceived removed the capacity to view the experience as an embodiment. In this trial, surrounding peers commented on how conversing with the remote participant through the Surrogate Avatar volunteer by “looking down” at them, compared to “looking up” at them changed their demeanor in conversation. This demeanor change was observed by the remote participant, who mentioned a few comments received regarding on the difference in height. For this reason, the remote participant ended up feeling disconnected in a negative way from SuAvE. It is important to note that in both trials, there was a height difference between the Surrogate Avatar volunteer and the remote participant by several inches.

Table 9

Implemented Trials for Case 2 of "Perception Studies", utilizing a body harness as Condition 2.

Height of Remote Participant	**Height of Surrogate Avatar**	
	≤5'2	**≥5'3**
≤5'2	Trial 5: Slight Difference	Trial 6: Notable Difference
≥5'3	Trial 7: Notable Difference	Trial 8: Slight Difference

Under Condition 2, when the height of the Surrogate Avatar volunteer and the height of the remote participant were in similar ranges, as in Trials 5 and 8, there was a slight difference in the experience. The remote participants in both trials mentioned that the placement of the device was at a lower viewpoint than they would normally experience, despite being within a similar height range to the Surrogate Avatar volunteer. While this did not have a large impact on SuAvE and their ability to interact with the surrounding peers, the mentioned observation was noted.

Meanwhile, in Trials 6 and 7, where there was a height difference between the Surrogate Avatar volunteer and the remote participant, there was a perceived and notable difference according to the remote participants similarly to that observed in Trials 2 and 3. The same observations were described, respective to when the Surrogate Avatar volunteer was taller than the remote participant and vice versa. In this case, it was also noted that the placement of the device was at a lower angle, which caused the height difference to feel even greater. Specifically, in Trial 7, where the Surrogate Avatar volunteer was much shorter in height than the remote participant, the remote participant explained that the noticeable demeanor in surrounding peers needing to adjust their height and placement to communicate with them on the personal cellular device. They also explained that the clarity of the surrounding surveillance was often unfocused

and had a lot of additional video movement. This created an uncomfortable experience for the remote participant.

Following interviews with the remote participants in each case, the Surrogate Avatar volunteers were specifically interviewed to inquire about their experience. The Surrogate Avatar volunteer in Trials 1 and 5, who was the same volunteer, described a greater sense of comfort in utilizing the neck harness compared to the body harness, which was echoed by the volunteer who conducted Trials 3 and 7. It is important to identify that, with their permission, both Surrogate Avatar volunteers in these cases were women. As such, the body harness had some difficulties in positioning and comfort due to the placement on the body, and a greater emphasis on contributed shoulder strain. This placement did impact the experience for the remote participant, as previously described in Trial 7, because the movement of the rib cage from the expansion of lungs during breathing, as well as the physical structure of the women volunteers contributed to the unfocused and sometimes shaky movement of the camera. Meanwhile, with volunteers in Trials 2 and 6, as well as Trials 4 and 8, where the Surrogate Avatar volunteers were taller and, with their permission, disclosed to be men, there was no noticeable difference in their comfort between using a body harness compared to a neck harness.

These observations are further discussed in the analysis but contributed to the expansion of the studies regarding the implications of gender; these observations were collected in the succeeding case study, (B) Gender Implications.

4.3.2 Gender Implications

Under the same concept of determining the role of perception in SuAvE studies, a separate section of observations was collected pertaining solely to the implications of gender in the roles of remote participant and Surrogate Avatar volunteer.

4.3.2.1 Case 1: Gender

Stemming from the results of the previous studies, it was identified that an understanding of the possible influence of gender in SuAvE needed an independent concentrated study. In this case, there were pairings of Surrogate Avatar volunteers and remote participants specifically according to gender pairs. Trial 1 entailed both participants being men and Trial 2 entailed both participants being women. In Trial 3, the Surrogate Avatar volunteer was a woman, and the remote participant was a man, and Trial 4 entailed the vice versa of this.

Following the experience conducted, a series of questions were posed to the participants for a greater understanding. There sets of questions asked were organized into 3 sections: (1) the remote participant, (2) the Surrogate Avatar volunteers, and (3) the surrounding peers. The notable results of questions are accumulated in respective Tables 10 to 12.

Table 10

Questions and answers obtained from posed questions to the remote participants in SuAvE.

	Trial 1	**Trial 2**	**Trial 3**	**Trial 4**
Did you feel that you were able to connect to your peers?	Yes	Yes	No	No
Did you feel that your gender impacted your experience?	No	No	Yes	Yes
Did you feel that the gender of your Surrogate Avatar impacted your experience?	No	No	Yes	Yes

Table 11

Questions and answers obtained from posed questions to the Surrogate Avatars in SuAvE.

	Trial 1	**Trial 2**	**Trial 3**	**Trial 4**
Did you feel that you were able to be an embodiment for your remote participant?	Yes	Yes	No	No
Did you feel that your gender impacted your experience?	No	No	Yes	Yes

As in Table 10, Trials 1 and 2 and Trials 3 and 4 had similar experiences for the remote participants interviewed that participated in this case. This was also seen in Table 11 regarding the Surrogate Avatar volunteers. When the gender was shared between the Surrogate Avatar volunteer and the remote participant, the remote participant felt that they were able to connect with their peers and that gender did not impact the experience. Meanwhile, when the gender was opposing, there was an impact regarding the remote participant feeling connected to the physical environment and their surrounding peers, while the Surrogate Avatar volunteer felt that they were not able to be an embodiment for the remote participant.

When further inquired on why this was the case, Trials 1 and 2 where the gender was shared between SuAvE participants, the remote participants explained that providing directions to navigate the physical environment felt easier to communicate with the understanding of sharing the same gender. In Trial 2 specifically, where both participants were women, it was shared that when the remote participant directed the Surrogate Avatar volunteer to raise their hand on their behalf, the act of hearing women pronouns be used to call upon the speaker and hearing a women's voice for clarifications felt more familiar and expected of an embodied experience.

Meanwhile, in Trials 3 and 4, participants in SuAvE felt that societal expectations had influence on the interaction. As in Trial 3, where the remote participant was a woman and the Surrogate Avatar volunteer was a man, the remote participant explained it was harder to want to ask the Surrogate Avatar to act on her behalf. She explained that while there was no specific action from the Surrogate Avatar volunteer that contributed to a negative environment, the act of asking someone who was taller, and a man felt inappropriate to direct on her behalf and felt that it did not represent her. She also found that the way surrounding peers interacted with her compared to when she physically attended was different, as she found more of her male peers interacted with her and had a different approach before noticing that she was attending remotely through the Surrogate Avatar experience. The remote participant in Trial 4 echoed some of this concern, as he explained that the tone and language used by his peers to interact with him was different than how his peers normally would communicate with him. In this trial, the Surrogate Avatar volunteer also explained that the tone of which questions were posed by the remote participant in discussion environments was different than she would communicate with her peers, which at times caused discomfort for her; where as this was not observed in same gendered situations. In these cases, physical embodiment was not achieved due to these barriers in connectivity.

Table 12

Questions and answers obtained from posed questions to the surrounding participants in SuAvE.

	Trial 1	**Trial 2**	**Trial 3**	**Trial 4**
Did you feel that the gender of the remote participant had any influence on your interaction?	No	No	No	No
Did you feel that the gender of the Surrogate Avatar participant had any influence on your interaction?	No	No	No	No

Meanwhile, when asking surrounding participants if they had any difference in perception regarding the gender of the Surrogate Avatar volunteer of the remote participant, they described that they did not consciously believe there was any difference in participation or interaction. However, this contrasts with the experience of the participants in Trial 3 and 4. This suggests an unconscious bias in participation which will be analyzed in Chapter 5.

4.3.4 Technological Implications

As observed in other conducted studies of SuAvE previously described, there has been speculation towards whether the type of technology used by Surrogate Avatar volunteers can impact the experience for the remote participant. Focusing on Apple and Samsung products, from statistics that suggest they are the most popularly owned devices in Canada, the observations of a case study conducted that compares these devices regarding usage in SuAvE is described below.

4.3.4.1 Case 1: Differing Devices Capacities

As cellular devices were not provided to Surrogate Avatar volunteers for the experience, all conducted cases of SuAvE implementations utilized personal cellular devices already owned by the Surrogate Avatar volunteers. This resulted in different devices utilized. To understand if the device utilized impacted the experience, this case study was conducted to compare devices, specifically Apple and Samsung cellular devices. For the purpose of comparative analysis, the different device models that were utilized were within similar launch year timelines. There were 3 total trials conducted to compare device capacities.

Condition 1 utilized the newest models of devices from 2023, Condition 2 utilized devices launched in the last 3 years, and Condition 3 utilized the oldest models in this case study,

from 4 to 6 years prior. The video capacity and audio fidelity of the device per their respective manufacturers were described as the in all devices across all years. Trials 1 and 2 were conducted simultaneously, to identify comparative observations. These observations are as listed in Table 13.

Table 13

The observations from 2-implemented trials of Case 1: Differing Device Capacities in Technological Implications.

	Trial 1: Apple Cellular Device		**Trial 2: Samsung Cellular Device**	
	Surrogate Avatar	**Remote Participant**	**Surrogate Avatar**	**Remote Participant**
Condition 1: Year of Device 2023 vs. 2023 respectively	No notable observations	No notable observations	No notable observations	Issues with autozoom on camera of the environment
Condition 2: Year of Device, 2022 vs. 2021 respectively	No notable observations	No notable observations	Issues with message delays from the remote participant	Audio concerns and delays with embodiment
Condition 2: Year of Device 2018 vs. 2020 respectively	Device size was of a smaller design for handling	Less physical environment to be observed, audio concerns	No notable observations	Issues with camera quality related to the environment, audio concerns

In general, the older the device utilized to conduct the experience in the physical environment, the more issues were present in the experience for the remote participant. This stemmed from camera quality and delays in the video, to muffled and unfocused audios between

surrounding peers and the professor. These issues were less present when the device was newer, regardless of whether the device was an Apple or a Samsung product.

However, in Condition 1, an issue that required resolution during the experience was specifically observed when using the Samsung 2023 device, which impacted the remote participant. Upon entering Microsoft Teams, the remote participant identified that the video auto-zoomed on the environment, which required the Surrogate Avatar volunteer to need to be located further from surrounding peers or objects in order for the remote participant to be able to interact. It was inquired as to whether this was an auto-set feature on either user's setting, but it was identified that this was not the case. The reason for this auto-zoom was not able to be determined during the trial, as it was hypothesized that it may have been an internal Microsoft Teams feature, but upon checking the settings of the device, this feature was not enabled despite this situation occurring. This was not experienced when using the Apple device in the same circumstance. In fact, no notable observations were determined in Trial 1, Condition 1, as the remote participant experienced minimal video or audio issues, and the Surrogate Avatar volunteer said that the device was easy to maneuver.

In Condition 2, there was again no notable observations in Trial 1, when utilizing the Apple cellular device. However, in Trial 2, there was an instance where, as a result of experienced audio concerns, the remote participant decided to attempt to use the message feature in the Microsoft Teams call to interact with the Surrogate Avatar volunteer. However, the Surrogate Avatar volunteer experienced slight delays in receiving these messages, which delayed embodiment interactions. The circumstance regarding the issue was repeated for the Trial 1 participants, where the remote participant in Condition 2 was instructed to try to direct the Surrogate Avatar volunteer by utilizing the message feature in Microsoft Teams. There were

minimal delays in obtaining the instructions compared to with the Trial 2, the Samsung counterpart. As both trials and conditions operated under the same internet connection, it was likely that system compatibility with the applications was the reason for the message delays experienced with the Samsung device.

Lastly, in Condition 3, Trial 1, utilizing the Apple device, the Surrogate Avatar volunteer identified that the model of the device was smaller in size, and thus required more adjustments in movement when directed to interact with the space, since the lens on the camera does showcase a different field of view since it operates at a 24 mm field of view compared to 28 mm field of view. The remote participant in this case identified that because of the smaller device, there was a smaller range of physical environment to be experienced, and less clarity of the environment settings unless specifically identified to move closer to environmental objects. Meanwhile in Trial 2, there were no notable observations regarding the interaction of the Surrogate Avatar volunteer. However, the remote participant experience issues with camera quality being pixelated even upon moving closer to physical objects. Furthermore, there were many audio concerns with the device which could be contributed to the difference from the technological advancement curve of newer devices with generally new or enhanced features added.

From these observations, it was drawn that the device capacity had an influence on the experience, where Apple devices were generally preferred in terms of the clarity of video, ease of use and audio control. However, in any case, the older the device, the reduced capacity for interaction that was experienced.

Chapter 5: Analysis of the Implementation

The observations obtained from the implementations, as described in Chapter 4, are further analyzed in this chapter using thematic analysis for a comparative analysis, which is a complementary method of data analysis through constructivist grounded theory(Mohajan & Mohajan, 2022).

5.1 Embodiment versus Relational Spaces

Embodiment in the classroom refers to the integration of physical presence, interaction, and experiential learning in educational spaces. The act of physically being present in a classroom is crucial to student comprehension, engagement, and the ability to connect with learning outcomes and other peers. For students participating in remote-learning activities through the integration of hybrid learning systems, SuAvE is a system of introducing aspects of embodiment through Surrogate Avatar volunteers, as implemented throughout this study. Thus, understanding whether embodiment as an objective was obtained is to be discussed.

Introductory implementations of SuAvE acted as a framework for the system, aiming to identify aspects that would need to be modified to conduct future experiences. In the conducted holistic experience studies, a large emphasis was placed on developing the roles and responsibilities of SuAvE participants, specifically the remote participant and their Surrogate Avatar volunteers. This entailed a call for volunteers, posters and classroom announcements made for outreach, and a clear direction of how to conduct the experience. In *Integrations in the Classroom for Students, Case 1: Summer 2022, Preliminary Studies,* a lack of embodiment was thought to have occurred because of the need to explain to the curious surrounding peer network about the first of SuAvE experiences to be conducted. Furthermore, the technological issues were

also thought to have been an issue preventing embodiment. However, even as the roles and responsibilities were further developed, all attempted holistic case studies of SuAvE implementations suggested that participants view SuAvE as a technology utilized to facilitate a relational space rather than encompass an embodied experience. In this case, relational space refers to the quality of meaningful connections and interactions that foster a sense of belonging in learning environments. This emphasizes the importance of human connections in learning process, and their disconnection through current hybrid learning methodologies. This relational space will also be discussed in relation to *Social and Collaborative Learning Classrooms.*

This relational space is also contributed to the level of expertise that the surrogate avatar volunteer poses. In environments where the surrogate avatar volunteer has had previous experiences participating in the project, there is more seemliness interaction for the remote participant to have more embodiment rather than a relational experience (Bruce, 2024). However, in experiences where the surrogate avatar volunteer has expertise in the physical environment and the task at hand, the volunteer's own biasness is observed through the actions taken by them, which prevents embodiment and only suggests relation to the space for the remote participant. Overall, this suggests required education and training for the surrogate avatar volunteers, ideally placing them in rooms where they have some understanding of the physical environment but would not be considered an "expert".

In these holistic studies, it was also observed that language and time-zone differences are barriers in the experience, as in *Integrations in the Classroom for Students, Case 2: Fall 2022 – Multidisciplinary Design Lecture Implementation* and *Integrations in Shared Learning and Presentations Environments, Case 2: Design Day Implementation.* In these cases, when the remote participant is in a different time zone that is largely either ahead or behind that of the

classroom environment, exhaustion in the experience is observed. This exhaustion causes a loss of interest by the remote participant, and thus a decreased participation from them and as a result their Surrogate Avatar volunteer. Aligned with these cases, language barriers also have an influence in the lack of embodiment for the remote participant, due to the increased effort on their end to direct and provide clarifications for actions for the Surrogate Avatar volunteer. These observations are also discussed with respect to *(B) SuAvE in Social and Collaborative Learning Classrooms* section of this chapter. While these were observed, perception factors were identified as a point required to be studied.

As related to the reason for experiencing a relational space for the remote participant, the *Analyzing Influencing Factors in SuAvE* section of studies was conducted, to attempt to identify specific factors that may have been preventing the embodied experience outside of the language barriers and time zone differences. Identified most predominantly in the studies that utilized a face cover, several interactions must be considered. One of these interactions is between the remote participant and the surrounding peers. It was observed that in attending lectures remotely without their cameras turned on, many virtual students have lost a sense of awareness for how they are perceived. This is contributed to factors related to physical presentation of someone's cleanliness and demeanor, as well as how they are interacting with their own remote environment. For this reason, when the remote participant is required to have their camera turned on, they experience the feeling of being perceived by their peers and find it more intense and structured compared to attending remotely through current hybrid learning modules. However, this increases their engagement in a relational space with their peers, where they are encouraged to interact more with the physical environment. However, this dynamic creates a barrier related to the remote participants want to have an embodied experience. This is further discussed in *(B)*

SuAvE in Social and Collaborative Learning Classrooms and *(D) Intrinsic Versus Extrinsic Motivational Factors for SuAvE Participation* of this chapter section of this chapter.

Alongside that, the other interaction to consider is the Surrogate Avatar volunteer acting on behalf of the remote participant. All participants in SuAvE are provided information about their role to consent to the experience, and this includes information that Surrogate Avatar volunteers are expected to act on behalf of the remote participant, in a way that may be different from their own actions or participation in the classroom. However, it seems even with extensive information about this, as well as tutorials and test implementations, *Case 1: Use of Face Cover, Perception Studies* depicted that Surrogate Avatar volunteers struggle to give up full bodily autonomy to act as a physical representation for the remote participant. As seen in the observations, Surrogate Avatar volunteers are reluctant to wear face covers due to discomfort physically and social stigma, and when inquired if they would wear other accessory materials to cover their physical identity, Surrogate Avatar volunteers were uninterested and unwilling to further participate in the experience. Their own disinterest in the experience directly affects the remote participants ability to interact with the physical environment. When Surrogate Avatar volunteers feel that they are expected to give up "too much of themselves" to be in the experience, it was described as a "robotic and dystopian" dynamic. This reluctance, combined with that previously described with the remote participant, prevents barriers of embodiment, and suggests people utilize and have interest in participating in SuAvE due to the perceived ability to aid their peers. This feeling of wanting to provide aid is what contributes to a relational space rather than an embodied space. This will be referred to furthermore in the (B) *Social and Collaborative Learning Classrooms* and *(D) Intrinsic Versus Extrinsic Motivational Factors for SuAvE Participation* section of this analysis.

As conducted in *Gender Studies, Case 1: Gender,* another influencing factor that prevents embodiment is the perception and societal expectations associated with gender. From this case study conducted, when the gender is shared between the remote participant and the Surrogate Avatar volunteer, both participants find the experience to be more comfortable and natural. From the perspective of the remote participant, having a shared gender correlates to a greater understanding of interaction with the environment, and this a greater sense of comfort to direct the Surrogate Avatar volunteer to act on their behalf. In a similar way, the Surrogate Avatar volunteer feels more comfortable to act on the behalf of the remote participant when the gender is shared, which was also concluded in the study conducted by Kim et. al (Kim et al., 2017). Meanwhile, when gender is not shared, there exists societal expectations and perceptions that is hard for people to remove themselves from to participate in the experience, which was also noticed in the study conducted by Kraus et. al that concluded stereotyping regarding implicit gender aligned is observed in relation to personality characteristics (Kraus et al., 2018).

This directly correlates with *Perception Studies, Case 2: Device Positioning and Height,* as the average man worldwide is 5 feet 8 inches, compared to the average woman who is 5 feet 3 inches (Phelps et al., 2024). As such, the impacts of taller height appearing more dominating, and a shorter height being perceived as less dominating in the environment correlates with gender (Cinnirella et al., 2010). Furthermore, women who acts as the Surrogate Avatar volunteer tend to experience more physical strain when using body harnesses as observed in this case study as well. These factors have also changed how surrounding peers interact with the remote participant and the Surrogate Avatar volunteer. These difference in behaviours and interactions is contributed to unconscious bias, as defined by APA as “the systematic error experienced in decision-making [by] some people oblivious of their bias” (American Psychological Association,

2022; Suveren, 2022). Unconscious bias has been studied with regards to engineering education, where women and underrepresented groups can be negatively affected by their peers in collaborative learning environments. These biases that are engrained into systemic systems are then observed in interactions with SuAvE as the lack of understanding related to diversity and inclusivity can ultimately hinder the capacity for embodied experiences in environments that can already be polarizing based on gender. When women encounter barriers and microaggressions rooted in unconscious bias, it undermines their sense of belonging and engagement within the field, diminishing opportunities for hands-on learning, collaborative projects, and leadership roles that are crucial for embodied experiences (Backhus et al., 2019). This further emphasises that based on gender and its disparity in engineering education, embodiment of utilizing different gendered SuAvE participants is not in the current possible scope of SuAvE work from our preliminary findings because of the difference in proportion of men and women enrolled in engineering. However, this is further acknowledged with regards to *(B) SuAvE in Social and Collaborative Learning Classrooms* pertaining to how these perspectives in SuAvE can still be utilized outside the scope of this thematic analysis.

Perception shapes classroom experiences and is thus found in SuAvE experiences. Unfortunately, aspects related to perception are barriers in providing embodied experiences, as students have grown to be autonomous learners, and volunteering to give up personal autonomy will remain an issue in ego-centric learning environments that are influenced by culture, age, and economic status (Han, 2021). As such, these studies suggest SuAvE is instead a systematic method of conducting experiences in a relationally physical environment for remote learners rather than an embodiment platform.

5.2 SuAvE in Social and Collaborative Learning Classrooms

With the understanding that SuAvE instead navigates a relational space, rather than an embodied space, SuAvE is best integrated in social-learning environments that promote collaboration, communication, and interactions with the physical environment. In these cases, SuAvE plays a vital role in the reshaping of the relational space by providing both the platform and the connection for interpersonal engagement and collaboration between Surrogate Avatars in the physical plane and the remote participants in the virtual plane of learning. Through the direction of Surrogate Avatars, the remote participants can interact with their peers and instructors to engage in discussions, group projects and collaborative activities regardless of geographic location and time-zone differences. The ability for Surrogate Avatars to facilitate real-time communication and interaction enables students to build relationships and share ideas in social-learning environment.

In environments where the classroom environment is strictly a lecture style, such as in the cases described in the methodology and observations pertaining to *Integrations in the Classroom for Students,* a lack of constant interactions in the classroom can cause the remote participant and their Surrogate Avatar volunteer to lose interest in the experience. In these cases, where there are limited opportunities to interact with the physical environment or surrounding peers, SuAvE has not been shown to be beneficial for the entire duration of 3-hour lecture experiences, where the lecture components have more scheduled time than the collaborative and action-based components. However, it has been observed that in classroom environments that promote social-learning and group work, SuAvE has a more positive experience for remote participants and their Surrogate Avatar volunteers – as in all cases conducted under *Integrations in Shared Learning and Presentation Environments* and *Integrations in Project-Based Studies.*

Pertaining to this is the aspect of attentiveness versus active learning on behalf of the remote participant and their Surrogate Avatar volunteer. While these concepts are related, in the context of education and cognitive engagement, attentiveness refers to the ability to focus on specific tasks and be present in engagement from the independent learner. Meanwhile, active learning is an instructional approach that actively engages students rather than having students passively receiving information. As such, while students may be attentive in lecture-based classroom environments, the responsibility for them to navigate their own focus and concentration is dependent on their own capabilities (Saunders & Wong, 2020). As to be further described in *(D) Intrinsic versus Extrinsic Motivational Factors for SuAvE Participation,* this interaction is reliant on motivation factors, and lecture-only classroom styles do not provide motivating factors to engage in active learning, but instead emphasize independence through relying on students to be attentive solely based on material delivered. Meanwhile, in educational spaces that have professors incorporating learning exercises and group discussions, the requirement to participate because of the incorporated active learning environment entails that there is a greater motivation to be attentive on behalf of the remote participant (Keller et al., 2020).

In the context of SuAvE implementations, this places responsibility on the remote participant to navigate and maintain focus on the environment through their Surrogate Avatar volunteer, which would also require the Surrogate Avatar volunteer to also participate attentively in the environment. For example, in the *Integration in Shared Learning and Presentations Environment, Case 1: Fall 2022 – Class Excursion Implementation,* active learning was mediated by the professor through the course requirement to partake in the class excursion. The navigation of the environment entailed that there were materials for the Surrogate Avatar

volunteer and remote participant to be attentive too. Similarly, *in Case 2: Fall 2023 – Design Day Implementation* of the same sub-section, the navigation of the physical environment, where there were opportunities for the remote participant to interact with physical projects increased attentiveness in the experience because of the opportunity to partake in active and physical learning.

Another aspect related to attentiveness and active learning in the theme of social and collaborative educational spaces is the influence of behaviours regarding hybrid learning that has been adapted from the influx of remote-learning from the Covid-19 pandemic (Carrion et al., 2023). Of these study habits, in a study conducted by Lepp et al., students in higher education partake in multitasking behaviours when they attend classroom lectures remotely, compared to in-person classroom lectures (Lepp et al., 2019). This ability to multitask is greater influenced when the remote participants' camera is turned off, as noted from the remote participant who volunteered in Trial 4 of the *Case 1: Use of Face Cover, Perception Studies,* who left their device for a period of time without participants in the physical environment noticing. This act of multitasking, and thus a lack of attention to the course material, can be perceived by surrounding peers in the physical environment. This further suggests that the responsibility of attentiveness solely on the remote participant presents its own set of challenges and emphasizes that SuAvE is best suited in environments that promote active learning.

Addressing the gender disparity in education that was aforementioned in *(A) Embodiment versus Relational Spaces,* social and collaborative learning spaces can address this disparity so that the scope of SuAvE in utilizing different gendered SuAvE participants has a benefit in being incorporated. With regards to positionality, which refers to "where one is located in relation to their various social identities", classroom environments that emphasize learning environments of

diverse thoughts and opinions for discussion activities would benefit from the observations obtained in *Perception Studies, (B) Gender Implications* (W. B. Knight & Keifer-Boyd, 2019). For example, in the context of engineering, it could be beneficial to utilize SuAvE in understanding the difference in treatment between male and female presenting engineers in the classroom and workspace by conducting the methodology again, solely focused on showcasing the impact of differing perspectives with different gendered matches of SuAvE participants that was observed. Similarly, in aspects of engineering that are reliant on understanding different perspectives and their influence, such as in stakeholder analysis, implementations of SuAvE provide an interactive method of showcasing the perspective through someone else's lens. As such, the ability of SuAvE to have a relation to differing spaces and perception can be implemented could address the gender disparity outside the scope of the current thesis.

However, as observed in *Integrations in the Classroom for Professors,* pertaining to attentiveness and active learning in social and collaborative learning spaces, current iterations of SuAvE do not fully support a multiple-user experience because of the requirement for multiple Surrogate Avatars volunteers to be constantly attentive, despite the remote participant not always being attentive to their specific environment. The overstimulating environment of too many Surrogate Avatar volunteers and remote participants navigating the same shared physical environment was also observed in *Integrations in Project-Based Studies,* and also suggests and impact to the ability to be attentive even in active learning environments.

With reference to the understanding of VARK learning styles, social and collaborative learning spaces can cater to diverse preferences of students. Using SuAvE, visual and auditory learning styles are catered to, through the interactions with the environments and other peers with use of a personal cellular device equipped with a camera and audio channel. In social and

collaborative learning spaces that prompt group discussions and physical interactions in the environment, there is an added benefit through the range of motion that SuAvE provides for kinesthetic leaners that is not currently addressed by traditional hybrid learning methods. However, students who learn best through reading/writing styles would still need accessory materials outside of the implementation of SuAvE to be best accommodated in the classroom, as the SuAvE work is not dependent on the VARK model.

5.3 The Socio-Material: Technological and Accessory Devices

An aspect of SuAvE is the implementation of technology and accessory devices, and their role or influence in interaction. SuAvE allows for capacity to interact with the socio-material space, which encompasses the dynamic interplay between social interactions, material resources, and technological infrastructure. Through the direction of the Surrogate Avatar volunteers, who are facilitating the integration of devices with video-conferencing capabilities and additional physical equipment to enable actions that involve communication and collaboration with the physical environment on behalf of their remote participants. Surrogate Avatars also embody socio-cultural nuances of the remote participants in their role of physical embodiment. SuAvE navigates the interplay of social and cultural spheres, as impacted by technological factors in higher education.

Throughout all trials, technological concerns arose. This includes issues with audio being unfocused or too loud, and the conflicting observations were obtained when try to solve this issue. This was seen as in *Integrations in the Classroom for Students, Case 1: Summer 2022, Preliminary Studies,* which suggested the use of a headset to control audio channels and be less distracting for peers, compared to cases implemented directly after that had more issues with the headset in being a barrier to navigate the physical environment, as seen in *Integrations in the*

Classroom for Students, Case 2: Fall 2022 – Multidisciplinary Design Lecture Implementation and Case 3: Fall 2023 – Graduate Design Lecture Implementation. Clear and reliable audio is important in the execution of hybrid learning, and as a result, there have been audio advancements made in these current environments for execution of controlled audio through connecting microphones to digital recording systems for clear capturing (Douaihy, 2021). However, SuAvE does not currently posses the access to these remote systems unless it is created by the professor, which contradicts the intention of the professor not requiring to conduct extra action for SuAvE to occur.

As suggested in *Integrations in the Classroom for Professors, Case 1: Fall 2022 – "Hydra",* the use of differing devices based on model and brand appeared to have differences for the remote participant in terms of interactions with the physical space. For this reason, the Perception Study, *Technological Implications, Case 1: Differing Devices Capacities* was conducted to more thoroughly understand the differences in devices utilized. In any case, the older the device, the reduced capacity for interaction that was experienced due to audio issues, video resolution quality, and general compatibility with the Microsoft Teams application. However, Apple products were generally preferred because of ease of use. As SuAvE is volunteer-operated, there is a current limitation to being able to provide devices for Surrogate Avatar volunteers to utilize, and as such, Surrogate Avatar volunteers utilizing their own device to connect with the remote participant. With the confirmation that there is an impact in experience, this information should be gathered on SuAvE related platforms to try to pair compatible devices. Should SuAvE face budget expansions in the future, it would be beneficial to lend out current generation devices to Surrogate Avatar volunteers to levelized the technological platform.

In holistic studies of SuAvE implementation, the use of the harness was not concretely determined regarding whether it was crucial to the design, as some implementations utilized the harness while others did not. The difference between the use of a neck harness and a body harness was conducted in *Perception Studies, Case 2: Device Positioning and Height,* determining that the use of the body harness did cause more strain on individuals, and the positioning of the camera was not preferred when compared to the utilization of the neck harness. While discussed previously in the analysis, this also suggests the requirement to provide Surrogate Avatar volunteers with options for accessory devices to aid with positioning the device for the purpose of navigating the physical environment for the remote participant.

5.4 Intrinsic versus Extrinsic Motivational Factors for SuAvE Participation

One of the most considerable barriers to the application of SuAvE is related to intrinsic and extrinsic motivational factors related to participation – where there is an overall lack of willingness to participate in SuAvE. Originally when developing the methodology for SuAvE, and with reference to the obtained Ethics Approval, it was hypothesized that there would be voluntary participation out of autonomous motivation from SuAvE providing aid in bridging connections for students who need to participate in educational remotely, which primarily stem from the inaccessibility of education(Deci & Ryan, 2008). However, finding volunteers to participate was a challenge.

There were very few instances of intrinsic motivation factors regarding autonomous motivation. There was no difficulty in finding a Surrogate Avatar volunteer for all studies conducted in *Integrations in the Classroom for Students and Integration in Shared Learning Presentations Environment*, as the intrinsic motivation factor was related to the involvement of developing the project, so the Surrogate Avatar volunteer was someone who already possessed

invested interest in SuAvE. This intrinsic motivation, which increased participation of the Surrogate Avatar volunteer, meant that the remote participant in these cases found a benefit and value to the experience. This suggests that there is an added benefit to having tactic knowledge of the SuAvE system in executing the experience to be beneficial to all participants involved.

However, once the execution of the scope of the study branched outside of the main researcher acting as the Surrogate Avatar volunteer, there was a shift to almost entirely extrinsic motivation in the distinction of controlled motivation. This is depicted in both case studies conducted in Perception Implications, where in *Case 1: Use of Face Cover,* only 18% of the students in the classroom agreed to participate, and where in *Case 2: Device Positioning and Height,* only 21% of the students in the classroom agreed to participate. As depicted in the observations of these studies, students were not motivated to participate as a volunteer due to the lack of interest in the study, or lack of willingness to participate in something outside of the course requirements. When polling the students in the classroom that opted to not participate, in both cases, there was a unanimous count of agreeance that had there been either a requirement or a reward to participate, by external regulation in controlled motivation environments, they would have been more inclined to volunteer. This extrinsic motivation was also identified in *Integrations in the Classroom for Professors, Case 1: Fall 2022 – "Hydra",* where the incorporation of SuAvE for the purpose of fulfilling a requirement of the course increased participation in usage and allowed for a multiple-user experience. This suggests that either, (1) modulation by the instructor in directed studies, to afford more interactions through lesson designs so that there are more opportunities to participate, or (2) that it is mandated for participation if students are unable to physically participate in the classroom (Darnell & Krieg,

2019; Deslauriers et al., 2019). This is in alignment with controlled motivational factors of external regulation by reward or a perceived consequence (Deci & Ryan, 2008).

Extrinsic motivation was also the reason for participation in *Integrations in Project-Based Studies,* where it was a requirement for the remote client to interact with the project by a regulator, and there were continuous scheduling and location conflicts. However, observations obtained from the first week that SuAvE was implemented, compared to the fourth week it was implemented showed that there was a perceived benefit of SuAvE, but it was only able to be determined as an option out of a need. A student in the group mentioned the following, "If I did not have to participate, I would not have….now that I have, I think I would be inclined to volunteer on my own to help another student, but I wouldn't had considered that possibility if I wasn't exposed to it…..In an unfortunate way, it does show my own bias that until I've experienced the benefit myself, I wouldn't understand why it was important for me to help anyone else benefit.". This is in alignment with a growth in internalized motivation, with extrinsic motivation of introjection, providing a new reason for learning (Deci & Ryan, 2008).

Observations pertaining to intrinsic versus extrinsic motivational factors were not solely observed in this case, but in an adjacent study conducted that was purposely left out of the data collected but holds relevance to this thematic analysis of SuAvE. In the initial methodology of the scope of this thesis, a comparative study was meant to be coordinated in conjunction with Singapore's University of Technology and Design (SUTD). On their campus, the CampusX team was also focused on hybrid learning collaboration tools to foster cross-cultural communication, using robots. When calling for volunteers to participate in SuAvE to draw comparisons between robot and human avatars, no students at SUTD who were interested in SuAvE, despite being open to working with CampusX. In general, students were both intrinsically and extrinsically

motivated to participate utilizing CampusX technology. Regarding intrinsic factors, students who pursue studies at SUTD exhibited a greater level of familiarity and understanding with group-oriented learning, including social collaboration within learning, which would hold relevance to the above discussion of *(B) SuAvE in Social and Collaborative Learning Classrooms*. This is attributed to the smaller program and class sizes, which have designated times for group collaboration in case-studies and examples. However, this is also directly related to extrinsic motivation, where the group collaboration is a requirement for their grade, and so a lack of attendance would impact their grade in the classroom. When inquired about why there was hesitation to use SuAvE despite the only difference in methodology being the material of the Surrogate Avatar volunteer (either a person or a robot), one of the students described the following, "I am already familiar with what my campus uses. I would rather help my own students progress in their research, rather than an international project that will have no relevance or name attached to my institution." This statement showcases a mutual intrinsic and extrinsic motivation under the distinction of autonomous motivation– a desire to participate if it helps their own institution advance.

For implementations of SuAvE, if it is to be conducted voluntary as through the scope of this study, there could be intrinsic motivating factors if only focused on a support-usage and appealing to autonomous motivation. This would suggest remote participants requiring this method of participation, and Surrogate Avatar volunteers being motivated to help these students out of compassion. In these cases where it is based on need and conducted out of compassion, there would be a less perceived negative impact pertaining to all the above thematic analysis sections – where perception implications such as gender, height, and language barriers would not be weighed as such complicated barriers in the experience. However, if not support-focused or

not mandated for classroom participation, implementation of SuAvE with willing participants is hard to conduct as noticed in the implementations of SuAvE in all studies pertaining to this thesis.

5.5 SuAvE versus Current-Hybrid Learning Methods

The concentration of this thesis was to develop the methodology and basis of SuAvE as an integrated system in the hybridization of higher education. While the above analysis has evaluated SuAvE's concept based on an interactive-learning, socio-material and relational space, the core of this project is to determine its feasibility of providing remote students with better opportunities to engage in virtual studies. This entails an analysis of the comparison where SuAvE excels, and where hybrid learning technologies may be better suited, as in Table 14. In Table 14, while there are still adjustments required to be made to SuAvE, its fluidity, peer-supported learning and ability to navigate the physical environment does place a greater foreseen benefit in the hybridization of learning compared to current hybrid learning technologies.

Table 14
Comparison of SuAvE and Current-Hybrid Learning Methods

	SuAvE	Current Hybrid Learning Technologies
Physical Environments	• Fluid and flexible in new and interactive environment integrations • Preferred in social-learning classrooms with activities and peer-support opportunities	• Structured and more commonly known by educators and learners • Telepresence robots cannot fully operate movement in physical spaces • Not fluid or dynamic • Preferred for stationary learning (lecture-formats)
Set-Up	• SuAvE platforms set-up by volunteer teams • Places emphasis, initiative and responsibility on students	• Responsibility placed on professors to set-up hybrid learning platforms for students • Additional set-up and knowledgeable attendees on site to operate robotic avatars
Engagement and Interaction	• Volunteer-based engagement • More opportunities for peer-connection and engagement with the physical classroom	• Distrust in utilizing telepresence robots, as well as operational delays that require knowledgeable attendees to operate
Peer-Connection	• Emphasized and supported as peer-peer support is fostered	• Lack of opportunity • Disconnection when using telepresence robots due to distrust and discomfort when operating robotic avatars
Technological Issues	• Issues with video resolution, and audio stability	• Issues with video resolution, and audio stability • Issues with requirement of physical mapping and programming for telepresence robots • Limitations to robotic avatar design
Assessment and Feedback	• Direct feedback for actionable change	• Delayed feedback due to systematic structure; harder for adaptability and change
Expenses	• Minimal costs for accessory devices which can be reused	• Operational and maintenance costs for telepresence systems, which is more expensive to implement

Chapter 6: Conclusions, Implications, and Recommendations

This thesis embarked on an exploration of the Surrogate Avatar Experience (SuAvE) as a pioneering socio-technical approach. SuAvE aims to provide embodied experiences in hybrid environments for remote participants through a surrogate avatar volunteer, with the intention of implementing it within higher education learning environments. As a novel approach to hybrid learning technologies, SuAvE has shown promising successes in engagement compared to traditional hybrid learning methods, however it also presents its own set of challenges.

6.1 Overview of Methodology Conducted Through Constructivist Grounded Theory

The constructivist grounded theory approach was used to develop the SuAvE methodology, which was observed through two distinct sections: SuAvE from a Holistic Lens and Analyzing Influencing Factors in SuAvE. The holistic lens study encapsulated a total of 7 conducted case studies, divided into respective sub-sections of differing scenarios in higher education classrooms. These scenarios included iterative student-student interactions and professor-student interactions with SuAvE, as well as group-oriented and multiple surrogate avatars for one remote user experiences. When conducting the holistic implications, human unconscious bias was prompted as a question to determine if it is a limiting factor in establishing embodiment and connection for remote participants, which prompted the secondary latter methodology. The latter methodology observed implications of appearance, height, gender and technological devices in 4 case-studies. The observations prompted thematic discussion in four predominant categories that arose: embodiment and the relational space, implementation in social and collaborative learning classrooms, the socio-material space navigated through technological and accessory devices, and motivation factors related to participation in SuAvE.

6.2 Main Takeaways from the Studies

The intention of SuAvE was to provide embodied experiences for remote learners in hybrid learning environment, but through conducting several implementations, SuAvE was found to focus on relational spaces between the remote participant and Surrogate Avatar volunteer rather than true embodied experiences. Participants often viewed SuAvE as a tool to facilitate meaningful connections in the classroom rather than to embody a remote presence, emphasizing the importance of human connection in hybrid learning environments. SuAvE was found to be most effective in social-learning environments that promote collaboration and communication. In these contexts, it allows remote participants to interact with their peers and instructors in a meaningful way, facilitating real-time communication and interaction in the physical environment, to be communicated directly to the remote user in the virtual environment.

6.3 Limitations of the Surrogate Avatar Experience

There are several limitations that were observed regarding the implementation of SuAvE. The first of these, related to the thesis statement is that SuAvE struggles to create a fully embodied experience for remote participants, and instead facilitates relational spaces. Meaningful connections are made, but the sense of feeling fully integrated in the physically present is diminished.

Summarizing these into themes, the limitations of technological and accessory devices is first mentioned. Regarding the technological barriers, the success of SuAvE heavily depends on the quality and compatibility of the technology used. Issues with audio clarity, video resolution, and device compatibility can hinder the effectiveness of the experience. Furthermore, the reliance on volunteers' personal devices introduces variability in the quality of the experience,

which could be mitigated with standardized or higher-quality equipment. The use of accessory devices such as the physical harnesses for device positioning can cause strain and discomfort, particularly for female volunteers, which may further reduce their willingness to participate. The physical demands of acting as a Surrogate Avatar volunteer can be a barrier to sustained engagement. Regarding applicability, SuAvE is less effective in traditional lecture-based environments where there is minimal interaction. Without opportunities for active learning or group work, both the remote participant and their Surrogate Avatar volunteer may lose interest, limiting the system's usefulness in such settings.

Regarding the human interaction, several limiting factors are associated with working with human participants to conduct the experience. Both Surrogate Avatar volunteers and remote participants face challenges in fully engaging with the experience, as Surrogate Avatar volunteers often struggle to give up bodily autonomy, especially when required to wear face covers or other accessories, which they find uncomfortable or stigmatizing. This reluctance impacts the remote participant's ability to interact effectively with the physical environment. A significant limitation of SuAvE is the difficulty in finding motivated participants, especially to act as the Surrogate Avatar volunteer. Intrinsic motivation pertaining to autonomous motivation in cases of volunteering was observed to be rare, as it was observed people in this study were not motivated by a personal value. Instead, most participants only engaged due to extrinsic factors from a controlled motivation of either external regulation or a related to personal ego-involvements, such as self-esteem and approval. This lack of motivation can result in lower participation rates and reduced effectiveness of the experience, as well as a reduced number of observations that can be measured. Societal expectations and unconscious biases related to gender can create discomfort and reduce the effectiveness of SuAvE, especially when the gender of the remote

participant and the Surrogate Avatar volunteer do not align. This can lead to awkwardness and a lack of natural interaction, further diminishing the sense of embodiment. Unconscious biases in the classroom, particularly related to gender, can negatively impact the interactions between remote participants, Surrogate Avatar volunteers, and their peers. These biases can undermine the inclusivity and effectiveness of SuAvE, limiting its potential to provide equitable learning experiences. Situationally, remote participants from different time zones or with language barriers face additional challenges. Time zone differences can lead to exhaustion and reduced participation, while language barriers increase the cognitive load on the remote participant, making it difficult to provide clear instructions and maintain engagement.

Many of these limitations, however, can be addressed and improved for future implementation. Since the scope of this thesis was foundational framework development, it serves as a starting point to identify these limitations and further build on them for the enhancement of SuAvE. This underscores the ongoing nature of research and development in this field.

6.4 Implications of Surrogate Avatar Experience

SuAvE has many positive implications for further implementation work. The most prominent is that SuAvE bridges the gap between remote and in-person learning by fostering a more interactive hybrid experience. Through the enhancement of relational space for hybrid learning, SuAvE fosters meaningful connections and interactions to occur between remote participants, Surrogate Avatar volunteers, and their peers, outside of the scope of current hybrid learning practices. By enabling remote participants to engage in physical classroom environments through Surrogate Avatar volunteers, SuAvE increases accessibility for individuals who may otherwise be unable to attend in person due to geographical, physical, or other barriers.

This inclusivity helps create more diverse learning environments, where different perspectives can be shared and explored. Furthermore, SuAvE empowers remote learners by giving them a tangible presence in the classroom, enabling them to actively participate in discussions, ask questions, and collaborate with peers. This empowerment helps remote participants feel more connected to the learning community and enhances their overall educational experience.

SuAvE encourages active learning by facilitating real-time interactions between remote participants and their Surrogate Avatar volunteers in various classroom activities, such as group work, discussions, and hands-on projects. This engagement can lead to a more immersive and dynamic learning experience compared to passive participation in a traditional online course. This is encouraged by the flexibility in engagement, where remote participants can join classes from different locations and time zones, while Surrogate Avatar volunteers can choose to participate in ways that align with their schedules and comfort levels. This flexibility can lead to increased participation and engagement from individuals who might otherwise be excluded.

Compared to telepresence and other hybrid learning implementation currently, SuAvE also encourages a culture of volunteerism and peer support within the classroom. The Surrogate Avatar volunteers play a crucial role in helping remote participants engage with the learning environment, fostering a sense of community and shared responsibility among students. The experience of participating in SuAvE, whether as a remote participant or a Surrogate Avatar volunteer, helps develop important interpersonal skills such as communication, empathy, and teamwork. Surrogate Avatar volunteers learn to be aware and navigate another students' presence and perception, while remote participants practice clear communication and instruction.

Overall, SuAvE represents an innovative approach to technological innovation for educational purposes. By combining video conferencing, wearable devices, and volunteer

surrogates, SuAvE demonstrates how technology can be used to overcome traditional barriers to education and create new learning opportunities. Since current hybrid classrooms still have limitations in providing embodiment or first-perspective experiences, SuAvE can conduct this experience without the requirement of changing instructional pedagogy completely. As compared to the limitations of telepresence robots, SuAvE is more flexible regarding responses times and lower associated operational and maintenance costs.

6.5 Future Scope of Surrogate Avatar Experience

This thesis is novel in the exploration of its field, laying the groundwork for future research. As this is one of the foundational papers related to the scope, it not only contributes to existing knowledge but also opens numerous avenues for further study that scholars are invited to expand on to refine and expand the project capacity.

In hybrid-learning classrooms specifically, there are dynamics of the educational space are constantly changing. This evolution stems from different learning styles that have emerged in the post-pandemic context, as well as the general differences in how newer generations approach learning. This thesis aims to introduce the concept of SuAvE within its current implementation scope. However, the aspects discussed – such as learning styles, pedagogical approaches, and the increase resources available to students, like ChatGPT – will necessitate modifications to SuAvE in order to adapt to these evolving hybrid-learning environments.

While initially developed for classroom settings, the principles of SuAvE could be applied to other areas, such as remote work, telemedicine, and virtual events. The success of SuAvE in educational environments suggests that similar Surrogate Avatar systems could be used to enhance participation and engagement in a variety of contexts. Situationally, the

implementation of SuAvE in communities that cannot travel would be beneficial to study it as a need-based support system. This could include remote communities such as in Northern Canada, students with physical disabilities, and the elderly.

In correlation to the thematic discussion, there would also need to be further studies on the relational studies of SuAvE. Perception as a topic covers many aspects of physical and non-verbal behaviours that could not fully be addressed in the scope of this thesis. This includes continuing evaluation on the influence of ego-centric environments and motivational factors, with regards to the intersectionality it has within realms of personal economics, culture, gender, and age. With the projected scope of SuAvE as a relational tool for continuation in hybrid spaces in-general, a further dive into other aspects of perception and the importance of self-representation for the remote participant will be required. Alongside this, there are still several technological challenges with attempting to provide seamlessness in the interaction for the benefit of the remote participant that require further study. This includes device studies on how bandwidth and quality change based on the internet connectivity of both the remote participant and the surrogate avatar volunteer. There also exists the technological issues related to usability, and the understanding of how usability is processed in remote environments outside of physical activities in the environment.

Future researchers are encouraged to consider the limitations and the scope of implications of SuAvE to conduct further studies that can refine the scope of the outreach and conduct. Of these future studies, the capacity for SuAvE to facilitate spontaneous interaction, convey non-verbal cues, and provide a sense of physical presence in the bridge of physical and virtual platforms will need to be continuously studied with quantifiable results.

6.6 SuAvE As A System

As submitted to the Department of Systems Science and Engineering, this section aims to draw direct comparisons between the concepts of Systems Science and Engineering with the SuAvE study. SuAvE is an innovative system that integrates a range of technological, human, and social components, enabling remote users to participate in physical environments through representation by Surrogate Avatar volunteers. This approach highlights the interdisciplinary nature of systems science, which emphasizes the integration of diverse fields to develop effective solutions.

A fundamental aspect of systems science is the design of systems that prioritize user experience. SuAvE is a human-centered design, where the needs of remote participants and Surrogate Avatar volunteers are at the forefront of the system's development. The system is specifically designed to enhance the experience of remote users in hybrid learning contexts to foster meaningful interactions and improve accessibility. Additionally, systems science and engineering provide tools and methods to model, analyze, and optimize interactions, to ensure that systems operate smoothly and effectively. Understanding these dynamics is crucial for ensuring that the relational spaces fostered by SuAvE are productive and beneficial to the learning process.

One of the challenges in systems engineering is the need to scale systems to accommodate a growing number of users or different application contexts. SuAvE’s design is inherently flexible and scalable, allowing it to be adapted to various educational settings and potentially extended to other fields such as remote work or telemedicine. This scalability reflects the systems engineering perspective, which considers how systems can evolve and expand over time. Furthermore, systems science and engineering involve optimizing system performance by

balancing various factors such as efficiency, reliability, and user satisfaction. For SuAvE, this means carefully balancing technological resources like video conferencing tools and wearable devices, with human factors such as user comfort and ease of use, to optimize the overall experience for all participants. This optimization process is a core aspect of systems engineering.

Systems thinking, a key concept in systems engineering, emphasizes the importance of understanding the entire system rather than just its individual contexts. SuAvE embodies this holistic approach by considering the entire educational system, including technology, human interactions, and educational curriculum. The aim is to create a comprehensive solution that meets the needs of all participants within higher education hybrid learning environments, especially with regards to a lack of physical embodiment in these spaces for remote users. Lastly, continuous evaluation and improvement are central to systems engineering. SuAvE, as a system, will require ongoing assessment to identify areas for improvement, whether in user experience, technological reliability, or educational outcomes. This iterative process of evaluation and refinement of SuAvE is essential in ensuring its effectiveness and relevance over time.

In conclusion, SuAvE illustrates many of the principles and practices of systems science and engineering, from interdisciplinary integration and human-centered design to scalability, optimization, and continuous improvement. It demonstrates a systems-thinking approach to addressing the challenges of a lack of embodiment for remote participants in hybrid education and demonstrates how complex systems can be designed and managed to achieve specific goals.

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CERTIFICAT D'APPROBATION ÉTHIQUE | CERTIFICATE OF ETHICS APPROVAL

Numéro du dossier / Ethics File Number	H-11-23-9882
Titre du projet / Project Title	The Surrogate Avatar Experience (SuAvE)
Type de projet / Project Type	Thèse de maîtrise / Master's thesis
Statut du projet / Project Status	Approuvé / Approved
Date d'approbation (jj/mm/aaaa) / Approval Date (dd/mm/yyyy)	04/03/2024
Date d'expiration (jj/mm/aaaa) / Expiry Date (dd/mm/yyyy)	03/03/2025

Équipe de recherche / Research Team

Chercheur / Researcher	Affiliation	Role
Anjaliya SONNILAL	École de science informatique et de génie électrique / School of Electrical Engineering and Computer Science	Chercheur Principal / Principal Investigator
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Conditions spéciales ou commentaires / Special conditions or comments

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University of Ottawa
Office of Research Ethics and Integrity

Le Comité d'éthique de la recherche (CÉR) de l'Université d'Ottawa, opérant conformément à l'*Énoncé de politique des Trois conseils* (2014) et toutes autres lois et tous règlements applicables, a examiné et approuvé la demande d'éthique du projet de recherche ci-nommé.

L'approbation est valide pour la durée indiquée plus haut et est sujette aux conditions énumérées dans la section intitulée "Conditions Spéciales ou Commentaires". Le formulaire « Renouvellement ou Fermeture de Projet » doit être complété quatre semaines avant la date d'échéance indiquée ci-haut afin de demander un renouvellement de cette approbation éthique ou afin de fermer le dossier.

Toutes modifications apportées au projet doivent être approuvées par le CÉR avant leur mise en place, sauf si le participant doit être retiré en raison d'un danger immédiat ou s'il s'agit d'un changement ayant trait à des éléments administratifs ou logistiques du projet. Les chercheurs doivent aviser le CÉR dans les plus brefs délais de tout changement pouvant augmenter le niveau de risque aux participants ou pouvant affecter considérablement le déroulement du projet, rapporter tout évènement imprévu ou indésirable et soumettre toute nouvelle information pouvant nuire à la conduite du projet ou à la sécurité des participants.

The University of Ottawa Research Ethics Board, which operates in accordance with the *Tri-Council Policy Statement* (2014) and other applicable laws and regulations, has examined and approved the ethics application for the above-named research project.

Ethics approval is valid for the period indicated above and is subject to the conditions listed in the section entitled "Special Conditions or Comments". The "Renewal/Project Closure" form must be completedfour weeks before the above-referenced expiry date to request a renewal of this ethics approval or closure of the file.

Any changes made to the project must be approved by the REB before being implemented, except when necessary to remove participants from immediate endangerment or when the modification(s) only pertain to administrative or logistical components of the project. Investigators must also promptly alert the REB of any changes that increase the risk to participant(s), any changes that considerably affect the conduct of the project, all unanticipated and harmful events that occur, and new information that may negatively affect the conduct of the project or the safety of the participant(s).

Catherine PAQUET
Directeur / Director
Pour/For **Daniel LAGAREC** Président(e) du/ Chair of the **Comité d'éthique de la recherche en sciences de la santé et sciences / Health Sciences and Sciences Research Ethics Board**