YOUTH PERCEPTIONS ON LEARNING IN IMMERSIVE VIRTUAL REALITY: DEVELOPING AND ASSESSING ESSENTIAL SOCIOEMOTIONAL SKILLS

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Abstract

This qualitative study investigated youth perceptions of educational virtual reality (VR) for developing socioemotional skills. A constructivist theoretical framework was utilized to guide the research design according to five key elements: learning in relevant settings, the social negotiation of learning, ownership in learning, multimodal representation, and metacognition. An exploratory case study approach was used. A grade 8 class of 28 students were invited to participate as the co-researchers for this study. The methods for data collection were semi-structured artifact analysis, observations, surveys, and interviews. Research activities involved guided exploration of sustainability issues in AltspaceVR, collaborative painting in MultibrushVR, and an artifact contribution to a co-created learning experience in FrameVR.

Empathy was the most predominant type of social-emotional learning (SEL) demonstrated by the co-researchers: Teamwork, creativity, and problem-solving skills were also evident. The youth exemplified new empathetic insights and activism for people, the environment, and animals based on their learning in immersive contexts. Findings indicate a rationale for educational VR to include SEL competencies, which VR excels at through its capacity for perspective-taking. The research activities within the virtual environments contributed to the co-researchers' sense of social presence through open communication, affective expression, and group cohesion. Although the scholarly literature identifies personalized avatars as influential for enhancing social presence in VR environments, there was a lack of consensus on avatar value. The data collected in this study may serve as a basis for further research on understanding the capacity of educational VR to promote empathy and SEL in youth.

Keywords: youth, learning, virtual reality, socioemotional skills, empathy, social presence

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Chapter 1. Introduction

My research interests derive from feelings of isolation during the COVID-19 pandemic. Life was disrupted when the pandemic first came to Saskatchewan in March of 2020. During the first few months, COVID-19 required rapid staff responses and created high-stress work environments across the education sector (Seymour et al., 2020). I was teaching in northern Saskatchewan and experienced complete physical isolation from others for a few months. I communicated with friends, colleagues, family, and students only through video meetings, email, and phone calls. While these communications were valuable to me, they did not fulfil my desire to be present around other people.

I realized that many students mirrored feelings of loneliness brought on by the limitations of available mainstream technology. In a remote class of 20 grade 4 and 5 students, few students were regularly engaging with each other and the supplemental and social learning activities. I initially thought that the current structure of distance education could be an effective way for students to learn, but it became evident that the remote physical environment needs to uncover the deep sense of presence and engagement that face-to-face instruction affords. Students reported missing their friends, teachers, and the general social atmosphere provided by the school.

With virtual reality (VR) as an emerging educational medium, my initial interests evolved to investigate how VR might enhance distance learning to provide shared learning experiences in meaningful ways. It is my hope to utilize VR as a technology to compliment online learning by providing authentic and engaging experiences for students. Hence, I investigated ways that VR can provide instructional and pedagogical value. Ahn et al. (2021)

advocate, “The COVID-19 global pandemic has provided an impetus to re-examine the possibility of holding social interactions in virtual worlds” (p. 2). Over an extended time, using VR in instruction for learning motivation has shown positive outcomes for content retention and overall achievement with in-person and distance learning (Lund & Wang, 2019). Distance learning environments where students feel socially present can reduce feelings of isolation by providing a better sense of community (Dickey, 2005). In a study that compares traditional distance education environments with a 3D virtual environment, Yilmaz et al. (2016) discovered that people did not feel as isolated in the virtual world. Thomas and Brown (2009) analyzed co-ordinated interactions in World of Warcraft and found that the characteristics of the 3D virtual worlds generally increased social presence, therefore offering the potential to overcome a common perceived shortcoming of distance education. Based on a thorough review of the literature, my research explores how social presence impacts youth learning in immersive environments. I investigated how constructivist approaches can contribute to developing essential socioemotional learning (SEL) competencies through participation in VR learning activities.

1.1 Study background and rationale

Presence is an essential psychological construct for determining engagement and quality of human to computer interactions and is a significant consideration in educational VR (Makransky et al., 2017). The notion of presence is at the core of all mediated interactions, from reading a book to complex VR experiences (Lee, 2004). Both involvement (with stimuli in the virtual environment) and immersion (as self-perception as being part of the virtual environment) are essential to experiencing presence (Witmer, 1998). Research suggests that VR has the potential to enhance presence in a range of essential fields, but more extensive studies are needed

(Matthews et al., 2020). The lack of knowledge regarding social presence in VR is a factor that could contribute to less authentic immersive experiences because notions of social presence are at the core of all interactions amongst people. It becomes more challenging to identify notions of social presence because VR is a rapidly improving technology and presence is a complex, multifaceted phenomenon. Research into youth social presence could prove advantageous in furthering awareness for educators and developers about what specific elements are conducive to meaningful VR collaborations.

To contribute youth perceptions of their experiences in VR, my study focused on constructivist approaches that prioritize meeting learner needs and perspectives. My motivation for pursuing constructivism was influenced by discussion boards and assignments in the graduate course *Historical and Theoretical Foundations of Educational Technology*. In this class, I learned what constructivism entails and its positive implications for learning. My thesis research is an extension of the work I began in this impactful course. The instructor provided me with supplemental readings regarding constructivism. Based on my analysis of these insightful readings, I believe constructivism is a relevant framework for exploring youth social presence in VR, especially because constructivist theorists value the importance of socialization as a key component of meaning making.

Sagor (2002) identified five needs learners have a desire to satisfy: the need to feel competent, useful, potent, optimistic, and to belong. Traditional procedural educational approaches do not allow for these fundamental needs to be met for all learners to the same extent as constructivist approaches. Studies show that rote learners are limited in their critical thinking, deep understanding, creativity, and problem-solving skills (Ugwuozor, 2020). Learners have a variety of educational needs and desires that cannot always be accommodated by prescriptive

approaches. A founder of social constructivism, Vygotsky, believed in a socio-cultural approach to learning, implying that learners should play an active role in their learning rather than being passive consumers of information (Liu & Chen, 2010). With constructivism, the teacher acts as a guide instead of being a director, and focuses on creative interactions with the class, instead of teaching outcomes (Onyesolu et al., 2013). Students have agency over their work and the higher level of individualization allows for increased learner engagement and the pursuit of passion projects. An instructional approach that prioritizes student needs, desires, and collaboration combined with VR as an engaging educational medium, has potential to achieve positive learning outcomes (Limniou et al., 2008; Lund & Wang, 2019).

1.2 Research problem

Collaborative learning during COVID-19 was challenging because the closer in proximity students were to each other, the greater the risk of transferring the virus. Since there were limited opportunities for collaborative youth engagement and leadership, this research addresses one of the most significant educational issues during the 2020-2022 school years. VR offered an alternative technology to Zoom meetings and other web-based communications. When the COVID-19 pandemic concludes or becomes endemic, it is possible for another virus to disrupt global educational systems at some point in the future. Exploring ways for education to continue in a safe and meaningful manner through VR has potential to slow the spread of viruses in pandemic situations and keep the general population safer.

Students' social connectedness and social identity are important considerations because these are elements of youth culture, yet high rates of loneliness and social withdrawal are often reported by today's young people (Matthews et al., 2019). Loneliness is problematic because it can co-occur with a range of health and lifestyle impairments, such as depression and

psychopathology (Matthews et al., 2019). Worldwide, youth may be impacted by the negative psychosocial consequences of prolonged social distancing (Power et al., 2020). For example, Zhou et al. (2020) affirm negative impacts of social distancing with their discovery that during the start of the COVID-19 outbreak, Chinese high school students exhibiting depression symptoms was 37.4%, those exhibiting anxiety symptoms was 31.3%, and those with a combination of anxiety and depression symptoms was 43.7%. Marchini et al. (2021) found that loneliness induced mental health issues during the pandemic was twice as prevalent. By April 2020, reports showed a dramatic surge in calls documented by Kids Help Phone, with a 48% increase in calls about social isolation and a 42% increase in calls about anxiety (Gadermann et al., 2021). Additionally, the frequency of alcohol and cannabis use in some adolescent populations had increased in the context of social distancing during the pandemic (Dumas et al., 2020). Since isolation is a significant detriment to youth mental health, exploring alternative ways to create meaningful and collaborative educational environments with an elevated sense of presence may help alleviate issues that the pandemic is causing for youth.

1.3 Research purpose

The research aims to develop a better understanding of youth perspectives on social presence and their identification of SEL in a constructivist VR environment, so that educational VR may be implemented in meaningful and purposeful ways. This research addresses the literature gap on underrepresented youth perspectives about learning in VR and the impact of social presence, with the goal of helping teachers and researchers make informed decisions about immersive learning opportunities. This research also seeks to identify which SEL skills are influenced in youth as they are designing, exploring, and learning a constructivist VR

environment. Grounded by the work of MacDowell & Lock (2023), I emphasize a critical and intentional adoption of VR amongst rapidly advancing educational needs and contexts.

1.3.1 Understanding how social presence affects youth learning in VR

There are a variety of general VR constraints such as cost of hardware, lower resolution graphics, and motion sickness for individuals less acclimated to being in an HMD. Argumentation in the literature highlight social presence and the capacity for communication as a factor that makes VR learning a worthwhile endeavor despite these shortcomings (e.g., Bente et al., 2008; Hoffmann & Kopp, 2019; Hudson et al., 2019; Oh et al., 2018, Siriaraya & AngAge 2012; Sivunen, & Nordbäck, 2015; Xianhui et al., 2016; Yilmaz et al., 2016). However, there is limited research involving youth with VR technologies for social presence, learning, and communication. If youth social presence is not adequately researched in VR, there may be issues with understanding and achieving social presence, promoting school-appropriate behaviours, and efficiency of instructional strategies.

Although the VR medium is established as being an effective mode for promoting social presence, Sivunen and Nordbäck (2015) found that social presence varies from situation to situation. Therefore, different VR applications and instructional tasks can offer a range of social experiences. The varying degree of social presence is worth investigating because the absence of social cues has a negative impact on learner satisfaction and some researchers argue that the potential resulting lack of genuine human connection reduces educational value (Jung, 2011; Noonan & Coral., 2013). Despite the claim that lacking human connection reduces educational value, it is important to note that some meaningful learning is necessary and more effective to take place individually and asynchronously. Sometimes less is more with social presence and interactions, especially non-personal interactions which may be more comfortable and efficient

with lower levels of social presence (Walther, 1996). Increased social presence does not always lead to higher learning outcomes and may even have a negative influence on student work. Walther (1996) says, "socioemotional concerns such as conflict or relationship management take time and effort away from task resolution, any mechanism that reduces the need or proclivity to expend efforts in these directions should enhance the efficiency of a group's efforts" (p. 6). However, holistic education is not always about producing measurable learning outcomes and the latent SEL skills gained through collaborative efforts are arguably essential for students to practice throughout their educational experience. Additionally, for some learners increased social presence can lead to improved enjoyment, motivation, and sense of connection to others. For many types of social learning experiences, students need to feel seen, valued, and heard for successfully establishing social connections and learning.

Since social context is a primary dimension of social presence, it is also essential to remember that learners are bringing a variety of preconceived notions of themselves and others into the virtual environment or experience (Sivunen & Nordbäck, 2016). How learners are treated by their peers impacts their sense of selves and their willingness to be social. Walther (1996) asserts that a downside of synchronous interactions is that often communicators with greater status or more social power sustain people's attention the most. Ultimately, it is evident that the power structures that keep people oppressed are still deeply embedded in VR social interactions. Eastwick and Gardner (2009) found racist implications with VR participants who had automatic racial bias or thoughtful bias imported from prior experiences. This finding implies that any racist and harmful preconceived notions of others are continued when an individual enters a VE. My personal experiences in social VR applications confirm that unmoderated VR applications can have oppressive commentary, with users having difficulty

treating others with dignity that would be expected in communications. This problem has potential to be magnified for youth without further understanding positive social interactions. Investigating youth interactions in VR addresses social power structures by contributing a deeper understanding of complex youth interactional dynamics in immersive learning environments.

1.3.2 Identifying SEL skills that develop in VR

Many existing VR studies are concerned with objective outcomes and measuring the learner's ability to complete a specific technical skill task (Cooper et al., 2018; Lui et al., 2018, Murray et al., 2016; Penn, & Ramnarain, 2019). Even though technical skills are often thought of as the most objectively beneficial skills, SEL skills are arguably just as important. The undervaluing of SEL in various settings is evident in how arts programs are typically the first to receive funding cuts in primary and secondary schools. For example, in 2013, the Lansing School District in Lansing, Michigan cut 20 arts educator positions in response to accommodate a large budget deficit (Shaw, 2017). In 2015, the Prairie Spirit School Division cut its band program to accommodate for budgetary constraints. In 2018, the University of Wisconsin proposed cutting 13 humanities programs, leading to the termination of faculty positions (Osley-Thomas, 2020). Even in postsecondary institutions, technical skill degrees generally bring more prestige and employability than SEL competencies. However, SEL skills such as creativity, adaptability, perseverance, teamwork, situational problem solving, and communication are essential to prepare learners for various settings and situations adequately (Goldman & Wong, 2020). Technical skills can be viewed as limited because they do not have the same transferability as SEL competencies. The constructivist learning environment employed in this study was designed to support the co-researchers in identifying essential technical and SEL skills that emerged during the study.

1.3.3 Implementing educational VR in meaningful and intentional ways

VR is anticipated to have substantial growth in the upcoming years, which makes this research essential. The global VR market size was valued at USD 15.81 billion in 2020 and is expected to grow at a compound annual growth rate of 21.6% to reach USD 62.1 billion by 2027 (Grand View Research, 2020). Frieda (2018) reports,

> Until very recently, the biggest VR company employed maybe 20 engineers. What you're seeing now is that the tech giants are getting involved — Samsung and Facebook, Sony, and Google — so you've literally got hundreds of engineers working on identifying problems and coming up with solutions. (p. 2)

Advanced engineers in major tech companies are currently working on developing more accurate tracking, higher latency (minimal delays), and higher update rate (speed) that should have ground-breaking advances within the next few years (Frieda, 2018). Experts are currently exploring VR contact lenses, brainwave controllers, and full sensory interfaces that may revolutionize the market: In twenty years, it is hypothesized that we may even experience VR through a direct nervous system link (Yadin, 2018). Although VR may not evolve as rapidly as anticipated, it is ideal for educators and researchers to be prepared for the possibility of quick VR market growth.

In October 2021, Facebook rebranded as Meta to prioritize VR technologies in communications. They have invested ten billion U.S. dollars to develop the metaverse. Facebook's recent investment is likely to have ripple effects on education, business, and social communications. With multiple technology influencers putting substantial resources into VR, it is imperative that they have an ethical plan for VR playing a major role in the future of mainstream technology usage. Lytras et al. (2016) affirms this prediction, saying that "the

provision of large-scale virtual reality worlds in the near future will promote a culture that quickly moves the typical computer and smartphone user to virtual and augmented reality modes" (p. 878). The constant development in VR should lead to improved systems that are seamlessly integrated with relevant applications.

Despite significant developer interest in VR to create the next ground-breaking user interface and dominate the market, there is not enough planning for education. Almost half of the VR applications for learning are designed for industry and medicine professionals, with less emphasis on VR for educational institutions (Checa & Bustillo, 2020). Hall et al. (2022) explored perspectives of IVR with an extensive mixed methods approach including surveys of 634 parents, workshops with 91 students, 21 expert opinions, and 12 parental interviews. Their findings indicate the IVR is not viewed as having value in homes beyond gaming. Hall et al. (2022) identifies limited consideration of IVR to enhance life, with a lack of direction and evidence from current innovation, policy, and research. Despite these considerations, there are a variety of recent quality educational VR research developments like science laboratories for STEM learning, or exploration of VE's for SEL learning (e.g., O'Connor & Domingo, 2017; Parong, 2018; Penn & Ramnarain, 2019; Thisgaard, & Makransky, 2017; Weissblueth & Nissim, 2018). There are also industry educational VR developments, like Kai XR, which is a web-based software that provides virtual field trips, and Labster, which provides virtual science laboratories to supplement a science learning at different age and experience levels. Still, this study contributes to ensuring that VR in education is continued to be represented in meaningful and quality ways as the field is rapidly progressing (MacDowell & Lock, 2023).

Educators and researchers actively promoting and exploring VR learning may alleviate significant unforeseen issues in the upcoming years. Educational research often fails because

there is not enough research at the beginning stages and adoption of new technologies. When considering educational VR, we need to be diligently supporting the designers early on so that we do not accidentally develop unsafe learning environments and scenarios that are harmful to youth, culture, and learning. To avoid negatives associated with new VR technology, Steele et al. (2020) suggest that designers and developers of instructional content using VR approaches should consider moral and philosophical positions related to designing learning content that uses technology affordances in VR media and hardware. Although ethical considerations associated with new VR implementation is not the specific focus of this research, it is a latent function. Through exploring constructivism in VR, I seek to discover moral ways to guide and support learners.

1.4 Co-researchers

Traditionally a co-researcher approach involves learners in helping to plan the research design and analyze study findings; however, the youth in this study did not participate to this extent. The grade 8 students are referred to as co-researchers to value the importance of their unique perspectives and contributions to the study findings. Students are essential stakeholders because they are experts on the research concerning their lives and learning experiences (MacDowell, 2017). Building on MacDowell's (2017) work with youth as co-researchers, I seek to empower and privilege youth voices in the research by giving them an opportunity to express themselves in their ways, on their terms, and for their purposes. It is my hope that the positioning of youth as co-researchers will enhance their sense of agency in the learning process. Code (2020) adds, "Agency is in operation only when individuals self-reflect and identify external influences that are most nurturing to the self. Students enact their agency to manage their cognitive, affective, and behavioral processes as they interact with environmental factors" (p. 1).

By utilizing the co-researcher approach, the learners had more motivation to achieve this level of ownership in their learning. Further, Creswell (2009) comments that positioning self in collaboration with participants leads to less hierarchical and more participatory data collection. Language has power, and co-researcher terminology allows for a reciprocal and relational approach aligned with Creswell's (2009) notion of effective qualitative research.

1.5 Research questions

In this research study, I am primarily interested in exploring youth perceptions on the influence that a constructivist VR's approach has on learning. Two questions are posed to determine VR's effect on presence, teamwork processes, problem solving, and creativity:

1. How can constructivist VR approaches foster youth learning of socioemotional skills?
2. How does sense of presence in youth manifest itself in immersive learning environments?

1.6 Definition of key terms

Collaboration: Ellis, Han, and Pardo (2019) state that "definitions of collaboration include helping groups to complete tasks and supporting the development of a group climate; an ability to deal with conflict, solve problems with others, set goals and manage performance" (p. 124).

Constructivism: Constructivism is a learner-driven approach that significantly differentiates from prescriptive learning approaches traditionally issued by teachers (Ugwuozor, 2020). Driscoll (2005) states that there is no single constructivist theory for learning, but instead five conditions qualifying learning for constructivism. These conditions are that learning is embedded in complex, realistic, and relevant environments, learning provides for social negotiation as an integral part of process, ownership in learning is encouraged, multiple perspectives and multiple modes of representation are supported, and there is a natural self-awareness of the knowledge

construction process. These conditions are included in Figure 1 which I designed to highlight the identifying criteria for constructivism in this study.

Figure 1

Five Elements of Constructivism (Driscoll, 2005)

Sensory Feedback: Cooper et al. (2018) highlight eight combinations of sensory feedback in a VR environment: audio, visual, tactile, audio-visual, audio-tactile, tactile-visual, and audio-visual-tactile. The combination employed is largely contingent on the type of VR system and purposes for why it is employed.

Desktop VR: Non-immersive VR systems are the cheapest and most inclusive type of VR that use desktop computers to reproduce visuals of the environment (Cipresso et al., 2018). An example of desktop VR used in this study is FrameVR, allows navigation of the virtual environment or experience from a browser on a desktop, mobile, or VR.

Head Mounted Displays: Head Mounted Displays (HMD) are wearable virtual computer interfaces which are placed over the user's upper face and held in place by adjustable straps. Fully immersive simulations require wearing an HMD for an effective experience.

Immersion: Researchers understand VR immersion differently, so it is difficult to draw definitive lines between the concepts of presence, interactivity, and immersion (Wohlgenannt et al., 2020). To some researchers, immersion and presence are interchangeable. In my study, I use a traditional understanding of immersion deriving from "the Latin immersus, refers to the idea of 'being immersed in something,' be it a liquid, a specific setting or a real or imaginary environment" (Benítez de Gracia & Herrera Damas, 2019, p. 78).

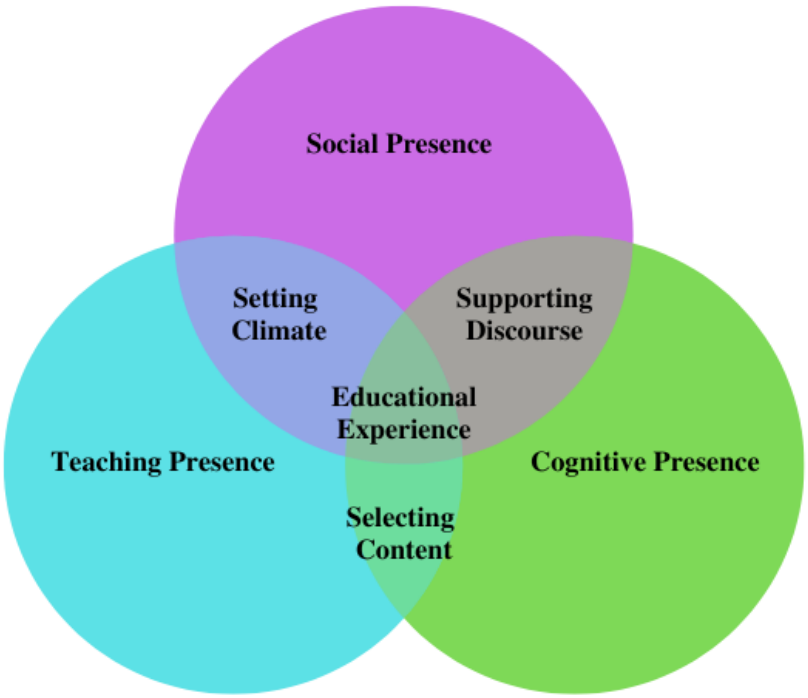
Immersive VR: Immersive virtual reality (IVR) offers a complete simulated experience through several sensory output devices like audio and haptic technologies, as well as HMDs to enhance the view of the environment to the motion of the user's head (Cipresso et al., 2018).

Interaction: Wagner (1994) defines interaction as "reciprocal events that require at least two objects and two actions. Interactions occur when these objects and events mutually influence one another" (p. 8). VR and immersive learning settings imply the existence of interactions and relationships between users and environments (Rubio-Tamayo et al., 2018). Virtual experiences also contain information, and interactions depend on the design of this information within the

environment (Rubio-Tamayo et al., 2018). Christopoulos et al. (2018) argue that interactions which are designed appropriately play a critical role in learner engagement in VR.

Figure 2

Elements of an Educational Experience (Garrison et al., 2000)

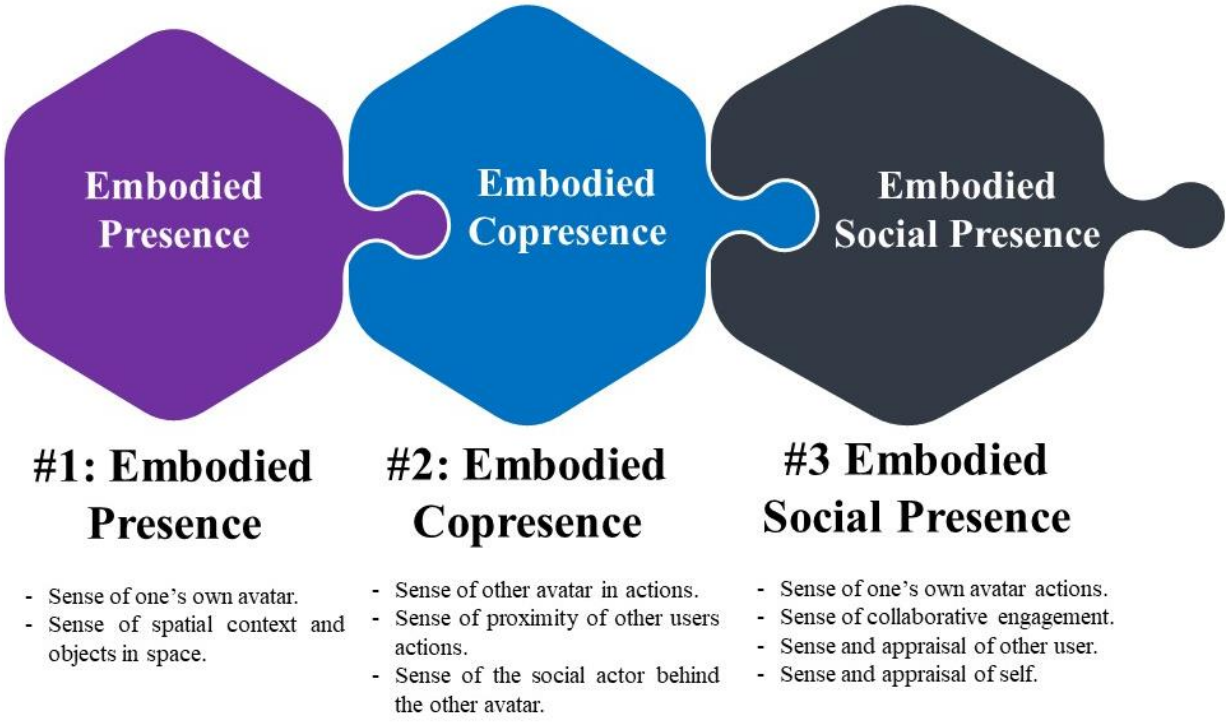


Presence: Lee (2004) provides a definition that efficiently encompasses the essence of presence in VR as "a psychological state in which the virtuality of experience is unnoticed" (p. 32). Presence is also associated with the creative flow, which is a positive psychological state where people barely notice their activities, and individuals are often so immersed that they are not aware of themselves (Yang et al., 2018). Garrison et al.'s (2000) community of inquiry identifies presence as three predominant subsections that contribute to the educational experience: social presence, cognitive presence, and teaching presence. See Figure 2 for a visual redesign of Garrison et al.'s (2000) Venn diagram explaining the different components of presence in an online educational experience. The figure has been revised with colour and repositioned with

social presence at the top of the diagram based on the relevance and importance of social presence to this research.

Figure 3

Embodied Social Presence Development Framework (Wang et al., 2016)



Social Presence: Biocca et al. (2003) explain social presence as "differences in technological connection, representations, and mediated access affect, distort, or enhance the perception (mental model) of others' intentional, cognitive, and affective states and behavior resulting from those perceptions" (p. 437). Siriaraya and AngAge (2012) add that some researchers believe social presence relates to the perceived potential of the medium to show non-verbal cues. However, social presence can also be defined most simply and effectively as "the sense of being together with another" (Sekhavat & Nomoni, 2017, p. 11). See Figure 3 for a visual representation of presence that I created based on the work of Wang et al.'s (2016) original

model to explain the psychological steps leading up to embodied social presence. I added the colour puzzle pieces above the presence stages and descriptions to clarify the identified notions of presence.

Socioemotional Learning: Lee et al. (2021) says, "Socioemotional learning (SEL) is an umbrella concept that encompasses students' acquisition and application of intrapersonal, interpersonal, and decision-making skills such as anger management, self-efficacy, empathy, grit, and cultural competency" (p. 2). If technical skills are associated with delivering objective products, then socioemotional learning is more process based, and more difficult to quantify. I am also considering socioemotional learning as synonymous with soft skills, but I intentionally deviated from this nomenclature because of the sense of inferiority implied compared to hard skills. SEL can also indicate social aptitudes, communication capability, friendliness, teamwork, and other personality traits that promotes relationships between people (Cimatti, 2016). Goldman and Wong (2020) add that SEL competences are essential for work with people and often take time to learn in experiential settings.

Virtual Environments: Virtual environments (VEs) are defined as collaborative places that afford geographically separated individuals the ability to interact with each other via avatars, which are digital self-representations in a visual 3D form (Yee & Bailenson, 2007). 3D VEs could be interpreted as a collaborative technology that solves some challenges of physical distance, as they offer a unique sense of togetherness in a virtual space (Sivunen, & Nordbäck, 2015).

Virtual Reality: To concisely define VR, Sherman and Craig (2003) highlight four key elements: a virtual environment, immersion, sensory feedback, and interactivity. However,

recent attempts to define VR is usually contingent on three aspects of interactivity, immersion, and presence (Mütterlein, 2018). VR is classified into three major types: non-immersive VR, semi-immersive VR, and immersive VR (Onyesolu et al., 2013).

Virtual Worlds: Virtual worlds are graphical immersive environments that are conducive to an array of activities ranging from social interaction (e.g., AltspaceVR, Engage VR, Meta Horizon Worlds, VR Chat, Mozilla Hubs) to multiplayer gaming (e.g., Population One, Onward, Echo VR). Virtual worlds are multi-modal platforms that include rich graphics, 3D rendering, high quality audio and video, movement, and interactivity (Schultze, 2010).

1.7 Organization of thesis

This study is organized in a traditional format with five chapters. Chapter one is an introduction to the research study, which includes background, purpose, problem, terminology, limitations, and ethical considerations. In chapter two, I provide a literature review of constructivism, VR and education, the nature of constructivism in a VR environment, and social presence in relation to VR. Chapter three describes the methodology, research methods, data analysis techniques, ethical considerations, and study limitations. In Chapter four, I analyze and report findings, organized by thematic sections to address the research questions. Chapter five concludes the study with a synthesis of the study contributions. I expand upon the results by discussing implications for future research and practical ways for teachers to implement constructivist approaches for VR instruction.

Chapter 2: Literature Review

In chapter two, I further explore concepts introduced in chapter one, and review key literature aligned with this research. I begin by providing a brief history of commercial and educational VR to establish necessary context. I then offer a brief history of constructivism, along with its major critiques and defenses. After discussing constructivism in VR, I proceed to examine VR and social presence explaining the influence of the VR constructivist environment on social presence. Next, I describe how avatar personalization and representation impact social presence. Finally, I conclude with comments on perpetuated social biases with VR avatars, and how these biases may be challenged with avatar embodiment.

2.1 Brief history of commercial VR and educational VR

Early VR usage was limited almost exclusively to educational and training purposes. The first recorded implementation of a VR system appeared in 1966, in the form of a flight simulator designed for the United States Air Force (Kavanagh et al., 2017). Along with military purposes, VR was used for training astronauts before going into space. VR was also used heavily in medicine for students performing endosurgery, eye operations, and leg operations (Mazuryk & Gervautz, 1999). It was not until 14 years later that VR became adopted by a more extensive consumer market.

The history of VR has challenging commercial origins. Over 10 years ago, it was difficult to implement an HMD (head mounted display) in an educational setting because it was expensive, the system was unstable, and the image quality was poor (Yang et al., 2018). In the 1980s, virtual programing languages research developed several VR devices, including the *EyePhone* HMD, *AudioSphere* sound system, and the *DataGlove* and *DataSuit* for measuring movements (Wohlgenannt et al., 2020). VR devices were mainly a widespread fad in the late

1980s and early 1990s, filling video arcades, mall corridors, and research laboratories (Boyer, 2009). In 1991, Virtuality Group produced a series of arcade games; however, these games proved to be unpopular and were discontinued a couple years later (Kavanagh et al., 2017). In 1993, SEGA designed an HMD and several game studios designed software for it, but it never progressed past the prototype stage (Kavanagh et al., 2017). In 1995, Nintendo released a VR-based game system called the Virtual Boy, which included a controller and a monochromatic HMD (Kavanagh et al., 2017). Even with an extravagant advertising campaign and revolutionary partnership deals, the system was a commercial failure (Boyer, 2009). Nintendo's Virtual Boy and other early VR systems had low graphic capabilities that caused motion sickness which contributed to their lack of success (Wohlgenannt et al., 2020).

Despite many early VR system failures, the technological and ideological goals to create a new immersive gaming platform with the high aspirations of VR have lived on far beyond their limited mainstream presence (Boyer, 2009). In 2013, the market was revolutionized when Oculus introduced their Rift model to kickstart a new generation of affordable and high-quality HMDs (Jensen & Konradsen, 2018). Over the next decade, various competitors launched their own HMDs, making this new technology accessible to the broader public and for research and education purposes (Jensen & Konradsen, 2018). This shift to more financially accessible VR technology was driven by lower production cost of components required for producing an HMD. The recent release of wireless, fully stand-alone VR systems like Oculus Quest and HTC VIVE Focus, where a high-powered computer connection is not required, has further lowered the obstacles for home and educational access (Wohlgenannt et al., 2020). Hodgson et al. (2014) provides an example of VR hardware evolution with an HMD available in 2010 (NVIS SX111), that cost $45,000 USD and weighs 10.9KG, compared to the HMD from 2013 (Oculus Rift) that

cost $1,300 USD and weighs 2.3KG. In 2022, VR has become more advanced and affordable, with quality Oculus headsets costing $400, and Google cardboard offering $20 alternatives that turn a cellphone into a fully functioning VR device. These advanced developments make VR a feasible choice to implement in educational settings.

VR as an emerging technology in education can take many forms. It varies in purpose and extent, contingent on the learning setting and what educators are trying to achieve through using it. Often, VR provides opportunities for learners to participate in simulations that are not feasible in reality or for teachers to address an instructional challenge (MacDowell & Lock, 2023). For example, Kavanagh et al. (2017) stated that public schools are "unlikely to consider frequent international travel for their students a viable option. However, through VR these same students could explore the architectural brilliance of the Pantheon or even purely imaginary structures without ever leaving their classroom" (p. 92). Educational VR applications like *Anne Frank House VR* allow students to go back and understand what being Jewish during WWII would have been like, providing an opportunity for learners to develop empathy and understanding of a major historical event.

VR has been used successfully to provide training to learners, which is concerned with applying practical skills rather than merely knowledge about a topic (Kavanagh et al., 2017). Learners can practice new skills and techniques in a simulated environment that enables correction, repetition, and non-dangerous failure and offers interaction with expensive or distant environments (Jensen & Konradsen, 2018). VR has often been used to allow students access to costly and limited resources through scientific labs with materials to conduct experiments (Kavanagh et al., 2017). In a youth setting, Al-Amri et al. (2020) used VR simulations for grade 8 science students to learn about sounds, waves, and lights. University students can also operate

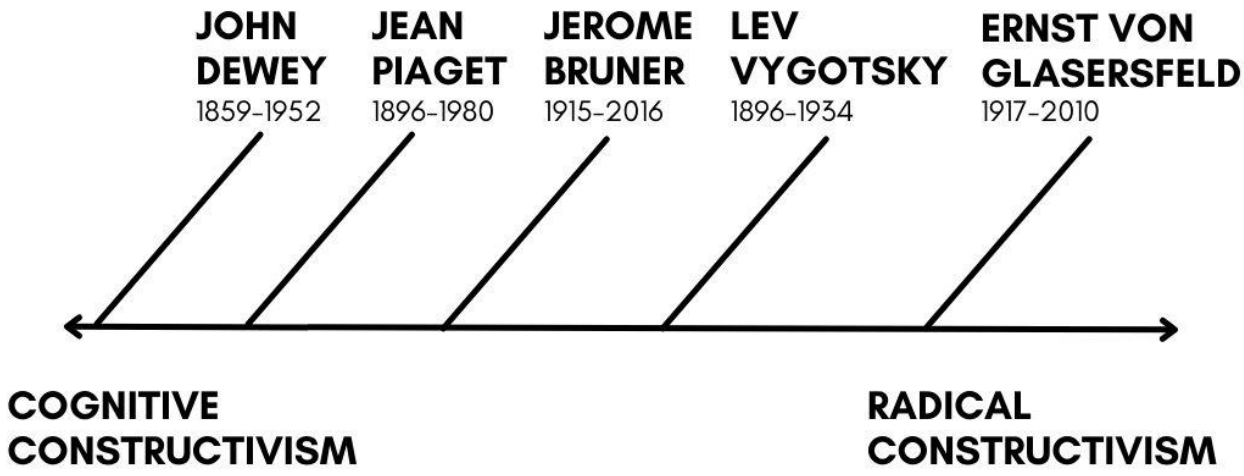
real tools located on campus grounds online through a virtual environment (Kavanagh et al., 2017). Yu, Wang, and Wu (2022) found VR to be effective for safety training of construction workers. Banow and Maw (2019) at the University of Saskatchewan found that engineering students were significantly more successful at naming truss types and identifying specific trusses in VR, and cautiously conclude that VR may have a positive effect on learning. As a new kind of remote education technology, VR's instructional advantages and potential are bound to provoke new developments in distance learning and impact the online education market. Perhaps VR's most impactful learning advantages will happen when it is combined with constructivist practices.

2.2 History of cognitivist constructivism to radical constructivism

The following sections offer a brief history of major learning theorist contributions to the currently understood notion of constructivism. Notably, some of the theorists I identify are not explicitly defined as constructivists, but they still had a notable influence on the development of constructivism as it is currently understood. The purpose of this historical analysis is to better understand the intent of constructivism so that it can be implemented with VR in authentic and relevant ways. Figure 4 is a timeline that I designed to introduce the learning theorist progression of cognitive constructivism to radical constructivism. From a cognitivist perspective, mental processing and cognition is only important to how external reality is comprehended, whereas the constructivist perceives the mind as symbol and tool builder to represent the learner's reality (Cooper, 1993). Cognitivists and social constructivists both view the learner as being actively involved in their learning, but constructivists view the learner as someone who elaborates upon and interprets information rather than just an active processor of information (Ertmer & Newby, 1993).

Figure 4

Progression of Cognitive Constructivism to Radical Constructivism



2.2.1 Contributions of John Dewey

Although there are many individuals who have been instrumental in developing constructivism, John Dewey was the spark that instigated the development of it as a learning theory. Dewey is regularly referenced as a critical originator of contemporary inquiry theories, as well as problem-based and experiential forms of learning (Stoller, 2018). These learning contexts are all strongly linked to core constructivism principals. Seen from a modern perspective, Dewey is regarded as an early twentieth century philosopher who expressed a unique sensitivity to the significance of contexts and had a sharp awareness for the importance of avoiding reductionism and criticizing all its forms (Reich et al., 2016). However, Godfrey-Smith (2016) argues that Dewey is not quintessential to constructivism as a philosophy because he deviates from the interpretivist notion that reality is subjective to everyone, and instead believes that the world has a before-and-after characteristic. Godfrey-Smith (2016) discusses how Dewey believes that:

> Before the activities of the thinker, there is a definite state the world is in. After the discovery of a new idea, the world is in a new state. The claim is not that the world *lacks* a definite structure prior to the inquiry, or that "we can make no sense" of the idea of a mind-independent state of the world. Rather, the world *was* one way and *now* it is another. (p. 77)

Despite this notable dissonance with contemporary constructivist philosophies, Dewey still laid the essential groundwork for other theorists to develop constructivism.

2.2.2 Contributions of Jean Piaget

It is well known in the literature that Jean Piaget is a founder of constructivism, and his work is still relevant and regularly discussed today (Vincente et al., 2021). He is best described as "a twentieth-century French-speaking Swiss professor (1896-1980) whose writings, collaborations, and students influenced a great deal of contemporary thinking about how children develop— especially regarding their cognitive development" (Burman, 2016, p. 37). Piaget revolutionized educational theory and understanding of child cognitive processes with his book, *La construction du réel chez l'enfant,* which is the second work of his well-known trilogy (Vincente, Pilar, & Isabel, 2021). For this contribution, his genre of constructivism is mostly often dubbed psychological constructivism (Van Bergen & Parsell, 2019). Piaget's (1953) four stages of cognitive development are defined by age and include: sensorimotor stage, pre-operational stage, concrete operational stage, and the formal operational stage. Piaget believed that cognitive development is neither an individual category nor a direct outcome of experience, but an outcome of a learner's active cognitive construction process (Tomljenović & Vorkapić, 2020). Piaget accentuated that new knowledge is fabricated on previous knowledge as learning is

refined through exploration, and on individual meaning construction. Constructivism from this viewpoint describes how people process information to shape their understanding and knowledge in their environment (Neutzling, Pratt, & Parker, 2019).

2.2.3 Contributions of Lev Vygotsky

Extending Piaget's work, Lev Vygotsky emphasized the importance of cooperative learning and social interaction in knowledge construction while groups communicate with each other (Neutzling et al., 2016). He claims that social interaction is an integral part of learning and the critical thinking process (Powell & Kalina 2009). Vygotsky contended that mutual social experiences within numerous social environments influence the social direction of individuals that ultimately affects their cognitive functions (Neutzling et al., 2016). For his efforts, Vygotsky is credited with being the key individual in establishing a social constructivist perception of psychological development (McQueen, 2010). Vygotsky's contributions to psychological development had a noteworthy impact on proceeding work. Vygotsky believed that brain functions are always the product of the activity of strictly differentiated and hierarchically interconnected centers (Balyasnikova, & Vasileva, 2019). In other words, Vygotsky implies that psychological processes are better explained by how various functional brain networks cooperate with each other in the moment rather than by where they are localized in the brain (Balyasnikova, & Vasileva, 2019). Along with a non-linear constructivist notion of psychological development, Vygotsky is also known for introducing an associated popular pedagogical approach known as the zone of proximal development (ZPD) (McQueen, 2010). The ZPD shows how learners are successfully able to perform a new task with the support of others.

2.2.4 Contributions of Jerome Bruner

Vgotsky's ZPD influenced other constructivist theorists such as Jerome Bruner. Vygotsky's ZPD directly inspired Bruner's notion of scaffolding. Both theorists felt that individuals learn best within a social environment, where meaning is developed during collaboration (Langford, 2005; Stapleton & Stefaniak, 2019). Bruner suggested that learners create their own knowledge by categorizing and organizing information in a mental coding system, and that the most effective way to develop a coding system is to discover it rather than being told it by the teacher (Jari & Pekka, 2018). Stapleton and Stefaniak (2019) report:

> His theory encourages educators to create instruction which leads the learner through a sequence of statements until the instructional content or problem has been mastered. The learner can understand the material, use organization to transform the concept in a new way, and transfer the knowledge to new situations. (p. 4)

A potential influence on Bruner's constructivist work is that he was born blind, and thus had a significant intuition about perceptions being controlled by the mind instead of just the senses (Jari & Pekka, 2018). Bruner's initial visual condition likely created an empathy for learners who are challenged by content because they perceive content in a different manner than high achieving learners. Bruner's formative evaluation approach to learning is ideal for struggling learners as it allows them multiple opportunities to process and master the content so they will gain increasing knowledge after each review (Stapleton & Stefaniak, 2019).

2.2.5 Contributions of Ernst Von Glasersfeld

Ernst Von Glasersfeld theorises a type of constructivism that is more extreme than anything Piaget, Vygotsky, or Bruner initially proposed. In Glasersfeld's impactful 1974 paper,

Piaget and the Radical Constructivist Epistemology, he introduced a new variation of Piaget, which he dubbed radical constructivism (Riegler & Steffe, 2014). In his paper, Glasersfeld describes cognition as "a constitutive activity which, alone, is responsible for every type or kind of structure an organism comes to know" (1974, p. 5). This theoretical idea of cognition is radical because this attempt is to remove constructivism from any vulnerabilities that it faces (Hsueh, 1997). This new notion of constructivism is positively accepted by some constructivist researchers, but others disapprove. For example, Van Bergen and Parsell (2019) argue:

> To commit to relativism, present in any radical view of constructivism, is to abandon the genuine pursuit of knowledge, however conceived and measured, and to insulate oneself from intellectual tradition and rational debate. To take academia seriously requires acknowledgement of discipline norms and discipline knowledge, and, on these terms, radical constructivism has no place in the academy. (p. 54)

Although this is a pessimistic perception of Glasersfeld's values, the importance of discipline-specific standards is a valuable critique of radical constructivism from an epistemological perspective. It is worthwhile to note that despite sharing a common title and some common components, not all variations of constructivism have the same critiques. Constructivism encompasses a broad range of learning theories, with up to 18 different types identified (Van Bergen & Parsell, 2019). This variety makes a definitive and holistic critique of constructivist an elusive endeavour. To provide further context, Table 1 is an original work that I designed to demonstrate constructivist theorist ideas and their implications for VR instructional design.

Table 1

Constructivist Theorist Contributions to VR

Constructivist Theorist	Theorist Big Idea	Implication for Constructivist VR Instructional Design
John Dewey	Inquiry and problem-based learning in rich contexts is ideal.	VR environments should be selected to allow learners to explore abstract ideas in complex and meaningful ways.
Jean Piaget	Cognitive development is an outcome of a learner's active cognitive construction process. New knowledge is fabricated on previous knowledge as learning is refined through exploration, and on individual meaning construction.	VR learning should rarely be a passive experience and instead allow learners to actively participate in learning. VR experiences and environments should be critically selected with awareness of the learner's prior experiences.
Lev Vygotsky	Social interaction is an integral part of learning, cognition, and the critical thinking process.	If appropriate to the learning objective, VR learning should take place socially instead of individually.
Jerome Bruner	Learners create their own knowledge by categorizing and organizing information in a self-discovered mental coding system.	Teachers should sometimes offer support and guidance, but students in VR should have opportunities to decide the direction of their own learning.
Ernst Von Glasersfeld	Cognition is responsible for every type or kind of structure a person comes to know.	VR should allow learners significant creativity capacity to process, showcase, and represent their unique perspective.

2.3 VR and constructivism

Although VR research and teaching are traditionally aligned with processes where students need to learn skills through simulated training, constructivist approaches where students learn in context may prove to be the most meaningful in VR environments. Dewey believed that learning should be real and applicable for daily life, and that knowing was an active process of being experimental and experiential in the environment (Huang & Liaw, 2018). VR offers the opportunity to experience in an exploratory fashion, making it a perfect match for instructional approaches that are less prescriptive. VR is exceptionally impactful for constructivist learning

because it fosters a direct, first-person learning experience (Chee & Hooi, 2002). Virtual experiences created with constructivist principles support pedagogically sound activities, such as situated learning, role-playing, cooperative or collaborative learning, problem-based learning, and creative learning (O'Connor & Domingo, 2017). VR experiences align with Piaget's constructivist view that knowledge is created by learners through interaction with the surrounding world and others, and is characterized by first-person, non-symbolically mediated interactions (Spalter et al., 2002).

A growing body of research identifies constructivist learning as a feasible educational VR delivery option in different settings (e.g., Blake, 2008; Chee & Hooi, 2002; Hadjipanayi & Michael-Grigoriou, 2020; Huang et al., 2010; Meggs et al., 2012; Onyesolu et al., 2013; Spalter et al., 2002; Winterbottom & Blake, 2008). Chee and Hooi (2002) utilized constructivist and active learning principals to support collaborative, interactive learning with desktop virtual simulations. Constructivism is achieved in Chee and Hooi's (2002) study through shared experiences revolving around shared objects in the virtual environment to create an authentic context for a discourse-based learning community. Since constructivism advocates socialization as essential for learning, interaction in a VR environment can be a valuable and reasonable alternative to a real experience. Huang et al. (2010) addressed using constructivism to assist educators with critically designing and applying a novel VR learning environment. In this study, medical students used a 3D interactive learning system designed to learn about the structure of the human body. Students could study any medical subjects they wanted by using VR systems and discuss their learning online with others. More recently, Collins et al. (2021) discovered a mutually beneficial reciprocal relationship between constructivism and VR after exploring non-experts and mathematically educated experts interacting with four-dimensional cubes in a VR

space. Collins et al. (2021) considers constructivism from the key principle of interaction in a physical space. One component in the VR constructivism literature that is generally elusive is what specific constructivist components are achieved, and how they may be achieved. To develop a clearer understanding of constructivism in VR, it is necessary to identify constructivist criteria and precisely identify how these components might be met.

2.3.1 Five conditions for identifying constructivism

Driscoll (2005) states that there is no single constructivist theory for learning, but instead five conditions qualifying learning for constructivism. These conditions are that (1) learning is embedded in complex, realistic, and relevant environments, (2) learning provides for social negotiation as an integral part of process, (3) ownership in learning is encouraged (4) multiple perspectives and multiple modes of representation are supported, and (5) there is a natural self-awareness of the knowledge construction process. The variety of ways for how VR can utilize these constructivist components is discussed.

2.3.2 Learning is embedded in complex, realistic, and relevant environments

The potential to create a complex, realistic, and appropriate environment conducive to constructivist instructional practice is an area where VR excels. Most constructivist authors agree that students cannot be expected to deal with complexity unless they have been provided with complex contexts to experiment in (Driscoll, 2005). VR can offer settings that replicate a complex physical place without the need for risk management or expensive transportation. Also, the VR environment provides this complexity through being designed for students to visualize, manipulate, and interact with information that is critical for its understanding (Onyesolu et al., 2013). O'Connor and Domingo (2017) argue, "Even without knowing how to create advanced

images or artifacts, instructors can bring in pictures, slide presentations, videos, and resources to take a predesigned environment and customize it to have the look-and-feel of the important aspects of the content" (p. 354). The complexity, realism, and relevance of the VR learning environment is partially contingent on the instructor's initial environment choice. However, environmental efficiency is determined by how well instructors can redesign an existing learning setting. Selection of an ideal VR environment and manipulating it to match the instruction are both valuable educator considerations. For the future application of VR technologies to be successful, researchers need to adequately evaluate their relevance, appropriateness, and usability in real-world contexts (Simon et al., 2017). Educators should assess whether a VR environment, device, and application has transferable relevance for learners

2.3.3 Learning provides for social negotiation as an integral part of process

Although VR initially seems like it would be somewhat isolating technology with restricting interactions in the real environment, VR can successfully provide a plethora of opportunities to develop skills and to socially construct knowledge. Collaboration is a critical feature of the constructivist VR learning environment. A core part of constructivism is the belief that higher mental processes in humans develop through social interaction (Driscoll, 2005). Additionally, humans are social beings, which implies that social competencies are just as important as cognitive skills (Flogie et al., 2019). Many VR applications employ environments that encourage students to develop and build knowledge in collaboration with other peers (González-Zamar, 2020). Weissblueth and Nissim (2018) found that learners who participated in collaborative work in a VR environment could perform diverse tasks in an improved, relaxing, and creative manner. Conye et al. (2018) supports this claim with their findings that participants felt confident expressing ideas with their team and felt engaged with their team in a VR

environment. Students are also able to solve medium-specific issues that arise during VR collaborations. Weissblueth & Nissim argue, "when working together, participants found it easier to tackle complex technological tasks in the VR environment" (2017, p. 1561). VR can be an effective social atmosphere to provide productive and creative possibilities for collaborations. Educators need to consider whether the VR application offers collaboration tools and whether collaboration can be designed outside of the HMD.

2.3.4 Ownership in learning is encouraged

VR can allow students to have ownership of their learning if instructors intentionally design tasks so that learners have agency and autonomy in their work. Hannafin (1992) reminds us that, "Student-centered learning systems essentially define the student as the principal arbiter in making judgments as to what, when, and how learning will occur" (p. 54). VR can contribute to this constructivist autonomy by enabling the learner to proceed through an experience at their own pace, thereby enjoying an expansive time frame not fixed or limited by a regular class schedule (Kim & Ko, 2012). Ideally, educators should determine how they can allow students to learn outside of the designated instructional time Students can also be principal arbitrators through creating. Onyesolu et al. (2013) found, "Creating their own virtual worlds has been shown to enable some students to master content and to project their understanding of what they have learned" (2013, p. 46). Tilt Brush is a specific app that allows students the opportunity to create art in a pre-existing constructivist VR environment (Johnston, 2018). Artists or art students can construct doodles, illustration, fine art, or design using a multitude of color and visual effects in three dimensions (Johnston, 2018). In Weissblueth and Nissim's (2018) article on using VR with pre-service teachers, participants had various visual options and topics to present their learning in a VR environment. These examples of the possible variability with what,

when, and how VR learning occurs offer an experience that learners can feel in control of their education.

2.3.5 Multiple perspectives and modes of representation are supported

Multiple perspectives and modes of representation add creative freedom to constructivist learning tasks, which further enhances willingness to participate and supports a connection to the creation process. Driscoll (2005) asserts that hypermedia provides an excellent tool for thinking about ideas, theories, or literary works from a variety of perspectives. Driscoll (2005) says, "viewing the same content through different sensory modes (such as visual, auditory, tactile) again enables different aspects of it to be seen" (p. 399). Therefore, usage of HMD in immersive education might currently work best as an option rather than as a mandatory learning task to avoid some associated side effects. Ritz and Buss (2016) comment that participants frequently noted that dizziness and motion sickness are common causes of discomfort. Hardie et al. (2020) found that some of their VR participants reported feeling motion sickness and dizziness from using the headset, and experienced neck soreness. Chang et al. (2019) found that learners indicated that the VR guiding system could effectively help them to learn, but they felt dizzy when they used it for more than one class period. Likewise, Hazim et al. (2016) discovered that two out of nine participants felt sick from the use of the VR headset and had to stop before completing the study. Issues with dizziness and nausea can cause students to lose focus on content while also distracting from their mental processing ability (Ritz & Buss, 2016). The record of negative impact from HMDs on some learners implies that until VR advances to the point where it does not create any issues, instructors should have alternative ways for students to complete VR tasks and simulations. At present, VR is a powerful and transformative learning opportunity for some learners, but not for all. A practical solution could be collaborations

through applications such as AltspaceVR, which is compatible with a HMD, but it also works in 2D mode in Windows. VR's ideal existence as different modes for students to learn and create helps support its positioning in the constructivist principle of multimodal representations.

2.3.6 Awareness of the knowledge construction process

Nurturing self-awareness of knowledge construction is a learning condition that constructivists claim is essential to acquiring skills such as reasoning, understanding multiple perspectives, and committing to positioning and beliefs (Driscoll, 2005). Self-awareness can often be built directly into the VR learning environment. Gaming formats can be designed to improve student metacognitive abilities, which may be difficult to incorporate through other teaching methods (Annetta et al., 2010). Metacognition might be particularly applicable for simulated VR experiences that can enhance student awareness of their performance. Annetta et al. (2010) says that "because simulations offer a 'no risk' approach for individuals to practice and demonstrate responses representative of authentic experiences, they are particularly powerful tools for the engagement and assessment of procedural and metacognitive learning processes" (p. 66). To help educators determine students' awareness of the learning, they may alternatively or additionally wish to carry out an evaluation method based on learner prediction of performance and actual performance. Muratore et al. (2019) found this evaluation to be an effective method for reliable self-awareness detection of VR learning. Effectiveness of VR instruction can also be increased by students providing summaries of their learning (Parong & Mayer, 2018). Students' self-evaluation and summaries may provide an instructor with the opportunity to understand learners thinking and creative processes in a VR environment. Educators may consider whether students can be directed to question their thinking in the VE and how metacognition can be promoted outside of VR learning. See Table 2 for a summary of constructivist principles and VR

examples. The following table is an original work that is intended to provide a relevant analysis of VR core constructivist components, while posing questions for educators to ensure an accurate representation of constructivism in VR instruction.

Table 2

Summary of Constructivist Principles and VR Examples

Constructivist Principles	**Constructivist VR Example**	**Questions for Educators**
1. Learning is embedded in complex, realistic, and relevant environments	• Customizing pre-made VR environment for learner visualization, manipulation, and interaction. • Evaluate VR environment relevance, appropriateness, and usability in real-world contexts.	• Does this environment, device, and application have transferable relevance for learners?
2. Learning provides for social negotiation as an integral part of process	• Select tasks and environments that encourage students to develop and build knowledge in collaboration with other peers. • Design for collaboration so that peers can help solve VR technology issues, thus reducing instructor workload.	• Does this VR application offer collaboration tools? • Can collaboration be designed outside of the HMD?
3. Ownership in learning is encouraged	• Offer students a non-limiting time frame for their progress and process. • Allow students to create virtual worlds. • Afford a plethora of options for students to represent knowledge.	• How can I allow students to learn outside of the designated instructional time? • How can I promote inclusivity in learning?
4. Multiple perspectives and modes of representation are supported	• Consider collaborative VR software, which is compatible with a HMD, but it also works in 2D mode in on a desktop.	• Which VR applications afford students with opportunities to contribute to their learning task outside of the HMD?
5. Self-awareness of the knowledge construction process	• Embed metacognition prompts directly into the learning environment. • Before VR education, learners may predict their performance, and later compare to their actual performance. • Students provide summaries of their learning at the conclusion of the experience.	• Can students be directed to question their thinking in the VE? • How can metacognition be promoted outside of VR learning?

2.3.7 VR constructivism critique

A major constructivism critique is whether students are prepared to take ownership and manage their learning because they are often not the best judges of their own learning needs (Driscoll, 2005). Also, sometimes the constructivist learning environment is decontextualized. Driscoll says, “Without a meaningful context to guide them learners are left to figure out ‘what the teacher wants’ or what will be on the test” (2005, p. 402). When a meaningful task is lacking, learning becomes an endurance test or something to overcome. Biggs (1999) suggests rigorous instructional design must ensure consistency and alignment between the curriculum, the teaching approach, the learning context, and the assessment procedures. Consistency is challenging in less structured learning tasks of constructivism, and even more so when new technology such as VR is being utilized. Instructors intending to use VR extensively should be diligent about implementation and consider integrating constructivism with situated cognition.

2.3.8 VR constructivist learning and situated cognition

Situated cognition is a learning approach commonly associated with constructivism (Joao, 2018). Situated cognition highlights how learning is not just a matter of what goes on inside people’s heads but is fully embedded in and situated within a material, social, and cultural world as well (Annetta et al., 2010). Situated cognition theory adds a focus from the individual to the setting, activities, and processes within that setting (Driscoll, 2005). Coyne (2007) asserts that the way spaces/places are configured are actively implied in thought, not just serving to convey meaning, as containers for people, or embodying ideologies. In this way, VR contributes to learning and cognition by redefining place (MacDowell & Lock, 2023). The virtual environment provides an alternative setting where learners can construct knowledge based on lived experiences and communities of practice within an HMD. An example of situated cognition

in VR through an alternative place is an application called Anatomage Table, where students can manipulate and dissect a 3D human model through multiple layers of skin, muscle, organs, bone, and nervous system (Johnston, 2018). The Anatomage Table supports individual or social interactions in various activities for potential learning while viewing and manipulating the virtual model (Johnston, 2018).

Arguments against VR from the perspective of situated cognition include concerns that VR misses out on the subtleties of spatiality; it lacks the spatial inflections and nuances against which ideas can happen (Coyne, 2007). In the case of Anatomage Table, there are differences with how the VR dissection and collaborations look and feel compared to a real environment. The lack of nuanced location-exclusive elements that are not replicable in VR, will change the type of thinking and learning that occurs, likely resulting in an understanding that would not be as accurate as if it were in a real situated cognition environment. Additionally, VR is a complicated process to plan for in situated cognition settings. Coyne (2007) says, "In the same way that VR gravity has to be programmed and every inflection of avatar muscle calculated to effect real-time simulation, the condition for every thought has to be anticipated in the VR design" (p. 34). This concern seems less legitimate for instructors because it is professional designers who generally develop VR applications. VR developers often have the time and diligence to create the most effective application possible, affording instructors time to design the learning experience. However, instructors should be exposed to enough VR applications to have awareness of a VR software's educational value.

2.3.9 Summary of constructivism in VR research

Jean Piaget, John Dewey, Lev Vygotsky, Jerome Bruner, and Ernst Von Glasersfeld were all instrumental in developing constructivism into the important learning theory that it is today.

Ultimately, constructivism's efficiency depends on the context, and VR offers unique contexts and opportunities for teaching and learning. When first introduced, VR was mostly used for procedural training in medicine, flight, and military (Kavanagh et al., 2017). VR has had commercial failures but has been more successful recently due to technological innovation and substantial financial investment from large companies like Meta. The recent commercial success of VR has led to more educational opportunities and constructivist options than possible before (MacDowell & Lock, 2023).

The educational possibilities of VR can be enhanced by utilising constructivism's five core elements. To embed learning in complex, realistic, and relevant environments, instructors can bring in features to take a predesigned environment and customize it to align with important content (O'Connor & Domingo, 2017). Many studies found that learners had positive experiences using VR in social situations, and that is it therefore effective for situations where learning needs to provide for social negotiation as an integral part of process (Conye, 2018; González-Zamar, 2020; Weissblueth and Nissim, 2018). Ownership of learning has been achieved through in VR by allowing students to work at their own pace, with freedom in creating art or their own virtual worlds (Kim & Ko, 2012; Johnston, 2018; Onyesolu, 2013). Since a plethora of studies have noted that VR can cause dizziness and nausea, it may work best to support multiple perspectives and modes of representation by being compatible with a HMD, but also working in 2D desktop mode. Offering access to an HMD mode and a 2D desktop mode would enable learners to see different aspects of a topic. To create self-awareness of the knowledge construction process, students may carry out an evaluation method based on their prediction of performance and actual performance, or by providing summaries of their learning (Muratore et al., 2019; Parong & Mayer, 2018).

Situated cognition constructivist applications like Anatomage Table allow an individual to go beyond textbook learning and be fully embedded in a material, social, and cultural world (Annetta et al., 2010). However, when aligning VR with these *real world* and constructivist elements, it is essential to maintain a consistent teaching practice between all the instructional variables (Biggs, 1999). Before proceeding to examine VR constructivist environment design for social presence, it is important to explain the significance of social presence in VR.

2.4 VR and social presence

Daft and Lengel (1986) assert that the richness of social data varies based on the setting. Some modes are more capable at delivering facial expressions, vocal cues, gestures, and physical appearance, meaning that social presence is co-created with the medium. One of the predominant attractions of VR is purported to be the amount of social presence it affords in comparison to other forms of technology-mediated communication like textual communications and video conferences (Oh et al., 2018). Scholarly literature generally finds that the presence of computer-generated avatars, human-based avatars or real others leads to greater immersion in VR (Hudson et al., 2019). Presence of others may help the simulation feel like reality, where most people live and interact socially in environments populated by other individuals. Absence, the antonym of presence, occurs when an individual is not attending to the social stimuli in the shared world, and retreated into a private imagined world in their mind (Hudson et al., 2019: Schultze, 2010; Waterworth & Waterworth, 2001). Absence tends to be a highly self-referential state, in which an individual focuses on their concept of what is happening in the external world and their role in it at the expense of their experience in the world (Schultze, 2010).

Extensive argumentation in the literature highlights the importance of VR in promoting social presence (Sajjadia et al., 2019). In a VR rowing exercise, Murray et al. (2016) found that

performance was enhanced by the presence of others. Participants who were socially present with other individuals rowed a further distance and at a higher performance output. Jung (2011) demonstrated that social presence is a significant predictor of satisfaction in VR but also that social presence has no impact on students' intention to continue with VR learning. However, there are conflicting results on social presence implications on continuation intention in the literature, so the desire to continue participating in learning is likely contingent on contextual variables (Jung, 2011). Sivunen and Nordbäck (2015) found interaction and level of participation play a significant role in the achievement of social presence within a dispersed team. Different tasks, groups, and environments are all interconnected in social presence, so these elements need consideration when analyzing the research. This study provides additional insights on intentions to continue learning because of youth learner experience and presence within additional learning environments. Since constructivism is a highly social learning method, it is an ideal strategy to support data collection on social presence. Kreijin et al. (2014) defines three operational subsections of social presence including open communication, affective expression, and group cohesion.

2.4.1 Designing the VR constructivist environment for social presence

Ugwuozor (2020) suggests that the environment in which constructivism is evaluated and implemented is critical for its success in student learning. It is argued that the importance of environment goes beyond student learning benefits and is important enough that it plays a pivotal role in developing student identity. Stoller (2018) states that "For Dewey, the self emerges as a result of its transacting in and through different environments. It is likely that students placed in different classrooms will not simply know different things but will become different selves" (p. 54). Diversification of environments is valuable because even subtle differences may change the

nature of experiences and interactions contained within the setting. Environmental differentiation allows the mind and soul to grow in a more holistic manner than that of one single place.

Dewey (1922) says that "the sailor is intellectually at home on the sea, the painter in his studio, the man of science in his laboratory" (p. 114). Each of these professionals has modeled their distinct aptitudes and capabilities into the unique manner of behaving in specific environments (Stoller, 2018). The allure and attraction of VR is in its potential to simulate the sea, a painter's studio, and a science laboratory. Certain places allow learner growth in ways that are not possible otherwise, and likewise each of these places will have a different impact on learner social interactions. Occupying a place is therefore a way of detailing the active negotiation that happens between the learner and the world (Stoller, 2018). VR is an ideal technology to utilize to achieve environment differentiation that allows for student growth and discovery because it provides access to a plethora of digital social learning locations.

Even though VR environments may provide a necessary differentiation from mediocrity, there are many variables in the environment that can influence educational quality. Some researchers reject virtual learning entirely and believe that education is only possible in a physically shared setting because the conflict and challenge upon which upon which cognitive development happens requires co-existence in a physical space (Noonan & Coral, 2013). Jung (2011) says that "The lack of social cues may make users feel that the environment is cold, and ultimately this experience has an extremely negative impact on users' satisfaction" (p. 497). Noonan and Coral (2013) support this notion of social cues with their belief that immersive experiences grant the exchange of valuable information, but the absence of felt and genuine human contact restricts educational value, even when environments provide highly moderated social interactions. Although not comparable to F2F interactions, social presence and elevated

shared learning is an element that VR seems to excel compared to video conference meetings. However, some virtual worlds are better than others at providing this core component that influences environment and socialization. Yilmaz et al. (2016) claim that feedback and interaction are some of the most important variables in the development of social presence, and it is important that virtual environments and experiences are appropriately designed to allow students to communicate and interact.

Although there are various ways to achieve a sense of community and togetherness, Christopoulos et al. (2018) found that students' virtual and physical togetherness can result in eliminating weaknesses of each environment, while simultaneously enhancing environmental strengths. Positive implications of togetherness suggests that group dynamics may play a significant role in the learner interpretation of the environment in virtual learning. Yan et al. (2020) supports the notion that group dynamics play a major role, with their findings that the more students are efficiently interactive with each other in the environment, the more reduced the feeling of social isolation. Environments that are adequately designed for interaction and communication are beneficial in overcoming limitations (Yilmaz et al., 2016). Michael Moore's theory of transactional distance declares that the factors, activities, and situations, which promote student interaction and involvement should be considered in virtual communications (Yilmaz et al., 2016). Moore recognized that the level of program structure, and level of educational communication required for success was dependent upon learner characteristics (Roach & Attardi, 2021). In most situations, to promote students interacting with each other in a virtual environment, Yilmaz et al. (2016) state that "it is important to provide activities that include warm, interesting, and flexible situations" (p. 875). Creating these situations can be achieved by embedding fun interactable objects, and through expert implementation of constructivism.

Findings from these studies imply that the positive perception of social virtual environmental learning is based on a cyclical relationship between pre-established developer characteristics, instructor environmental utilization, and group dynamics.

Along with the social interaction and technology capacity, the scholarly literature supports the notion of quality of immersive learning relating to visual qualities of environment. Yan et al. (2020) find that presence reflects an individual's perception of reality about the virtual environment, contingent on media qualities and individual characteristics. However, it is important to note that media and character qualities do not have to be photorealistic to be enjoyed and interpreted positively. For example, gamers who have jumped off a cliff in a video game have encountered a pit of your stomach feeling as they have made the leap (McCreery et al., 2013). A VR user's sense of social realism in a virtual environment is somewhat influenced by higher media qualities and characters. Most important is to understand is how these visual elements are utilized to stimulate the feeling of being socially present. Instructors choosing VR for education need to be mindful of how well a specific environment can foster genuine human contact through interaction components, media qualities, and individual characters (MacDowell & Lock, 2023). Still, even when some environmental decisions are not as intentional considered, VR can be a strong instructional choice if it aligns curricular outcomes. Educators should also be keenly aware of student avatar representation when designing instruction for VR learning.

2.4.2 Avatar representation and social presence

McCreery et al. (2013) claim that the relationship between learner and avatar, developed through many hours of digital character advancement and socialization, take precedent over the media and environmental characteristics as a predominant factor in social presence. The relationship between learner and avatar is a notable point because it is easy to develop

misconceptions on the influence of presence, and attribute importance to less influential factors. Other researchers affirm this finding with discoveries that anthropomorphism (human-like avatars) influenced the user perception of environmental potency and social presence (Nowak & Biocca, 2003). The influence of having a virtual body makes sense from the perspective of social interaction, since it allows users to maintain *peripersonal* spaces or show emotional expressions when interacting with others (Gonzalez-Franco & Peck, 2018). But going deeper yet, having an avatar or body in VR additionally helps to foster seemingly natural interactions, can alter our sense of space, influence our distance estimation, and even impact cognitive load. In social situations we are often analyzing our body language, eye contact, facial expressions, and a variety of other features based on the context of the social interactions. Outside of VR, we exist socially in a state that is constantly aware of and negotiating with our bodies, so being socially present somewhere involves a bodily experience (Gonzalez-Franco & Peck, 2018).

2.4.3 Avatar personalization and social presence

Along with inhabiting avatars for a bodily social presence, research supports the importance of avatar personalization for immersion in VR (Blascovich., 2002; Gonzalez-Franco, et al., 2020; Li et al., 2021). Waltemate et al. (2018) state that "personalized avatars significantly increase body ownership, presence, and dominance compared to their generic counterparts" (p. 1643). Contrarily, these studies are challenged by Bente et al. (2008), who says, "It can be asked whether the artificial nature of avatars and the nondisclosure of physical appearance and identity cues might even run the risk of generating negative effects, such as loss of trust and relatedness" (292). Additionally, Sivunen and Nordbäck's (2015) findings which show that avatars played an insignificant role for social presence in virtual group meetings, since their participants hardly utilized controlling movements and view of the avatars. Yet, this finding makes sense because

avatars are hypothesized to enhance social presence through their ability to convey social cues (Bente, 2008). Differentiating research perspectives on the importance of avatars for social presence may suggest that group dynamics and VR usage purposes influence how valid the avatars are for social presence to the group. Still, research generally shows that accurate avatars are an important distinction that have a positive influence on social presence in a variety of settings.

Wrzesien et al. (2015) explored how teenagers with avatars that are physically similar and dissimilar to themselves are influenced in emotional regulation learning. They found that teenagers had a stronger emotional connection and activation of specific brain regions when they observed an avatar that physically represented themselves. Similarily, in a study on exercise behaviours, Fox and Bailenson (2009) found that participants exercised significantly more when shown a virtual representation of their physical selves compared to a neutral virtual representation. Results from these studies affirm the importance of avatars that closely resemble the self as an essential visual development for behavior modification and learning in general (Wrzesien et al., 2015).

It is then surprising that Jin's (2009) research on Mii's, the avatars in Wii games, had a contrary outcome on psychological attachment for self- representation. She found that users who created an avatar of their ideal self-reported greater psychological immersion compared to those who created a replica of an avatar that mirrors their actual self. Perhaps people who do not authentically represent themselves virtually do so because they are not comfortable with their real-life representation. It is also possible that they are not confident or comfortable yet with an emerging technology. Alternatively, an inauthentic avatar may be created for entertainment or purposes to express their ideal self. Regardless, in all scenarios, the learner's personality

determines whether an authentic or ideal avatar is more comfortable for themselves. However, often creating convincing avatars and conveying meaningful social behaviours remains a challenge for VR. This challenge involves the technical elements of VR, such as the capacities of the HMD systems, and the psychological elements of the task, such as the human communication dynamics (Weissblueth & Nissim, 2018).

2.4.4 Perpetuated social biases with VR avatars

Even though VR can provide a lower stakes opportunity for individuals to experiment with different representation, people are constantly aware and assessing themselves and others in a VR setting to an extent that mirrors traditional social interactions. Gonzalez-Franco and Peck (2018) make it clear that,

> In the real world, we experience our self as being inside a body that moves according to our intentions. Our body provides important social cues when interacting with others, as well as information about our location, posture, and self-perception of the world. (p. 1)

In a traditional social setting, an individual immediately judges other people based on their visual appearance such as clothing choices, hairstyles, and shape. Even though we do not desire to judge people based on their appearance, it is often an unavoidable subconscious reaction that provides an indication of socio-economic status and personality. Pena et al. (2009) furthered the understanding of perception with their discovery that users could be subconsciously primed to think about each other in a specific manner based on situational cues, and that factors of the virtual environment creates an automatic cognitive response. They found that "participants using black-cloaked avatars developed more aggressive intentions and attitudes but less group

cohesion than those using white-cloaked avatars" (Pena et al., 2009, p. 838). It is evident that how individuals represent themselves will influence interactions in group dynamics.

Avatar representation influences social interactions on a more individual level as well. Yee and Bailenson (2007) found that users who interact with attractive avatars were closer in self-disclosure and interpersonal distance than participants assigned to less attractive avatars. They also found that participants with taller avatars were more confident in a task negotiation than participants with shorter avatars. Often these judgements are unintentional and are made before a person even speaks, which has a huge influence on preceding perceptions of communications. Nowak and Rauh (2005) provide valuable insights on social influence of avatar visualization choices. They find that more gendered and human-like avatars significantly positively influenced other user's perceptions. Additionally, participants with feminine avatars were more attractive, but everyone still preferred other users that reflected their own gender (Nowak & Rauh, 2005).

Virtual worlds are not immune to real-world racial biases, which can prohibit social interactions amongst users (Eastwick & Gardner, 2009). Hansen (2006) says, "the conceptualization of the virtual body is a directly political issue, one that will determine not only the image but also the degree of agency our culture is willing to accord the body" (p. 14). Eastwick and Gardner (2009) argue that reciprocation concerns influence how a VR Avatar reacts, and that these concerns are determined by attractiveness or race of the requester. They found that individuals were less willing to reciprocate when an avatar was dark skinned, and that the perceived importance of a request was higher with an individual who is light skinned. Eastwick and Gardner (2009) say that whether "skin tone bias reflects either an automatic racial bias unfortunately imported from the real world or a thoughtful bias against users who would

choose an unusually dark (but not unusually light) skin tone, both explanations undoubtedly have racist implications" (p. 28). This inference is unsurprising since most social VR platforms intend to replicate social situations in the real word, and racism is undoubtably a predominant component of society. It is possible to challenge social biases through activism education and research.

2.4.5 Challenging social biases with VR avatar embodiment

Even though racism is an unavoidable issue in VR, intentionality about embodying avatars and VR usage can play a positive role in dissembling unhealthy perspectives and dialogue that contribute to the racism power structure. Hasler et al. (2017) performed a study where 32 female participants were to embody either white or black avatars. They found that after being embodied in a black avatar, white participants treated other black avatars as their new in-group and whites became their new out-group. Participants' level of implicit racial bias had no impact on the reversed in-group bias effect. Additionally, Bedder (2019) finds that the reduction of implicit bias by light-skinned participants preceding embodiment in a dark-skinned avatar does not weaken following multiple exposures. This finding suggests that either VR maintains its novelty well, or that the synaptic neural connections encoding dark-skinned and optimistic features in light-skinned participants have not been negatively influenced by a lifetime of exposure to their own self-image (Bedder, 2019). Essentially, Bedder's research suggests that there is high plasticity and opportunities to change biased psychological perceptions through embodiment in VR. Bedder's (2019) research has profound implications for social justice researchers who are interested in challenging racism at an individual level to create ripple effects to change policies that keep people oppressed. Notably, culture likely plays a significant role in both social biases and the interpretation of colour because people would have various colour

associations depending on their lived experiences and interactions. Thus, findings regarding perceptions of colour may vary significantly between geographical locations, contingent on latent cultural assumptions.

VR has also been applied in scenarios where users to embody avatars of various ages to help gain an empathetic understanding of ages that differ from user perspectives. Hamilton-Giachritsis et al. (2018) performed a study with 20 Spanish mothers. These mothers took on avatars of a 4-year-old child, and their full body was synchronized with a virtual body from the first-person perspective. They interacted with a maternal avatar, which responded in either a positive or negative way. Researchers found that participants had strong body ownership over the child body, and that negative parental behaviour increased participant empathy levels. On the other end of the spectrum, the negative effect of ageism towards individuals over 65 years dissipated when participants were involved in a VR perspective taking exercise (Oh et al., 2016). VR ageism reduction has implications for preventative measures in developing youth empathy to support the development of children becoming more engaged citizens. However, it also serves to bring credibility to the notion the VR can be used for good, and that the possibilities for social justice outweigh the negative consequences of inequities being perpetuated through VR interactions.

Rosenberg et al. (2013) examined how participants embodying avatars with the superhero flight abilities increases helping behavior compared to participants who rode along in a helicopter. Through a variety of tests, researchers found that participants who had the ability to fly were much more helpful than the than those who did not. This increased helpfulness is likely because primed concepts and understandings associated with superheroes led participants to uphold more prosocial behaviour. Implications of primed concepts further enforces the assertion

that social presence and interactions in VR are influenced by avatars. The virtual body and perceptions of self impact how immersive interactions unfold. See Table 3 for a timeline of noteworthy social presence contributions. The following table is an original contribution that I developed to break down the chronological timeline of social presence research identified in this literature review.

Table 3

Timeline of Noteworthy Social Presence Contributions by Researchers

Author & Timeline	**Noteworthy Social Presence Contributions**
Nowak & Biocca (2003) Nowak & Rauh (2005)	Gendered and human-like avatars significantly positively influenced other user's perceptions of environmental and social presence.
Yee & Bailenson (2007)	Attractive avatars are closer in self-disclosure and interpersonal distance.
Bente, Rueggenberg, Kraemer, & Eschenburg (2008)	Avatars enhance social presence through ability to convey social cues.
Eastwick & Gardner (2009)	Attractiveness and race of a requester influences reciprocity of requests.
Fox & Bailenson (2009)	Exercise increased with a realistic representation of physical selves.
Jin (2009)	Ideal self-image avatars are more likely to be psychologically immersed in the virtual environment than accurate avatars.
Pena, Hancock, & Merola (2009)	Black-cloaked avatars were more aggressive than white-cloaked avatars.
Jung (2011)	Social presence is a significant predictor of satisfaction in VR.
McCreery, Schrader, Krach, & Boone (2013)	Relationship between learner and avatar take precedent over media and environmental characteristics as a predominant factor in social presence.
Rosenberg, Baughman, & Bailenson (2013)	Embodying avatars with the superhero flight abilities increases helping behavior.
Wrzesien, Rodríguez, Rey, Alcañiz, Baños, & Vara (2015)	Teenagers had a stronger emotional connection and activation of specific brain regions with an accurate avatar.

Sivunen & Nordbäck (2015)	Interaction and level of participation play a significant role in the achievement of social presence within a dispersed team.
Oh, Bailenson, Weisz, & Zaki (2016)	Ageism is reduced after individuals embody an older avatar.
Yilmaz, Aydemir, Karaman, & Goktas (2016)	Feedback and interaction are important variables of social presence.
Murray (2016)	Performance effects are enhanced by the presence of others.
Hasler et al. (2017)	After being embodied in a black avatar, White participants treated other Black avatars as their new in-group and Whites became the new out-group.
Christopoulos, Conrad, & Shukla (2018)	Students virtual and physical togetherness can result in eliminating weaknesses of each environment.
Hamilton-Giachritsis, Banakou, Garcia Quiroga, Giachritsis, & Slater (2018)	After embodiment as a child avatar that interacts with a maternal avatar, participant empathy levels increased with negative parental behaviour.
Waltemate, Gall, Roth, Botsch, & Latoschik (2018)	Custom avatars notably increase presence, body ownership, and dominance.
Gonzalez-Franco & Peck (2018)	Being socially present is a bodily experience. Avatars support natural interactions, sense of space, distance estimation, and less cognitive load.
Bedder (2019)	Reduction of racial bias lasts beyond multiple proceeding activities.
Hudson, Matson-Barkatb, Pallaminc, & Jeqou (2019)	Avatars lead to greater immersion in the VE.
Yan, Ni, Wang, Liu, Zhang, & Peng (2020)	The more students efficiently interact with each other in the environment, the more reduced feeling of social isolation will be.

2.4.6 Conclusion: A review of social presence in VR research

One major component of VR literature is the significance that social presence affords in comparison to other modes of technology-mediated communication (Oh et al., 2018; Sajjadia et al., 2019). Researchers generally find that the presence of avatars leads to greater immersion in the virtual environment or experience (Hudson et al., 2019). Additionally, it is important that VR

designers allow students to speak and connect in meaningful ways because feedback and interaction are critical variables in the development of social presence (Yilmaz et al., 2016). Students' sense of togetherness can result in eliminating environmental weaknesses, while simultaneously enhancing environmental strengths (Christopoulos et al., 2018). These findings are important for the constructivist researchers and educators when developing VR learning environment that enhance social presence.

McCreery et al. (2013) claim that the relationship between learner and avatar is the most important component for developing social presence. This claim makes sense because in social situations, we are constantly self-monitoring our body and facial reactions to fulfill the tribalistic desire to be accepted by a group or individual (Gonzalez-Franco & Peck, 2018). Various studies show that avatars create a stronger psychological immersion that results in higher performance from learners (Fox & Bailenson, 2009, Wrzesien et al., 2015). Interestingly, in virtual worlds, environmental cues can be placed so that users have a targeted automatic cognitive response to interact with each other (Pena et al., 2009). Individual factors in avatar decisions also plays a role in others' perceptions and actions. Taller avatars are viewed as more confident, while gendered, and humanlike avatars are more positively perceived, feminine avatars are judged on attractiveness, and an accurate avatar representation is preferred (Nowak & Rauh, 2005; Yee & Bailenson, 2007).

Virtual environments are not immune to real-world racial biases, which can negatively influence the social atmosphere and learning experience (Eastwick & Gardner, 2009). However, after white participants were embodied in a black avatar, black avatars were more respected and treated as their new in-group, and this reduction of implicit bias did not weaken after multiple sessions (Bedder, 2019; Hasler et al., 2017). VR can also combat ageism and support empathy

and kindness development through stimulated embodiment as children, senior citizens, and superheroes (Hamilton-Giachritsis et al., 2018; Oh, et al., 2016; Rosenberg et al., 2013).

2.5 Summary of the literature review

This chapter described the development of constructivism and its critiques to fully explore the possibilities for how the learning theory may work in VR. I examined the complexities of social presence, including how the constructivist environment may be designed to elicit social presence, the influence of avatar personalization on social presence, and how social biases may be perpetuated or mitigated in immersive learning environments. In addition, the literature review provided an appropriate theoretical foundation for the study design and research methodology, which will be described in the following chapters.

Chapter 3: Methodology

This chapter provides a detailed account of the necessary components for this study. I begin by reiterating the purpose of this study and then make connections between the research questions and the guiding framework. A description of learner demographics and learning activities precedes the procedures for data collection. I outline the facilities, equipment, and agenda for each day of the data collection. Next, I carefully explain the instrumentation design, data analysis techniques, and validity decisions. I assess the study limitations and delimitations, and the ethical considerations to ensure a high-quality and trustworthy research process.

3.1 Study overview

In this study, I investigated how constructivist VR approaches can support youth SEL skill development and how virtual environments impact the sense of social presence in VR. This research was conducted in collaboration with an elementary school in Saskatoon and a class of grade 8 students. 28 students were invited to participate as co-researchers in the study. They learned about sustainable development goals (SDGs) and socially constructed knowledge while they collaborated to develop a multimedia project in an immersive art gallery. Qualitative data was collected using surveys, observations, pair interviews, group interviews, teacher debrief, and multimedia artifacts to triangulate results and provide detailed examples of youth perceptions on learning in VR (McMillan & Schumacher, 2010). This research was designed to develop an understanding of what conditions promote social learning and personal development in VR. The two primary research questions examine:

1. How can constructivist VR approaches foster youth learning of socioemotional skills?
2. How does sense of presence in youth manifest itself in immersive learning environments?

The first learning activity was a virtual field trip into the social VR platform AltspaceVR. In AltspaceVR, students explored multiple secure private virtual worlds designed to learn and socially construct knowledge about sustainable living practices. For the second activity, the class proceeded to collaborate in a creative application called MultiBrushVR, where they created 3D art together in real-time online. Students created their artifacts based on the Sustainable Development Goal (SDG) 15, life on land, to enhance their learning of deforestation (Bridgewater et al., 2015). Students had a variety of virtual tools and materials to use in 3D and the freedom to express themselves through the art they choose to create. The only guideline was the work must be appropriate to share with peers and the public. Activities were designed to promote the development of a class project where students showcased their ideas and opinions in a virtual art gallery within FrameVR. The ultimate objective of the FrameVR showcase was to offer an interactive experience for students' friends, family, and community to learn about the SDGs.

3.1.1 Demographics

This research was conducted at the University of Saskatchewan in collaboration with an elementary school in Saskatoon and a class of grade 8 students (ages 12-13, mixed gender, with varying levels of experiences and skills in VR) that were split into two groups for VR learning. The class consists of students from a range of socioeconomic backgrounds because it is a specialized program that involves a selective entrance process that intentionally targets individuals from around the city. The 28 students (15 female and 13 male) were invited to participate as co-researchers in the study. There was a range of knowledge about the SDG's, various levels of experience in HMDs, and different levels of development with SEL skills. The

grade 8 students were referred to as co-researchers throughout the study to empower youth voice and value the importance of contributions provided by the group.

3.2 Research design

Constructivism is a learning theory utilized in my study, and the philosophy I use for collecting and analyzing data. Constructivism is aligned with the interpretivism paradigm, which examines people's process of socially constructing meaning through daily interactions (Levy, 2017). The constructivist/interpretivist paradigm generally works best with qualitative data collection activities.

The research design is an exploratory case study approach that utilized a qualitative procedure with 28 students ages 12 to 14 who entered grade 8 in the fall of 2021. A case study approach was chosen to provide in-depth insight into social presence, constructivism, and SEL. A case study examines a researcher-defined bounded system, over time in detail, collecting multiple data sources found in the case study setting. The case may be an event, an activity, a program, or a set of individuals sharing a common time and place (McMillan & Schumacher, 2010). VanWynsberghe and Khan (2007) clearly outline the essential components of a case study, "The circumscription of the unit of analysis is accomplished by (a) providing detailed descriptions obtained from immersion in the context of the case, (b) bounding the case temporally and spatially, and (c) frequent engagement between the case itself and the unit of analysis" (p. 9). Case study research involves a detailed description of the context or individuals, followed by an analysis of data for themes or issues (Creswell, 2009).

This research explored and reported a case study by dividing the 28-student class into two separate groups during the learning activities. A case can be selected to understand its

uniqueness or used to explain an issue (McMillan & Schumacher, 2010). For this research, I selected a case study approach to explore the unique context of VR technology with youth. Levy (2017) advises, "When you conduct a literature review and come up short, this absence of adequate research is often an indicator that exploratory research is needed" (p. 5). In my literature review, I did not find any case studies about VR learning with grade 8 students, hence my research makes an original contribution. Exploratory case studies are useful to explore situations where there is no clearly outlined set of outcomes, which is the nature of studying SEL skills in this thesis (Lucas et al., 2018). There are no outlined SEL skills being investigated, instead the SEL skills discovered were those that co-researchers highlighted. My objective for choosing an exploratory case-study research design is to provide an understanding of the process of VR learning that is relevant for educators and researchers. Case studies help researchers consider the context of learning and understand how different elements influence the outcome.

Whereas discourse analysis or content analysis studies only offer insights into a specific aspect of a phenomenon, case studies provide holistic context analysis with data collection from a variety of sources: Artifact analysis, observations, surveys, and interviews. Case studies also have the potential for practical implications since it captures a legitimate context. Although a participatory action research (PAR) approach would contribute to an empowering study context with reciprocal benefits for the co-researchers, PAR was avoided because it needs a more extensive timeline for the cyclical nature of the research to take place. The ongoing community engagement required from PAR would not be practical for the youth in this study with the amount of time, knowledge, and pedagogical insight needed to set up the VR HMDs and immersive learning activities.

3.2.1 Facilities

The research occurred at the College of Education at the University of Saskatchewan. The scheduled research activities took place in room 2014 and the Education Library. The pair interviews occurred outside in an open space behind the building.

3.2.2 Equipment

All equipment used for this research is organized into two categories. The first category discussed is researcher equipment. Then, essential hardware and software for co-researchers in this study will be outlined. During learning activities on both days, notes were taken to record observations as unobtrusively as possible. iPads were utilized on day two for students to interview each other. Also on day two, I used a Zoom H2n audio recorder mounted on a small handle to be passed around as students respond to sharing circle prompts. I brought my Oculus Quest HMD to demonstrate virtual worlds and to help students troubleshoot any issues. I taught the co-researchers how to use the Clean Box technology to sanitize the VR hardware. The Clean Box uses UVC light to eliminate pathogens on shared electronics devices to prevent virus and bacteria transmission and ensure the highest standards of health and hygiene.

The co-researchers used the College of Educations' 15 Oculus Quest HMDs to learn in VR. Arrangements were made to borrow an iPad cart and a laptop cart with 30 Dell Latitude 2-in-1 laptops from the College of Engineering. Because previous studies identify that some learners experience physical discomfort using the HMD for learning, laptops were used to offer an alternative 2D collaboration option for learning that is compatible with co-researchers in a 3D HMD (Chang et al., 2019; Hardie et al., 2020; Hazim et al., 2016; Ritz & Buss, 2016). Laptops were also the primary technology used for students to view and create their FrameVR contribution.

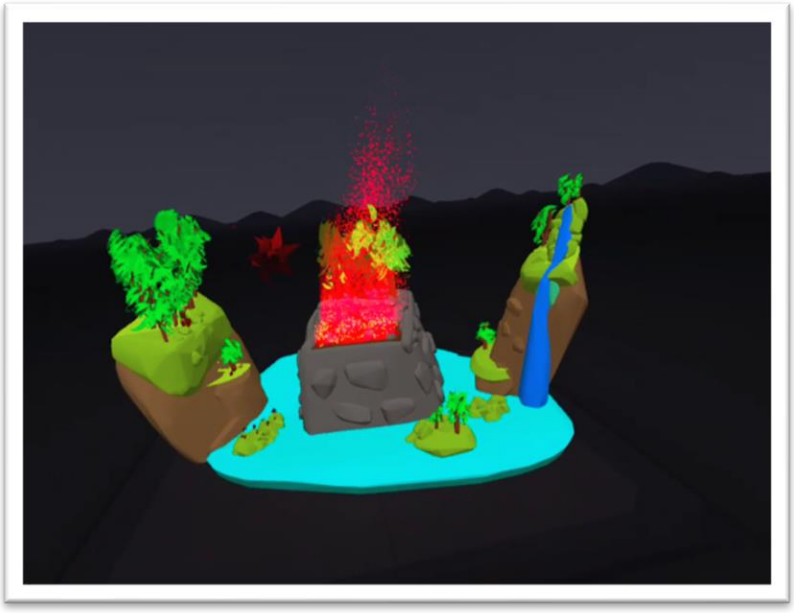
For peer interviews, iPads were used for the youth co-researchers to gather data from each other. In addition, iPads were needed to set up AltspaceVR learning activities. AltspaceVR has strong verification procedures to ensure that people do not have multiple accounts linked to the same computer to prevent banned users from easily rejoining the platform. Due to this security feature, I needed to spend a day assigning each account and iPad to a specific HMD before the learning commenced. AltspaceVR and MultibrushVR applications needed to be added to each headset before learning began. AltspaceVR is a social VR platform that allows users to create and embody avatars that they can use to explore various worlds. See Figure 5 for an image of an AltspaceVR world, called Plastic Mountain, that co-researchers explored. MultibrushVR is also a social VR platform that allows avatar creation, but it focuses on creating 3D art together in real time with groups of two to six. See Figure 6 for art that co-researchers created in MutlibrushVR. FrameVR operates from a web-based platform, so preliminary preparations were unnecessary for each headset with this software.

Figure 5

Plastic Mountain in AltspaceVR

Figure 6

Art created in MultibrushVR



Finally, conditions to accommodate for non-university students to access the Internet needed to be considered. IT Services set up a conference Internet connection used exclusively for this research project, which ensured a streamlined and secure way for the youth to connect to the Internet through their HMD's. Temporary usernames and passwords were given to students so that they could log into computers to view the FrameVR project.

3.3 Research methods

An exploratory case study is utilized, and the qualitative approach is beneficial because of the novelty of VR as an emerging technology for youth learning. Notably, case studies are not defined as research methodology but a choice as to what is being studied (VanWynsberghe & Khan (2007). Case studies are not considered a research design because it is not prescriptive, and they are unable to provide theory or analysis for how research is to proceed (VanWynsberghe & Khan 2007). However, Creswell (2009) discusses the merits of a qualitative approach when

there is a need to better understand a concept which with minimal existing research, “Qualitative research is exploratory and is useful when the researcher does not know the important variables to examine” (p. 18). There is limited amount of research on immersive constructivist learning with youth, and the important variables are still emerging. Additionally, qualitative research is appropriate for the grade 8 class because qualitative approaches are widely understood to be useful in developing an understanding of single cases, settings, or an intentional selection of participants (Maxwell, 2019). Creswell (2009) advises, “Those who engage in this form of inquiry support a way of looking at research that honors an inductive style, a focus on individual meaning, and the importance of rendering the complexity of a situation” (p. 4). This qualitative approach includes the co-researcher’s unique perspectives and the complexity of the learning context.

Once ethical approval was received from the school division, I gave permission forms to the grade 8 class and obtained parental consent and student assent. This study relies on four core data collection methodologies: artifact analysis, observations, surveys, and interviews. I analyze the primary sources with the secondary sources of books, dissertations, journal articles, and textbooks to increase the validity of findings.

3.4 Procedure

This research was conducted during two school days, between 9 am to 3 pm, for a total of 12 hours of research and learning activities with the grade 8 class. Each day, the two grade 8 teachers supported students working on and viewing the FrameVR project on laptops, while I did VR activities with the other group using HMDs for VR learning. Groups then switched for the afternoon, and the same activities repeated. Table 4 identifies what happened each day and the required materials.

Table 4

Research Study Schedule

Day	VR Learning Events	Data Collection Activities	Materials
1	• AltspaceVR exploration • FrameVR development begins	• Observations • Artifact creation • Pair interviews • Teacher debriefs	• Oculus HMD lab • Laptop cart • Notebook • Sony Handycam
2	• MutlibrushVR introduction and group challenge • FrameVR development completes	• Observations • Surveys • Pair interviews • Artifact creation • Sharing circle • Teacher debriefs	• Oculus HMD lab • Laptop cart • Notebook • Zoom H2n audio recorder • Sony Handycam

3.4.1 Day 1

Day one took place on May 9th, 2022. The co-researchers were divided into two groups for a more manageable instructional size. Students were introduced to the HMD through pre-installed application called *First Steps.* Some co-researchers have never used an HMD before, so *First Steps* taught them how to interact and navigate in a 3D immersive environment.

Once co-researchers achieved a basic level of familiarity with VR, we visited AltspaceVR to explore secure, private, virtual worlds as a group. The co-researchers had opportunities to interact with the virtual environments and each other to socially construct knowledge. They learned about waste by exploring *Plastic Mountain*, which is a beautiful natural environment that offers a contrasting image of the earth being destroyed by an overwhelming amount of plastic garbage. The co-researchers explored the *Boreal Forest*, to experience a deeper appreciation for the natural environment in northern Saskatchewan.

The co-researchers began their class FrameVR project, with the goal of teaching friends, family, and the local community about deforestation from a youth perspective. FrameVR allows the importation of various media elements, so students could create posters, digital images, videos, or anything else they imagined representing their ideas. Their work was uploaded into FrameVR to demonstrate and share learning. Teacher debriefing took place after the conclusion of the school day so that the classroom teacher could accurately provide any additional insights without influence from the group of co-researchers.

3.4.2 Day 2

Day two took place on May 30th, 2022. Co-researchers were introduced to MultibrushVR, and they had time to familiarize themselves with most of the features based on an instructional manual that I developed (Appendix A). Students were then placed into groups of six to work together and create 3D art together in real-time. The design challenge was to create a compelling message about deforestation. All the digital artifacts were collected to showcase their efforts in the VR art gallery. In this art gallery, the class could view their work in an HMD, a laptop, or a cellphone, and share it with friends and family at a personally convenient time.

The co-researchers completed physical surveys with a pencil and paper for twenty minutes (Appendix C). They interviewed each other using iPads and guiding interview questions for an hour (Appendix B). The co-researchers were interviewed together with a large concluding group sharing circle for half an hour. The questions for this were open-ended and allowed the co-researchers to offer their concluding thoughts.

3.5.1 Observations

For field observations, I used three different notetaking strategies to capture various elements involved in the research and learning activities. 1) On-the-fly notes were used to catch informal words and phrases that I wanted to remember, and interview notes offered specific details of observations during the final formal interviews. 2) Each day, I journaled after the research activities so that nothing important was lost. 3) Daily summary and reflexive notes captured what I learned in the field, the questions I wished to follow up on, ideas to assess the quality of the data, and suggestions for new interpretations of findings (Levy, 2017; McMillan & Schumacher, 2010). I watched carefully for social presence indicators such as group cohesion, open communication, and affective expression (Kreijn et al., 2014). Determining the quantity of field notetaking was a fine balance. I wanted to collect enough notes to support my data analysis but was careful not to overdo notetaking to the point where it was detrimental to my role in supporting research activities.

3.5.2 Peer interviews

Peer interviews were the primary method selected for this given study. Peer interviews asked open-ended semi-structured questions to allow co-researchers to use their language, provide long or detailed responses if they choose, and have the freedom to go in any direction they want in response to the questions (Levy, 2017; MacDowell, 2017). Interview questions focused on interpersonal skill development, social presence, and constructivist learning. An interview guide (Appendix B) was followed and included interview probes to increase comprehensiveness (McMillan & Schumacher, 2010). In addition, qualitative interview questions usually include meaningful and relevant deviations from the guide to pursue unexpected leads (Maxwell, 2019). I encouraged students to be open-minded to pursuing ideas

that deviate from the interview while keeping each other focused on core themes relevant to the research questions. To elicit genuine and beneficial responses from co-researchers, I encouraged the group to be intentionally inviting and positive towards each other. Levy (2017) discusses how meaningful interview research "is dependent on building rapport with your participants through active listening. Eye contact and gestures can go a long way to showing participants that you are interested in what they are saying, and you want them to continue" (p. 140). During the interview process, I encouraged the co-researchers to intentionally be attentive listeners to their interviewees.

3.5.3 Teacher debriefing

Since the two grade 8 teachers have a more extensive understanding of the learners involved and more experience teaching this age group, their contributions helped to overcome my knowledge and experience limitations. The grade 8 teachers had invaluable additional insights into the learning in this research study, which offered an opportunity to further ensure the validity of findings. Teacher debriefing was intentionally short and informal to respect both teachers' time and energy.

3.5.4 Artifact analysis

The class developed a variety of different artifacts throughout their learning. Artifacts are commonly described as "tangible manifestations that describe people's experience, knowledge, actions, and values" (McMillan & Schumacher, 2010, p. 361). However, artifacts might even extend beyond creative products to represent a process or a learner's perception of a process (Wilson, 2013). In the context of this study, artifacts ranged from 3D VR art to digital posters and videos on the topic of SDGs. Each artifact that co-researchers produce tells a unique story

about their learning experience in VR and provide additional insights into survey and interview responses that co-researchers provide. McMillan and Schumacher (2010) identify five strategies essential to artifact analysis: location of artifacts, identification of artifacts, analysis of artifacts, criticisms of artifacts, and interpretation of artifact meanings. I was mindful of these strategies when analyzing artifacts that students create. Code and Zap (2017) assert that alternative performance assessments, like artifact analysis, provides a valid measure of learner conceptual understanding and high-level skills such as inquiry and problem solving.

3.5.5 Survey

Surveys (Appendix C) took place before interviews and were intended to encourage students to think about their interview answers. The first three sub-questions in the first survey question align with Driscoll's (2005) five elements of constructivism (Figure 1). Since some studies use constructivism only by name and feature instructivist approaches in practice, this question exists to identify how effectively students perceive the learning experience is aligned with three of the five theoretically established constructivist principles (Ural & Bümen, 2016). The last two constructivist principles of multimodality and metacognition are excluded because they are challenging to assess on a survey and can be established through observations and interview responses.

Kreijn et al. (2014) identified three theoretically and operationally derived categories for effectively assessing social presence: group cohesion, open communication, and affective expression. These categories are represented in questions the following sub-questions within the first question in the survey. Affective expression is avoided because this category is difficult to assess. Since the literature review identified that affinity to one's avatar was a significant component of social presence, question two asks co-researchers to identify how much their

avatar looks like themselves (Jin, 2009; McCreery et al., 2013). Question three asks co-researchers to rate their comfort level within the HMD because previous studies identified physical discomfort as detrimental to social presence and the learning experience (Chang et al., 2019, Hardie et al., 2020, Hazim et al., 2016, Ritz & Buss, 2016). Finally, the last two questions are included to understand youth perspectives of the most and least valuable VR learning experiences.

3.6 Data analysis

The data was analyzed using inductive *in vivo* coding and an exploratory case study approach. The in vivo coding strategy was chosen because it did not limit my focus, and it allowed me to sustain the participants' language so that codes developed organically (Levy, 2017). With inductive analysis, more general themes and conclusions can emerge from the data rather than imposed before the data collection phase (McMillan & Schumacher, 2010). The inductive approach was more suitable than other data analysis methods by including participant language and fewer researcher-imposed conclusions, which facilitated authentic representation of youth perspectives (MacDowell, 2017).

Coded data was organized into categories derived from research questions and emerging unanticipated themes that arose from the research. I regularly returned to my research questions, exploring the data, answers, problems, and conflicts which co-researchers faced in their responses. This process required that I navigated back and forth between research questions and data, repeating the process many times to explore themes and exceptions that emerged (Hamilton, 2011). Interview data was placed into larger patterns to be described and discussed with field notes, surveys, and artifacts. Nvivo 12 qualitative coding software was provided by the

University of Saskatchewan and used to organize, analyze, and gain insights data during the coding phase.

3.6.1 Strategies for validating findings

Yazan (2015) says, "Validity and reliability are the concepts which were first postulated in natural sciences and borrowed by quantitative research in social sciences. Therefore, reconciling these terms with constructivist epistemology that undergirds the qualitative research is a thorny task" (p. 147). To ensure qualitative research is rigorous, Creswell (2009) suggests checking transcripts to ensure that they do not contain obvious mistakes made during transcription. This process was undertaken to ensure that the analysis included verbatim accounts and quotations from interviews and surveys for authentic co-researcher representation (MacDowell, 2017; McMillan & Schumacher, 2010). Inclusion of verbatim quotations in the data analysis promoted objectivity by reducing researcher bias. I followed a careful process to ensure that the definition and meaning of codes were consistent during the coding process, which was accomplished by comparing data with the codes and by writing notes about codes and their definitions (Creswell, 2009).

Case studies are sometimes criticized as lacking scientific rigor because they do not offer testable generalizations (Gustafsson, 2017; Lucas et al., 2018). This study loses generalizability and transferable relevance to other classrooms due to constraints like cost, technology setup time, and constantly evolving VR technology. Still, the research has relevance to other classrooms by utilizing multiple full school days. Notably, Lucas et al. (2018) says, "It is also worth noting that there is the argument for an absence of generalizability across the board in education and social science, not just a shortcoming of case study research" (p. 217). Each

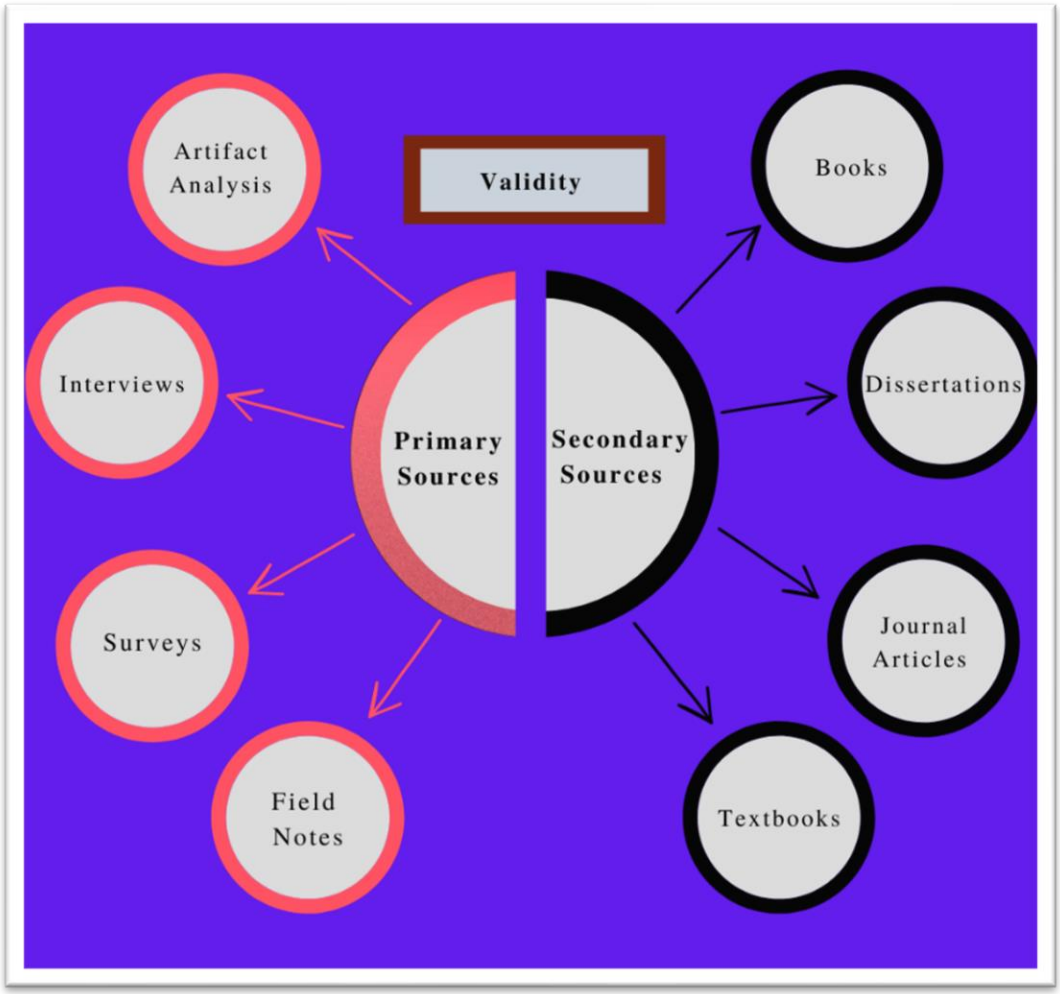
educational context offers unique instructional styles and a unique set of learners with different reactions to learning. Thus, any educational study features contextual variables that would be impossible to replicate.

Typically, validity is a term less associated with qualitative research because of the complex nature of data collected. However, the notion of catalytic validity helped ensure that the findings are useful and rigorous. Catalytic validity is the extent to which the research, focusses, re-orients, and energizes participants (Lather, 1986). The research purposefully channeled its impact so that the youth gained self-understanding and self-determination through their roles as co-researchers. Findings report the catalytic or generative artifacts and narratives that reveal how youth analyze their experiences learning in VR (MacDowell, 2017). Catalytic validity means that there was documentation that the research and learning process has led to insight and activism from the respondents (Lather, 1986). In this thesis, catalytic validity was demonstrated through activism and insights achieved by learning the SDGs in AltspaceVR and creating deforestation artifacts in FrameVR.

I used rich, thick descriptions to convey the findings, and authentically presented discrepant or negative information that counters or conflates with the themes (Creswell, 2009). Additionally, this study used various data sources to triangulate results and increase validity (McMillan & Schumacher, 2010). Triangulation occurred through combining artifact analysis, observations, surveys, and interviews. These primary sources were synthesized with the secondary sources of books, dissertations, journal articles, and textbooks to increase the validity of findings (Figure 7).

Figure 7

Validity of Research Findings



For example, Creswell's (2009) textbook, *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*, was carefully considered to ensure that that qualitative research proceeds in systematic and credible ways. Bair's (2013) doctoral dissertation, *3D Virtual Reality Check: Learner Engagement and Constructivist Theory* is similarly themed to my study and offered valuable notions of constructivism in VR settings. Kreijn et al.'s (2014) journal article, "Community of inquiry: Social presence revisited" was used to assess social presence. Driscoll's (2005) textbook, *Psychology of Learning for Instruction*, was used to support the development of

the constructivist learning environment envisioned for this study. Other secondary sources were also considered, in addition to these examples.

3.7 Limitations and delimitations

Throughout this research study, I carefully made decisions about the research focus and design, what data to collect, and how the data was analyzed. With the multitude of different decisions being made, personal bias was unavoidable. Specific questions were developed in the spirit of creating an authentic discovery-oriented inquiry (Chenail, 2011). However, to some extent, researchers who develop their own questions "become the instruments through which results for their studies are collected" (Chenail, 2011, p. 14). To help address this issue of bias, some instrumentation and questions were derived from prior studies. Still, some questions are original, and my subjective interpretations of the results influenced how the findings were reported. With awareness of how my perspective influences the outcome, I endeavoured to report findings as authentically as possible.

Although this study included many beneficial insights for educational VR, one limitation is the practical classroom application potential in 2022. There were four certified teachers (two who are educational technology research specialists) involved in setting up this learning and supporting a group of 28 students during the process. This support is much greater than a classroom teacher would generally receive. Additionally, access to enough HMDs for a classroom is a budgetary constraint that would not be possible without external funding that many educators would not have access to. The scope of this research is also limited because my technological expertise and capacity to problem solve during this research project likely exceeds that of classroom teachers who are not educational technology specialists. Future research should

identify ways to involve classroom teachers with a range of expertise to make the VR instructional adoption process more streamlined.

Oh et al. (2016) compared face-to-face (F2F) interaction communication with computer-mediated interaction as a benchmark to determine how successful a given system is at establishing a social presence. Presence research in this study does not perpetuate F2F interaction as an ideal standard target for social presence. Turoff (1991) suggests that questioning how to make computer-based interactions feel like F2F process is a misguided perspective, and it is best to prioritize facilitating group processes that are better than F2F interactions. It is important to note the purpose of this study was also not to directly compare VR to F2F interactions because there is extensive research on VR comparative studies (e.g., Ahn et al., 2014; Lui et al., 2019; Oh et al., 2016; Penn & Ramnarain, 2019; Thisgaard & Makransky, 2017; Yan & Lv, 2020; Yang et al., 2018). The scope of this study also avoids comparing VR learning with video, pencil and paper, reading, or any other learning method.

While some researchers maintain that attributes of media affect learning outcomes, others contend that the instructional method influences learning more than the delivery medium (Clark, 1983, 1994; Kozma, 1991, 1994). Even though this debate continues, some educational technology specialists consistently recognize the futility of media comparison studies that do not address the complexity of classroom teaching and learning (Lockee et al., 1999). Ultimately, rich media is better suited towards interpersonally demanding tasks, whereas lean media is best for direct and individual tasks (Walther, 1996). Therefore, VR is treated as a learning technology that is utilized when the need or desire arises, rather than a replacement for existing effective learning methods. I also intentionally avoided a control group comparing VR learning to another

learning approach because this would not be fair to the group of students that do not get to learn and explore in VR.

3.8 Ethical considerations

The moral imperative guiding this research is empowering and inspiring positive social and environmental change through learning about the SDGs, which aligns with the core values of the grade 8 sustainability curriculum. Upon completion of the study, findings will be shared with the co-researchers through the University of Saskatchewan research website *Teach SDGs,* designed to make this work readily transparent to individuals involved and the public. The *Teach SDGs* (Media, Tech, XR for Good) website was initiated by Dr. MacDowell, and I am currently the website developer.

To ensure that I have the necessary research ethics training to work with human participants, I completed the mandatory classes to receive the University of Saskatchewan Ethics Committee Approval. This involved GPS 960: *Introduction to Ethics and Integrity and Ethics* and GPS 961: *Integrity in Human Research.* Upon completion of the ethical requirements, I endeavored to approach the study with a holistic mindset for what ethical research with youth entails. In early December of 2021, Dr. MacDowell and I received research ethics approval from the University of Saskatchewan Behavioural Research Ethics Board to investigate VR learning with the grade 8 students in a learning session at the College of Education. Additionally, the school division had a mandatory ethical review process that occurred after the research was approved by the University. Dr. MacDowell and I submitted an ethics proposal to the Greater Catholic Saskatoon Catholic Schools; approval was received in April 2022.

All the co-researchers received a consent letter detailing the nature of the study, including the research investigators, procedures, purposes, the conditions for participating, the right to withdraw, confidentiality, compensation, potential benefits, potential risks, and how to follow up (Appendix D). All data was collected and coded by using pseudonyms to protect each co-researcher's identity. Additionally, I completed the COVID-19 Health and Safety Certificate, which was required for research during the pandemic (Appendix E).

3.9 Summary

In this chapter, I discussed the research design, methodology, and data collection procedures. The purpose of this study was aimed at understanding youth perceptions of social presence and constructivist VR learning. The research is an exploratory case study that utilized interviews, surveys, field notes, and artifact analysis to contribute findings and recommendations. In addition to elaborating on specific procedures, techniques, timelines, and equipment necessary for the outlined VR education and research activities, I also provided an understanding of the study design, and the learning activities. Interview data was inductively analyzed using in vivo coding and compared with other data and secondary sources to ensure validity. I conclude with discussion on limitations and delimitations, and the steps I took to ensure the research adhered to ethical protocols. The next chapter will present my analysis and interpretation of the data.

Chapter 4: Findings

This is an exploratory case study that investigates constructivist VR approaches for learning SEL skills and developing an understanding of how social presence manifests in VR. The findings of this study are presented in two main sections. Section one answers the first research question in four themed subsections, while section two address the findings that address the second research question, organized in six themed subsections. Surveys, interviews, co-researcher artifacts, journal articles, and scholarly books were analyzed to triangulate and validate the findings. Peer interviews were recorded on iPads and transcribed using transcription software. Individual surveys were completed by the co-researchers at the end of the study. Data was also collected through my written observations, audio recordings, and video recordings both inside and outside the HMDs. The 28 youth co-researchers were assigned randomly chosen pseudonyms.

For section one of the study, I analyzed SEL competencies that derived from the co-researcher responses by undertaking a thorough coding process of identifying their skill improvements. The second section utilizes Kreijin et al. (2014) C*ommunity of inquiry: Social presence revisited* as a guide to explore social presence in this study. The second section concludes with student avatar decisions, avatar affinity, and learner engagement in relation to social presence.

4.2 How can constructivist VR approaches foster youth learning of socioemotional skills?

This section explores the co-researchers' identified SEL skills developed throughout the immersive learning instruction. The first SEL skill discussed is teamwork and related elements of collaboration, interactive environments, collaborative VR tools, and social negotiation. The second SEL skill identified is creativity in relation to FrameVR projects, MutlibrushVR

collaborations, and Yang et al.'s (2018) notion of psychological creative flow. The third SEL skill discussed is problem-solving and the capacity of VR to solve problems of instruction or problems of learning, as well as improving youth problem solving skills. Empathy was the fourth and most reported on SEL skill in the data, with the co-researchers emphasizing environmental empathy, empathy for other people, empathy for animals, and the capacity for empathy to create change. The first draft of this chapter included a detailed breakdown of how the study aligned with constructivist principles, but this initial approach was superfluous and redundant considering the detailed constructivism discussion in previous chapters. Table 5 offers a concise overview of constructivist principles and VR implications in this study.

Table 5

Co-researcher Identified Implications of Constructivist Principles in VR

Constructivist Principle	**Co-researcher Identified VR Implications**
1. Learning is embedded in complex, realistic, and relevant environments	• Real life field trips should be prioritized because VR cannot match the complexity of the natural land-based environment • VR could save plane ticket cost or travel cost, but VR may likely still inaccessible for some groups • Expands universe to go to different countries or planets • Possibilities for land-based exploration in non-ideal weather conditions • Reducing risk of injury or death
2. Learning provides for social negotiation as an integral part of the learning process	• Freedom with social engagements • Making heavy topics more emotionally manageable with embedded collaborative objects • Some learners have difficulties managing distractions, and may need to be placed into groups to retain educational value
3. Ownership in learning is encouraged	• Multiple modes to represent knowledge, including poetry, picture collage, poster,

	Tiktok video. Personalization can lead to greater sense of ownership.
4. Multiple perspectives and modes of representation are supported	• AltspaceVR and FrameVR are both accessible in a non-HMD 2D mode • MultibrushVR does not support non-HMD 2D • Important to have alternatives because some co-researchers experienced discomfort
5. Self-awareness of the knowledge construction process	• A lack of touch based sensory immersion (finger tracking) negatively changes interpretations • Feels like a different dimension • Unpleasant to be disturbed by external stimulus while in HMD • Awareness of higher social risk taking in VR

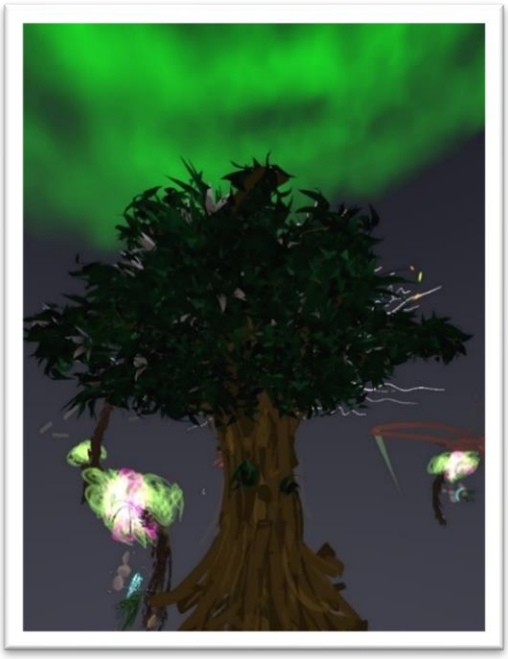
4.1.1 Teamwork

The co-researchers suggested that they acquired collaborative skills and improved their teamwork throughout the VR experiences. In MultibrushVR, youth needed to work together to create art that represented deforestation. See figure 8 for a tree that co-researchers created in MultibrushVR. Overall, 56 percent of survey respondents identified MultibrushVR collaborations as their favourite VR learning activity. One anonymous survey respondent said, "*I think my favourite part about the VR learning was when I got to connect with my friends through the VR and we were able to share our learning experiences together."* Savanah mirrors with this sentiment, "*I did have fun when I was in the Multibrush world today. It was very interesting. And you could work together, to make art with your classmates in like a virtual world*." Emma stresses that working together is necessary to create quality art. She added, "*I've gotten better at teamwork because you'll have to work together to make something that's okay*." Emma highlighted how the synergy of collaboration is invaluable in MultibrushVR. Her comment is

congruent with Murray et al. (2016) who claims that performance effects are enhanced by the presence of others. In a study on healthcare professionals learning in VR, Buchman and Henderson (2019) also found that students identified teamwork as a crucial element for discussing needs and improving outcomes.

Figure 8

MultibrushVR Tree Art Sample



Environments that encouraged informal socialization were beneficial to collaboration and learning about challenging topics. Despite processing the devastating effects of climate change and negative impacts on people, many of the co-researchers identified exploring the flooded house virtual world with their friends as a highlight of their learning experience. Brooks said, "*There was a flood, and we did a bit of exploring and we got a good view of everything. It was an interesting place to be, but it was also very important. Understand how it was happening and why.*" In the AltspaceVR flooded house, the co-researchers got to be immersed in an

environment where climate change has a direct and tragic impact on people. This type of experience might have a depressing effect on learners, yet Brooks identified it as impactful and positive, likely due to the design of the virtual world. Since VR offers the potential to embed playful interactable objects, it may be opportune for positive framing of difficult topics. Clara reported, "*I would say that VR, it lightens the mood around like heavy topics such as the SDGs and how badly it's affecting people*." Leonardo contributed how specific collaborative environmental characteristics allow for balanced learning about heavy topics. He said, "*It was teaching about the effects of climate change. And there was a basketball hoop and I got to play a round with my friends on that once we were done learning about it. So that was really cool*."

Notably, the basketball did not interfere with the learning because this group was responsible enough to begin playing after the exploratory learning. In the preceding interview responses, Leonardo still showed evidence of learning and understanding because of the flooded house experience. He shared, "*I know more about sustainability because we went to the ocean, we went to a flooded house to see the aftermath of a natural disaster, which could be caused by climate change*." Lennon added, "*And we were playing basketball and it was just a really good time*." Christopher commented, "*It was just really fun to just play like play basketball in VR and like being able to learn with them and collaborate with them through VR and seeing all their different avatars.*" The environment was expertly designed to support fun collaboration through incorporation of digital elements like basketball hoops, while still promoting meaningful learning.

Some of the co-researchers identified freedom to socially negotiate who they were talking to in AltspaceVR as positive component of their learning. For example, Christopher contributed, "*I felt I had more freedom to roam around venture around and stuff. So, since it was new, I felt*

adventurous being able to the freedom to be able to move around, go places, talk to some people." Kiera mirrored this sentiment. She said, "*So some benefits are, you get to talk to different people, which is cool, because I don't think you see that often, you know? And I thought it was cool that I was able to communicate with my class*." Although student socialization is often predominant during school breaks and recess, this opportunity is less common in technology-mediated interactions during school hours.

Embedded collaborative tools and the opportunity to socially negotiate learning had transformative moments for some of the co-researchers, but it did not work as well with others in this group. Kiera suggested, "*You have to make sure with the VR that it's strictly used for education and everything in that world doesn't get blown out to proportion*." It is a fine line with collaborative tools because some groups may not be responsible enough to prioritize the learning over the fun moments. Clara added, "*And a lot of people wouldn't have the maturity to deal with this, right now, which is why it might be a problem teaching other classes.*" Clara's argument has validity even within this group of co-researchers. The morning AltspaceVR exploration group was highly focused and seamlessly traveled between virtual worlds, but the afternoon group had more challenges because they were distracted by all the exciting stimuli. A student of the afternoon group, Kiera, suggested, "*I mean obviously some of it can be fun and stuff, but if it's mainly for education, you don't want the education purposes to be down here. And then all the fun stuff to be like up here.*" This supports the argument that some learners may not be the best judges of their own learning needs in constructivist settings (Driscoll, 2005).

Some of the co-researchers added that there was inclination for higher social risk taking in VR. Concordia reported, "*You don't have consequences for your actions*." Victor agreed, adding, "*Whatever you do in there doesn't necessarily apply to your life outside of the VR*

headset. I believe that you might be a little more careless if you're in VR." Although this setting was regulated with multiple educators present for support, students are aware that the simulated VR setting offers the potential for a minimal risk space to socially experiment in (Annetta et al., 2010). Additionally, previous studies have reported more dominating behaviours in VR because a lack of clear direction or active participation from the whole group (Kolomaznik, 2017). Upon debriefing with the grade 8 teacher, he suggested that the youth be strategically placed into groups for the second VR learning day rather than self-selecting groups. He also suggested a more structured task for the students to work towards, and this advice was applied for VR learning on day two on May 30. Although de Back et al. (2020) suggests group sizes may have a significant impact on collaborative efforts, findings from my study imply that compatible learner placement and task-oriented learning are just as valuable factors at the grade 8 level.

4.1.2 Creativity

Creativity is considered a fundamental human characteristic that is essential to our individual and combined capacity; hence it is unsurprising that creativity enhancement is a priority in many areas of contemporary education and industry (Thornhill-Miller & Dupont, 2016). When assessing creativity, a valuable consideration is that originality is more valuable indicator than what is a useful, profitable, or beautiful product because what is not useful now may be useful in the future (Smith, 2005). Thus, the co-researchers were pushed to worry less about achieving a certain standard and readjust their focus to developing something new. Some of the co-researchers appreciated the creativity that they express in FrameVR. Amelia reported, "*FrameVR has that way of that creativity where you can create your own world and worlds*." Kiera added, "*In the FrameVR and we saw how you could create things and the whole new world that you were in, it was really fun and getting to also participate in the creation of that was a*

really cool experience." Overall, the youth positively viewed the variety of ways to be involved in the Frame VR project and appreciated the scale of which the platform allows users to develop and design spaces. See Figure 9 and 10 for examples of the completed FrameVR projects.

Figure 9

FrameVR Learning Environment (view 1)

Figure 10

FrameVR Learning Environment (view 2)

To benefit the development of creative solutions, it is valuable to consider appropriate creative technologies in which learners can most clearly express ingenuity or innovation (Liu et al., 2011). Some technologies better promote specific characteristics, social interaction processes, and environmental factors of creative tasks (Gabriel et al. 2016). Many of the co-researcher responses mentioned MultibrushVR as their favourite application because of how it fosters creativity. A survey response reported, "*I was able to tap into my artistic side. I never really knew I had*." Another survey response said, "*I've learned many skills in VR, like navigating the menu and painting in MultiBrush*." Damien speaks to how his drawing skills have improved. He reflected, "*I've really improved, with drawing because I'm a really bad drawer*."

Sabrina emphasizes the collaborative aspect of creativity in MultibrushVR. She shared, "*it was for when we were just experimenting with the multibrush that was really fun, with my classmates, just experimenting and making artworks and stuff*." Autumn highlighted, "*It was really, really cool to be able to use my hands or use my eyes instead of just writing stuff down, drawing stuff, with a pencil or pencil Crayon, marker things like things like that.*" Autumn appreciated how MultibrushVR can emulate artistic materials to promote creativity, whereas Lana appreciates its capacity for breaking the rules of reality to create a variety of artifacts (Figure 11). Lana said, "*I would tell them how creative you can be in virtual reality, because it's not real. You can do whatever you want pretty much, in our world we made a bunch of big trees*." MultibrushVR allowed the co-researchers to use a variety of realistic and unrealistic materials to promote their imaginative potential.

Figure 11

Variety of MultibrushVR Artifacts

Creative flow was evident in some of the co-researchers' MultibrushVR experiences. Flow theory offers a theoretical perspective on the dynamics between psychological state and creativity, such as the feelings of athletes and dancers who are completely immersed in their activities (Yang et al., 2018). Clara demonstrated creative flow in one of her interview responses about MultibrushVR:

> *I would say it was this morning painting because we had all set up room boundaries. And then everyone was bumping into each other. Well, I was bumping into everyone because I was just like so obsessed. I just needed to get all those brush strokes in and I didn't realize that I could resize myself at the time. I was just going around my tree and I was just like hitting everyone with my Oculus thing*.

Clara iterated how creative flow is a pleasant and positive mental state when people barely notice the activities they are participating in, sometimes not even being aware of their own presence

(Yang et al., 2018). Dan (2021) examined the associations between flow, creativity, and learning interest amongst secondary students in eastern China. His results indicate that the learners' interest is directly related to flow and creativity. The relationship between learner interest and creativity is implied through the co-researchers' positive regard for MultibrushVR.

4.1.3 Problem-solving

According to Vygotsky, each problem encountered has different possible solutions, which must be assembled in the mind of the solver (Langford, 2005). There was significant evidence of learners assembling solutions of VR to solve learning problems and considering the different ways that the technology can be effectively applied in educational settings. Although the co-researchers were aware that VR is not always the best instructional approach, they identified a variety of different contexts that may benefit the application of utilizing VR. The co-researchers found that VR becomes a powerful technology to provide complex, realistic, and relevant alternative environments for settings that are rare, expensive, impossible, or dangerous.

VR proves advantageous for types of learning which are rare and expensive. Leonardo said, "*I got to visit the places that were affected by the main SDG that we were focusing on … because I don't see it a lot in the city*." Although it would be possible for students to bus or fly somewhere that is heavily affected by deforestation, it may be more sustainable and financially feasible to borrow VR headsets to learn about these issues. Autumn shared, "*We can do pretty much anything we want without having to pay a plane ticket or having to limit ourselves by thinking, 'oh, that isn't even possible'*." Damien agreed, "*If we're gonna go somewhere and it would be like a lot of money, you could just pop on a headset and then just go there in VR*." Most classes would not consider international travel an option, but VR allows opportunity for place-based learning without leaving the classroom (Kavanagh et al., 2017). However, some students

were hesitant of the cost of HMDs as an alternative. Emma said, "*I assume that it uses some pretty expensive technology that probably isn't very available*." Clara has similar thoughts. She says, "*It's a reality that not a lot of classrooms have these things or they're able to access, VR headsets and stuff or even the Internet sometimes*." These are valid concerns about inclusion and equity, considering school divisions often struggle to adjust their budget to meet diverse needs.

The co-researchers identified VR as an excellent solution for situations that would be impossible to do with a regular grade 8 class. Evan said, "*VR is a great way to learn about the world and … to learn about everything you can visit different countries, you can visit the moon, you can visit Mars. It very literally expands your world and your universe*." Additionally, VR may be beneficial when the local weather conditions are unfavourable. Saskatchewan weather can get as cold as -40 degrees Celsius and is not always conducive to safe outdoor learning. Christopher shared, "*When it's a cold winter day, I would say being able to go do VR stuff instead of being outside in the cold would help a lot*." Emma added, "*We live in Saskatoon and you're limited to the classroom for about six months of the year*." VR can be a solution that works around some of the extreme weather to provide students with meaningful experiences in times where classrooms are less mobile outdoors.

VR offers a safe way to learn that would otherwise be dangerous by reducing the need for risk management. Christopher said, "*So the dangerous trips, let's say, jumping off a cliff, like you won't actually get hurt, but you'll experience what it'll be like."* Patricia agreed, *"last time we did VR, some of us were literally going up to a giant Anaconda snake and that would've been super dangerous because you could have died, but in VR, you can actually go up to things*." In land-based experiences, there is risk of falling or experiencing dangerous wildlife, but VR eliminates these concerns.

Even though many of the co-researchers appreciated the richness of VR environments, some youth prefer field trips and exploration in the natural environment. Evan reflected, "*It depends what you're learning about. If you're learning about your immediate environments, what's around you, I would personally rather be outside learning.*" Damien mirrored this sentiment, "*If you're going on a field trip to Waneskewin or something like that, then you get to see all the stuff like with your own eyes. But in virtual reality it's not really the same thing*." Ideally, if there is an opportunity for learning in the local environment it should be considered first because VR cannot match the complexity of the natural land-based environment.

In survey responses and interviews, the co-researchers emphasized learning how to problem solve technology better and solving VR headset issues as one of the areas that challenged them. A survey response said, "*Getting started on the VR was a bit challenging*." Another response says, "*Learning how to use the headset was difficult at first, but I got the hang at it fairly quick*." Autumn said, "*I found getting on the different apps challenging*." A survey response said, "*The only challenging part was just learning how to actually use the device and how it operates as you learn*." Learning how to move around and use hand controls was a notable technical problem that learners had to solve too. A survey response said, "*Some moments that challenged me was knowing what the controls were*." Lennon agrees, "*It took a little bit to get the hang of it. Just moving around and like getting used to the hands and stuff*." VR as an emerging technology places learners in an environment that have never been in before, and the students must overcome new obstacles that they may have not encountered before.

Despite the learning curve that comes from using VR, the co-researchers were able to solve problems that arose. Concordia said, "*Oh, I suppose I've improved in a sense. Well, I know how to work technology better. This experience was really helpful. I learned how to move my*

hands so that I could control the headset." Along with problem solving physical VR hardware, the youth were able to troubleshoot and develop skills within the VR software. Nyomi said, "*I've also developed like skills in VR because like I'd never used it before. I mean now I'm like pretty comfortable in Altspace*." Some adults have difficulties navigating AltspaceVR, so it is impressive that the co-researchers became proficient using this software.

Many of the co-researchers identified how improved technology problem solving skills could be beneficial to their future. Clara notes, "*I've improved like my technology skills, I don't know, I can use, I can just put on a VR headset and just know what to do right now. And that's gonna be useful skills in the future, considering how fast like technology is advancing.*" A survey response said, "*Things that I've improved because of my experience in VR, is being able to better understand technology .... This improvement can help me in the future by helping me in my career depending on what it is*." Clara added later how she can see these VR technical skills as useful in her career. She commented, "*If we were ever to apply to a job and like say we have this experience that puts us on the hot seat*." Araiza-Alba et al. (2021) suggest that VR problem-solving task gains are transferrable to the physical world and other practical contexts. Technology problem solving skills may have a positive impact on employment as society shifts to more automized and technology related work, but this remains to be studied.

4.1.4 Empathy

Enhanced perspective taking and empathy were the most discussed SEL competencies in the data. This outcome is supported by Bertrand et al. (2018), who claim that constructivist notions of collaboration and self-reflexivity are ideal for promoting empathy in VR learning. Lennon articulates that VR's capacity to immerse an individual in a space and allow them to experience the issue rather than passively consuming information is critical for empathy. Lennon

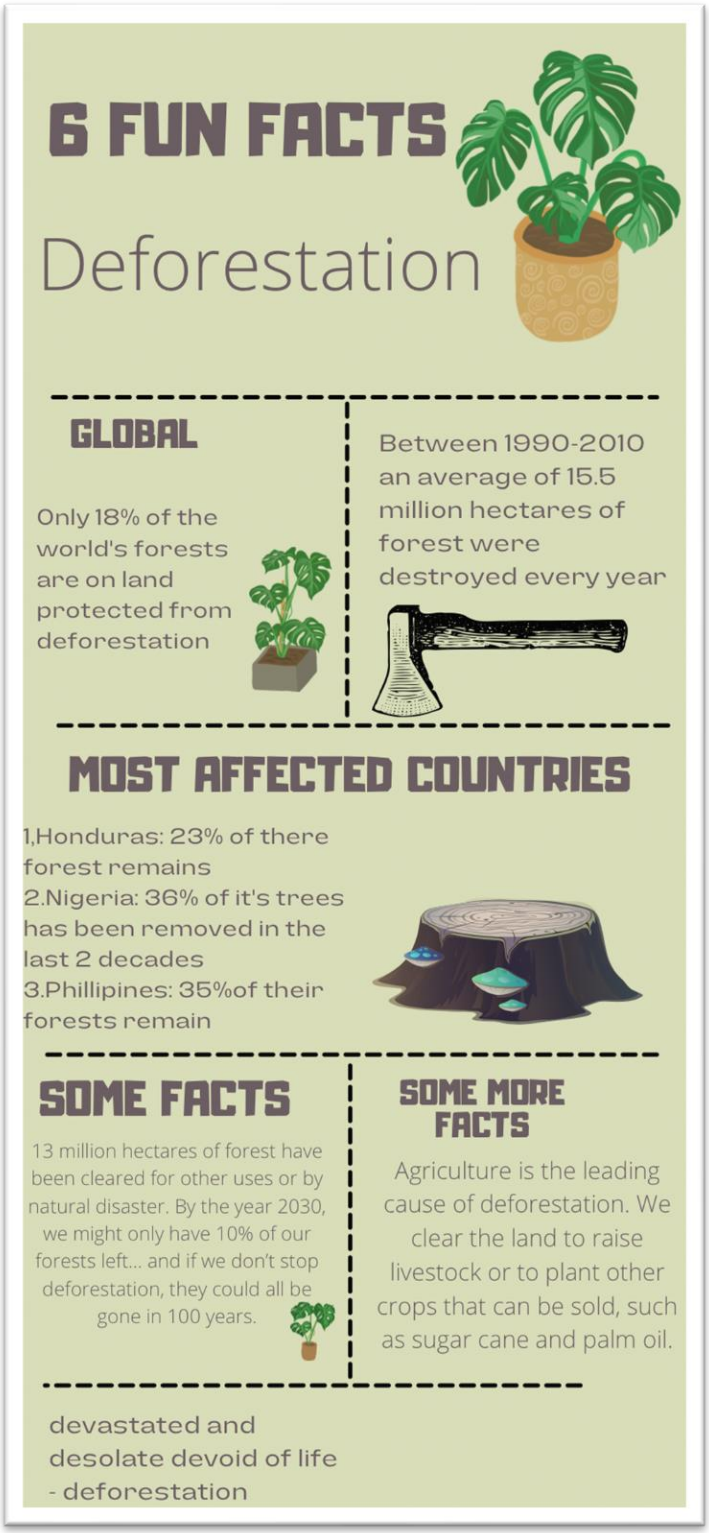
said, "*Sometimes when you're not in VR, you don't really see what's happening in front of you. But when you're in VR, you're able to see and what people are actually going through and therefore … you care more*." Concordia added that that physically embodying the space creates more of a holistic experience. She said, "*when you're there and experiencing it, you're automatically going to care because it's triggering more in your physical self than just your mind, right? It's triggering your heart and your emotions, and that affects you*." The mind and body connection are an often-disregarded aspect of advanced learning, but it may be creating a more emotionally compelling experience. Findings from this study concur with Hamilton-Giachritsis et al. (2018) and Schutte et al. (2017) who discovered that virtual reality experiences lead to a higher level of empathy, empathic perspective taking, and empathic concern. Notably, Bertrand et al. (2018) emphasises how SEL skills are interconnected because enhanced interpersonal skills allow an individual to develop empathetic accuracy.

Environmental empathy

VR offers a space for individuals to consider the impact on the environment. Hailee provided a description of how VR could promote environmental empathy for trees and the land. She said, "*it actually gives you a visual, because if people are just telling you, trees are burning down and trees are getting cut down, you can't really picture what the scene looks like.*" Sabrina adds, "*Places that are strongly affected by like deforestation and stuff like that, and you actually go to that place, it makes you care much more about it than you would just looking at pictures or just talking about it.*" Concordia offered comments on how VR can build empathy for ocean pollution. She reflected, "*When we go in VR and we're actually swimming in the ocean, filled with garbage, something you could never do in a classroom, it impacts how you feel about the environmental issue, because you are experiencing it*."

Figure 12

Deforestation Infographic



The notion of experiencing rather than just knowing about environmental issues was one of the highlights for most of the co-researchers. Autumn said, "*It's a lot easier to learn about topics like that because you get to experience firsthand what it is about.*" VR offers the possibility for an extensive range of empathy from exploring challenging environments. Autumn added, "*We can be in the situations like a flooding house, a burning forest, a normal forest, a forest with cut down trees. There are so many things, it's really unlimited*." The experience of autonomously navigating these settings was impactful to the co-researchers. Also, students expressed environmental empathy in their FrameVR contributions which ranging from videos to posters to infographics. For an example of environmental empathy in the FrameVR project, see Figure 12 for an infographic designed by one of the co-researchers to teach about the effects of deforestation.

Empathy for other people

Along with considering the impact on different environments, VR allows individuals to take the perspectives of other people. "*It's hard to empathize with situations that are far away … but when you're in VR you feel like you're really there. … And I think that would definitely help, citizens become aware and empathize with other people*." Clara agreed on how it is easier to connect with people when there is an individual is physically present somewhere:

> *VR really helps you practice empathy and the act of standing in someone else's shoes. Just the art of talking doesn't cut it most of the time, because a lot of people there's a saying 'I'll believe it when I see it'. And when you see it and you're actively in that world that can really help you change your perspective.*

Clara suggested that VR's active involvement of learners allows significant capacity to change perspectives and help promote respect for others, which are elements that have positive implications for an individual and for society. Rueda and Laura (2020) add that VR embodied perspective-taking is a morally strong instructional option if the empathetic context is justified, if social targets are appropriately specified, and if they are perceived as essential to supplement other opportunities for pro-social agency.

Holistic empathy

Some of the co-researchers gained a well-rounded empathy for the people, animals, and the natural environment. Sabrina said, "*Moments that challenged me was actually seeing how much garbage there was in the ocean and actually seeing how people are affected by the flooding of houses or the flooding of the community and actually being there*." Concordia commented how she gained empathy for animals in the natural environment. She said, "*A part of learning that was challenging was when we went into the ocean, and I really saw how much the animals were suffering. That was really challenging. That was a lot to take in.*" Savanah iterated empathy for animals negatively impacted by pollution. She said, "*I think in the ocean life specifically, that world, seeing the animals caught up in the plastic. Yeah. That just really affected me*." Christophers agreed, "*Took us to the ocean of where there's lots of plastic in the ocean. Sea creatures are dying because of that, being able to learn all that, being able to be taken to those places to learn."* Many of the co-researchers expressed significant empathy for various sea creatures and the state of the ecosystem they exist in.

Empathy to create agency

Enhanced empathic capacity has potential to create agency in learners. Damien said, "*It might get us to care more by showing us what would happen if we were to keep doing what we're doing, like burning fossil fuels and stuff.*" Amelia agreed that VR offers significant potential to put energy consumption into perspective and create a sense of agency. She said,

> *And I feel we'd be able to really show how much energy and how it would be used and worked it through VR. And I feel that would really help start getting people to care because there wouldn't really be that barrier of, well, 'how do we know it works?', because we would already have tested it out in VR*.

The possibilities of VR to frame environmental solutions in a positive light was less discussed, likely because many of the environments were designed to elicit an emotional response. Brooks said, "*You've seen the underwater, the pollution in the water with the flooded houses, all of that. But this can be an example that if we don't do something right now, that's what our world will look like permanently*." Damien added, "*So then people would be like, 'oh no, if this is what's gonna happen, then I kind of want to help prevent that."* Damien, Amelia, and Brooks implied that VR can simultaneously increase knowledge and caring, to create a proactive mindset. This affirms Rosenberg et al.'s (2013) findings about VR's potential to improve prosocial helping behaviours. See Table 6 for a summary of SEL skills identified by the co-researchers.

Table 6

SEL Skills Identified by the Co-researchers

SEL Skill	**Co-researcher Examples**
Teamwork	• Making art together in MultibrushVR • Teamwork to create a quality product

	• Informal socialization was valued • Embedded interactable objects were conducive to enhancing connection • Freedom to decide who they talked to was beneficial for some, not for others • Higher social risk taking in VR • Strategically placing the co-researchers in groups was recommended by teacher
Creativity	• Creating own VEs • Taping into artistic side • Learning to paint/draw in VR • Navigating MultibrushVR menu • Physicality of creating art • Emulating real-life materials • Unlocking imaginative potential • Creative flow while in MultibrushVR
Problem-solving	• VR as a learning solution for situations that are rare, expensive, impossible, or dangerous • Learning how to use HMD, software, hand controllers, navigate VEs • Advanced tech problem-solving has potential to enhance employability
Empathy	• Mind and body connection to create enhanced experience • Environmental empathy by getting to experience issues firsthand • Empathy for people by *standing in someone else's shoes* • Enhanced care for animals by seeing how pollution impacts marine life. • Pro-active mindset development through perspective taking

4.2 How does sense of presence in youth manifest itself in immersive learning environments?

The second half of this chapter directly addresses the second research question. I utilize Kreijin et al.'s (2014) *Community of inquiry: Social presence revisited* as framework to present three operational subsections of social presence including open communication, affective expression, and group cohesion. Group cohesion is further broken down based on Forsyth (2010) three indicators of cohesive groups (perceived cohesion, emotional cohesion, and task cohesion).

Since the literature was rich with discussion about the role of avatars for social presence, I also include the co-researchers' avatar decision-making process and their sense of connection to their avatars. Next, I discuss the co-researchers' motivation based on the novelty of VR instruction and ownership that the youth had in their learning process. Finally, I conclude with how the HMD discomfort may have interfered with learner sense of social presence.

4.2.1 Open communication

Open communication reflects the interactive and intentional nature of communication. Kreijn et al. (2014) defined open communication as "the extent to which communication within a team or organization is characterized by transparency, honesty, and mutual understanding" (p. 15). Transparency, honesty, and mutual understanding is difficult to assess but this can be indicated with survey responses about how much co-researchers enjoyed being with other classmates. There were 80% of co-researchers that agreed or strongly agreed that they enjoyed each other's company. Even though the co-researchers generally enjoyed each other's presence in VR, they are also aware of the medium's limitations. Damien said, "*You can't actually see the person face to face. You have to see the character, avatar to avatar. So, if you're telling them happy or sad news, then you can, they, you can't really see their face.*" Damien was concerned that the nondisclosure of identity cues and visual appearance might have negative impacts, such as a lack of trust and relatability (Bente, 2008). VR lacks the subtleties of spatiality, including spatial inflections and nuances against where communicational ideas can happen (Coyne, 2007). VR cannot currently capture emotions as well as in real life, and that this could be a hinderance to open communication.

4.2.2 Affective expression

Affective expression reflects the socio-emotional aspects of communication for the intention of forming interpersonal relationships (Kreijn, 2014). Survey responses signified a lack of self-disclosure (expressing vulnerability and presenting details of personal life), which is an indicator of affective expression (Kreijn, 2014). When asked, "When in VR, I found it easy to share about myself," three youth disagreed, which is more than any other question. However, expression of emotions is also an indicator of affective expression, and this was evident in many interview responses. Clara shared an appreciation for her co-researchers' creative and collaborative process. Clara said, "*It was really fun and I love to see everyone just painting and having fun.*" Sabrina commented that experimenting with art was a positive bonding moment. Sabrina said, "*When we were just kind of experimenting with the Multibrush that was really fun, with my classmates, just experimenting and making artworks and stuff*." Autumn added insights on serendipitous creation and being able to show it off in real time to her classmates. Autumn said, "*Being able to draw a cat and being able to show it off because I don't know, drawing is really, really fun and in MultibrushVR, you can really go 3D and walk around it and draw whatever you want*." Figure 13 demonstrates the co-researchers' process of collaboratively creating art in VR. Although some were hesitant to share in VR, the group highlighted that MultibrushVR was an experience that promoted the socio-emotional aspects of interpersonal relationships through the expression of emotions.

Figure 13

Co-researchers Creating Art Together

4.2.3 Group cohesion

There is evidence of effective group cohesion amongst the co-researchers. Group cohesion reflects the shared identity of the learners and their collaborative behavioural intention (Kreijn, 2014). Group cohesion can be broken down into three sub-categories, including perceived cohesion, emotional cohesion, and task cohesion (Forsyth, 2010). The co-researchers' positive regard for taking photos together is an indicator of *perceived cohesion.* Perceived cohesion is when individual members express group belonging by stressing their commitment to group through loyalty, self-identifying with the group, and actively classifying themselves as members (Forsyth, 2010). Perceived cohesion is best exemplified through the co-researchers' positive regard for taking selfies in VR. Emma said, "*I think definitely taking, pictures in the boreal forest, environment, altogether was good*." Hialee agreed, "*I enjoy taking selfies with*

everyone." If the group did not have a sense of perceived cohesion in VR, they would likely not describe taking selfies as a favourable moment.

The co-researchers also had many moments that showed *emotional cohesion.* A variety of nomenclature is used to define group emotional states, including morale and positive affective tone, but despite its label, a shared positive emotional state is one of the most notable features of many effective and cohesive groups (Forsyth, 2010). This positive emotional group state is present in Damien's description of flying in VR. Damien reported,

> *A fun moment was when we were kind of fooling around and learning how to first do VR, everyone was talking and chatting and, then our, VR instructor, was like, "oh, here's how you fly again, fly and move around quicker." Then we were having these flying contests to see who could get the highest up by flying. And then, it was kind of like a game of tag where we flew up and were flying around, which was really fun*.

As the elevated mood of one co-researcher was picked up by another, the youth eventually developed a shared emotional experience (Forsyth, 2010). There were other moments of emotional cohesion with the basketball hoops in the flooded house virtual world and with collaborations in MultibrushVR.

Although teamwork was already previously discussed as a SEL competency that the co-researchers brought up, *task cohesion* is a related but crucial element of group cohesion. A survey response said, "*My favourite experience was MultiBrushVR. I loved getting to create art that was 3D and being able to collaborate with my team*." Although this response suggests enjoying the presence of others, cohesion is likely more to do with an individual's willingness to collaborate to accomplish goals than it does with favourable interpersonal relations (Forsyth,

2010). Another survey response articulates this willingness to work together. They said, "*It is difficult to collaborate with others, so it was difficult in VR as well, but we made it work.*" Despite some self-identified collaborative challenges that the youth brought with them into the learning environment, VR was not an obstacle for task cohesion. See Table 7 for an analysis of the co-researchers' experiences of social presence.

Table 7

Co-researchers and Social Presence

Social Presence Indicator	**Definition**	**Co-researcher Examples and Non-Examples**
Open Communication	The extent to which communication within a team or organization is characterized by transparency, honesty, and mutual understanding (Kreijn, 2014).	• Enjoying each other's presence is an indicator for transparency, honesty, and mutual understanding. • Limitation is lack of facial expressions.
Affective Expression	The socio-emotional aspects of communication for the intention of forming interpersonal relationships (Kreijn, 2014).	• Appreciating each other's creative process. • Creating art together. • Sharing work with each other.
Group Cohesion		
Perceived Cohesion	When individual members express group belonging by stressing their commitment to group through loyalty, self-identifying with the group, and actively classifying themselves as members (Forsyth, 2010).	• Taking photographs in VEs.
Emotional Cohesion	A shared positive emotional state as one of the most notable features of many effective and cohesive groups (Forsyth, 2010).	• Elated emotions derived from flying and tag in VR.
Task Cohesion	An individual's willingness to collaborate to accomplish goals (Forsyth, 2010).	• Collaborating to create art. • Pushing through relational difficulties.

4.2.4 Avatar and identity

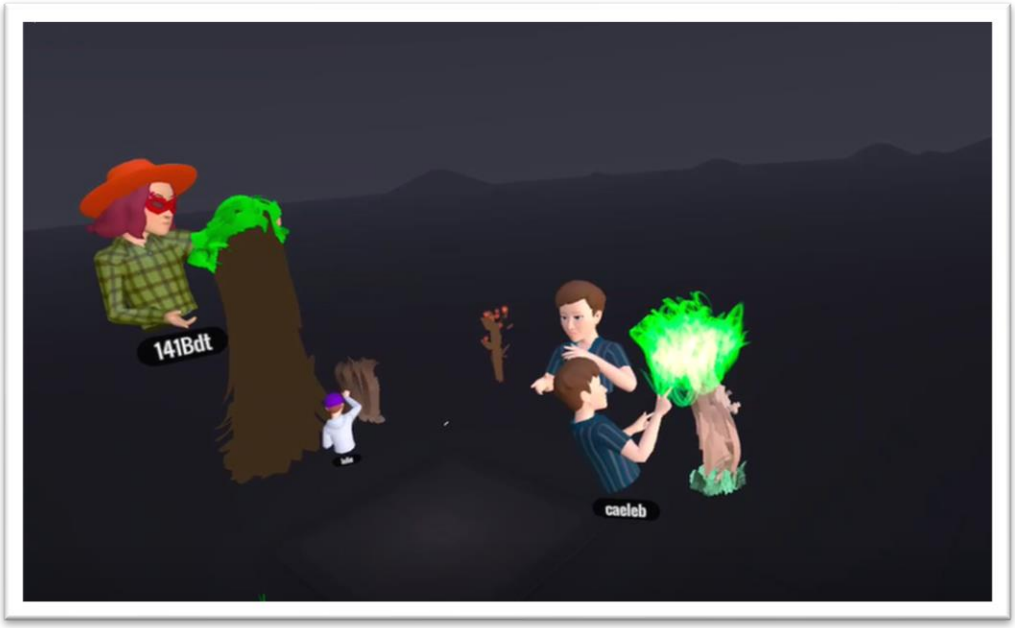
Garrison et al. (2000) suggests that social presence is contingent on the ability of learners to project their personal characteristics into the community, so analysis of avatar personalization is relevant. The co-researchers had opportunities to customize avatars in AltspaceVR and MultibrushVR. They appreciated the variety of different ways to develop digital personas. VR Avatars also offers possibilities for individuals to representing themselves in a way that is more authentic. Clara said, "*it can also be a space for, gender dysphoric or just body dysphoric people, to create something that they want to look like*." Madison adds valuable insights into the notion of avatar personalization to achieve a closer version of the ideal self. Madison says,

> *I feel this is good because, you can personalize yours to express yourself in whatever way you want to. And even if, let's say you wanted to have something in real life, on your body. If you wanted to change something, you couldn't do really do that in real life. But you can do it in VR. And I think that can give people a sense of freedom*.

Learners who wished they had a different physical and biological appearance get to embody their desired visual to interact with others. The co-researchers affirm the importance of Jin's (2009) research that found avatars of the ideal self are more important than an accurate self. Also, VR can be beneficial for representation of more temporary visual attributes. Clara commented, "*It can be just what you look like now, or maybe you can find an outfit that you wore, and you really liked. And it's just a really good way to showcase your individuality, as who you are*." Whereas some of the co-researchers designed their avatars to realistically represent them, others were more experimental with their digital personas. See Figure 14 for a picture of the youth avatars in MultibrushVR.

Figure 14

Avatars in MultibrushVR



The co-researchers who designed their avatars to mirror their real-life appearance had a variety of reasons for doing so. Emma designed her avatar so that others would recognize her and feel more immersed in the virtual worlds. She reflected, "*I made it look like me. It was mostly so that my classmates could recognize my avatar when we were in the world together*." Similarly, Autumn added, "*I chose to make it look like me because I wanted people to be able to tell it was me*." Brooks intentionally designed his avatar so that he would personally feel more immersed in the VE. Brooks contributed, *"I wanted to see myself like, because I found this VR experience very exciting. I guess maybe that's why I decided to design my character like that. Because I wanted to see me in those words.*" Christopher had related intentions for creating a similar avatar. He said, "*I wanted to make it look like me, because I wanted to feel like that I'm in that space.*" Damien designed his after to look like himself but desired to frequently change his avatar contingent on how he is feeling on a given day. Damien said, "*I might have sweatpants*

and a long shirt on or might have shirts and a t-shirt, depending on how I'm feeling when I am making my character or how I'm feeling that day." These co-researchers seem to affirm Hudson et al.'s (2019) claim that avatars can lead to greater immersion in the virtual environment.

The co-researchers who were experimental with their avatars predominantly did so because of the novelty and fun associated with playing with appearance. Leonardo shared, "*I tried to make it look like myself, but also add some creativity to it. I gave him a beard, glasses, sunglasses and cool clothes.*" Cooper reported, "*It looks pretty much like me except I had like a mustache*." Lennon commented, "*I didn't wanna do something very basic. So, my avatar was green, and it had a big mustache, and I was just trying to be creative with it.*" Concordia said, "*I never wear hats. And I think people may have had trouble recognizing my avatar because I had a hat on, but no, it didn't feel like an important decision because it was just an avatar*." Even something like wearing a hat is often regulated within a school setting, but it is inconsequential in VR. The possibility of experimenting with identity and self-representation in VR allows for a less intimidating social impact than may happen outside of VR. As the co-researchers were more experimental with their visual appearance in VR than in real life, there was less social judgement about deviating from the norm. Concordia reflects, "*I suppose the real world, I'm very concerned about how other people see me, but in VR, I wasn't*." Ultimately, some of the co-researchers felt more connected with a realistic representation of themselves while others appreciated the differentiation. Lana said, "*If you connect with your avatar while you're making it, if it looks like you, or some few people made it green and blue and stuff and they just they're able to connect with it*." Victor agreed, "*It's pretty cool that you can say you wanna dress up funky. You wanna have red long hair with bug eyeglasses with yellow eyes? I find it's pretty cool that you could do that*."

Despite having freedom to make a realistic or ideal avatar, half of the co-researchers did not express having a connection to their avatars, which contradicts Hudson et al.'s (2019) connection between avatars and greater immersion. This outcome is expected because generally meaningful connections take a longer time to foster than just a few days. A survey response said, "*I don't really feel connected to my avatar because I've only really used VR for about two days*." In this another case, the co-researcher viewed the avatar as a means to an end for their learning experience. A survey response said, "*No, I didn't really feel a connection to my avatar. I was just a tool others could use to recognize me and didn't change my experience very much*." Others were too excited about proceeding VR learning experiences to care about their avatars. One survey response said, "*I really just wanted to start exploring so I didn't spend much time on my avatar*." The avatars were not the highlight of the learning for many.

A few of the co-researchers gave less attention to their avatar appearance because they did not see it themselves. Lennon commented, "*I wouldn't say I had a real connection to my VR avatar, maybe a little bit just because it wasn't third person. You were right there, you could see your own hands … but other than that, not really.*" Sabrina agreed, "*I didn't really feel like a connection, but I was the person, so I didn't really care about how other people saw me.*" Being unable to see themselves in the setting, these co-researchers lost concern over what their avatar looked like.

Some of the youth who did have a connection with their avatar often implied that they made it realistic, whereas others made it unrealistic. A survey response reported, "*I did feel a connection to my VR Avatar because I made it to look like myself in the real world*." Another agreed, "*I felt a connection because I feel like it was a copy of myself*." Contrarily, there were some who made a realistic avatar but did not feel connected. A survey response said, "*I didn't*

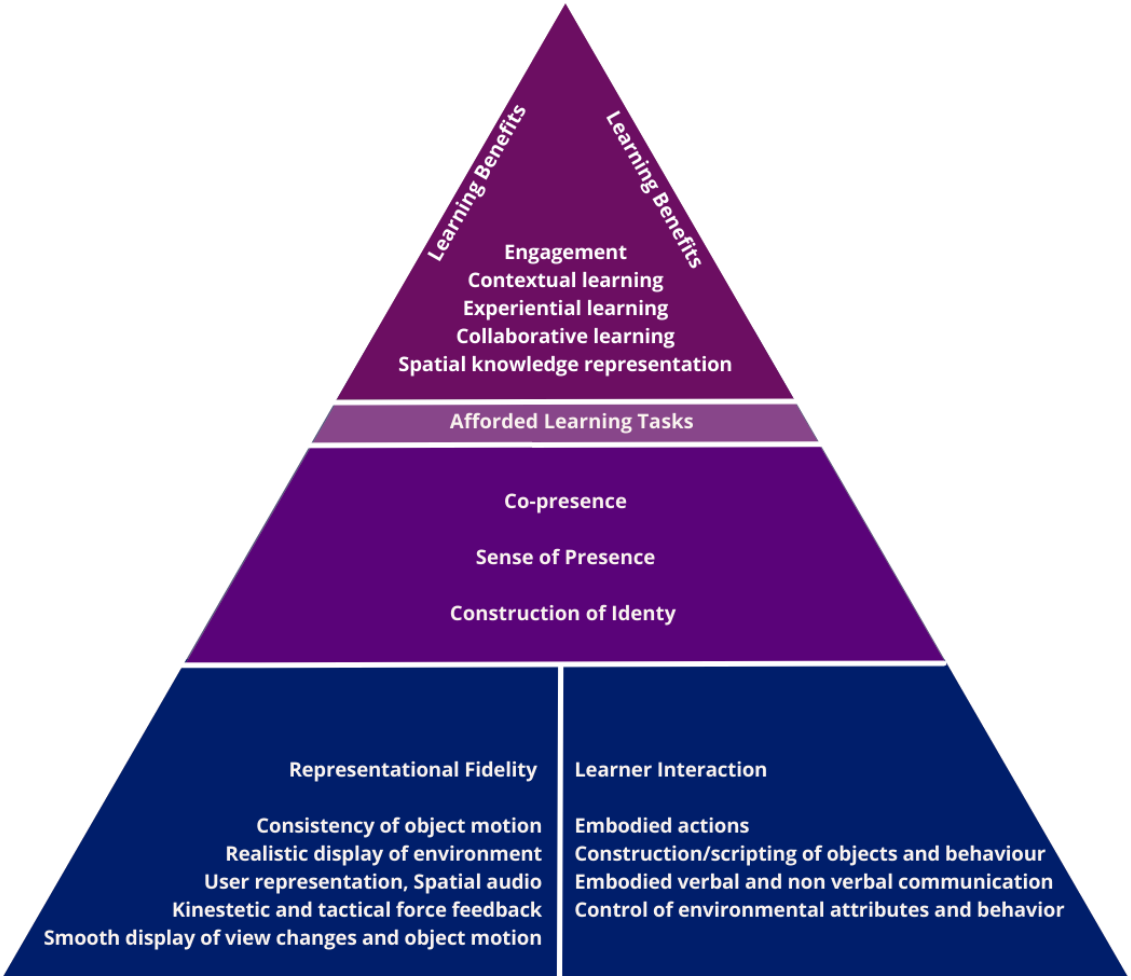
feel a connection to my avatar. I didn't put a lot of thought when making it I just tried to make it resemble me." Therefore, there is no common consensus on whether a customized avatar increases social presence, and the level to which avatars increase social presence is contingent on individual learner preferences.

4.2.5 Motivation

One of the notable primary features of VR in educational contexts is to increase student motivation to learn important content (Limniou et al., 2008; Lund & Wang, 2019). Schutte et al. (2017) find an association between engagement/motivation, presence, and high levels of empathy. Lennon contributed, "*You can actually go to these places with the real problems that we're studying about and it's a much more engaging and immersive experience than just learning in a classroom.*" However, VR research is influenced by intrinsic factors, including the belief that students would be motivated by the novelty of VR technologies, which is a factor that has the potential to diminish as learners habituate to using VR (Kavanagh et al., 2017). Brooks articulates the novelty of VR, "*Since I was exploring something completely new, completely different, I felt more excited. I felt more adventurous. I just felt like I wanted to enjoy the experience the fullest*." Evidently, VR also positively impacts mood, with the co-researchers having an overall increase in positive emotions and an overall decrease in negative emotions during their learning (Allcoat, & Mühlenen, 2018). Youth emotions, engagement, and motivation are interconnected and critical aspects of learning (Pintrich, 2003). Figure 15 is an adaption from Dalgarno & Lee (2010), which I visually redesigned to help explain how VR contributes to achieving learning benefits through social presence and identity construction.

Figure 15

VR Learning Benefits



The co-researchers had control over their learning with a variety of options to present learning in FrameVR, which is an element that contributed to increased motivation. The learning artifacts included a wide range from poetry, videos, and posters. Clara commented, "*It can be a video, it can be a song, it can be like just a picture or like even like a piece of writing and stuff. And you can integrate it into the world*." Amelia chose to do a poem (Figure 16). She said, "*I wrote a poem, and it was kind of clarifying the fact that normally in society, when we talk about the environment or any kind of thing to involve nature in the earth is normally ignored*." Riley chose to do a picture collage (Figure 17); Nyomi and Cooper contributed posters (Figure 18).

Figure 16

Deforestation Poem

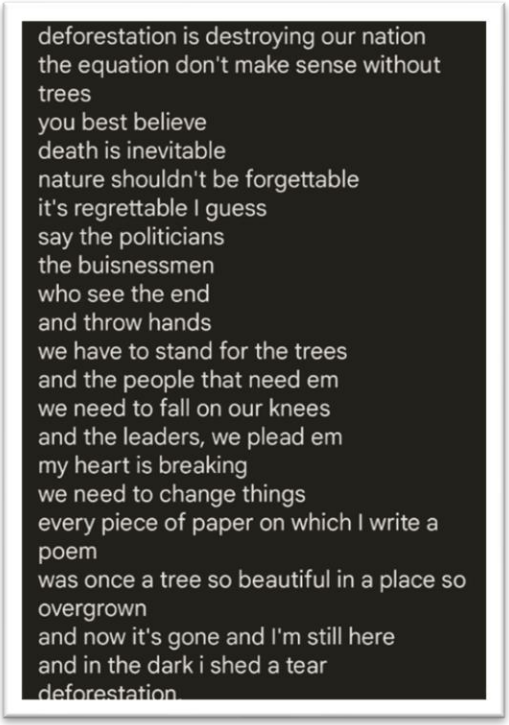


Figure 17

Deforestation Picture Collage

Figure 18

Nyomi & Cooper's Deforestation Poster

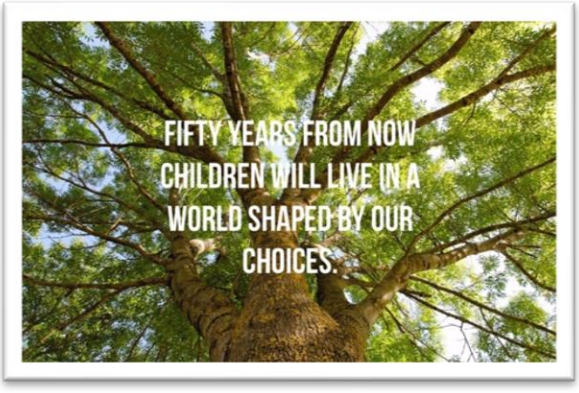


Figure 19

Hailee & Autumn's Deforestation TikTok

Hailee and Autumn choose to collaborate on a TikTok awareness video on deforestation (Figure 19). Hailee said, "*We decided to make a TikTok about deforestation …. And I think it's good to educate people on something that so many people are on, like TikTok*." Autumn added, "*And I feel like it's just a really good way to showcase, what deforestation is and like how we can help it. And it's just really easy to do like a really easy platform to use.*" The TikTok was an innovative decision and a creative standout to the FrameVR group project. Emma highlighted, "*there's so many different forms of media that, we chose to represent. And I think it's really cool because you get to look around and see what everyone's perspective on the issue is*." The creative freedom afforded to the co-researchers through different mediums allowed them to provide a variety of impactful messages.

4.2.6 HMD comfortability

The co-researchers' comfort level in an HMD had an impact on both social presence and learning motivation. Although none of the youth decided to use a laptop instead of the HMD during the AltspaceVR learning, this alternative could have been emphasized more for some learners. Emma had a negative experience with the HMD. She said, "*I did experience, some nausea and I had a headache throughout the experience. It got bad about halfway through and I ended up having to take off the headset and sit out for the rest of the experience.*" Some of the co-researchers were unable to participate fully in the HMD activities, which was an unfortunate but anticipated outcome based on previous studies (Chang et al., 2019, Hardie et al., 2020, Hazim et al., 2016, Ritz & Buss, 2016). The laptop alternative could have been promoted when Emma was having issues, but HMD headaches and nausea often require a break from other screens as well.

Most of the co-researchers were comfortable with using an HMD for majority of the required learning. Leonardo reported, "*In the VR headset, my head only started to hurt a little because, I'd been looking at it for like an hour and a half, but other than that, it was fine*." Sabrina says, "*it was pretty good for the first hour or so, but then like your head kind of starts to hurt after it, after a little bit, but it was pretty ok*." Victor had a similar experience, "*I did get a little dizzy at the very end, but I think that was just due to the time that I was in the VR*." A laptop alternative might have been welcomed for more extended periods after the novelty of the HMD wears off.

Others had negative experiences with the physical hardware because there was not explicit frontloading instruction on the importance of adjusting the HMD. Concordia said, "*I was not dizzy or nauseous, but I wasn't very comfortable in it. Everything was pretty blurry and my head, so really, really hurting*." In Concordia's situation, she likely needed to adjust the HMD more so that they could be more comfortable. Savanah added, "*I didn't really adjust the headset much, so I think it would've helped a little bit if I did, but it wasn't really that bad*." With a HMD display that fits learners well, there is less need for accommodations based on discomfort.

4.3 Summary

In this chapter, I anaylzed the findings of the research study based on artifact analysis, observations, surveys, and interviews. The co-researchers provided authentic and valuable insights which were synthesized into themes relevant to the study questions. I presented youth voice as authentically as possible to offer a sincere representation of their experience and perspectives. The co-researcher responses resulted in an enhanced understanding of how constructivist VR approaches foster SEL competencies and how immersive spaces impact learner sense of social presence. The findings identify the affordances of VR to enhance specific

SEL skills, as well as the limitations and delimitations of the VR medium to promote youth a sense of social presence. The co-researchers' collaborative FrameVR gallery that they designed gives agency to youth as changemakers and offers insights into the nature of youth interaction in immersive settings. Next, chapter five highlights the research contributions and overall importance of this study. I offer recommendations of immediate interest to academics and educators.

Chapter 5: Conclusions, Contributions, and Recommendations

This study was guided by the following questions: How can constructivist VR approaches foster youth learning of socioemotional skills? How does sense of presence in youth manifest itself in immersive learning environments? To investigate these questions, I worked closely with Dr. MacDowell and a grade 8 class to develop a two-day workshop to promote socialization, self-directed learning, sustainability, creative artistic expression, and land-based exploration. In this final chapter, I summarize the study design. I then highlight four research contributions that emerged, including: (1) Identifying VR as a technology for promoting empathy and SEL skills in youth (2) Defining characteristics and influences of social presence with youth (3) Expanding understanding of youth directed constructivist learning (4) Promoting sustainable and equitable technology interactions and pro-social change. Finally, I discuss study limitations and offer my recommendations for practical application and future research involving educational VR.

5.1 Summary of the youth VR study

As VR becomes an increasingly popular as a mainstream technology option, it is paramount to study youth interactions in VR learning environments. Educational VR may be considered more readily in the future for situations like the COVID-19 pandemic, where learners must be isolated but would benefit from the opportunity to be socially present amongst their peers in virtual environments. This research was situated on Driscoll's (2005) notion of constructivist learning and utilized Kreijin et al.'s (2014) three categories for assessing social presence. In order to provide insights into the utility of VR as a learning technology to promote social presence and SEL, the co-researcher's interviewed each other, completed surveys, and created artifacts in immersive environments. Validity was promoted through a range of verbatim quotations from surveys and interviews (McMillan & Schumacher, 2010). Catalytic validity was

evidenced from responses on how the research focused, re-oriented, and energized participants (Lather, 1986). This study was useful in developing an understanding of how social presence can be achieved with youth in VR and the relevance of avatars on youth sense of social presence. Despite the cultural prioritization of technical skills and many previous studies utilizing VR for technical skill enhancement, this study affirmed the need for SEL in immersive education (Cooper et al., 2018; Lui et al., 2018, Murray et al., 2016; Osley-Thomas, 2020; Penn, & Ramnarain, 2019; Shaw, 2017).

5.2 Contribution 1: Exploring VR as a technology for empathy and SEL in youth

This research makes theoretical and practical contributions. First, the capacity of VR to promote empathy and SEL skills offers new knowledge to current understanding of how VR learning impacts youth learning of challenging subject matter. The co-researchers demonstrated development of creativity, teamwork, as well as empathy for the environment, animals, and people. Findings affirm previous studies that acknowledge VR for its ability to promote SEL (e.g., Bertrand, et al., 2018, Buchmann & Henderson, 2019, Hamilton-Giachritsis et al., 2018, Kolomaznik, et al., 2017, Thornhill-Miller, & Dupont, 2016). Notably, this study offered youth perspectives, which are not represented in the literature on SEL and immersive education. Empathy was the most discussed SEL skill amongst the co-researchers, which implies that the most substantial learning gain for youth was the notion of perspective taking and empathetic enhancement. While empathy is challenging to teach, VR can be a useful technology for learning situations where the intended outcome is an increased empathetic awareness.

5.3 Contribution 2: Defining characteristics and influences of social presence in VR

The second contribution of this research identifies the extent of social presence and what factors contribute to social presence with youth in VR. The literature claims that a plethora of

different environmental, avatar based, and instructional factors contribute to learner social presence (Christopoulos et al., 2018, Hudson et al., 2019, Waltemate, et al., 2018). To assess social presence, I built upon Kreijin et al's (2014) *Community of inquiry: Social presence revisited* to present three operational sections of social presence including open communication, affective expression, and group cohesion. There was evidence of social presence to meet all three criteria: Open communication was indicated by co-researchers enjoying each other's presence in VR, affective expression was exemplified by created art together in VR and appreciating each other's creative process, and group cohesion was demonstrated by taking photographs in VEs, working together to create quality art, and overcoming relational difficulties. Thus, VR proved to be an effective technology to promote sense of social presence amongst youth. The co-researchers had varying levels of attachment to their avatars and varying levels of effort put into to avatar creation. Overall, avatars were not found to be a major factor influencing social presence. The significance of avatar design on learner sense of social presence is also somewhat contingent on the learner's preferences and affirms Jin's (2009) research that ideal avatars are more important than accurate avatars because of the varying levels of avatar attachment.

5.4 Contribution 3: Expanding understanding of constructivist learning in VR

The third contribution of this research shows an application of how the constructivist learning theory is applied in youth contexts. Many studies use constructivism in name, but still feature instructivist approaches in practice (Ural & Bümen, 2016). To address this issue, I was intentional about clearly identifying constructivist principles in the literature review and highlighting the ways that this study met constructivist principles in the findings. The co-researchers identified that constructivism was an effective approach to SEL in VR environments. However, there were some issues with self-selected groups because co-researchers initially chose

to work with peers who distracted them. This finding implies that constructivism is a sound theoretical approach but educator-based restrictions contingent on the group dynamics should be considered, as appropriate for the grade 8 level.

5.5 Contribution 4: Promoting sustainability learning through VR

The last contribution is studying VR as a technology for changemaking and societal progress. In learning about deforestation and sustainability, many of the co-researchers developed an increased empathetic awareness for the environment, for people, and for animals. This increased empathy exemplifies Lather's (1986) notion of catalytic validity, which suggests that research must have evidence that the research and learning process has led to new insights and activism from the respondents. Findings documented new insights and activism with the amount of commentary on empathy that was identified. It is impossible to fully grasp the impact of this study because it may influence youth perceptions for years to come, which may generate a ripple effect on families, friends, and local communities. Additionally, by promoting sustainability in education and research, other academics and practitioners may be motivated to focus on topics that are essential to address promptly for a more sustainable future. It is my hope that this research inspires educational research and practice to see VR as a technology for empathy enhancement through perspective taking, and that this research helps immersive education to more confidently utilized by teachers and training professionals.

5.6 Contribution 5: Co-researchers active voice and participation in VR research

A major contribution of this research is the extent that youth had an active voice and participation in the VR learning and research. Most previous VR studies position and define youth as participants, but my study intentionally disrupts the researcher/participant dichotomy

and hierarchy by using the co-researcher nomenclature to define youth in this study. The co-researcher approach values youth voice in the research by affording them the potential to represent themselves in meaningful ways (MacDowell, 2017). In doing so, this study offers learners agency in their learning. Code (2020) identifies four pillars of agency, which are intentionality, forethought, self-reactiveness, and self-reflectiveness. Intentionality was evident in the goal setting and planning that youth put into their FrameVR projects to achieve quality artifacts. Forethought was demonstrated in the co-researchers' capacity to anticipate the limitations and delimitations of VR's future role in society and learning. Self-regulation was demonstrated in the HMD, where the co-researchers needed to regulate cognition, motivation, and behaviour for the class to successfully proceed with exploring the virtual worlds as a group. Self-reflectiveness was evident in the rich responses to interview and survey questions in which the co-researchers had an authentic and meaningful opportunity to reflect on their learning experiences and design processes.

5.7 Contribution 6: Complex VR learning tasks

The complexity of learning task in my study offers a different perspective than some of the previously existing VR literature. For example, Yang et al. (2018) investigated 60 undergraduate students in a design challenge either in IVR or with a pencil-and-paper. Although their findings were in favour of IVR, the learning task was only five minutes long, with most participants not even utilizing the full five minutes. Comparably, my study covered two full school days (12 hours) with grade 8 youth, using multiple desktop and HMD applications, and featuring artifact creation in FrameVR. My study operates on the belief that complexity and context of learning needs more time to be adequately represented. The more extensive nature of

my study places the learning in a more legitimate and practical setting for educators in the K to 12 educational system.

5.8 Classroom applications

Findings from this study have resulted in recommendations to support educators in the application of constructivist VR, which may promote SEL skill development in a middle years or high school classroom. The FrameVR artifacts were a primary way that the youth demonstrated understanding, creativity, and learning. This task encouraged the co-researchers to be creative by allowing a variety of different mediums to present their knowledge and shared group values, while still being mindful of the constraints of the VR medium. Educators should encourage learners to have agency by utilizing their strengths in the FrameVR contribution. With this group of co-researchers, there were a variety of different talents and skills, including written word poetry, video editing, and visual design. The co-researchers utilized whatever approach they were most comfortable with to present their understanding, resulting in the FrameVR project including a plethora of impactful messages about deforestation, which was presented in ways that were meaningful to the co-researchers.

Despite allowing the opportunity for creative freedom, I also suggest that educators keep it simple with learners who are unsure about what to contribute. Some learners may feel an obligation to be extra innovative in their project and may experience hesitation on where to begin. Learners should know that a meaningful poster or two is just as valid of a contribution as anything else. I suggest providing learners with a variety of relevant resources and learning experiences prior to beginning work on a FrameVR artifact. In this study, a similar FrameVR exemplar was developed based on what their final product could look like to inspire the co-researchers in creating a quality deforestation contribution. Educators should also facilitate VR

learning experiences and provide access to resources that could be integrated into the FrameVR artifacts to make them more rigorous.

Findings indicated that there was evidence of social presence, including open communication, affective expression, and group cohesion based on Kreijin et al's (2014) *Community of inquiry: Social presence revisited.* Educators can consider the potential to meet these indicators of social presence when selecting instruction with different VR experiences and environments. Additionally, I suggest testing each HMD before beginning instruction. HMD's may need additional unanticipated steps prior to logging into or downloading AltSpaceVR or MultiBrushVR. It would also be advantageous to have instructional support with VR, so that one person can help solve technology issues while the other can prioritize keep the instruction flowing smoothly. Although every VR application was tested prior to learning, there were still issues connecting to the Internet and logging into applications that required additional support. The additional workload created by applying VR technology should not be understated.

Even with a mature group, middle years learners still require guidance in establishing rules of a digital and physical space involving VR. Since findings identified the potential for higher social risk taking online in VR, learners need to be reminded that virtual environments involve living people, and thus are places that have real-world implications. It should be clear that actions and language in virtual worlds must remain to the same level of school-appropriate standards that would be expected on a typical school day. In a physical space, learners need to be reminded not to intentionally disrupt individuals who are in an HMD because it is unpleasant to have unexpected outside stimulus. Some students may be experiencing a level of anxiety due to the experience of learning a new technology, and outside of HMD disruption can add to this anxiety. To increase ideal behaviours, learners can be strategically placed into groups rather than

self-selecting groups. I suggest allowing learners creative freedom with their avatar creation, if their self-representation is cultural and school appropriate. Findings indicated that there is no consensus on whether avatars increase social presence, so it is an inconsequential to enforce limitations beyond what is deemed appropriate in the social context. Some learners may feel empowered by the ability to represent themselves in new ways. Finally, there should be a plan for learners who feel uncomfortable in a HMD, since is an expected problem with VR. To help alleviate discomfort, learners can be reminded to adjust the HMD to fit them better.

5.9 Future research

The integration of VR for learning generated vital knowledge about the notion of social presence, SEL skills, and constructivism in VR. A study with a more extensive timeline could prove beneficial in better understanding youth perceptions of VR once the novelty factor of using a new technology wears off. VR applications of constructivism which focus on different VR experiences are needed and could include other social and artistic VR applications. Future studies into youth perceptions of a variety of VR learning contexts and tasks would provide further insight and support into best practices for developing meaningful immersive education. Additionally, since some learners identified the lack of facial expressions as a limiting factor to open communication and social presence in VR, further research and software development should focus on capturing and conveying emotions.

Further experimentation and exploration with AltspaceVR, FrameVR, and MultibrushVR would help determine how to better promote SEL skills and investigations into VR for social presence. This study unveiled teamwork, creativity, problem-solving and empathy as SEL competencies derived from constructivist learning. Future researchers could investigate ways these SEL skills have transference beyond the initial HMD learning experience. Findings from

this study overwhelmingly indicated empathy as the predominant SEL developed from the constructivist VR environment, likely due to the learning topic of sustainability. Future research could explore different learning topics with middle years learners to determine if empathy is still the most predominant SEL skill. Also, future research could explore ways to create more seamless VR experiences as this study required significant preparation and teacher support during the learning activities.

With mindful instructional design and collaborative efforts, educators and researchers can develop a better understanding of VR for learning, which may lead us to discover best practices for middle years learners and teachers. A final recommendation is to build on the findings of this study to explore the relationship between social presence and SEL while in VR. While social presence is a complex topic that is difficult to assess, there is a need to extend this research by determining how SEL in VR can be used to increase social presence. The benefit of pursuing this connection is unveiling the ways to use VR as a technology to promote positive social and mental well-being for youth. Enhanced SEL skills like empathy and teamwork have the potential to negate harmful interactions amongst youth, while helping others feel included and welcomed. Although the connection between SEL and social presence is a challenging topic to research, the connection becomes essential as VR becomes increasingly mainstream and youth begin to utilize VR as a mode of communication.

References

Ahn, S. J. G., Bailenson, J. N., & Park, D. (2014). Short-and long-term effects of embodied experiences in immersive virtual environments on environmental locus of control and behaviour. *Computers in Human Behaviour, 39*, 225–245. https://doi.org/10.1016/j.chb.2014.07.025

Ahn, S.J., Levy L., Eden, A., Won, A.S., MacIntyre, B., Johnsen, K. (2021). IEEE VR2020: Exploring the first steps toward standalone virtual conferences. *Frontiers in Virtual Reality, 2.* https://doi.org/10.3389/frvir.2021.648575

Al-Amri, A. Y., Osman, M. E., & Al Musawi, A. S. (2020). The effectiveness of a 3D-virtual reality learning environment (3D-VRLE) on the Omani eighth grade students' achievement and motivation towards physics learning. *International Journal of Emerging Technologies in Learning*, *15*(5), 4–16. https://doi.org/10.3991/ijet.v15i05.11890

Allcoat, D., & Muhlenen, V.A. (2018). Learning in virtual reality: Effects on performance, emotion and engagement. *Research in Learning Technology, 26*. https://doi.org/10.25304/rlt.v26.2140.

Annetta, L.A., Folta, E., & Klesath, M. (2010). *V-Learning: Distance education in the 21st century through 3D virtual learning environments*. Springer. https://link.springer.com/content/pdf/10.1007/978-90-481-3627-8.pdf

Araiza-Alba, P., Keane, T., Chen, W.S., Kaufman, J. (2021). Immersive virtual reality as a tool to learn problem-solving skills. *Computers and Education, 164,* 1–13. https://doi.org/10.1016/j.compedu.2020.104121

Bair, R.A. (2013). *3D virtual reality check: Learner engagement and constructivist theory.* [Doctoral Dissertation, Capella University]. Proquest LLC.

Banow, R, & Maw, S. (2019). First results from a study on the efficacy of using virtual reality (VR) to teach truss mechanics. *Proceedings of the Canadian Engineering Education Association (CEEA).* https://doi.org/10.24908/pceea.vi0.13763.

Balyasnikova, N., & Vasileva, O. (2019). (Re)Introducing Vygotsky's thought: From historical overview to contemporary psychology. *Frontiers in Psychology, 10*(1515), 1–15. https://doi.org/10.3389/fpsyg.2019.01515

Bedder, R. L., Bush, D., Banakou, D., Peck, T., Slater, M., & Burgess, N. (2019). A mechanistic account of bodily resonance and implicit bias. *Cognition, 184*, 1–10. https://doi.org/10.1016/j.cognition.2018.11.010

Benítez de Gracia, M.J., & Herrera Damas, S. (2019). Analysis of the level of immersion of 360° video features produced by Spanish media. *Communication & Society, 32*(2), 77–95. https://doi.org/10.15581/003.32.2.77-95

Bente, G., Rueggenberg, S., Kraemer, N.C., & Eschenburg, F. (2008). Avatar mediated networking: Increasing social presence and interpersonal trust in net-based collaborations. *Human Communication Research, 34*(2), 287–318. https://doi.org/10.1111/j.1468-2958.2008.00322.x

Bertrand, P., Guegan, J., Robieux, L., McCall C.A., & Zanasni, F. (2018). Learning empathy through virtual reality: Multiple strategies for training empathy-related abilities using body ownership illusions in embodied virtual reality. *Frontiers in Robotics and AI, 5*. https://www.doi.org/10.3389/frobt.2018.00026

Biggs, J.B. (1999). What the student does: Teaching for enhanced learning. *Higher Education Research and Development, 18*(1), 57–75. https://10.1080/07294360.2012.642839

Biocca, F., Harms, C., & Burgoon, J.K. (2003). Toward a more robust theory and measure of social presence: Review and suggested criteria. *Presence Teleoperators & Virtual Environments, 12*(5), 456–480. https://doi.org/10.1162/105474603322761270

Blascovich, J., Loomis, J., Beall, A. C., Swinth, K. R., Hoyt, C. L., & Bailenson, J. N. (2002). Immersive virtual environment technology as a methodological tool for social psychology. *Psychological Inquiry, 13*(2), 103–124. https://doi.org/10.1207/S15327965PLI1302_01

Braat, T. (2019, Oct 6). Educators continue to raise concerns over class sizes in Saskatchewan. Global News. https://globalnews.ca/news/5997290/class-sizes-saskatchewan/

Bridgewater, P., Régnier, P., García, R.C. (2015). Implementing SDG 15: Can large-scale public programs help deliver biodiversity conservation, restoration and management, while assisting human development? *Natural Resources Forum, 39*(3-4), 214-223. https://doi.org/10.1111/1477-8947.12084

Buchmann, S., & Henderson, D. (2019). Interprofessional empathy and communication competency development in healthcare professions' curriculum through immersive virtual reality experiences. *Journal of Interprofessional Education & Practice, 15*, 127–130. https://doi.org/10.1016/j.xjep.2019.03.010.

Burman, J.T. (2016). *Constructive history: From the standard theory of stages to Piaget's new theory* [Doctoral Dissertation, York University]. York Space institutional repository.

Carter, N., Bryant-Lukosius, D., DiCenso, A., Blythe, J., & Neville, A.J. (2014). The use of triangulation in qualitative research. *Oncology Nursing Forum, 41*(5), 545–547.

Chang, S.C., Hsu, T.C., Kuo, W-C., & Jong, M. (2019). Effects of applying a VR-based two-tier test strategy to promote elementary students' learning performance in a geology class. *British Journal of Educational Technology, 51*(2). https://doi.org/10.1111/bjet.12790

Checa, D., & Bustillo, A. (2020). A review of immersive virtual reality serious games to enhance learning and training. *Multimedia Tools Applications,* 79, 5501–5527. https://doi.org/10.1007/s11042-019-08348-9

Chee, Y.S., & Hooi, C.M. (2002). C-VISions: Socialized learning through collaborative, virtual, interactive simulations. *International Society of the Learning Sciences.* http://dl.acm.org/citation.cfm?id=1658616.1658789

Chenail, R. (2011). Interviewing the investigator: Strategies for addressing instrumentation and researcher bias concerns in qualitative research. *Qualitative Report, 16*(1). https:// doi.org/10.46743/2160-3715/2011.1051

Christopoulos, A., Conrad, M., & Shukla, M. (2018). Increasing student engagement through virtual interactions: How? *Virtual Reality, 22,* 353–369. https://doi.org/10.1007/s10055-017-0330-3

Cimatti, B. (2016). Definition, development, assessment of soft skills and their role for the quality of organizations and enterprises. *International Journal for Quality Research,* 10, 97-130. https://doi.org/10.18421/IJQR10.01-05

Cipresso, P., Giglioli, I.A.C., Raya, A.M., & Giuseppe, R. (2018). The past, present, and future of virtual and augmented reality research: A network and cluster analysis of the literature. *Frontiers in Psychology, 9* (2086), 120. https://doi.org/10.3389/fpsyg.2018.02086

Clark, R. (1983). Reconsidering research on learning from media. *Review of Educational Research, 53*(4), 445–459. https://doi.org/10.3102/00346543053004445

Clark, R. (1994). Media will never influence learning. *Educational Technology Research and Development, 42*(2), 21–29. https://doi.org/10.1007/BF02299088

Code, J. & Zap, N. (2017). Assessment in immersive virtual environments: Cases for learning, of learning, and as learning. *Journal of Interactive Learning Research, 28*(3), 235-248. https://www.learntechlib.org/primary/p/172803/

Code, J. (2020). Agency for learning: Intention, motivation, self-efficacy and self-regulation. *Frontiers in Education, 5*, 1-19. https://doi.org/10.3389/feduc.2020.00019

Collins, J., Regenbrecht, H., & Langlotz, T. (2021). Expertise and Experience in VR-supported learning: Achieving a deep non-verbal comprehension of four-dimensional space. *International Journal of Human-Computer Studies, 152.* https://doi.org/10.1016/j.ijhcs.2021.102649

Conye, L., Takemoto, J.K., Brittany L., Parmentier, B.L., Merritt, T., & Sharpton, R.A. (2018). Exploring virtual reality as a platform for distance team-based learning. *Currents in Pharmacy Teaching and Learning, 10*(10), 1384–1390. https://doi.org/10.1016/j.cptl.2018.07.005

Cooper, N., Milella, F., Pinto, C., Cant, I., White, M., & Meyer, G. (2018). The effects of substitute multisensory feedback on task performance and the sense of presence in a virtual reality environment. *PloS one, 13*(2), 1–25. https://doi.org/10.1371/journal.pone.0191846

Cooper, P. A. (1993). Paradigm shifts in designed instruction: From behaviorism to cognitivism to constructivism. *Educational Technology, 33*(5), 12–19. http://www.jstor.org/stable/44428049

Coyne, R. (2007). Thinking through virtual reality: Place, non-place and situated cognition. *Techné: Research in Philosophy and Technology, 10*(3), 26–38. https://doi.org/10.5840/techne200710310

Creswell. (2009). *Research design: Qualitative, quantitative, and mixed methods approaches.* Sage Publications.

Daft, R.L., & Lengel, R.H. (1986). Organizational information requirements, media richness and structural design. *Management Science, 32*(5), 554–571. http://dx.doi.org/10.1287/mnsc.32.5.554

Dalgarno, B., & Lee, M. J. W. (2010). What are the learning affordances of 3-D virtual environments? *British Journal of Educational Technology, 41*(1), 10–32. https://doi.org/10.1111/j.1467-8535.2009.01038.x

Dan, Y. (2021). Examining the relationships between learning interest, flow, and creativity. *School Psychology International*, 42(2), 157–169. https://doi.org/10.1177/0143034320983399

de Back, T.T., Tinga, A.M., Nguyen, P., & Louwerse, M.M. (2020). Benefits of immersive collaborative learning in CAVE-based virtual reality. *International Journal of Educational Technology in Higher Education, 17*(51), 1–18. https://doi.org/10.1186/s41239-020-00228-9

Dewey, J. (1922). *Human nature and conduct.* New York, NY: Holt and Company. https://freeditorial.com/en/books/human-nature-and-conduct

Dickey, M. D. (2005). Three-dimensional virtual worlds and distance learning: Two case studies of active worlds as a medium for distance education. *British Journal of Educational Technology, 36,* 439–451. http://dx.doi.org/10.1111/j.1467-8535.2005.00477.x

Driscoll, M. P. (2005). *Psychology of learning for instruction* (3rd ed.). Pearson Allyn and Bacon.

Dumas, T. M., Ellis, W., & Litt, D. M. (2020). What does adolescent substance use look like during the COVID-19 pandemic? Examining changes in frequency, social contexts, and pandemic-related predictors. *The Journal of Adolescent Health: Society for Adolescent Medicine, 67*(3), 354–361. https://doi.org/10.1016/j.jadohealth.2020.06.018

Eastwick, P.W., & Gardner, W.L. (2009). Is it a game? Evidence for social influence in the virtual world. *Social Influence, 4*(1), 18–32. https://doi.org/10.1080/15534510802254087

Ellis, R.A., Han F., & Pardo, A. (2019). When does collaboration lead to deeper learning? Renewed definitions of collaboration for engineering students. *IEEE Transactions on Learning Technologies, 12*(1) pp. 123–132. https://doi.10.1109/TLT.2018.2836942

Ertmer, P. A., & Newby, T. J. (1993). Behaviourism, cognitivism, constructivism: Comparing critical features from an instructional design perspective. *Performance Improvement Quarterly, 6*(4), 50–72. https://doi.org/10.1111/j.1937-8327.1993.tb00605.x

Flogie, A., Aberšek, B., & Pesek, I. (2019). The impact of innovative learning environments on social competences of youth. *Research in Learning Technology, 27.* https://doi.org/10.25304/rlt.v27.2214

Fox, J., & Bailenson J.N. (2009). Virtual self-modeling: The effects of vicarious reinforcement and identification on exercise behaviors. *Media Psychology, 12*(1), 1–25. https://doi.org/10.1080/15213260802669474

Forsyth, D.R. (2010). Components of cohesion. *Group Dynamics, 5th Edition*. Wadsworth: Cengage Learning. pp. 118–122

Frieda, K. (2018). The quest to create utterly normal virtual reality experiences. *MIT Sloan Management Review, 59*(3), 1–5. https://sloanreview.mit.edu/article/the-quest-to-create-utterly-normal-virtual-reality-experiences/

Gabriel, A. Monticolo, D., Camargo, M. & Bourgault, M. (2016). Creativity support systems: A systemic mapping study. Thinking skills and creativity, 21, 109–122. https://doi.org/10.1016/j.tsc.2016.05.009

Gadermann, A., Thomson, K., Richardson, C., Gagné, M., McAuliffe, C., Hirani, S., & Jenkins, E. (2021). Examining the impacts of the COVID-19 pandemic on family mental health in Canada: Findings from a national cross-sectional study. *BMJ Open, 11*. https://doi.org/10.1136/bmjopen-2020-042871

Garrison, D., Anderson, T., & Archer, W. (2000). Critical inquiry in a text-based environment: Computer conferencing in higher education. Internet and Higher Education, 11(2), 114.

Godfrey-Smith, P. (2016). Dewey and the question of realism. *Noûs, 50*(1), 73–89. https://doi.org/10.1111/nous.12059

Goldman, J., & Wong, B.M. (2020) Nothing soft about 'soft skills': Core competencies in quality improvement and patient safety education and practice. *BMJ Quality & Safety, 29*(8), 619–622. https://doi.org/10.1136/bmjqs-2019-010512

Gonzalez-Franco, M., Steed, A., Hoogendyk, S., & Ofek, E. (2020). Using facial animation to increase the enfacement illusion and avatar self-identification. *IEEE Transactions on Visualization and Computer Graphics, 26*(5), 2023–2029. https://doi.org/10.1109/TVCG.2020.2973075

Gonzalez-Franco., & M., Peck, T.C. (2018). Avatar embodiment. Towards a standardized questionnaire. *Frontiers in Robotics and AI, 5*(74), 1–9. https://doi.org/10.3389/frobt.2018.00074

González-Zamar, M-D., & Abad-Segura, E. (2020). Implications of virtual reality in arts education: Research analysis in the context of higher education. *Education Sciences, 10* (225), 1–20. https://doi.org/10.3390/educsci10090225

Gustafsson, J. (2017). Single case studies vs. multiple case studies: A comparative study.

Grand View Research. (2020, June). *Virtual reality market size, share & trends analysis report by device, by technology, by component, by application, by region, and segment forecasts, 2022–2030.* https://www.grandviewresearch.com/industry-analysis/virtual-reality-vr-market

Hadjipanayi, C., & Michael-Grigoriou, D. (2020). Conceptual knowledge and sensitization on Asperger's syndrome based on the constructivist approach through virtual reality. *Heliyon, 6*(6). https://doi.org/10.1016/j.heliyon.2020.e04145

Hall, L., Paracha, S., Mitsche, N., Flint, T., Stewart, F., MacFarlane, K., & Hagan-Green, G. (2022). When will immersive virtual reality have its day? Challenges to IVR adoption in the home as exposed in studies with teenagers, parents, and experts. *Presence: Teleoperators and Virtual Environments, 28*, 169–201. https://doi.org/10.1162/pres_a_00347

Hamilton, L. (2011). Case studies in educational research. *British Educational Research Association*. https://www.bera.ac.uk/publication/case-studies-in-educational-research

Hamilton-Giachritsis, C., Banakou, D., Garcia Quiroga, M., Giachritsis, C., & Slater, M. (2018). Reducing risk and improving maternal perspective-taking and empathy using virtual

embodiment. *Scientific Reports, 8*(2975), 1–10. https://doi.org/10.1038/s41598-018-21036-2

Hannafin, M.J. (1992). Emerging technologies, ISD, and learning environments: Critical perspectives. *Educational Technology Research and Development, 40(*1), 49–63. https://doi.org/10.1007/BF02296706

Hansen, M.B.N. (2006). *Bodies in code: Interfaces with digital media.* Routledge.

Hardie, P., Darley, A., Carroll, L. Redmond, C., Campbell, A., & Jarvis, S. (2020). Nursing & Midwifery students' experience of immersive virtual reality storytelling: An evaluative study. *BMC Nursing, 19***(**78), https://doi.org/10.1186/s12912-020-00471-5

Hasler, B.S., Spanlang B., & Slater M. (2017). Virtual race transformation reverses racial in-group bias. *PLoS ONE, 12*(4). https://doi.org/10.1371/journal.pone.0174965

Hazim El-M., Eugenia F., Christian R., Tamer W., & Jesse., S. (2016). Assessment of STEM e-learning in an immersive virtual reality (VR) environment. *ASEE Annual Conference & Exposition,* New Orleans. http://www.asee.org/public/conferences/64/papers/15724/view

Hodgson, E., Bachmann, E. R., Vincent, D., Zmuda, M., Waller, D., & Calusdian, J. (2015). WeaVR: A self-contained and wearable immersive virtual environment simulation system. *Behavior Research Methods, 47*(1), 296–307. https://doi.org/10.3758/s13428-014-0463-1

Hsueh, Y. (1997). *Jean Piaget, spontaneous development and constructivist teaching.* (Publication No. 9734802). [Doctoral Dissertation, Harvard University]. ProQuest Dissertations and Theses Global.

Huang, H-M., & Liaw, S-S. (2018). An analysis of learners' intentions toward virtual reality learning based on constructivist and technology acceptance approaches. *International*

Review of Research in Open and Distributed Learning, *19*(1), 91–115. https://doi.org/10.19173/irrodl.v19i1.2503

Huang, H.M., Rauch, U., & Liaw, S.-S. (2010). Investigating learners' attitudes toward virtual reality learning environments: Based on a constructivist approach. *Computers & Education, 55*(3), 1171-1182. https://doi.org/10.1016/j.compedu.2010.05.014

Hudson, S., Matson-Barkatb, S., Pallaminc, N., & Jeqou, G. (2019). With or without you? Interaction and immersion in a virtual reality experience. *Journal of Business Research, 100*(1), p. 459–468.

Hunter, A. (2019, May 10). Teachers' union president says Saskatchewan government's stated average class size of 19 not 'reality'. CBC News. https://www.cbc.ca/news/canada/saskatchewan/sask-class-size-1.5131249

Jari, M., & Pekka, R. (2018). Cognitive–linguistic and constructivist mnemonic triggers in teaching based on Jerome Bruner's thinking. *Frontiers in Psychology, 9*(2543), 1–13. https://doi.org/10.3389/fpsyg.2018.02543

Jensen, L., & Konradsen, F. (2018). A review of the use of virtual reality head-mounted displays in education and training. *Education and Information Technologies, 23,* 1515–1529. https://doi.org/10.1007/s10639-017-9676-0

Jin, S. (2009). Avatars mirroring the actual self versus projecting the ideal self: The effects of self-priming on interactivity and immersion in an exergame, Wii Fit. *Cyberpsychology and Behavior*, *12*(6), 761–765. https://doi.org/10.1089/cpb.2009.0130

Joao, M. (2018). Constructivism and connectivism in education technology: Active, situated, authentic, experiential, and anchored learning. *Revista Iberoamericana de Educación a Distancia, 21*(2). https://doi.org/10.5944/ried.21.2.20055.

Johnston, E., Olivas, G., Steele, P., Smith, C., & Bailey, L. (2018). Exploring pedagogical foundations of existing virtual reality educational applications: A content analysis study. *Journal of Educational Technology Systems*, *46*(4), 414–439. https://doi.org/10.1177/0047239517745560

Jung, Y (2011). Understanding the role of sense of presence and perceived autonomy in users continued use of social virtual worlds. *Journal of Computer-Mediated Communication, 16*(4), 492–510. https://doi.org/10.1111/j.1083-6101.2011.01540.x

Kavanagh, S., Luxton-Reilly, A., Wuensche, B., & Plimmer, B. (2017). A systematic review of virtual reality in education. *Themes in Science and Technology Education*, *10*(2), 85–119. https://eric.ed.gov/?id=EJ1165633

Kim, A. J., & Ko, E. (2012). Do social media marketing activities enhance customer equity? An empirical study of luxury fashion brand. *Journal of Business Research, 65*(10), 1480–1486. https://doi.org/10.1016/j.jbusres.2011.10.014

Kolomaznik, M., Sullivana, M., & Vyvyan, K. (2017). Can virtual reality engage students with teamwork? *International Journal of Innovation in Science and Mathematics Education, 25*(4), 32–44. https://openjournals.library.sydney.edu.au/CAL/article/view/12172

Kozma, R. (1991). Learning with media. *Review of Educational Research, 61*(2), 179–211. https://doi.org/10.2307/1170534

Kozma, R. (1994). Will media influence learning? Reframing the debate. *Educational Technology Research and Development, 42*(2), 7–19. https://doi.org/10.1007/BF02299087

Kreijn, K., Van Acker, F., Vermeulen, M., & Van Buuren, H. (2014). Community of inquiry: Social presence revisited. *E-learning and digital media, 11*(1). https://doi.org/10.2304/elea.2014.11.1.5

Langford, P. (2005). *Vygotsky's Developmental and Educational Psychology.* New York: Psychology Press.

Lather, P. (1986) Issues of validity in openly ideological research: Between a rock and a soft place. *Interchange* 17, 63–84. https://doi.org/10.1007/BF01807017

Lee, J., Kim, M., & Kim, J. (2020). RoleVR: Multi-experience in immersive virtual reality between co-located HMD and non-HMD users. *Multimedia Tools and Applications, 79*, 979–1005. https://doi.org/10.1007/s11042-019-08220-

Lee, J., Kim, T., & Su, M. (2021). Reassessing school effectiveness: Multi-objective value-added measures (MOVAM) of academic and socioemotional learning. *Studies in Educational Evaluation, 68*. https://doi.org/10.1016/j.stueduc.2020.100972

Lee, K. (2004). Presence, explicated. *Communication Theory, 14*(1), 27–50. https://doi-org/10.1111/j.1468-2885.2004.tb00302.x

Levy, P. (2017). *Research design: Quantitative, qualitative, mixed methods, arts-based, and community-based participatory research approaches.* The Guilford Press.

Li, Z., Chen, L., Liu, C., Zhang, F., Li, Z., Gao, Y., Ha, Y., Xu, C., Quan, S., & Xu, Y. (2021). Animated 3D human avatars from a single image with GAN-based texture inference. *Computers and Graphics, 95*, 81–91. https://doi.org/10.1016/j.cag.2021.01.002

Limniou, M., Roberts, D., & Papadopoulos, N. (2008). Full immersive virtual environment CAVE TM in chemistry education. *Computers & Education, 51*(2), 584–593. https://doi.org/10.1016/j.compedu.2007.06.014

Liu, C., Chen, I (2010). Evolution of Constructivism. *Contemporary Issues in Education Research, 3*(4), 63–66

Lucas, P., Fleming, J., Bhosale, J. (2018). The utility of case study as a methodology for work-integrated learning research. *International Journal of Work-Integrated Learning, 19*(3), 215-222.

Lui, J. T., Compton, E. D., Ryu, W., & Hoy, M. Y. (2018). Assessing the role of virtual reality training in Canadian otolaryngology-head & neck residency programs: A national survey of program directors and residents. *Journal of Otolaryngology Head & Neck Surgery, 47*(61). https://doi.org/10.1186/s40463-018-0309-4

Liu, X., Li, Y., Pan, P., & Li., W. (2011). Research on computer-aided creative design platform based on creativity model. *Expert Systems with Applications, 38*(6), 9973-9990. https://doi.org/10.1016/j.eswa.2011.02.032

Lockee, B.B., Burton, J.K. & Cross, L.H. (1999). No comparison: Distance education finds a new use for 'no significant difference'. *Educational Technology Research and Development, 47*, 33–42. https://doi.org/10.1007/BF02299632

Lund, B., & Wang, T. (2019). Effect of virtual reality on learning motivation and academic performance: What value may VR have for library instruction? *Kansas Library Association College and University Libraries Section Proceedings, 9*(1), 1–7. https://doi.org/10.4148/2160-942X.1073

Lytras, M.D., Damiani, E., & Mathkour, H. (2016) Virtual reality in learning, collaboration and behaviour: Content, systems, strategies, context designs. *Behaviour & Information Technology, 35*(11), 877–878. https://doi.org/10.1080/0144929X.2016.1235815

MacDowell, P., & J. Lock. (Eds.). (2023). *Immersive education: Designing for learning*. Springer Nature. https://doi.org/10.1007/978-3-031-18138-2

MacDowell, P. (2017). Girls' perspectives on (mis)representations of girlhood in hegemonic media texts. *Girlhood Studies: An Interdisciplinary Journal, 10*(3), 201–216. https://doi.org/10.3167/ghs.2017.100315

Makransky, G., Lilleholt, Lau., & Aaby, A. (2017). Development and validation of the multimodal presence scale for virtual reality environments: A confirmatory factor analysis and item response theory approach. *Computers in Human Behaviour, 72*, 276–285. https://doi.org/10.1016/j.chb.2017.02.066

Marchini, S**.,** Zaurino, E., Bouziotis, J., Brondino, N., Delvenne, V., & Delhaye, M. (2021). Study of resilience and loneliness in youth (18–25 years old) during the COVID-19 pandemic lockdown measures. *Journal of Community Psychology*, *49*(2), 468–480. https://10.1002/jcop.22473

Matthews, B., See, S.Z., & Day, J. (2020). Crisis and extended realities: Remote presence in the time of COVID-19. *Media International Australia*, 1–12. https://doi.org/10.1177/1329878X20967165

Matthews, T., Danese, A., Caspi, A., Fisher, HL., Goldman-Mellor, S., Kepa, A., Moffitt, TE., Odgers, CL., & Arseneault, L. (2019). Lonely young adults in modern Britain: Findings from an epidemiological cohort study. *Psychological Medicine, 49*, 268–277. https://doi.org/10.1017/ S0033291718000788

Maxwell, J. (2019). *Qualitative research design.* Sage publications. https://dx.doi.org/9781529746204

McCreery, P.M., Schrader, P.G., Krach, K., & Boone, R. (2013). A sense of self: The role of presence in virtual environments. *Computers in Human Behaviour, 29*(4), 1635–1640. http://dx.doi.org/10.1016/j.chb.2013.02.002

McMillan, J. H., & Schumacher, S. (2010). *Research in education: Evidence-based inquiry* (7th Edition). New Jersey: Pearson.

McQueen, K. (2010). Chasing Vygotsky's dogs: Retrieving Lev Vygotsky's philosophy for a workers' paradise. *Studies in Philosophy and Education, 29*(1), 53–66. https://doi.org/10.1007/s11217-009-9160-4

Meggs, M.S., Greer, A., & Collins, S. (2012). Virtual reality in interior design education: Enhanced outcomes through constructivist engagement in Second Life. International *Journal of Web-Based Learning and Teaching Technologies, 7*(1), 19–35. https://doi:10.4018/jwltt.2012010102

Muratore, M., Tuena, C., Pedroli, E., Cipresso, P., & Guiseppe, R. (2019). Virtual reality as a possible tool for the assessment of self-awareness. *Frontiers in Behavioural Neuroscience, 13*(62), 1–7. https://doi.org/10.3389/fnbeh.2019.00062

Murray, E.G., Neumann, D.L., Moffitt, R.L., & Thomas, P.R. (2016). The effects of the presence of others during a rowing exercise in a virtual reality environment. *Psychology of Sport and Exercise, 22,* 328–336. https://doi.org/10.1016/j.psychsport.2015.09.007

Mütterlein, J. (2018). The three pillars of virtual reality? Investigating the roles of immersion, presence, and interactivity. In *Proceedings of the 51st Hawaii International Conference on System Sciences.* Available at: https://core.ac.uk/download/pdf/143481013.pdf

Neutzling, M., Pratt, E., & Parker, M. (2019). Perceptions of learning to teach in a constructivist environment. *The Physical Educator, 76*(3), 756–776. https://doi.org/10.18666/TPE-2019-V76-I3-8757

Noonan, J., & Coral, M. (2013). Education, social interaction, and material co-presence: Against virtual pedagogical reality. *Interchange, 44,* 31–43. https://doi.org/10.1007/s10780-013-9195-x

Nowak, K. L., & Biocca, F. (2003). The effect of the agency and anthropomorphism on users' sense of telepresence, copresence, and social presence in virtual environments. *Presence: Teleoperators and Virtual Environments*, 12(5), 481–494.

Nowak, K.L. & Rauh, C. (2005). The influence of the avatar on online perceptions of anthropomorphism, androgymy, credibility, homophily, and attraction. *Journal of Computer Mediated Communication, 11*(1), 153–178. https://doi.org/10.1111/j.1083-6101.2006.tb00308.x

O'Connor, E.A., & Domingo, J. (2017). A practical guide, with theoretical underpinnings, for creating effective virtual reality learning Environments. *Journal of Educational Technology Systems*, *45*(3), 343–364. https://doi.org:10.1177/0047239516673361

Oh, C., Bailenson, J., & Welch, G. (2018). A systematic review of social presence: Definition, antecedents, and implications. *Frontiers of Robotics and AI*, *5*(114). htpps://doi10.3389/frobt.2018.00114

Oh, C., Bailenson, J., Weisz, E., & Zaki, J. (2016). Virtually old: Embodied perspective taking and reduction of ageism under threat. *Computers in Human Behaviour, 60,* 398–410. https://doi.org/10.1016/j.chb.2016.02.007

Onyesolu, M.O., Nwasor, V.C., Ositanwosu, O.E., & Iwegbuna, O.N. (2013). Pedagogy: Instructivism to socio-constructivism through virtual reality. *International Journal of Advanced Computer Science and Applications, 4*(9). http://dx.doi.org/10.14569/IJACSA.2013.040907

Osley-Thomas, R. (2020). The closing of academic departments and programs: A core and periphery approach to the liberal arts and practical arts. Minerva, 58(2), 211–233. https://doi.org/10.1007/s11024-019-09389-y

Parong, M. (2018). Learning science in immersive virtual reality. *Journal of Educational Psychology, 110*(6), 785–797. http://dx.doi.org/10.1037/edu0000241

Pena, J., Hancock, J.T., & Merola, N.A. (2009). The priming effects of avatars in virtual settings. *Communication Research, 36*(6), 838–856. https://doi.org/10.1177/0093650209346802

Penn, M., & Ramnarain, U. (2019). A comparative analysis of virtual and traditional laboratory chemistry learning. *Perspectives in Education, 37*(2), 80–97. https://doi.org/10.18820/2519593X/pie.v37i2.6.

Piaget, J. (1953). *The origins of intelligence in children.* New York, NY: Basic Books. https://archive.org/details/in.ernet.dli.2015.458564/mode/2up

Pintrich, P. R. (2003). A motivational science perspective on the role of student motivation in learning and teaching Contexts. *Journal of Educational Psychology, 95*(4), 667-686. https://doi.org/10.1037/0022-0663.95.4.667

Powell, K.C. & Kalina, C.J. (2009). Cognitive and social constructivism: Developing tools for an effective classroom, *Education 130*(2), 241–250.

Power, E., Hughes, S., Cotter, D., & Cannon, M. (2020). Youth mental health in the time of COVID-19. *Irish Journal of Psychological Medicine, 37*(4), 301–305. https://doi/10.1017/ipm.2020.84

Reich, K., Garrison, J., & Neubert, S. (2016). Complexity and reductionism in educational philosophy—John Dewey's critical approach in 'democracy and education' reconsidered. *Educational Philosophy and Theory, 48*(10), 997–1012. https://doi.org/10.1080/00131857.2016.1150802

Riegler A. & Steffe L. P. (2014). "What is the teacher trying to teach students if they are all busy constructing their own private worlds?" *Constructivist Foundations, 9*(3), 297–301. https://constructivist.info/9/3/297.editorial

Ritz, L.T., & Buss, A.R. (2016). A framework for aligning instructional design strategies with affordances of CAVE immersive virtual reality systems. *TechTrends, 60*(6), 549–556. https://doi-org.cyber.usask.ca/10.1007/s11528-016-0085-9

Roach, V.A. & Attardi, S.M. (2021). Twelve tips for applying Moore's theory of transactional distance to optimize online teaching. *Medical Teacher,* 1–7. https://doi.org/10.1080/0142159X.2021.1913279

Rosenberg, R.S., Baughman, S.L., & Bailenson, J.N. (2013). Virtual superheroes: Using superpowers in virtual reality to encourage prosocial behavior. *PLOS One, 8*(1), 1–9. https://doi.org/10.1371/journal.pone.0055003

Rubio-Tamayo, J.L., Gértrudix, M., & García, F. (2018). User experience and interaction design in creative processes and educational sciences with virtual and augmented reality technologies: A research with quantitative and qualitative methods. *Enseñanza & Teaching, 36*(1), 63–79. https://doi.org/10.14201/et20183616379

Rueda, J., & Lara, P. (2020). Virtual reality and empathy enhancement: Ethical aspects. *Frontiers in Robotics and AI, 7*. https://doi.org/10.3389/frobt.2020.506984

Sagor, R. (2002). Lessons from skateboarders. *Educational Leadership, 60*(1), 34.

Sajjadia, P., Hoffmann, L., Cimianoa, P., & Kopp, S. (2019). A personality-based emotional model for embodied conversational agents: Effects on perceived social presence and game experience of users. *Entertainment Computing, 32,* 1–10. https://doi.org/10.1016/j.entcom.2019.100313

Schultze, U. (2010). Embodiment and presence in virtual worlds: A review. *Journal of Information Technology*, *25*, 434–449. https://doi:10.1057/jit.2010.25

Sekhavat, A.Y., & Nomani, P. (2017). A comparison of active and passive virtual reality exposure scenarios to elicit social anxiety. *International Journal of Serious Games, 4*(2), 3–15. https://doi.org/10.17083/ijsg.v4i2.154

Seymour, K., Skattebol, J., & Pook, B. (2020). Compounding education disengagement: COVID-19 lockdown, the digital divide and wrap-around services. *Journal of Children's Services, 15*(4), 243–251. https://doi.org/10.1108/JCS-08-2020-0049

Shaw, R.D. (2017). The vulnerability of urban elementary school arts programs: A case study. *Sage Journals, 65*(4). https://doi.org/10.1177/0022429417739855

Sherman, W.R. & Craig, A.B. (2003). *Understanding virtual reality.* Morgan Kaufmann Publishers: Amsterdam.

Schutte N, Bhullar N, Stilinović E. J., & Richardson K. (2017). The impact of virtual environments on restorativeness and affect. *Ecopsychology 9*(1), 1–7. https://doi.org/10.1089/eco.2016.0042

Simon W., Parsons, S., & Bailey, A. (2017). Self-reported sense of presence and responses to social stimuli by adolescents with autism spectrum disorder in a collaborative virtual reality environment. *Journal of Intellectual & Developmental Disability, 42*(2), 131–141. https://doi.org/10.3109/13668250.2016.1234032

Simon, H.A. (2001). Creativity in the arts and the sciences. *The Kenyon Review, 23*(2), 203–220. https://www.jstor.org/stable/4338222

Siriaraya, P., & AngAge, C.S. (2012). Age differences in the perception of social presence in the use of 3D virtual world for social interaction. *Interacting with Computers*, *24*(4), 280–291. https://doi.org/10.1016/j.intcom.2012.03.003

Sivunen, A., & Nordbäck, E. (2015) Social presence as a multi-dimensional group construct in 3D virtual environments. *Journal of Computer-Mediated Communication, 20*(1), 19–36. https://doi.org/10.1111/jcc4.12090

Spalter, M.A., Stone, P.A., Meier, B.J., Miller, T.S., & Simpson, R.M. (2002). Interaction in an IVR museum of color: Constructivism meets virtual reality. *Leonardo, 35*(1), 87–90. https://doi.org/10.1162/002409402753689380

Stapleton, L., & Stefaniak, J. (2019). Cognitive constructivism: Revisiting Jerome Bruner's influence on instructional design practices. *TechTrends 63,* 4–5. https://doi.org/10.1007/s11528-018-0356-8

Steele, P., Burleigh, C., Kroposki, M., Magabo, M., & Bailey, L. (2020). Ethical considerations in designing virtual and augmented reality products — virtual and augmented reality design with students in mind: Designers' perceptions. *Journal of Educational Technology Systems, 49*(3). https://doi.org/10.1177/0047239520933858

Stoller, A. (2018). Dewey's creative ontology. *Journal of Thought, 52*(3), 47–64. http://journalofthought.com/wp-content/uploads/2018/12/09stoller.pdf

Thisgaard, M., & Makransky, G. (2017). Virtual learning simulations in high school: Effects on cognitive and non-cognitive outcomes and implications on the development of STEM academic and career choice. *Frontiers in Psychology, 8*. https://doi.org/10.3389/fpsyg.2017.00805

Thomas, D., & Brown, J. S. (2009). Why virtual worlds can matter. *International Journal of Media and Learning, 1*(1), 1–20. http://dx.doi.org/10.1162/ijlm.2009.0008

Tomljenović, Z., & Vorkapić, S.T. (2020). Constructivism in visual arts classes. *Center for Educational Policy Studies Journal, 10*(4). https://doi.org/ 10.26529/cepsj.913

Thornhill-Miller, B., & Dupont, J. (2016). Virtual reality and the enhancement of creativity and innovation: Under recognized potential among converging technologies? *Journal of Cognitive and Educational Psychology, 15*(1). https://doi.org/10.1891/1945-8959.15.1.102

Turoff, M. (1991). Computer-mediated communication requirements for group support. *Journal of Organizational Computing, 1*(1), 85–113. https://doi.org/10.1080/10919399109540151

Ugwuozor, F.O. (2020) Constructivism as pedagogical framework and poetry learning outcomes among Nigerian students: An experimental study. *Cogent Education, 7*(1), https://doi.org/10.1080/2331186X.2020.1818410

Ural, G., & Bümen, N. (2016). A meta-analysis on instructional applications of constructivism in science and technology teaching: A sample of turkey. *Education and Science, 41*(185), 51–82. https://doi.org/10.15390/EB.2016.4289

Van Bergen, P., & Parsell, M. (2019). Comparing radical, social and psychological constructivism in Australian higher education: A psycho-philosophical perspective. *Australian Educational Researcher, 46,* 41–58. https://doi.org/10.1007/s13384-018-0285-8

Vincente, B., Pilar, E., & Isabel, M. (2021). A constructivist intervention program for the improvement of mathematical performance based on empiric developmental results (PEIM). *Frontiers in Psychology*, 3784. https://doi.org/10.3389/fpsyg.2020.582805

Von Glasersfeld, E. (1974). Piaget and the radical constructivist epistemology. In C.D. Smock & E. von Glasersfeld (Eds.), *Epistemology and education: The implications of radical constructivism of knowledge acquisition.* University of Georgia, Athens. http://www.vonglasersfeld.com/034

Wagner, E (1994). In support of a functional definition of interaction. *American Journal of Distance Education, 8*(2), 6–26. https://doi.org/10.1080/08923649409526852

Wang, X., Laffey, J., Xing, W., Ma, Y., & Stichter, J. (2016). Exploring embodied social presence of youth with Autism in 3D collaborative virtual learning environment: A case study. *Computers in Human Behaviour, 55*, 310–321. https://doi.org/10.1016/j.chb.2015.09.006

Waltemate, T., Gall, D., Roth, D., Botsch, M., & Latoschik, M. E. (2018). The impact of avatar personalization and immersion on virtual body ownership, presence, and emotional response. *IEEE Transactions on Visualization and Computer Graphics, 24*(4), 1643–1652. https://doi.org/10.1109/TVCG.2018.2794629

Walther, J. B. (1996). Computer-mediated communication: Impersonal, interpersonal, and hyperpersonal interaction. *Communication Research, 32*(1), 3–43.

Waterworth, J. A., & Waterworth, E. L. (2001). Focus, locus, and sensus: The three dimensions of virtual experience. *Cyberpsychology and Behavior, 4*(2), 203–213. https://doi.org/ 10.1089/109493101300117893

Weissblueth, E., & Nissim, Y. (2018). The contribution of virtual reality to social and emotional learning in pre-service teachers. *Creative education*, *9*(10). https://doi.org/1551-1564. 10.4236/ce.2018.910114

Wilson, J. (2013). Course design using an authentic model. *Canadian Journal of Learning and Technology, 39*(1), 1–14. https://doi.org/10.21432/T22S3P

Winterbottom, C., & Blake, E. (2008). Constructivism, virtual reality and tools to support design. *ACM Digital Library*, p. 230–239. https://doi.org/10.1145/1394445.1394470.

Witmer, B. G., & Singer, M. J. (1998). Measuring presence in virtual environments: A presence questionnaire. *Presence: Teleoperators and Virtual Environments*, *7*(3), 225–240. https://doi.org/10.1162/ 105474698565686

Wohlgenannt, I., Simons, A., & Stieglitz, S. (2020). Virtual reality. *Business & Information Systems Engineering, 62*, 455–461. https://doi.org/10.1007/s12599-020-00658-9

Wrzesien M., Rodríguez A., Rey B., Alcañiz M., Baños R.M., & Vara, M.D. (2015). How the physical similarity of avatars can influence the learning of emotion regulation strategies in teenagers. *Computers in Human Behavior, 43*, 101–111. https://doi.org/10.1016/j.chb.2014.09.024

Xianhui W., James L., Wanli X., Yanfei M., & Janine S. (2016). Exploring embodied social presence of youth with autism in 3D collaborative virtual learning environment: A case study. *Computers in Human Behavior, 55*, 310–321. https://doi.org/10.1016/j.chb.2015.09.006.

Yadin, G. (2018). Virtual reality exceptionalism, 20 *Vanderbilt Journal of Entertainment and Technology Law, 20(2),* 839–880. https://scholarship.law.vanderbilt.edu/jetlaw/vol20/iss3/5

Yan, B., Ni, S., Wang, X., Liu, J., Zhang, Q., & Peng, K. (2020). Using virtual reality to validate the Chinese version of the independent television commission-sense of presence inventory. *SAGE Open, 10*(2). https://doi.org/10.1177/2158244020922878

Yan, Z., & Lv, Z. (2020). The Influence of immersive virtual reality systems on online social application. *Applied Sciences, 10*(15), 1–19. http://dx.doi.org/10.3390/app10155058

Yang, X., Lin, L., Cheng, P-Y, Yang, X., Ren, Y., & Huang, Y-M. (2018). Examining creativity through a virtual reality support system. *Education Tech Research Development, 66,* 1231–1254. https://doi.org/10.1007/s11423-018-9604-z

Yazan, B. (2015). Three approaches to case study methods in education: Yin, merriam, and stake. *The Qualitative Report, 20*(2), 134-152. https://doi.org/10.46743/2160-3715/2015.2102

Yee, N., & Bailenson, J. (2007). The proteus effect: The effect of transformed self-representation on behavior, *Human Communication Research, 33*(3), 271–290. https://doi.org/10.1111/j.1468-2958.2007.00299.x

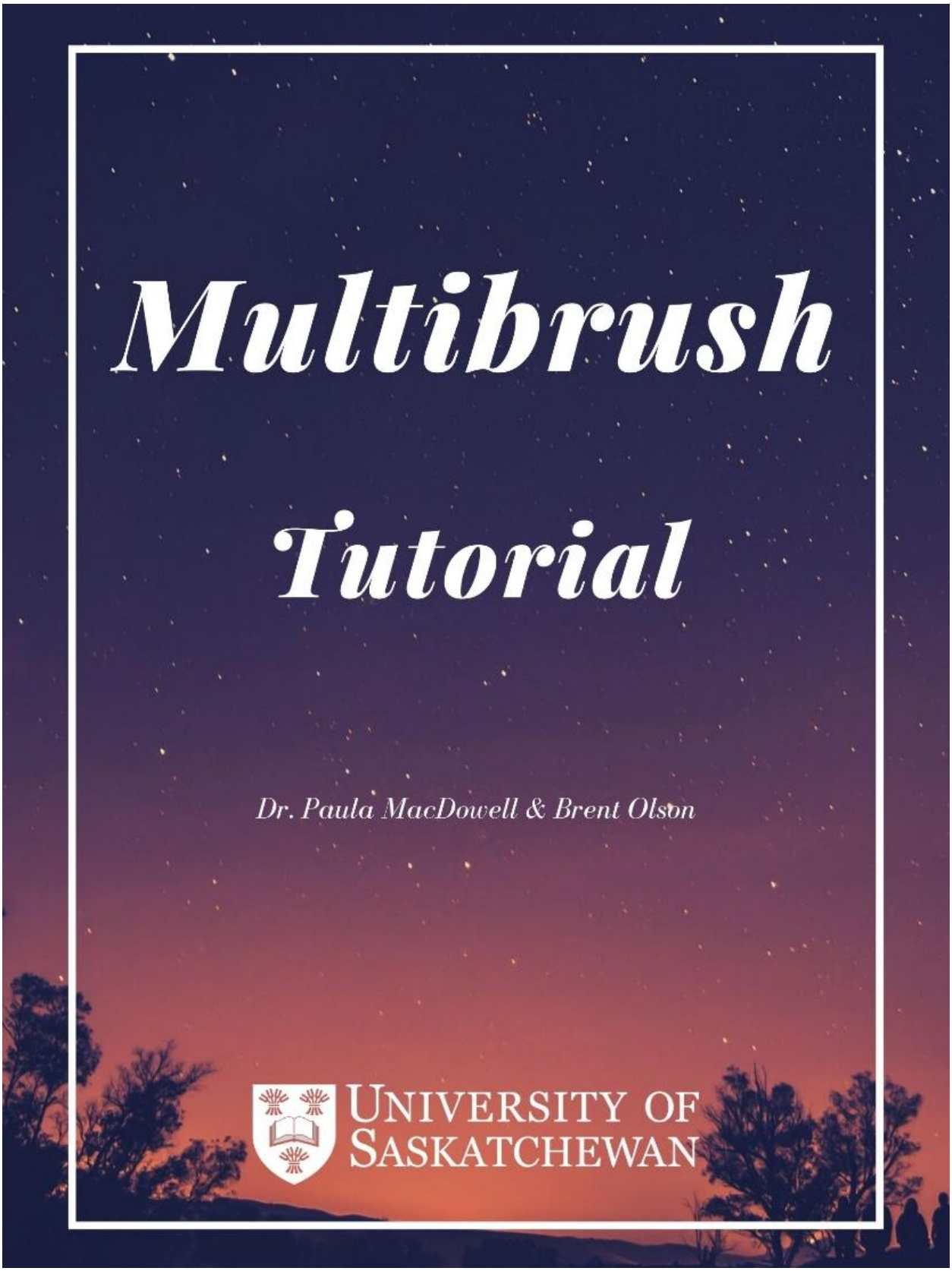
Yilmaz, R., Aydemir, M. Karaman. S., & Goktas, Y. (2016). Social presence in a three-dimensional virtual world used for distance education. *Croatian Journal of Education, 18*(3), 859–897. https://doi.org/10.15516/cje.v18i3.1664

Yu, W., Wang, K., Wu, H. (2022). Empirical Comparison of Learning Effectiveness of Immersive Virtual Reality–Based Safety Training for Novice and Experienced

Construction Workers. *Journal of Construction and Engineering Management, 148*(9), 1-13. https://ascelibrary.org/doi/10.1061/%28ASCE%29CO.1943-7862.0002337

Zhou, S.-J., Zhang, L.-G., Wang, L.-L., Guo, Z.-C., Wang, J.-Q., Chen, J.-C., Liu, M., Chen, X., & Chen, J. X. (2020). Prevalence and socio-demographic correlates of psychological health problems in Chinese adolescents during the outbreak of COVID-19. *European Child & Adolescent Psychiatry, 29,* 749–758. https://doi.org/10.1007/s00787-020-01541-4

Appendix A: MultibrushVR tutorial

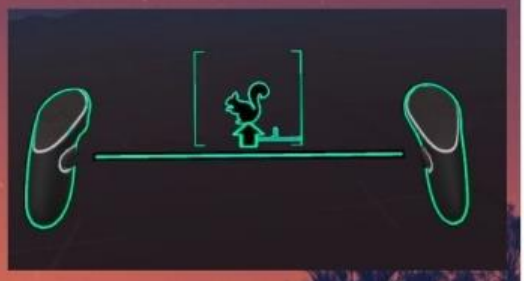


Resizing yourself

Click this button on both controllers

Push controllers together to make yourself larger

Pull controllers apart to make yourself smaller



Teleportation

Rotate left hand or left thumbstick until you find 'Tools'

Choose 'Teleport' button with right trigger

Point and click the right trigger where you want to go!

Creating art

Rotate left hand or left thumbstick until you find 'Brushes'

Choose a material with the right trigger

Point and click the right trigger to create!

Erasing errors

Rotate left hand or left thumbstick until you find 'Tools'

Choose 'Eraser' with the right trigger

Move eraser to art you want to eliminate, press right trigger

Changing color

Rotate left hand or left thumbstick until you find 'Color Picker'

Point and select a color on the circle

Move slider on right to make color brighter or darker

Undo, redo

Rotate left hand or left thumbstick until you find 'Tools'

If you want to take back a recent action, choose 'Undo'

**Or press 'X' on left controller*

If you want to return this action, choose 'Redo'

**Or press 'Y' on left controller*

Connecting Online

Rotate left hand or left thumbstick until you find 'Brushes'

Use right trigger to select 'Multiplayer'

Use right trigger to join a group and enter the pasword

**If you are having issues, check your internet connection*

Duplicating art
(Part 2)

Select 'Re-brush'

Press the 'B' button on right controller to open options

Click 'Selection'

Duplicating art
(Part 2)

Select 'Re-brush'

Press the 'B' button on right controller to open options

Click 'Selection'

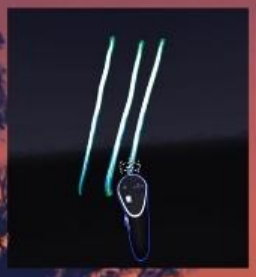
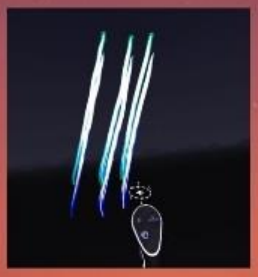
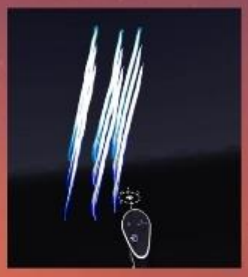
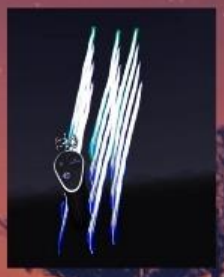
Duplicating art
(Part 3)

Press right trigger to select an object
**it will temporarily disapear*


When you unpress the trigger, the object will have a glowing pulse



Hold 'B' to duplicate selection (Repeat for more duplication)

Saving your work

Go to square box, 'Sketchbook' at the bottom of the left controller

Go to save icon on top of sketchbook, and press 'Save Sketch'

Take a picture to remember your art when you access it later

Access your save file through 'Your Sketches' in sketchbook

Appendix B: Guiding interview questions

SEL Skills

1. How have you improved because of your experience in VR?

   A. How might you use this improvement in your future?
   B. Were there any moments in the learning that challenged you? What were they, if any? What aspects did you find challenging?

Social Presence

1. Did you feel a connection to your AltspaceVR Avatar?

   A. What made you feel this way?
   B. What are some decisions you made about VR Avatar?
   C. Why did you make these decisions?

3. What are some benefits and drawbacks of communicating in VR?

   2. Was it easy to clearly deliver information to others? (Open communication)
   3. Explain a fun moment you had with classmates (Affective Expression, Group Cohesion)
   4. How comfortable were you in the VR headset? Did you experience any dizziness or nausea?

Constructivist Learning

4. What was your favourite VR experience?

   A. Why was this experience better than others?
   B. Who would you recommend this experience to?

5. List some decisions you made about your VR project. Why did you make these decisions?

6. Is there anything else you would like to say?

Appendix C: Survey

VR Learning Checklist

I consider the VR learning useful to my future	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
When in VR, I enjoyed being with other classmates	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I had freedom to make decisions about my learning in VR	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
When in VR, I asked my classmates questions	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
When in VR, I could easily answer my classmates questions	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
When in VR, I could easily express my opinions	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
When in VR, I generally got along well with my classmates	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
When in VR, I found it easy to share about myself	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I felt my point of view was appreciated by my other group members in VR	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

Working on the SDG project in VR helped me to develop a sense of teamwork	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
If needed, I felt comfortable disagreeing with my classmates in VR	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

1. On a scale of 1-10, how much did you design your avatar to look like you?

   Not very much 1---2---3---4---5---6---7---8---9---10 Very much

2. On a scale of 1-10, how comfortable were you in the VR Headset?

   Not very much 1---2---3---4---5---6---7---8---9---10 Very comfortable

3. What was your favourite experience with VR for learning? Please explain a little bit.

4. What was your least favourite part of VR for learning? Please explain a little bit.

Appendix D: Consent and assent forms

UNIVERSITY OF SASKATCHEWAN
College of Education
EDUCATION.USASK.CA

Department of Curriculum Studies
28 Campus Drive Saskatoon SK S7N 0X1 Canada
Phone: (306) 966-2683

Consent Form for Guardians and Assent for Participants

Date: December 1, 2021
Study: Immersive virtual reality (VR) as a meaningful tool for youth to learn about the Sustainable Development Goals (SDGs)

Principal Investigator:
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Purpose

The purpose of this research is to provide an understanding of how we can improve the reach and effectiveness of youth engagement on the United Nation's Sustainable Development Goals (SDGs), humanity's best hope and vision for working together to make a better world. We aim to identify how digital storytelling and design processes can empower learners with the knowledge and motivation to improve SDG education and awareness in our lives, homes, schools, and communities.

Participation

The study location is the College of Education, University of Saskatchewan. Grade 8 youth in the GSCS Ecojustice Program are invited for a 3-day workshop that consists of land-based education in VR, virtual field trips to learn about the SDGs, and creating digital art with friends in virtual environments. Participants will be invited to answer a short survey (taking about 20 minutes to complete) followed by a group discussion (taking about 40 minutes) that will be audio recorded. Participants will be asked open-ended questions to discuss their experiences learning about the SDGs by creating and exploring in immersive virtual reality.

Confidentiality and Data Privacy

Participation in this research is voluntary. The study will only collect data from participants who provide their assent and whose parents/guardians provide their consent. The data collected may be presented at professional conferences or published in academic journals without additional informed consent. Direct quotes may be used from the participants' questionnaire but names, images, or any other personally identifying information will not be shared. Individual privacy will be maintained in all published and written data resulting from the study.

By agreeing to participate, be assured that:

- All research data collected will be confidential with the Principal Investigator and Co-investigator listed at the top of this form. You may review the data collected that pertains to yourself anytime.
- All research data will be stored in a locked office accessible only by the researchers.
- All research data will be stored in computers and files protected with strong passwords.
- The survey will be hosted by Survey Monkey. All data will be stored in secure facilities hosted in Canada. Please see the following for more information on the Survey Monkey Privacy Policy.
- All research data will be transferred to the P.I.'s USask OneDrive account for the long-term storage period of five-years post-publication.

Risks and Benefits

The risks associated with this study are minimal. There are no known or anticipated risks to you by participating in this research. The interview discussions will not be personal or sensitive in nature. Each participant will receive a USask hoodie as a thank you for contributing their stories, experiences, and knowledge to the research.

Right to Withdraw

Your participation is voluntary and you can participate in only the discussions that you are comfortable with. You may withdraw from the research project for any reason, without explanation or penalty of any sort. Should you wish to withdraw, you may leave the focus group meeting at any time; however, data that have already been collected cannot be withdrawn as it forms part of the context for information provided by other participants.

Confidentiality

As the online surveys are anonymous, it is not possible to withdraw the survey data after it is submitted. You can decide not to participate at any time by closing your browser or choose not to answer any questions you do not feel comfortable with. Survey responses will remain anonymous. Whether or not you choose to participate in the research, this will have no effect on your educational services or how you will be treated.

The researcher will undertake to safeguard the confidentiality of the discussion but cannot guarantee that other members of the group will do so. Please respect the confidentiality of the other members of the group by not disclosing the contents of this discussion outside the group and be aware that others may not respect your confidentiality.

Questions

If you have any questions or desire further information about this study, please contact the principal investigator, Dr. Paula MacDowell, Assistant Professor, Department of Curriculum Studies, College of Education, University of Saskatchewan. Phone: 306-996-2683. E-mail: paula.macdowell@usask.ca

Independent Contact

This research project has been approved on ethical grounds by the University of Saskatchewan Behavioural Research Ethics Board. Any questions or concerns regarding your rights as a participant may be addressed to that committee through the Research Ethics Office: ethics.office@usask.ca; 306-966-2975; out of town participants may call toll free 1-888-966-2975.

Research Project Funding

This research project is funded by a John Ranton McIntosh award from the College of Education at the University of Saskatchewan.

Signed Consent

Your signature below indicates that you have read and understand the description provided, and consent to participate in the research project. You acknowledge that your participation in the study is voluntary. You may withdraw from this study at any time, without any consequences, regardless of parental notification, even if you sign this letter of consent. To obtain published results from this study, contact Dr. Paula MacDowell at (paula.macdowell@usask.com).

FOR GUARDIANS TO SIGN (Consent)

TO PARTICIPATE IN THE STUDY:
Immersive virtual reality as a meaningful tool for youth to learn about the Sustainable Development Goals (SDGs)

☐ **I CONSENT** to my child's participation in the research project. I have read and understand the description provided. I have had an opportunity to ask questions and they have been answered. A copy of this consent form has been given to me for my records.

Child's Name (please print): _____

Parent/Guardian Name (please print): _____

Signature:_____**Date:** _____

FOR PARTICIPANTS UNDER AGE 18 TO SIGN (Assent)

TO PARTICIPATE IN THE STUDY:
Immersive virtual reality as a meaningful tool for youth to learn about the Sustainable Development Goals (SDGs)

☐ **I AGREE** to my participation in the research study. I understand the study activities explained in this form and how I will participate in this study. With my consent I confirm that I have also received a copy of the project information for my records.

Your Name (please print): _____

Your Signature:_____**Date:** _____

Appendix D: COVID-19 health and safety certificate