ATHABASCA UNIVERSITY

A VIRTUAL EDUCATION INTERVENTION TO APPROXIMATE HANDS-ON LEARNING: VIA TASK-CENTRED LEARNING PRAXIS

BY

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Approval of Dissertation

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Dedication

This work is dedicated to the one Creator. Like oxygen, deep in the unseen, present, life-giving, and often unacknowledged, I take Them for granted when success is at hand yet demand help when it isn't. I am grateful for being shown the careful steps to take along this log flume of life and for providing the next log to jump to when I was frequently on the edge. Like one of my endorsed task-centred learning principles, I am grateful for the internally encoded human Model of Excellence given as a beacon to find the high road, and for the many externally provided examples of excellence in others to inspire me.

This work is also dedicated to my late husband, Dr. Paul Coleman. He was a big proponent of education and he believed in me unconditionally when I began with no degree at all a few years ago. He stayed alive long enough, when he was seriously ill, to see me graduate the Master of Education degree, and he continues to propel me every day with his love through this doctorate program and beyond.

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In the warm and fuzzy realm, there are my fellow doctoral students. We have been a unified team, with four of us having collaborated on six conference presentations and a book chapter. Three of us formed a group called the “Pajama Mamas”, because we were online higher education learners often working in our PJs, arguing scholarly articles, sharing hummus recipes, and visiting on Oculus Quest VR, long before COVID. A number of us have supported each other personally in a unique online “swarm” (following the swarm leadership model). As such, our online Teams library is always open and at least two of us can be found working quietly together most days, each on their research dissertation. We have also been able to share just-in-time information or give emotional support to each other when we needed help fast. This camaraderie mixed with accountability to each other was instrumental for me in completing this dissertation. When there were long days or nights of concentrated writing, it was comforting and focusing to have my colleague close by, just a few screen inches away, doing the same thing. I will treasure these friendships and memories. Thank you, Cohort 11.

Thalia and Michaele, close friends, always called or sent a message or a gift at the uncanny right time. Thalia frequently provided time and space and belief in the potential of the HAvatar intervention. Another friend, a Masters of Distance Education student, Cynthia, encouraged me with her enthusiasm; she devoted time in the first tentative year of the HAvatar idea to our mutual mission of transforming online education, even composing a unique musical sound-bite I could use. Thank you for your friendship.

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As a cyborg, it would be remiss of me not to salute the brilliant technology, electronic devices, cell telephony, global net-connectedness, accessible human knowledge, hundreds of software apps, and electric power machinery; dependencies that have truly made it possible for me to do this degree and enable the making of the HAvatar. Many thanks to the tech geniuses.

Abstract

As yet, technology cannot offer online learners a way to physically touch real objects in a remote learning environment. The gap in provisioning hands-on learning virtually is widening due to the global population explosion and society's quantum move to a net-connected world. A conundrum is growing where organizations are bound to continue using existing equipment, labs, and worksites to teach physical hands-on skills yet need to move curriculum online. Further, the quality of the pedagogy vis-à-vis the needs of tech-oriented twenty-first century learners, as well as wide accessibility to many demographics at minimal cost, are factors of great concern. Microworld solutions are nascent and out-of-range for all but the most well-funded early adopters such as medical, military, aerospace, and gaming. With this situation in mind, held against the three vectors of the iron triangle of distance education — quality, affordability, and accessibility — I designed a pedagogical-technological intervention called HAvatar. It uses a human avatar to stand in for online learners for equipment-based skills acquisition so that existing facilities can reach online learners with little disruption.

The intervention was evaluated using design-based research methodology in iterations grounded in task-centred learning theory criteria (quality) using existing real-world facilities and readily-available retail technology (affordability) conducted with remote learners via broadband connectedness (accessibility). Data were collected via mixed methods with multiple data sources.

Findings reported that the quality of HAvatar as a way to master hands-on equipment skills was high. The seven participants unanimously recommended that HAvatar be taken further into technical and vocational training organizations. A quantitative in-situ study on its efficacy would be a future recommendation. HAvatar could contribute to the field of distance education by providing a viable solution for virtual hands-on learning.

Keywords: virtual hands-on learning, task-centred learning, task-centred instructional design, quality distance education pedagogy, avatar-based learning, online hands-on learning, simulated virtual learning, design-based research, project-based learning, problem-based learning, learning-by-doing, serious gaming, online tactile skills, pragmatism paradigm, education intervention, experiential learning, outcome-based integration, prior learning activation

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Definitions and Acronyms

Term	Definition
Active Learning	Learners construct their meaning from critical thinking about their learning, not just from passive acceptance of what they are told (Dewey, 1916).
Advance Organizers	"Learning and retention of unfamiliar but meaningful verbal material can be facilitated by the advance introduction of relevant subsuming concepts (organizers)" (Ausubel, 1960, p. 267).
App	This is an abbreviation for the word application of a software program. Most often used to describe programs for mobile devices, such as smartphones and tablets (TechTerms, 2021a).
Approximate	means to come near to or be close to (something), or a reproduction that approximates the original (Merriam-Webster Dictionary, 2021).
Artificial Intelligence (AI)	enables computers and machines to mimic the perception, learning, problem-solving, and decision-making capabilities of the human mind (IBM, 2021).
Augmented Reality (AR)	is an emergent technology that superimposes computer-generated screens and semiotics onto a real-world environment (Scope AR, 2019).
Avatar	is an icon, graphic, or other images which represents a person on a communications network or in a virtual community, such as a chatroom or multiplayer game (Your Dictionary, n.d.). In the case of HAvatar, a human avatar stands in for the learner in the learning venue and enacts their verbally mediated commands.
The Cloud	is close to a synonym for the Internet—more specifically, all affordances accessed remotely over the Internet. Cloud storage is on Internet servers, not on computer hard drives (GCF Global, n.d.).
Cloud Services	reside on a global network of connected computers, with software delivered on-demand to end-users over the Internet (Citrix, n.d.).
Cohort	is a group of individuals having a statistical factor (such as age or class membership) in common in a demographic study (Merriam-Webster, 2021b).
Cyberspace	signifies the online world of computer networks and especially the

	Internet (Merriam-Webster, 2021c).
Edtech	is a short-form for educational technology (*Education Technology: What Is Edtech? A Guide. | Built In*, n.d.).
Fidelity	denotes the objective degree of exactness with which real-world experiences and effects are reproduced by a computing system (McMahan et al., 2012).
Gen Z	abbreviates generation z, the demographic born after 1996 (Pew Research Center, n.d.).
Gestalt Principles	Principles/laws of human perception describe how humans group similar elements, recognize patterns, and simplify complex images when they perceive objects. Designers use gestalt to organize content on websites and other interfaces, so it is aesthetically pleasing and easy to understand. (The Interaction Design Foundation, 2021, para.1)
Haptic	is anything based on the sense of touch in the metaverse (Merriam-Webster, 2021d).
Human-Computer Interaction (HCI)	"…deals with the theory, design, implementation, and evaluation of the ways that humans use and interact with computing devices" (Kim, 2015, p.1).
Information & Communication Technology (ICT)	Although there is no single, universal definition of ICT, the term is generally accepted to mean all devices, networking components, applications and systems that combined allow people and organizations (i.e., businesses, nonprofit agencies, governments, and criminal enterprises) to interact in the digital world (TechTarget, 2021).
Intervention	"The object, activity, or process…is designed as a possible solution to address the identified problem….including educational products, processes, programs, and policies" (Shattuck & Anderson, 2013, p.187).
Learning & Development (L&D)	"Learning and development is a systematic process to enhance an employee's skills, knowledge, and competency, resulting in better performance in a work setting" (GCF Global, n.d.).
Machine Learning	represents the science of getting computers to act without being explicitly programmed has given us self-driving cars, practical speech recognition, effective web search, and a vastly improved understanding of the human genome (Stanford University, n.d.).
Member-Checking	is a process of sharing research data or transcriptions garnered

	from a participant as the co-creator of that data, providing an opportunity to revise their representation (Goulding, 1999).
Metaverse	combines the words "meta" and "universe." While "meta" has several different meanings, in "metaverse," it means something of a higher or second-order kind. In other words, the metaverse is another realm that exists outside the real world. While still in the early stages, the goal of the metaverse is to provide a virtual environment that simulates reality. It will allow people to explore an online space, meet other people, and build relationships (TechTerms, 2021c).
Microworld	is used in this study to represent any reference to XR learning venues.
Node	This signifies any system or device connected to a network (TechTerms, 2021b).
Online Learning	is synonymous with distance learning, distance education, elearning, Internet learning, distributed learning, net-centric learning, virtual learning, and web-based learning (Ally, 2008).
PedTech	describes the phenomenon of developing pedagogical theory and practice with technological solutions hand-in-hand, in education institutions (Ives et al., 2005).
Praxis	is the synthesis of theory and practice without assuming the primacy of either (Definitions.net, 2021).
Semiotics	is the study of signs, symbols, and signification. It is the study of how meaning is created, not what it is (*Definitions of Semiotic Terms*, n.d.).
Situated Learning	represents the embedded real-world context is vital in quality education to undertake complex tasks in situ (Lave & Wenger, 1991).
Software Design Lifecycle (SDLC)	comprises the phases of requirements, design, development, testing, and implementation of developing a software product (Altvater, 2020).
Software Requirements Specification (SRS)	represent a comprehensive description of the intended purpose and environment for software under development. The SRS fully describes what the software will do and how it will be expected to perform (TechTarget, 2022).
Task-Centred Learning Praxis	encapsulates many learning theories: project-based, practice-based, task-based, problem-based, evidence-based, experience-

	based, elaboration theory, professional task development-based, maker-based and more – all within the theoretical neighbourhood of learning-by-doing (O'Brien, 2017; Reigeluth & Carr-Chellman, 2009; Reigeluth et al., 2017).
Twenty-first century Learners	denotes learners born into the digital age and broadly indicates all those born and yet to be born in this century.
Unity	is a cross-platform game engine based on programming language C sharp (#) to create games and experiences in both 2D and 3D (Gregory et al., 2016).
Virtual Reality (VR)	is a virtual re-creation of the real world to transport the user to fully digitized and interactive environments. This technology was initially conceived for video games; however, it has reached various fields, such as industry, medicine, army, education, and tourism (Naranjo et al., 2020, p. 2).
Zoom	is proprietary software for webconferencing, the primary software used in this study (Zoom.US, 2021).
XR	means extended reality encompassing virtual reality, augmented reality, and human computer interaction (Goode, n.d.).

Chapter 1: Positioning

…if I could just get my hands on that thing!

As yet, technology cannot offer online learners a way to touch real objects in a remote learning environment. The gap in provisioning hands-on learning online is widening due to the global population explosion and society's quantum move to a net-connected world, looking to the Internet for just-in-time learning of all kinds (Christensen & Johnson, 2008). Learning on the web instantly makes everyone a remote, virtual learner. Rapid improvements in technology and shared human knowledge are outstripping our ability to keep up (Manville, 2001; Sarder, 2016). The societal demand surpasses the capacity of outdated and expensive delivery methods of physical presence to learn (UNESCO, 2016). Despite advances in virtual reality, augmented reality, and robotics innovations, these technologies are still preliminary, expensive, complex to develop, frequently evolving, and marginally accessible to mainstream education (e.g., Kim, 2015; Lane, 2014; Laurillard, 2012; Manville, 2001; Naranjo et al., 2020; Visser et al., 2012).

I pondered if there was a way to approximate real-world, hands-on learning through the Internet using readily available retail technology and existing physical facilities. This query led me to design an intervention and to examine its effectiveness in this design-based research study. Borrowing concepts from the gaming world and guided by sound task-centred learning theory and instructional design practice, this intervention is called HAvatar, which stands for the human avatar and learning online. Learners can approximate hands-on learning remotely connected to a live workshop.

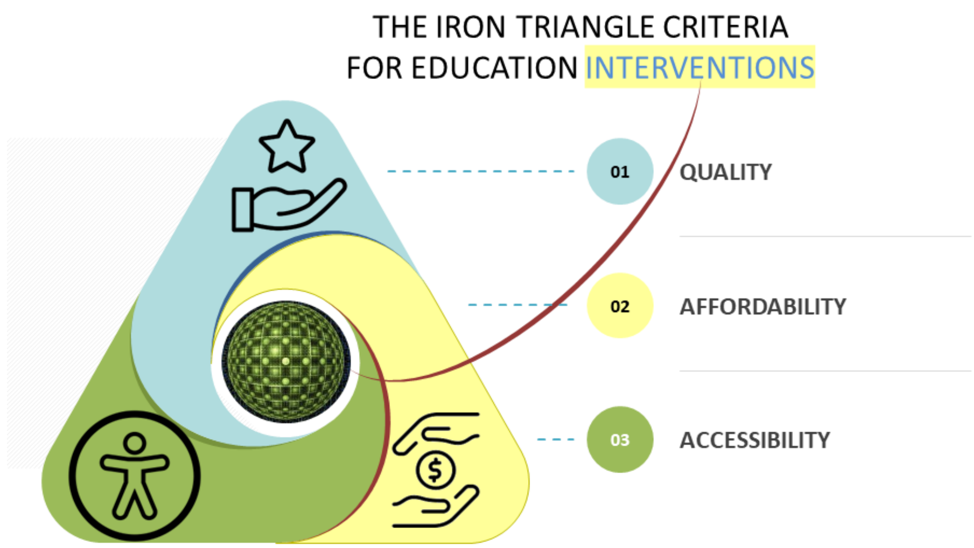
Background

In order to understand the current state of online learning, I began with a look at the cannon of progress made to date in distance education. Simonson and Schlosser (2009) define distance education as disparate learning groups where interactive networks unite instructors, learners, and resources to provide institution-based formal education. Knowledge of the field of education supports understanding the implications of online learning needs.

The Iron Triangle of Education

Distance education solutions can be assessed through the vectors of the iron triangle of education as informed by Daniel et al. (2009) and Lane (2014). These three vectors, quality – affordability – accessibility, predicate the viability of education innovations; I used them to inform the purpose of this study as depicted below in Figure 1.

Figure 1
The Iron Triangle Affecting Education Interventions (M. Doran, informed by Daniel et al. (2009))



According to UNESCO (2016), Lane (2014), and Daniel et al. (2009), the iron triangle is of prime importance to national government mandates, education and training organizations, as well as individual students. Millions of learners are seeking a way to access and afford education to prepare for jobs, looking to the Internet for answers; institutions are seeking ways to effectively prepare their incumbents to fill current and future labour gaps (Daniel et al., 2009; Daniel, 2019; Educause, 2020; International Labour Organization, 2019; Neal, 2020).

Distance Education (DE)

DE theory and practice have risen to the iron triangle challenge in tandem with the rapid development of cloud technologies that enable mass remote learning. Over the past 30 years, DE leaders understood the opportunity via the Internet to exponentially transform the passive lecture-based paradigm rooted in pre-millennial education to the much-needed paradigm of active learning for this millennium while simultaneously reaching a globally accessible student body. Research into interventions and statistics claims that DE increases the quality of learning experiences, removes situational barriers, and is cost-effective (Kanuka, 2008) – the latter three factors being the iron triangle vectors. Hallmarks of DE prevail in the proliferation of open universities, massive open online courses (MOOCS), and increasing numbers of DE departments in universities. Learning management systems (LMSs) are replacing classrooms and lecture halls; social media and open education resources (OERs) have become acceptable sources of education (Conrad et al., 2013; Miyazoe & Anderson, 2013; Ozturk, 2015; Visser et al., 2012).

Increasingly, the decades-honed epistemology of DE distributed to distance students is being scrutinized as the norm rather than the exception by a web-enabled world now ready for it. As Conrad confirms, "DE has become synonymous with innovative models of program delivery that offer more generous open and flexible learning opportunities to wider and more diverse audiences than did traditional classrooms" (2008, p.76).

DE thinking, married with technology, has brought to the fore many of the researched paradigms and theories of learning (Kanuka, 2008). For example, constructivism, constructionism, complexity theory, connectivism, the community of inquiry, and situated problem-based learning are widely and richly deployed in DE institutions (Anderson, 2008). Digital-age educators and instructional designers orchestrate the creation of relevant, varied, and colourful curricula from the vast array of human knowledge now available online. They chunk it into focused, manageable, meaningful, and engaging instruction — a far cry from in-person lecture-based learning (Visser et al., 2012). DE assumes the prescience of interaction with peers, facilitators, and content via mobile anytime-anywhere access. Educators of today must know the different approaches and styles of learning, encourage deep processing, provide relevant feedback, find and orchestrate pertinent content, and scaffold the individual learner astutely while encouraging self-directed learning in tandem with collaborative work (Ally, 2019; Anderson, 2008b)—no small task.

In Chapter 6, I attest to the continuum between academia struggling to move towards state-of-the-art technologies and technologies working to invoke engaged learning through graphical, virtual, and gaming interfaces. Some futurists aver this struggle as heralding technology's domination over education "should long-established providers of education not respond to accelerating globalization and increasing competition" (Anderson, 2008b, p. 98). In their book, *Learning in a Digital Age*, Anderson warns that universities will cease to exist, replaced by consumer-oriented education. More than a decade since this publication, the proliferation of e-learning companies independent of public education has indeed become a billion-dollar industry. This commercialization of education impacts the quality vector of the iron triangle (Bates, 2015). According to Clark (1994), "media and their attributes have important influences on the cost or speed of learning but only the use of adequate instructional methods will influence learning" (p. 27). The learning meant to prepare incumbents for the digital age often favours appeal over robust instructional design and researched theory (Reigeluth et al., 2017; Zhou et al., 2018).

The Rationale for the Intervention

Pedagogy comprising verbal communication, discussions, writing, software app development, or anything that requires soft skills can readily transform into an online format supported by seasoned DE theory and practice.

However, hands-on learning is a different case in DE.

There is a growing conundrum where organizations are bound to continue using existing equipment, labs, and worksites to teach physical hands-on skills yet need to move curriculum online (Reigeluth et al., 2017). No mainstream technology allows a remote learner to manipulate solid objects remotely. The world has countless scientific, technical, and vocational institutions with onsite facilities for tactile learning. For example, there were 2,840,000 hits on the literal string "technical college" from Google search, and there are an estimated 6,000 universities and colleges in the USA alone. To date, if a learner requires an equipment-based, industry-wide accredited skill in, for example, robotics, agriculture, computer or network hardware assembly, machinery, woodworking, or laboratory work, they attend a physical facility to learn hands-on. As Neal (2020) explains, technical and vocational education and training (TVET) institutions are working to bring their offerings to the virtual classroom. "As distance as possible" (p. 1) is the goal of the Commonwealth of Learning, an international organization running apprenticeship programs. Commonwealth of Learning's blended learning models target essential workers with both soft skills and hands-on training. The more contextually situated the delivery system is, the more learner-centric, promoting the advantages of learning away from physical campuses. However, the third apprenticeship option, hands-on, requires the learner to be physically present at the worksite. The Commonwealth of Learning reports limitations of affordability and accessibility for these programs.

Some innovative technologies, such as the haptic glove (Ma & Ben-Tzvi, 2015), provide a sensation of touch through the cloud; however, this solution requires programming virtual objects in microworlds. Technology can direct robots from a distance to manipulate physical objects, still at great expense, limited application, and niche contexts. Augmented reality can incorporate physical venues into the design but still demands the development of software requirement specifications (SRS) and software design lifecycles (SDLC) (Scope AR, 2019). Figure 2 illustrates the sophistication of a virtual reality application where a microworld replaces reality completely. Virtual reality initiatives naturally demand complex SRS and SDLC using a 3D software programming engine (e.g., Unity).

Out of the plethora of studies and reports disseminating from the domain of immersive technologies, by far the most developed advancements are found in the well-funded industries, that is, medical, military, aerospace, and gaming. These domains have the most extended history of applied simulation experimentation models and remain at the leading edge of edtech (Naranjo et al., 2020).

However, these domains have not been studying the learning and education of humans as their primary focus. Public and private education organizations are not perceived or reported as front runners in the trend towards virtual immersion, yet the education industry is expected to reach millions of learners with high-quality online learning (e.g., UNESCO, 2014; Visser et al., 2012). The Pedagogical-Technological Change Continuum discussed in Chapter 6 as well as the Literature Review in Section 2 explore this disparity further.

Essentially, edtech is still largely beyond the budgets and time constraints of the minimally resourced education industry, the industry that greatly needs virtual affordances to transform learning to reach a global cohort.

Figure 2

VR Application

The Human Avatar and Learning Online (HAvatar) Intervention

Real-World Approximation

Online educators and instructional designers constantly seek ways to improve authenticity, interactivity, and collaboration at a distance (Anderson, 2008b). Gregory et al. (2016) contend that, in online interventions, "the difficulty lies in designing an interface that scaffolds the motivational and learning goals of a specific virtual world" (p. 3). The HAvatar intervention attempts to address this need with an up-close virtual experience that approximates hands-on practice of a manual tactile skill. Its components comprise readily available retail technology, the Internet, existing physical learning venues, and minimally trained staff; thus, mitigating the affordability and accessibility issues of the iron triangle of education. As with all online interaction, HAvatar can only approximate a tactile hands-on experience.

A HAvatar Learning Session

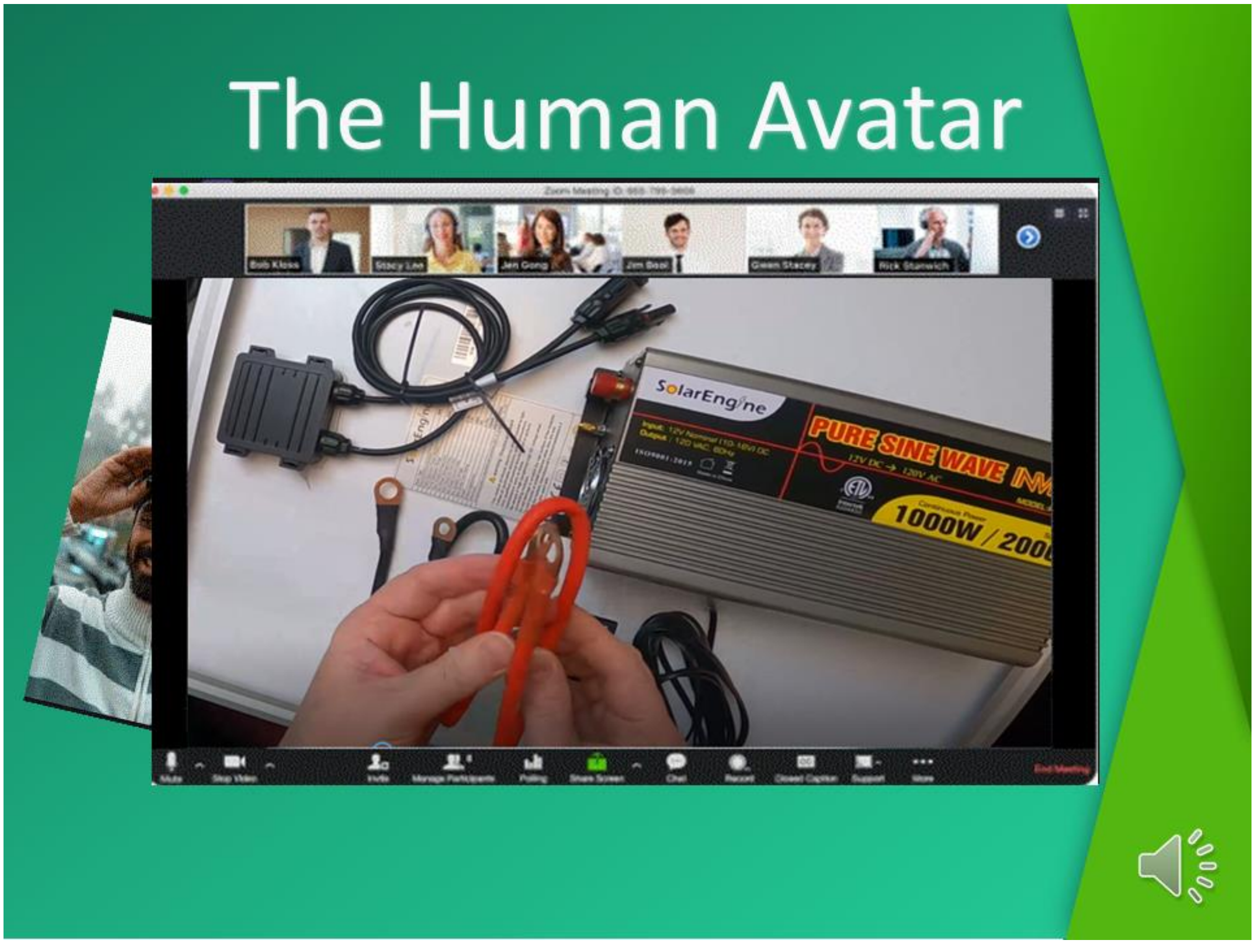
HAvatar engages a small group of learners (a cohort) virtually present in cloud-based webconferencing such as Zoom. The cohort views a physical learning site via a maximized screen. See the clip in Figure 3 as to how this appears. The screen is livestreamed to the webconference through the "eyes" of an action camera worn by someone at the physical learning venue. I have labelled the person at the physical venue the human avatar because their role is similar to a virtual gaming avatar. The differentiation between a gaming avatar and the human avatar lies in the video gamer moving the avatar with hand controllers while the remote learner moves the human avatar via spoken words.

The Human Avatar

As such, the learners do not interact in a social relationship with the human avatar; instead, they direct the human avatar’s eyes and hands via verbal commands to complete the learning task of manipulating the objects. The non-interference of the human avatar in a puppet role and the non-visibility of their face give the learner a sense of being in control of their learning. Although the learners cannot touch the objects with their own hands, the action camera worn by the human avatar is up-close and focused on the objects.

Figure 3

YouTube Clip of the Human Avatar



Note. YouTube Clip of HAvatar

Roles in HAvatar

An overview of the context and roles of the HAvatar study is as follows:

(1) The combined role of researcher, designer, and facilitator orchestrates all other relationships and gathers the data. In addition, the facilitator role involves touchpoint participatory moments outlined in Chapter 3, the Research Design.

(2) The learning venue could be a workshop, a laboratory, a classroom, a studio, or any venue where physical equipment to be learned is located.

(3) The human avatar is physically present in the workshop, equipped with an action camera, a still camera, proper lighting, and livestreaming through broadband.

(4) The small cohort of online learners, viewing the learning venue remotely in webconferencing, practice the pre-determined task by giving the human avatar verbally-mediated commands.

Purpose of the Intervention and the Research Study

The HAvatar intervention aims to improve the practice of online education (McKenney & Reeves, 2013). Its purpose is to approximate a hands-on learning experience with a real-world task, provide an online way to see it, come as close to touching it as possible, and collaboratively practice the task to competency within a small cohort.

The objectives of this study seek to reveal: (1) compelling feedback about the quality of the HAvatar as a DE solution; (2) improvements to the technical intervention; (3) refinements to task-centred learning praxis when online; (4) recommendations for enacting design-based research methodology on education interventions.

Problem Statement

Succinctly restated, this study addresses a growing conundrum where organizations are bound to use existing equipment, labs, and training sites to teach physical hands-on skills yet need to reach remote learners. Further, the quality of the pedagogy vis-à-vis the needs of twenty-first century learners, as well as wide accessibility at minimal cost, are factors of great concern. Virtual reality and augmented reality solutions with haptic touch capability are nascent and out-of-range for all but the most well-funded industries, i.e., medical, military, aerospace, and gaming.

Research Questions

Based on the iron triangle presented earlier as prescient, I reiterate the sidelining of affordability and accessibility issues of HAvatar as a generalized assumption, due to its low cost of requisite equipment, the use of existing facilities and resources, and the minimal disruption to the status quo of the existing learning organization. This stance brings the vector of quality to the fore, that is, the quality of the HAvatar intervention.

Therefore, quality becomes the driving keyword in this study. I have defined quality within the principles of task-centred learning praxis.

What is the quality of HAvatar as an online experience approximating real-world, hands-on learning via task-centred learning praxis?

(1) *…in learning a task involving tactile skills?*

(2) *…in the experience of guiding the avatar with verbally-mediated instructions to accomplish tasks at a distance?*

(3) …with respect to solving tasks in a small-group format to direct the avatar and learn the skill?

(4) *…with respect to adding motivation and interest to learning online through the avatar to accomplish this task?*

(5) *Was the skill attained correctly according to the attainment task prior to ever touching the physical objects?*

(6) How important to the avatar experience is the task-centred learning pedagogy that organized it?

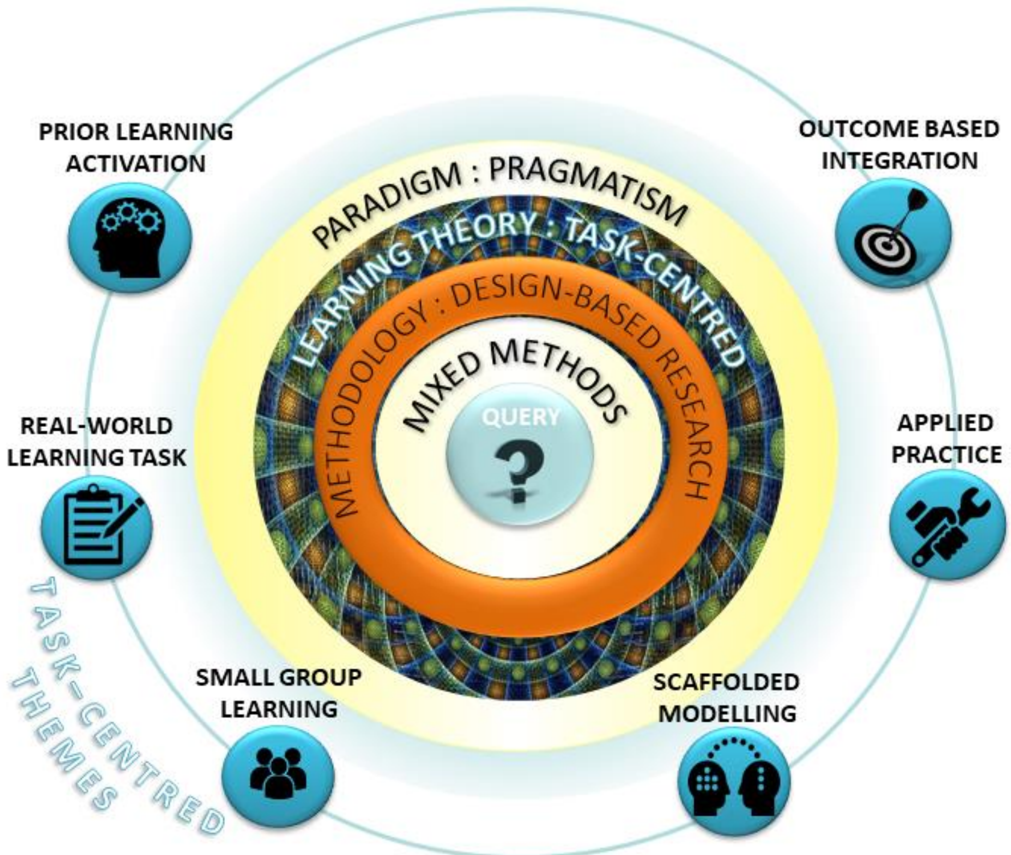
(7) *What are the impacts or refinements to task-centred learning praxis and learning-by-doing theory in this online format?*

Theoretical Framework

Figure 4 furnishes a high-level overview of the theoretical framework guiding this study, further plumbed in Chapter 3, the Research Design. The concentric rings start from the broadest perspective, the paradigm, to the central focus, the query. These positioning rings are depicted below, introduced with labels in italics as I discuss them.

Figure 4

Theoretical Framework



Paradigm

The outer ring in Figure 4 represents the *Paradigm*, the philosophical worldview permeating the study. I chose *Pragmatism* as my paradigm because it prioritizes the real-life application of learning with the centrality of change (Arthur et al., 2012; Cousin, 2009; Morgan, 2014). Furthermore, pragmatism is action-based, so it cannot be separated from the situation and context where the action occurs. Education interventions reflect this premise because they occur in real-world settings in specific contexts involving the researcher and the participant-learners in active engagement to advance design changes (Wang & Hannafin, 2005).

Morgan (2014) contends that pragmatism counteracts the notion of universal truths. However, pragmatism can attest to warranted beliefs resulting from "repeated experiences of predictable outcomes" (p. 26). This study explores how and if HAvatar warrants such beliefs related to quality aspects held against the theory of task-centred learning, which is the next concentric ring in Figure 4.

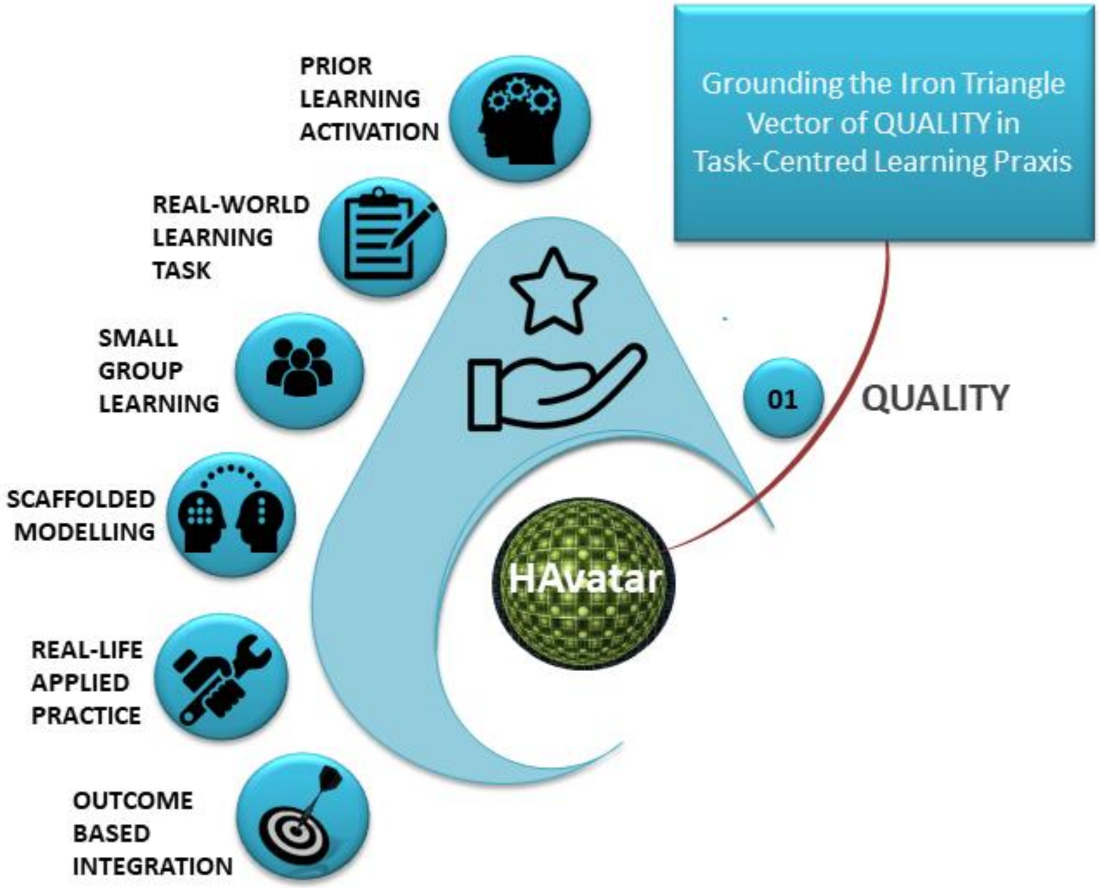
Learning Theory

From seminal to contemporary, research studies spanning more than a century purport that real-life tasks in real-world situations promote the most effective, lasting, and germane learning (e.g., Dewey, 1938; Francom, 2017; Merrill, 2002; Reigeluth et al., 2017). I further discuss these authors' works informing such claims in Chapter 2, Section 1, the Literature Review.

In connecting the quality vector of the iron triangle to the HAvatar intervention, the *Learning Theory* provides evaluation criteria for the research (Reigeluth & Carr-Chellman, 2009; Reigeluth et al., 2017). *Task-centred* learning principles comprise both a learning theory (Francom & Gardner, 2014) and an instructional design theory (Francom, 2017; Reigeluth & Carr-Chellman, 2009). From this point on, I have labelled it task-centred learning praxis, given that praxis means theory-into-practice (Definitions.net, 2021). Reigeluth and Frick (1999) further substantiate the term praxis by arguing that learning theories often do not include the dimension of practical criteria for instructional design. Task-centred learning praxis does.

Figure 5

The Quality Principles of Task-Centred Learning Praxis



The following brief descriptions summarize the icons in Figure 5 (Francom & Gardner, 2014; Merrill, 2002; Reigeluth & Carr-Chellman, 2009; Reigeluth et al., 2017):

(1) **Prior Knowledge Activation.** Learning grows when existing knowledge and skill are activated as a foundation for the new learning.

(2) **Real-World Learning Task.** Learning grows when learners are in a real-world learning situation completing whole tasks.

(3) **Small-Group Learning.** Learning grows within a small collaborative cohort.

(4) **Scaffolded Modelling.** Learning grows when new knowledge is demonstrated to the learner and scaffolded by a mentor or facilitator.

(5) **Real-Life Applied Practice.** Learning becomes real when learners apply the skill to solving tasks in a real-life situation.

(6) **Outcome-Based Integration.** Learning becomes firmly established when purposefully reflected upon, demonstrated in students' artifacts, and integrated into the learners' world. Attainment matches the real-world learning task.

The reader will meet these principles again in the Literature Review (Chapter 2) and in the Evaluation Criteria (Chapter 3).

Methodology

The third concentric ring in Figure 4 is the chosen *Methodology*: *Design-Based Research* (DBR). DBR relates well to the paradigm of pragmatism because it provides a research strategy for producing and evaluating applied education. Wang and Hannafin (2005) describe the characteristics of DBR as including the researcher in collaboration with participants to systematically design and implement interventions, improve initial designs, and "ultimately seek to advance both pragmatic and theoretical aims affecting practice" (p. 6). Dewey (1938) expresses the concept of DBR as lines of inquiry examining theories as to their ability to work in the world.

The HAvatar intervention examines such abilities against task-centred learning praxis as the guiding theory. Due to its iterative, systematic approach, DBR is particularly well-suited to technology-enhanced learning interventions such as this one (Wang & Hannafin, 2005). Chapter 3, the Research Design, further details the DBR methodology.

Mixed Methods

In the fourth concentric ring of Figure 4, *Mixed Methods* represent the methods and instrumentation for the data collection and analysis supporting the DBR methodology, both qualitative and quantitative. The paradigm of pragmatism and the methodology of DBR with their existential principles suggest that the research approach is free to use what generates the best data to address the research questions. As such, both pragmatism and DBR associate well with mixed methods (Barab & Squire, 2004; Morgan, 2014; Wang & Hannafin, 2005). Denscombe (2010) succinctly states the purpose of mixing quantitative and qualitative methods, “In line with the principles of triangulation, the mixed methods approach provides the researcher with the opportunity to check the findings from one method against the findings from a different method” (p. 139). As explained by Akilli (2008), "The pragmatist philosophy keeps the researchers away from pointless philosophical arguments" (p. 4) by prioritizing the research question and its context first and foremost then applying a confluence of methods and instruments to serve the answers.

About My Qualitative Methods. The HAvatar intervention as a DBR proposes a sampling of six participants. This initial study implements the intervention design to investigate its efficacy as an innovation within the purview of just a few participants. Qualitative methods appropriate data into interpreting meanings from the experiences of these six participants to generate rich depictions of the sessions, with a scope that is deep rather than wide (Denscombe, 2010; Silverman, 2005). As such, in this study, extensive feedback is gathered from written descriptions of rating scale choices collected formatively from session to session, from video footage, from a quiz, from my personal researcher reflections, and from a critical summative debrief meeting.

About My Quantitative Methods. The proposal of the HAvatar research does not involve quantifiable input from large numbers of participants, characteristic of quantitative studies (Cohen et al., 2018). Nonetheless, the DBR could still benefit from aspects garnered from rating scales that allow feedback sensitivity beyond binary responses yet are more quantifiable than a narrative description (Cohen et al., 2018; Creswell, 2013; Denscombe, 2010). One binary instrument is set to establish how well the participants learned the task, i.e., Does the computer boot up successfully?

The strategizes concurrent analysis of the quantitative and qualitative data as per Cohen et al. (2018), aligned with the HAvatar mixed methods instruments. In Chapter 3, Section 3, I have detailed the proposed instruments.

Query

At the centre of all the concentric rings in Figure 4 resides the *Query*, illustrating that the theoretical framework revolves around the quintessential research question.

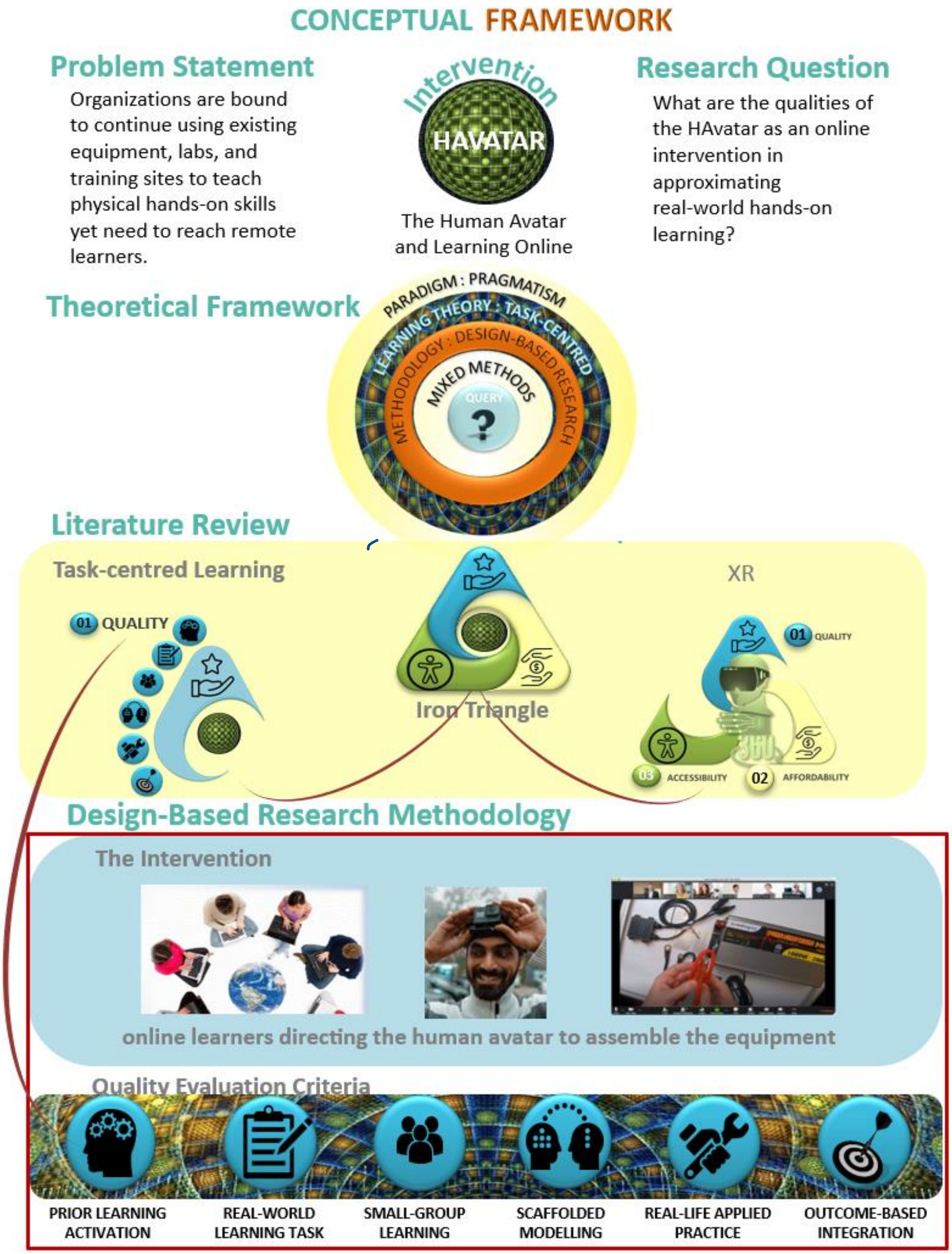
Scope Considerations

Conceptual Framework

The scope bounds the study's concepts, theoretical framework, literature exploration, data and analysis parameters, and project planning. It is essentially a big picture view which I have schematized in an overall Conceptual Framework (Figure 6). Tracking Figure 6, I provide a walkthrough of the Conceptual Framework of this research project, referencing the labels in italics.

Figure 6

Conceptual Framework



Note. Link to a larger, scalable version

The *Problem Statement* summarizes the dilemma facing organizations in providing online learning via existing physical facilities. The *Intervention, the Human Avatar (HAvatar)*, proposes a possible solution to this dilemma. The *Research Question* centralizes the query of investigating the quality of HAvatar. The research unfolds within the *Theoretical Framework* of learning-by-doing—paradigmatically, theoretically, methodologically, and methodically. The *Iron Triangle* of education bounds the *Literature Review* by examining the implications of *quality – affordability – accessibility* for mainstream education and training. The first section of the literature plumbs the praxis of task-centred learning as a way to establish the criteria of quality for best learning practice. The second section, held in the context of the iron triangle, explores the current state of virtual reality, augmented reality, and human-computer interaction which I have grouped under the extended reality label, *XR*. *Design-Based Research Methodology* guides the procedures of *The Intervention* with *online learners directing the human avatar to assemble the equipment*. *Quality Evaluation Criteria* drawn from task-centred learning praxis (see the connecting line from the Literature Review) are used to assess the quality of the HAvatar intervention.

Chapter 3, Figure 16, drills into the detailed methodology, that is, the DBR design portion of this schematic.

Credibility, Risks, and Ethics

"Research is an undertaking intended to extend knowledge through a disciplined inquiry or systematic investigation" (*TCPS 2: CORE*, n.d.). Part of the inquiry discipline involves addressing multiple factors that affect credibility, risks, and ethics (Cohen et al., 2018; Frey, 2018; Neuman, 2002). This due diligence in ensuring a quality study ranges over personal integrity, regulatory requirements of the academic institutions and national ethics boards, trustworthiness and depth of the data analysis, alignment with the learning theory, unexpected contextual risks, and informed consent of the participants and stakeholders. All of these considerations apply to the research about HAvatar.

Conole et al. (2011) stated, "Tools and users are not static….technologies are continually developed and upgraded, but more importantly, users adapt and change their behavior and interaction with tools over time" (p. 120). As a caveat, I am inserting the HAvatar intervention into a rapidly developing global arena in DE and technologically evolving microworlds.

In HAvatar, the most significant risk lies in the human avatar's role. Suppose the avatar was knowledgeable about the skill or was even the original teacher. In that case, it would be challenging for the avatar to enact directions that are incorrect, especially if they carry on for some length of time. The avatar's role purports to be silent except for some signals about technical difficulties.

Chapter 1. Summary

In Chapter 1, I have sought to provide a chain of reasoning (Krathwohl & Smith, 2005) in assembling the components for this research study. I introduced it in the context of the iron triangle of DE informing the rationale behind the intervention. I provided the description of the intervention model, the purpose of this study, the summative problem statement, the research questions, the theoretical framework as a comprehensive guide, and the scope considerations via a conceptual framework.

Chapter 2 reviews the seminal and classic literature related to task-centred learning praxis and current efforts to render online learning more real-life.

Chapter 3 defines the overall research design through the following sections: the research lens and 'ologies approach, the baselined implementation of DBR into the HAvatar intervention procedures, the selection of participants, the instruments of the mixed methods for data collection, and finally, the accountability framework.

Chapter 4, Findings, reports on the data, based on the chosen methods.

Chapter 5, Discussion, analyzes these findings against the research questions and evaluation criteria.

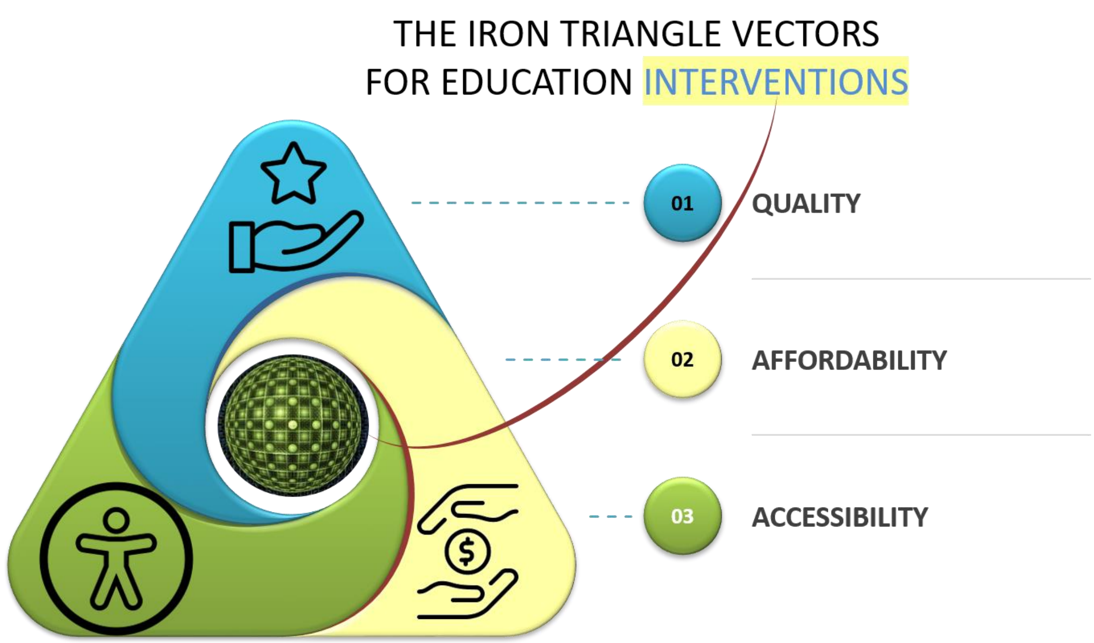
Chapter 6, Conclusions, summarizes the study’s results, partly as recommendations arising out of its revealed limitations and partly out of its significance for the future.

Chapter 2. Literature Review

The literature is divided into two sections. The first section assumes that education organizations need to offer more online real-life experiences for Gen Z (born after 1996) and twenty-first century learners (the wider demographic denoting all of this current century) who were born into the digital age. As such, I concentrate on task-centred learning praxis as a determinant of the quality of online pedagogy. The second section centres on XR microworlds and current interventions addressing real-life learning online viz., affordability for organizations to implement, and accessibility for mainstream education and training. Both sections address the three requisites introduced in the iron triangle, as re-illustrated below in Figure 7.

Figure 7

The Iron Triangle in the Literature (Repeat from Figure 1)



Section 1. Themes of Quality

As introduced in Chapter 1, Merrill, Reigeluth, Francom, and their colleagues primarily inform this study about task-centred learning praxis. Based on the spirit of Merrill's (2002) first principles and Francom and Gardners' (2014) task-centred learning theory, general principles determine "effective and efficient instruction" (p. 44). Honebein (2019), who conducted quantitative research on this theory, concurs that first principles have overarching generalities, "They collectively represent the best instructional components for most instructional situations" (p. 686). Task-centred learning principles share tenets from the theoretical neighbourhood of learning-by-doing, for example:

- situational practice-based (Lave & Wenger, 1991)
- cognitive apprenticeship (Brown & Duguid, 1991)
- experiential (Kolb, 1984)
- problem-based (Barrows & Tamblyn, 1980)
- project-based (Kilpatrick, 1918)
- competency-based (Reigeluth & Karnopp, 2013)

This family of pragmatic learning theories is increasing in popularity because it promotes students into an active role in their learning experience – an active voice involved in purposeful tasks. Demonstrating chosen artifacts or attainments becomes outcome-based evidence of learning (Blumenfeld et al., 1996; Francom, 2017). In contrast, the industrial hegemony of education emphasizes linearity, conformity, and standardization. UNESCO (2016) expresses the import of this transformation for society as requiring, “a wholesale change in the way we think and the way we act – a rethink of how we relate to one another and how we interact with the ecosystems that support our lives” (p. 8). Sir Ken Robinson at the FETC conference (2018) urged educators to drop standardized education, which does not cater to the fact that real life is organic, adaptable, and diverse.

Twenty-First Century Learners

Twinning with the qualities transforming education are the qualities reportedly required for Gen Z or twenty-first century learners (e.g., Binkley et al., 2012). For example, the Education for Sustainable Development (ESD) report (UNESCO, 2014, 2020) lists essential proficiencies needed in dealing with the "wicked" problems our world faces around sustainability and species survival: systemic thinking, decision-making jointly with others, intergenerational perspectives, competencies in action-taking, and problem-solving. Blaschke (2012) expounds the term *heutagogy* to describe the highly autonomous, self-determined learner gestalt, “Emphasis is placed on development of learner capacity and capability with the goal of producing learners who are well-prepared for the complexities of today’s workplace” (p. 56). Reigeluth et al. (2017) confirm this stance, "We need graduates who are equipped to embrace change, who are prepared to make sense of the vast amounts of information at their fingertips, and who are curious and eager to communicate, collaborate, innovate, and create new knowledge” (p. 13). As early as 1916, Dewey spoke of this same need for connectivity, collaboration, and authentic context-based learning venues for youth – qualities now considered modern in education: "Playgrounds, shops, workrooms, laboratories not only direct the natural active tendencies of youth, but they involve intercourse, communication, and cooperation—all extending the perceptions of connections" (p. 366). A century later, Bell (2010), representing a project-based learning model in American public schools, confirms that twenty-first century learners, “will be evaluated not only on their outcomes, but also on their collaborative, negotiating, planning, and organizational skills” (p. 43). Binkley et al. (2012) posit that, across the workboard, careers as technicians or professionals require an ability to communicate, collaborate, and use powerful global affordances and information repositories to solve complex problems. Twentieth-century-learners need to modulate, innovate, and ideate in the face of constantly changing situations "to marshal and expand the power of technology" (p. 17), to construct new knowledge, and evolve humanity's capacity to be productive. Francke and Alexander (2018) recommend, "content through a livelier and more engaging experience…bridging the gap between their [twenty-first century learners] virtual and physical worlds" (p. 99).

Real-World Learning – a Historical Perspective

Real-world learning overarches the themes of task-centred learning praxis in fulfilling the purpose of the intervention. I have aligned real-world learning with similar tenets in the literature, for example: active learning (Dewey, 1938), situational learning (Brown & Duguid, 1991), authentic learning venues (Laurillard, 2012), real-life learning environments (Reigeluth et al., 2017), and experiential learning (Kolb, 1984). Further, tactile learning involving the manipulation of objects with our own hands avers to deepen learning (Montessori, 1917; Rau, 2020).

Polar-opposite to real-world learning, the industrial-age mindset of education still dominates in the twenty-first century on a global scale within education institutions: homogenized, passive, lecture-style, time-based, low sensory, subject/teacher-focused learning. This mindset seems to result in passive, inactive learners who fail to develop critical thinking skills, independence, or creativity in solving the challenges of current fast-paced technological advances (e.g., Manville, 2001; Reigeluth & Carr-Chellman, 2009; Reigeluth et al., 2017; UNESCO, 2020). "The industrial-age paradigm systematically destroys that self-motivation by removing all self-direction and giving students boring work that is not relevant to their lives"

(Reigeluth & Carr-Chellman, 2009, p. 394). However, this entrenched system is so endemic that all other education systems appear as reform movements. As Robinson and Aronica (2016) espouse,

> Some features of conventional schools have little to do with learning and can actively get in their way. The revolution we need involves rethinking how schools work and what counts as a school. It is also about trying a different story about education. (p. xviii)

In current theories about transforming public education to the active paradigm, threads consistently lead back to Dewey. He was a prolific pragmatist of the late nineteenth century (e.g., 1899, 1916, 1938). As Dewey (1916) noted, "[Industrial] education proceeds by instruction taken in a strictly literal sense, a building into the mind from without" (p. 74). Dewey had a naturalistic, progressive ethos about learning as “humanity's innate need to adapt and fully work with its environment” (p. 74). He elaborated,

> If I were asked to name the most needed of all reforms in the spirit of education, I should say: 'Cease conceiving of education as mere preparation for later life and make of it the full meaning of the present life’. (p. 393)

Following Dewey, still a century ago, Montessori (1917) of Italy founded an education system emphasizing practical hands-on play self-selected through a child's natural propensities. Montessori private schools are still thriving in today's active education domain. These pioneers of active learning contributed to the learner-centric movement, prioritizing hands-on, puzzle-solving interactive learning, with the teacher as a guide and the student as a reflective, self-directed learner.

In the 1980s, as the information age began to take hold and unfold, the models and theories of several contemporary and seminal author-educator-researchers have become beacons of real-world education praxis. They are currently still prolific activists in leading transformation to this new paradigm.

Papert, who died in 2016, published the first version of his famous book, *Mindstorms: Children, Computers, and Powerful Ideas* in 1980—recently republished posthumously in 2020. His pioneering insertion of computers into American schools instantiated this fortuitous prediction from the 1993 version:

> I shall try to give you some idea of these possibilities, many of which are dependent on a computer-rich future, a future where a computer will be a significant part of every child's life…forging new relationships between computers and people…That the computer will be there to be used is simply a conservative premise. (p. 18)

The *constructionism* paradigm, attributed to Papert, perceived as a pragmatic offshoot of constructivism, supports the building of human knowledge combined with the additional presence of tools, media, and context—this combination promotes self-directed learning (Ackermann, 2001). An accurate visionary, Papert connected the learner in a hands-on/brains-on relationship with technology.

Reigeluth is a formidable leader in education reform, relentlessly promoting "a quantum improvement in meeting new educational needs of the information age" (Reigeluth et al., 2017, p. 390). From publishing instructional-design theories and models in 1983 to recently authoring a book personalizing competency-based education (2020), Reigeluth and his co-authors have provided a rich panoply of principles, theories, designs, and solutions for pragmatizing real-world learning, including online models. Over a 40-year period, in 12 books and 170 journal articles, their consistent message of real-world learning is infused into this study's conceptual framework.

Kolb (1984), another influential contemporary and seminal author from this era, still publishing today, spring boarded off Dewey's philosophy of humans as "the learning species" with an ability to adapt, shape, and create our worlds. The creator of the *experiential learning theory of development*, Kolb advocates immersive learning in rising spirals of knowledge. His globally recognized work has brought validity to the tenets of experiential, whole-person learning to the academic and training domains.

The following section drills into the components of task-centred learning praxis introduced in Chapter 1, conceptually preparing the reader for Chapter 3, where they become evaluation criteria for the data.

Task-Centred Learning Praxis

One of the differentiating factors from other learning-by-doing or problem-based theories is that task-centred learning praxis attempts to balance sufficient learner support with self-directed learning. The underpinning philosophy of task-centred learning lies in intrinsic motivation, effectiveness, and efficiency with gradually faded scaffolding, prioritizing the transfer of learning to real-world applicability. It claims to have the right ingredients to promote the twenty-first century learner qualities outlined above (Francom & Gardner, 2014; Merrill, 2009; Reigeluth et al., 2017). The development of a problem-solving, critically thinking mindset and the encouragement of a self-regulating yet collaborative attitude are the idealized outcomes of this praxis (Francom, 2017; Reigeluth & Carr-Chellman, 2009).

Figure 8

Task-Centred Learning Praxis Principles in the Literature (Repeat from Figure 5)

Here are the principles re-iterated from Chapter 1 (Francom, 2017; Merrill, 2002):

- Prior Learning Activation – Learning grows when existing knowledge and skill are activated as a foundation for the new learning.
- Real-World Learning Task – Learning grows when a complex task needs to be completed in a real-world situation.
- Small-Group Learning – Learning grows within a small collaborative cohort.
- Scaffolded Modelling – Learning grows when new knowledge is demonstrated to the learner and facilitated through excellent learning materials and gradually faded scaffolding.
- Applied Practice – Learning becomes real when learners apply the skill to solving tasks where attainment rather than time bounds the outcome.

- Outcome-Based Integration/Reflection – Learning becomes firmly established when integrated into the learner's world.

In support of these seemingly universal principles, Reigeluth and Carr-Chellman (2009) assert, "Just as the grammar of the English language is based on eight parts of speech, so it is possible to trace the many constructs of instruction to a discrete number of sufficiently flexible categories and descriptions" (p. 29). It follows that I would utilize these principles in the context of evaluation criteria to judge the quality of the HAvatar intervention.

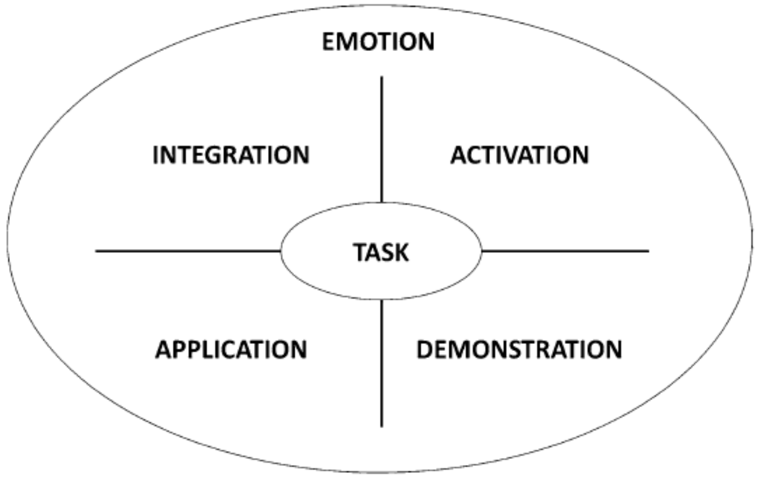
Missing Emotional Engagement Principle?

Honebein's 2019 study introduces the caveat that the affective realm is missing in task-centred learning theory. Reigeluth et al. (2009) partially concur in their metaphor of first principles as guiding stars within a universe but not the entire universe. Galaxies as subsets represent clusters of values and conditions situational to selected clusters of methods. Honebein (2019) gives an example of this specificity regarding the real-life applied practice principle where "practicing a skill, for instance, is far different from practicing an understanding or an emotional disposition" (p. 59).

Kraiger et al. (1993) further assert that priority has been given to measurements of behaviour or cognition while diminishing or omitting attitudinal or motivational measures of learning. Thus, this omission presents an incomplete picture of the learning process.

Figure 9

Revision of Merrill's First Principles to Include the Affective Domain (Honebein, 2019, p. 685)



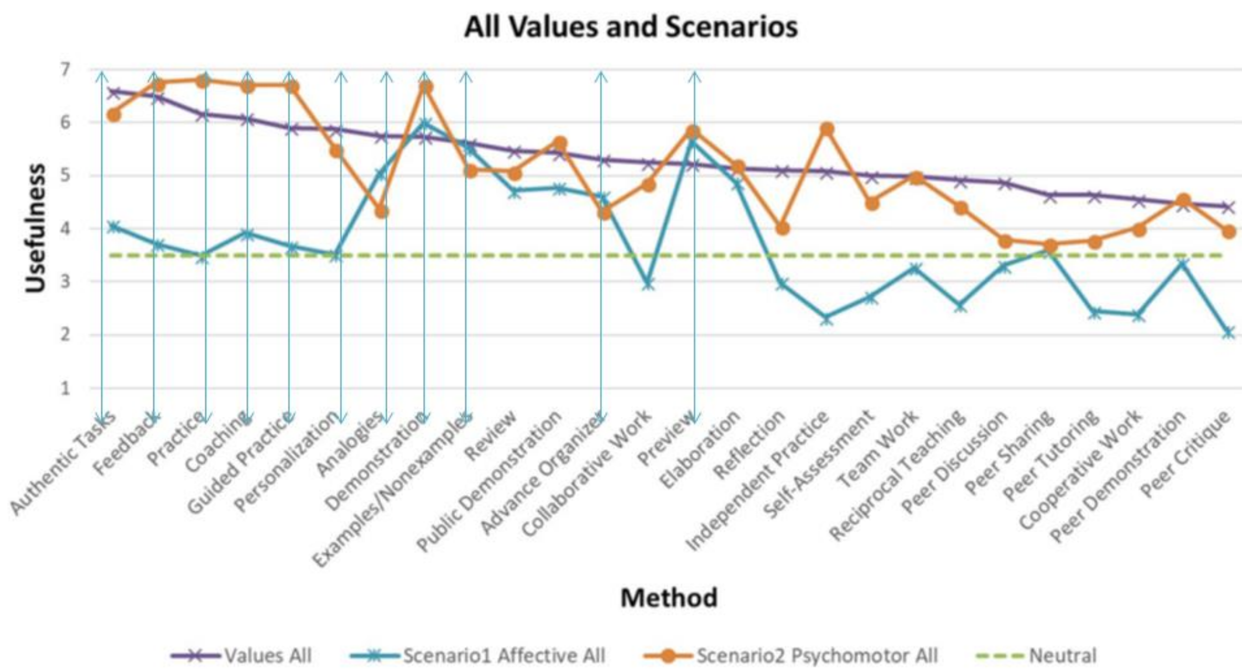
Honebein's (2019) research explores two learning scenarios for instructional design, one termed *affective* because it is an information-sales session to parents about enrolling their children in lacrosse; the other termed *psychomotor* because it is a short kinesthetic course for lacrosse players about using hands, arms, and wrists in cradling the lacrosse basket while running. Figure 10 illustrates an x-axis of 26 instructional methods graphed on a y-axis of usefulness vis-à-vis the two scenarios where the middle line represents a combination of affect and psychomotor. The copper line represents psychomotor only, and the blue line represents affect only.

However, I countervail the claim to the absence of affect in task-centred learning praxis shown on the graph in Figure 10 (italicized when referred to). The evidence does not align with the stated objection, given that the highest metrics graph the strongest methods. These are clearly principles of the task-centred learning praxis. *Authentic Learning Tasks* is the first, the central tenet of task-centred learning; feedback, demonstration, analogies, and examples are part of *Scaffolded Modelling*; personalization, advanced optimizers, and preview are part of *Prior*

Learning Activation; practice and guided practice are part of *Real-Life Applied Practice*; with a spike of emotion in the demonstration point which is at the core of *Outcome-based Integration*.

Figure 10

Learning Scenarios for Affect and Psychomotor Methods (Honebein, 2019, p. 683)



Regarding the HAvatar study, indeed, psychomotor learning does dominate the intervention, aligning with the methods of strength in Figure 10. Affective feedback from the participants needs inclusion in the data gathering described in Chapter 3, the Research Design. Accordingly, concerned about the motivation of the participants; I explore their feedback through the data collection in research question (4): *…with respect to adding motivation and interest to learning online through the avatar to accomplish this task?*

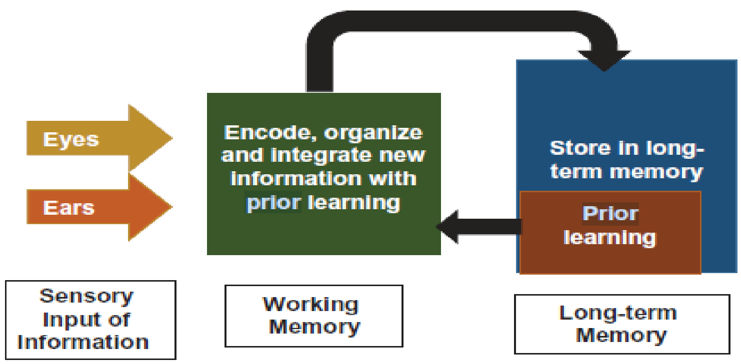
Prior Learning Activation

– Learning grows when existing knowledge and skill are activated as a foundation for the new learning (Merrill, 2002).

The first principle corroborates the premise, "Learning is promoted when learners are directed to recall, relate, describe, or apply knowledge from relevant experience that can be used as a foundation for the new knowledge" (Merrill, 2002, p. 46). Entwistle and Pearson (2004) urge educators to, "relate teaching directly to prior knowledge and to…understanding aims" (p. 424). In 1879, Wilhelm Wundt first "investigated how experience is assimilated into one's previous knowledge structure" (Merriam et al., 2007, p. 276). Laurillard (2012) furthers, "…teacher[s] may always be building on sand. The best way to insure against this is to discover what the students already know, especially where this may be critical for making sense of the new concepts" (p. 70).

Figure 11

The Brain Assimilating New and Prior Knowledge (Foster et al., 2016, p. 79)



A plethora of brain science studies now support the prior-learning activation premise as a biological process (e.g., Medina, 2014; Schunk, 2011; Zull, 2006). Activating prior knowledge related to a learning event helps new experiences take hold (Laurillard, 2012). Foster et al. (2016) have adapted the above schematic (Figure 11) to illustrate the neurological process of connecting new information in working memory to long-term memory of prior learning.

Further elaborated in the next principle, real-world learning task, goals separated into achievable pieces create a spiraling effect when the attainment of one level constitutes a complete cycle before engagement in the next level of skill is undertaken (Foster et al., 2016; Francom, 2017; Francom & Gardner, 2013). By breaking a complex topic into segments – called *chunking* –the learner can engage in necessary thought processing without overloading the cognitive system (Emerson & Berge, 2018; Mayer et al., 2003).

Learners bring preconceived ideas of how things work to the learning experience, whether conscious or not. Therefore, understanding needs to be engaged and connected. Otherwise, learners might not move their thinking into a new and broader understanding "informed by their current conceptual organization" (Laurillard, 2012, pp. 46-59).

Pre-instructional strategies such as expository advance organizers can prepare learners to assimilate all the components of a module (Palalas & Anderson, 2013). Online apps which provide games, quizzes, and interactive sequences are readily available and are suitable learning objects for this content element, as are guided peer-group discussions, either asynchronous or synchronous (Laurillard, 2012). Carefully crafted quizzes can determine learner styles (Ally & Coldeway, 2007) to guide the educator in refining the curriculum to the individual. All these activities help tease out the learners' qualities and experience, preparing them to connect to the new learning.

Real-World Learning Task

– Centre all learning around whole, complex, ill-defined, real-world tasks (Merrill, 2002).

The word task further implicates the application of real-world learning as one of the first principles (Merrill, 2002). It is pivotal in understanding task-centred learning praxis. As per Francom and Gardner (2014) and Savery (2009), the learning task mimics an authentic real-life task, is complete unto itself, but leads to a progression of more complex tasks. It begins with a complete albeit elementary task. In this way, the novice learner can experience attainment without much prior skill (Francom & Gardner, 2014, p. 32). Learning tasks include articulating the desired outcomes with a clear picture of what excellence looks like and why. Van Merriënboer (1997) recommends that the first elementary task in a series be preceded by an example of the task in a completed state.

Small-Group Learning

*– Learning grows within a small collaborative cohort (Merrill, 2002)***.**

Another task-centred learning principle revolves around learning in small groups. Notably, authors Blumenfeld et al. (1996) ascertain that peer work can be successful, provided it is couched in the other principles: task-based, goal-oriented, modelled, applied with practice and problem-solving, and demonstrated with competence. Without the other first principles accompanying the peer work, students can "flounder in mutually progressive ignorance" or "stigmatize low achievers [and] exacerbate status differences" (Blumenfeld et al., 1996, p. 37). The larger the learners' group, the less likely brainstorming and sharing thoughts occur. The idea of voice, of being heard, is conducive to a small group. As Brookfield (2017) contends, "It is common sense that students like group discussion because they feel involved and respected in such a setting. Discussion methods build on principles of participatory, active learning" (p. 5). Small groups involving students at various performance levels, working toward a shared learning goal, foster responsibility for one another's learning beyond their own (Gokhale, 1995). Small groups allow learners to become familiar with each other and thus make safe critical reflections—situations in which people feel safe can help reveal their strengths and interests. For example, one student might express the wish to be the spokesperson; another, the technical troubleshooter; another, the writer; some may choose other participatory roles as needed in the situation (Brookfield, 2017). Longo (2013) posits, "Small learning communities with deep relationships take precedence over larger, more passive groups" (p. 7), suggesting that 200 passive listeners have less reach than 20 active learners.

In Workman's (2017) thesis, he discusses the background of informal learning in the workplace by revealing that workers usually consult with each other to solve problems. Peer teaching is a little-discussed, endemically common culture in most organizations. However, a small cohort who set out to solve a task can form a powerful learning unit, as confirmed by Merriam et al. (2007) and Eraut (2004) in reference to on-the-job learning amongst peers.

Scaffolded Modelling

– Learning grows when new knowledge is demonstrated to the learner and scaffolded by a facilitator, learning materials, or learning technology (Merrill, 2002).

This task-centred learning principle states that learners orient to the material to be learned when the instructional content or facilitators demonstrate the skill in a mastery format (Merrill, 2002). Laurillard (2012) defines it as the teacher modelling cycle where the outcome has been shown, reiterated, and represented with explanations and procedures. Van Merriénboer (1997) posits that a worked example provides an understanding to the learner of what they will achieve. "The learner must be able to recognize a solution to a particular class of problems before he is himself able to produce the steps leading to it without assistance" (Wood et al., 1976, p. 90). Visual, audio, and tactile demonstrations can clarify conceptual understandings of the knowledge. Often a reduction into progressive parts by looking “over a shoulder” at the task while articulating the thought processes behind it is favoured over a whole task demonstration (Romiszowski, 2009). This point leads to the definition of scaffolding, described here by Singer et al. (2000), "A learning scaffold can be thought of as any method or resource that helps a learner to accomplish more difficult tasks than they otherwise are capable of completing on their own" (p. 170). Condliffe (2017) adds, "Scaffolds can be teachers, peers, learning materials, and technology" (p. 8). Further to this definition, Francom (2017) and Merrill (2009) claim that the fading of supports over time as a component of scaffolding serves the dual purpose of ensuring excellent foundational knowledge while gradually withdrawing support encourages self-directed thinking.

The multimodal inventory of human knowledge found on the Internet serves this principle well for virtual learners and educators. It provides a rich panoply of opportunity to model excellence scaffolded through contextualized imagery/videography/documentary media from countless sources worldwide with persistent site accessibility, which can be played and replayed by the learner as needed. Virtual reality affordances can demonstrate excellence by porting the learner into an interactive 3D experience.

Regarding this balance of scaffolding, Laurillard (2012) explains,

> The teacher is not always present, so the learner is working independently, supported by the teacher represented in the form of presentations in books, documents, websites, videos, and working in the practice or modeling environment… as practice exercises, projects, labs, [and] programs. (p. 87)

Inversely, too much independence can result in a sink-or-swim model, which implies too little scaffolding or scaffolding withdrawn too quickly (Merrill, 2009). Merrill further warns instructional designers to filter too many forms of multimedia that might compete for the learner's attention.

Real-Life Applied Practice

– Learning becomes real when learners apply and practice the skill to solving tasks where attainment bounds the outcome (Merrill, 2002).

Closely related to modelling, this task-centred principle incorporates a hands-on/brains-on practice experience as authentic to real-life as possible; whether tactile or intellectual; or whether the learning involves kinds-of (classification), how-to (performance), or what happens (consequence) outcomes (Merrill, 2009, p. 48). The adage "practice makes perfect" is still ever-green in achieving quality learning outcomes.

Although time constraints are commonly an issue in education curriculum, in task-centred learning praxis, every attempt is made to allow the learner to be self-paced so that foundational understanding is thorough. This may appear to be a slow process, but in the end, it saves time by avoiding mistakes and retracements due to knowledge gaps (Reigeluth et al., 2017, p. 19).

The educator plays a vital role as a coach in providing feedback to the learner whether the task is complex or straightforward; iterations of modelling and practice cycles ensure mastery (Laurillard, 2012). The teacher's knowledge in determining whether the learner is appropriately cognitively ready for the level of difficulty in the course prevents mis-mentoring their skill levels (Vygotsky, 1980). Elementary corrections of a learner with considerable skill can be demeaning while sophisticated corrections directed at a novice learner can diminish confidence. "Rigor …[can be] enhanced when students have the opportunity to struggle with a problem before teachers provide them with directive hints or solutions" (Condliffe, 2017, p. 29).

The resource-intense design of such a teaching environment makes or breaks the efficacy of this component (Laurillard, 2012). In online education, the applied practice is the principle where the most hi-tech digital learning technologies can assist, ergo, where the most technical programming and preparation affect the overall design. It is the interactivity piece. The instructional design of applied practice shapes the faded scaffolding principle and the handoff from teacher to learner, where the learner gradually takes the reins. How better to support this transition than with technologies that provide realistic practice (Reigeluth et al., 2017).

Outcome-based Integration/Reflection

– Learning becomes firmly established when integrated into the learner's world (Merrill, 2002).

Within this principle lies the crucial revisiting element, the reflection exercise. From the urging of evidence-informed research (e.g., Blaschke, 2012; Brookfield, 2017; Denton, 2011; Francom, 2017; LaPrade et al., 2014; Laurillard, 2012; Schön, 1983), reflection on the learning as a practice is a mandatory dimension of instructional design and quality learning, regardless of the progress of the learner's independence. As a seminal author of reflective practice, Schön (2017) describes the reflection process as double-loop learning where "learners consider the problem and the resulting action and outcomes, in addition to reflecting upon the problem-solving process and how it influences the learner's own beliefs and action" (Blaschke, 2012, p. 59). As explained by Knowles et al. (2005), "the locus of evaluation…resides definitely in the learner. Its essence [the learner's experience] is meaning" (p. 14). I see meaning-making reflection as both an inward process in the form of undemanding soak-time (Rose, 2013) and an outward process in the form of recapping the experience via expressive activities, skill demonstrations, and dialogue. Denton (2011) describes reflection as the seat of metacognitive development—it is the ability to critique our own thoughts. Learner-centred instruction, now gaining momentum due to the plethora of online education programs, is set to replace the typical classroom environment. Denton (2011) warns, “When teachers encounter large class loads or apply primarily didactic teaching methods, the interactional and communal aspects of learning weaken and so does the potential for prompting metacognition” (p. 844). Given that self-regulation, group process, and critical thinking underpin task-centred learning in developing higher-order thinking (Francom, 2017), the integration/exploration phase is essential to successful outcomes and the generalizability of the competency (Merrill, 2002).

By enhancing the learning event with asynchronous thought-provoking exercises, activities, slow-motion replays of the live events, collaborative think tanks, and undemanding moments, the reflective practice can provide a rich opportunity for ongoing, meaningful learning (Denton, 2011; Reigeluth et al., 2017).

In addition, students can make sense of their task-centred experience because they are required to present artifacts or visible efforts showing that their learning matches the task outcomes (Blumenfeld et al., 1996; Condliffe, 2017; Reigeluth et al., 2017). Assessments involving presentations to an audience of peers or the public add engagement tension and motivation (Condliffe, 2017). Checking off achievements on an attainment list, journaling in an ongoing e-portfolio, showcasing and demonstrating competencies, engaging in peer discourse—all of these consolidate the learning (Francom, 2017; Merrill, 2002; Reigeluth et al., 2017).

Section 1. Summative Reflections

In sum, Section 1 has detailed task-centred learning praxis by seminal and contemporary author-educators pertaining to the purported ingredients for best learning. Therefore, the principles inform the praxis of task-centred learning, providing a quality benchmark for this education intervention. Chapter 4, Findings, uses these principles as criteria to evaluate the research data from the HAvatar sessions.

In Section 2 of this Literature Review, I take the reader online to the virtual world, exploring immersive learning in the cloud.

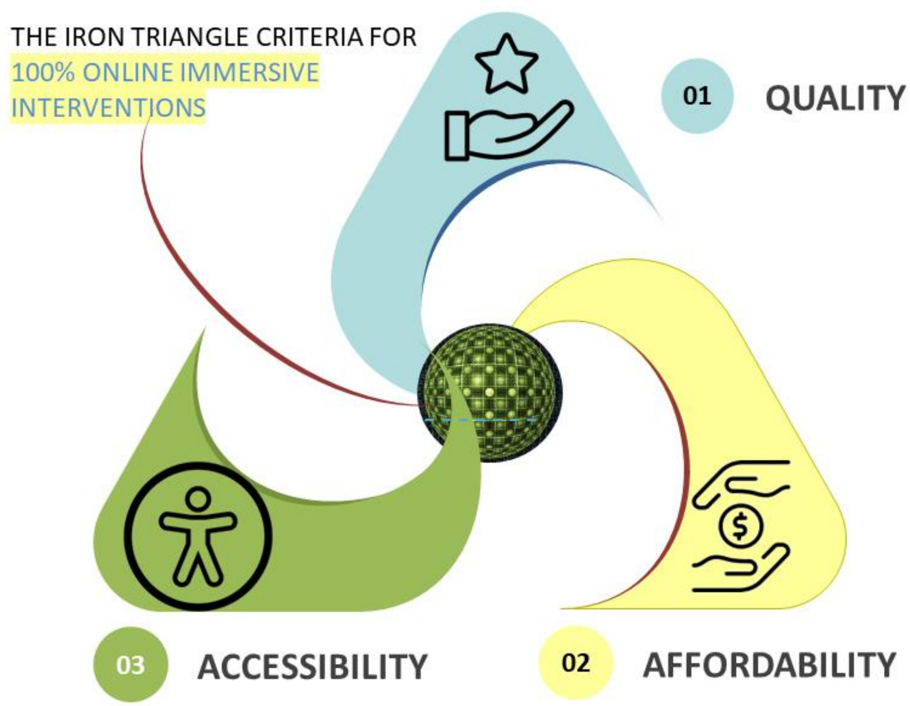
Section 2. Current Virtual Real-World Learning

As introduced in Chapter 1, I merged the abbreviated references to the virtual domains of VR, AR, and human-computer interaction (HCI) into this acronym, XR, which stands for extended reality (Goode, n.d.). I have also synonymized references to virtual learning venues with the term microworld. The XR microworld literature in this study is distilled through contributions and constraints to the iron triangle of education (Daniel et al., 2009) as shown in the Figure 12 version. Although it is straightforward to judge the general cost-effectiveness and the ease of access and user-friendliness of a technological intervention, the quality of the learning experience as a credible solution for virtual hands-on learning is necessarily held against the standards of empirical learning theory and instructional design theory.

As such, I investigated current studies and reports about the approximations of real-life learning in virtual microworlds afforded through visual and haptic technologies. As Bhargava et al. (2018) write, “Transfer of skills from training simulations to the real world is one of the most essential aspects justifying the development and use of complex VR-based educational simulations” (p. 1419).

Figure 12

Iron Triangle Criteria and Immersive Interventions



State of XR and Pedagogical Constructs

The majority of studies concurred that microworlds involving XR do afford a powerful way to provide interactive and dynamic education, promote engagement and motivation in learners, and offer individuation – key goals in self-directed learning. However, their efficacy as instruments of knowledge lies wholly in their design (Bhargava et al., 2018; Blaschke, 2012; Fowler, 2015; "How VR Education Will Change How We Learn & Teach | Adobe XD Ideas," n.d.; Merriam, 2001; Naranjo et al., 2020; Reigeluth & Schwartz, 1989; Zhou et al., 2018).

In 1989, Reigeluth and Schwartz were already concerned with the weakness of the pedagogical theory and design in their analysis of the field of simulated education. Now several decades later, this same concern about the lack of instructional foundation in microworld design prevails (Fowler, 2015; Radianti et al., 2020; Zhou et al., 2018). In examining the components of

XR simulations, Reigeluth and Schwartz indicated a three-part breakdown: the scenario, the underlying model, and the instructional overlay. The scenario represents the microworld, simulating a real-world situation comprised of a medley of characters, objects, scenes, and learner roles with their interaction options. An expert in mathematical and coding algorithms programs the underlying technical model which determines the creation of the microworld. The instructional overlay should govern the model and the scenario in deciding the learning aspects. As Fowler (2015) expressed, "What is required to fully describe the learning experience is a framework that is not solely derived from technological affordances but also includes pedagogical requirements" (p. 415).

Rau et al. (2020) recognized that visual and physical representation modes were drawing more and more attention due to the rapid progress of modality design online and the revolution in education. That said, they concur there needs to be more research on *conceptual salience*. Conceptual salience relates to how effectively the strategy predicts the learning outcome. *Intrinsic overload* from too many chunks of complex information and the lack of due diligence in activating prior experience can occur both in virtual and physical learning venues. This study supported my assumption that the hands-on manipulation of learning objects, whether those objects are real-world physical or microworld virtual, may or may not promote understanding. The quality of the pedagogical design scaffolds the learning event, which "reduces seductive detail and split attention" (p. 303).

Fidelity of technological application expressed as salience by Rau et al. (2020) has a great deal to do with the efficacy of the microworld simulation as a replica of a real learning venue. Too much fidelity with too many superficial elements detracts from the instruction's focus and distracts the learner—too few, and the virtual experience loses its sense of "realness"

(Reigeluth & Schwartz, 1989) hence attenuating engagement. Reigeluth and Schwartz further distilled four criteria for decision-making around the scenario and model aspects of the simulation: cost (the design, development, and the production expenses), overload (the balance of complexity in the fidelity to avoid overstimulation or under-stimulation), transfer (the ability to use the learning in the real world) and affect (the motivational intrigue).

Due to the riveted focus of the ICT industry on the technological development of complex microworld design, the pedagogical quality furnished by experts in the field of education seems secondary and overlooked. As Reigeluth and Schwartz (1989) concluded after their field review, “Most simulations have been produced using a ‘seat of the pants’ approach. Some are quite good. Many are nothing more than video-type games or drill-and-practice exercises. Almost none provide a complete instructional package” (p. 2). Gagné and Merrill (1990) alluded to four of the six principles of task-centred learning praxis as necessary functions in microworld simulation design: introduction (the task), acquisition of the content (scaffolded modelling), application of the content (applied practice), and assessment of learning (outcome-based integration). Points of contact (scaffolding) are pertinent to progressing the learning to its ideal outcome via natural or artificial feedback. With microworld design, artificial feedback can be programmed as just-in-time formative responses in a complex learning task or motivationally as just-in-time responses in programmed messages of encouragement about completed tasks (Reigeluth & Schwartz, 1989).

Further to the tension between appealing edtech and good pedagogy, the learning theory determines what constitutes effective knowledge acquisition and should guide the instructional overlay of the microworld. In their systematic review of VR applications for higher education, Radianti et al. (2020) uncovered that 68% lacked any reference at all to learning theories. In the remaining 32%, the experiential learning category garnered an 11%, with the rest at 3%. There was no mention of applied learning-by-doing or task-centred learning theories with no citations to be found for the experiential learning studies.

Ives et al. (2005), in their study involved in introducing technology into higher education curriculum, coined it appropriately *pedtech*, which leaves no doubt of the pedagogical construct that needs to accompany edtech. Fowler (2015) alleged that learning principles are lost or loosely defined if they are adjunct to the technological design. As Zhou et al. (2018) espoused, XR scaffolded learning focuses on the technical attributes, lacking “well-defined learning theories and custom-designed models” as foundational guidelines (p. 239). Fowler (2015) presented *designing for learning*. This process evolved from a general contextual description through a set of teaching and learning requirements based on defining what stage the learner is at cognitively, infused into the learning outcomes, tailored to a set of learning activities. Task-centred learning instructional design micro-level specifications encompass the same goal (Francom & Gardner, 2014; Gagné & Merrill, 1990; Reigeluth & Carr-Chellman, 2009). To design a culturally appropriate mix of learning and teaching, the designer must astutely select examples, objects, and activities (Fowler, 2015, p. 420).

Reigeluth and Schwartz (1989) contended that an automated chain of responses in complex learning tasks was more effective than naturally occurring feedback. The programming in the specifications must then recognize a plethora of stimuli and provide appropriate corrective or informational responses. “Regardless of the approach adopted, the key message is that designing for learning must explicitly incorporate pedagogical considerations into their specification of a technology-enhanced learning experience” (Fowler, 2015, p. 420).

Affordability Issues Lead to Accessibility Issues

The advancement of technology, business, and the onset of globalized education are the driving forces compelling traditional education institutions to move towards XR pedagogical models. For five years in a row, the Horizon Reports have promoted XR as the most critical technology to be applied to education (Lan, 2020).

One of the confounding issues in the design of microworlds using XR for education is the upfront cost and time required for analysis, design, development, testing, and implementation in addition to ongoing updates. The resulting product can offset these concerns – that is, microworlds, once developed, operate at low cost, and can accommodate large numbers of virtual learners engaged in fascinating microworlds, previously impossible in face-to-face courses.

AR is the technology that best approximates hands-on learning because it superimposes virtual objects onto an actual livestreaming site. Instead of a microworld, a real-world physical site renders the learning real, familiar, and place-based. Further, removing the need to develop an entire virtual microworld mitigates some of the development costs. Even with the growing sophistication and cost reduction of XR technology incorporating 360-degree footage or AR cloud-based overlays on physical venues, organizations cannot ignore the upfront resource-intense development.

Lane (2014) further problematized the iron triangle in education by analyzing the interactive factors, and the intricacies of relationships amongst the entities of a learning venue (student, teacher, content, technology). Intrinsic and extrinsic interactions amongst these entities also add tension to the vectors, that is, quality results, cost efficiency, and scaling to bigger audiences – now thoroughly skewed and disrupted by the exponentiality of cloud-based environments replacing place-based environments. Lane believed that empirical studies favour one aspect, mainly in the socio-constructivist principles, and have no handle on the overall complexity of student interaction/success factors in microworlds for either a student or an institution. Daniel et al. (2009) summarized the dilemma,

> The aims of wide access, high quality, and low cost are not achievable, even in principle, with traditional models of higher education based on classroom teaching in campus communities. A perception of quality based on exclusivity of access and high expenditure per student is the precise opposite of what is required. One based instead on student achievement enables developing countries to scale up their higher education APRs [age participation rates] without breaking the bank or fatally compromising quality. (p. 8)

In conclusion, given there are millions of courses in thousands of educational institutions, the transition to microworlds pings the affordability and accessibility vectors of the iron triangle without question. While it is true that numerous XR applications are employed in education nowadays, virtual content has to satisfy a wide array of learning needs and contexts (Lan, 2020). There are far-reaching implications in sidelining an existing physical learning venue, such as a lab or workshop and its accompanying existing equipment and courseware, in favour of redesigning it into a microworld.

The advancement of simulation is grounded in the advancement of technology. The medical, military, aerospace and gaming industries are quick to implement new technologies and are the progressive pioneers. These industries have the most robust history of applied simulation technology and the most well-funded simulation experimentation models (Naranjo et al., 2020). Figure 13 provides a glimpse into this simulation world in medicine. Unfortunately, these industries tend to treat learning as resource training; a prescriptive, behaviourist endeavour. As such, their deployment of hi-tech often lacks heutagogical principles and learner-centric instructional design (Arnold-Schwartz, 2019; Clark, 1994; Reigeluth et al., 2017; Visser et al., 2012).

Figure 13

Virtual Simulation in the Medical Industry (DevTeam.Space, 2020)

XR Intervention Studies

Reminiscent of the wild-west frontier and reflective of the rapidly changing net-centric landscape, XR technology is difficult to lasso. It is a massive movement, inconsistent, and inchoate, with new articles and research feeds constantly downloading from myriad journals and publication sites. As such, the intervention studies discussed below provide only a representative sample. Each of the articles uniquely illustrates different aspects of the exciting progress towards immersive, hands-on/brains-on education in technologically-afforded microworlds, yet they bristle with gaps and constraints.

The intervention described by Adnan et al. (2020) informed my study because it deployed livestreaming video via a 360-degree camera to create a quality learning experience entirely online. Adnan et al. (2020) made a solid introduction to their paper about the revolutionization of our world by technological inventions. Leonhard (2016), a notable futurist, predicted that in the next twenty years, human civilization will see more changes than the last 300 together. Adnan et al. (2020) opened their report with sensationalist, broad-sweeping statements about the impact of XR changing the world and how their suggested intervention with a 360-degree camera could provide immersive learning experiences at a minimal cost. This claim was followed by a caveat, "…even though the initial setup will need investments to defray high costs" (p. 374). Further, there was no discussion of the importance of learning theory design accompanied by an instructional design model. The study's validity was confirmed empirically using a quantitative approach with 560 university students. The results were positive, but as one student stated, "I feel there should be many more things (content) using VR and 360-degree videos, but I also understand they're not easy to create" (p. 379). Finally, Adnan et al. (2020) concluded that VR helped teach soft skills. Therefore, this VR intervention seemed promising but premature in providing accessible, affordable virtual learning venues; the quality of theoretical instructional design and a method for hands-on hard skills were missing.

Rao et al. (2017), authors from the Academy of Armoured Force Engineering in Beijing, champion virtual reality to maintain increasingly complex systems for aerospace, automobile, and military systems. The report about using virtual maintenance for aerospace equipment belied a public relations promotion for XR in China rather than a research study. Frequent unsupported statements of virtual maintenance providing future solutions leading to economic and military benefits attenuated the credibility. In reference to the institutions mentioned above, "All of them have done a lot of researches and they have achieved fruitful results” (p. 61). This report provided some clues as to the efficacy of microworlds without clear, current, or methodological substantiation or case study examples. The authors, being affiliated with a military academy and aerospace universities, were projecting from the perspective of a high-end, well-funded industry. The article enthused that VR and AR maintenance training was developing rapidly in China, and “the effect is not bad” (p. 61) but lacked core technology.

Paxinou et al. (2018) described a VR simulated lab environment called OnLab in a university in Greece, paralleling an actual physical microscopy lab as a preparatory phase for the in-person course. Pre-test and post-test scores were gathered from two groups, using the same questions: one with the VR experience, one just following the traditional format, no VR. The VR simulation module consisted of an online demonstration of the microscopy procedure by a tutor on SKYPE, followed by time for the students to practice it in the simulated lab prior to the wet lab. The study reported higher scores for the VR-prepared group at the most challenging level. However, the research paper's brevity combined with a sidelined one-line variable that the students had microscopes to practice with on their own, left me questioning the trustworthiness of the control group conclusion. There was no mention of development costs for the simulation software scenario (affordability) or what was involved in its design, nor how much cognitive learning it provided (quality). The curriculum did employ some principles of task-centered learning praxis such as a focused task outcome, scaffolded modelling, unrestricted time for applied self-directed practice in the simulation, and chunked learning modules. It was accessible and affordable for the students on the university website. That said, the unstated assumption purveyed the online scenario to be a support for the real course and the real lab, not a replacement.

In this study, Zafeiropoulos and Kalles (2019) further extended the empirical work of Paxinou et al. (2018). OnLabs is an interactive virtual lab for biology students in the open university in Greece mentioned above. Before accessing the on-site laboratory in person, the stipulations expected the students to practice in the virtual lab. “OnLab resembles a modern computer game; it contains state-of-the-art 3D graphics while the user interacts with it through the keyboard and the mouse and has tasks and missions to follow” (p. 224).

Whereas the 2018 report focused on the pedagogical aspects from an instructional design perspective, Zafeiropoulos and Kalles (2019) provided a peek behind the curtain to the technological development of the OnLab simulation. They revealed the ongoing challenge of training artificial intelligence (AI) to think like a human brain, intrinsically exposing the complexity behind the programming for just one short module of a virtual learning course. The following quote illustrates a behind-the-scenes look into the development thinking:

> As genetic algorithms resemble biological evolution, they usually do not accommodate supervised learning. However, there is a branch of genetic algorithms, namely interactive genetic algorithms, which make use of some human guidance…. Being an adventure game, OnLab is a suitable test-bed for the training of artificial agents. (p. 227)

Extensive research has been done by DE academics regarding *conversational agents as historical figures* (CAHFs) in online education (e.g., Heller, 2017; Heller et al., 2005; Heller & Procter, 2009, 2011). Conversational agents (CAs) are often configured as virtual animations that can hold a real-life conversation taking turns with a live person (e.g., Apple iPhone’s Siri). Since 2005, Heller et al. have sought to increase engagement and social presence for online students via CAHFs. By bringing a historical figure “alive” such as Sigmund Freud (Freudbot), the innovation uses “fame to leverage engagement” (Heller, 2017, p. 361). Developed through AI markup language (AIML) to include narratives and more life-like fidelity, the effect provides the learner with an experience of having a conversation with famous historical persona. The continuing sophistication and variations on this technology in building rapport and relationships in virtual microworlds abound in applications such as Second Life or Altspace where CAHFs become avatars. This capability holds important potential for online education as it addresses social presence, a pervasive element for successful learning (Garrison et al., 2001).

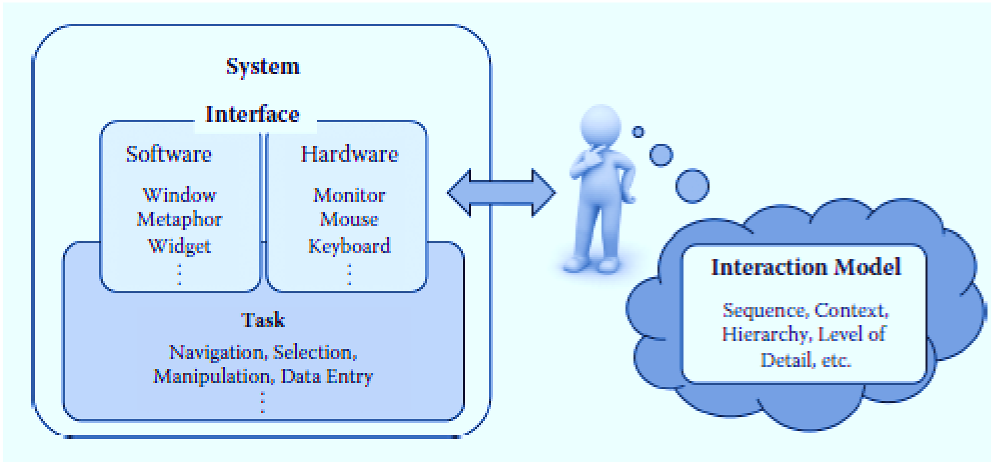
According to Heller and Proctor (2009), conclusions about the efficacy of *animated pedagogical agents* (APAs) in learning outcomes were hard to validate due to the many “confounded variables” at play (p. 56). For example, the CAHFs’ conversational programming is best suited to narratives for social exchange, yet APAs infrequently use them. An APA might not be sensitive enough to answer the learner’s questions and thus cause cognitive frustration. Another result suggested the discourse with a historical figure was more like a journalistic interview vis-à-vis a pedagogical goal, thus questioning the outcomes compared to standard text learning. How lifelike and believable the CAHF fidelity is impacts the learner’s personal connection. Connection rapport pings another essential element in engaged learning (Heller, 2017). In sum, the 17-year span of development on virtual APAs as CAHFs remains promising with room for evolvement. Evolution could address the as-yet small number of them accessible to mainstream DE, in the fidelity quality of the interaction falling short of expressing the academic rigour programmed into the CAHF’s knowledge, in the cost of programming needed to produce more “fully-loaded” narrative-style CAHFs, and in the confounding disparities in research results showing a continuum from effective to not effective (2017).

Homing in on Haptic Capability

Haptic technologies are concerned with HCI touch interaction models. Kim (2015) clarifies the electronic mouse as the "linchpin" (p. 2) in the beginnings of haptic technology, freeing us from computer command sequences on a keyboard and leading us to a much more intuitive HCI. Interactive web browsers propelled us into a visceral, graphical, image-based, and animated journey far beyond flipping the pages of a book. Smartphones with their touch interface have intrinsically taught us a universal semiotic language of pokes, clicks, swipes, and taps. Body-based gaming such as Wii and a market flooded with action-oriented avatar-based video games using VR head-mounted gear and hand controllers, is evolving haptic technology to a high usability level. HCI continues to "redefine how we view, absorb, exchange, create, and manipulate information to our advantage" (p. 4). Kim (2015) depicted the relationships of interaction within an HCI construct in Figure 14. The image hints at the complexity of the system interface attempting to achieve high usability for the human – a complex set of functional specifications involving software and hardware capabilities that provide navigation, selection, and manipulation choices in an appealing visual and touch-based sequence.

Figure 14

HCI Interaction Components (Kim, 2015, p. 1)



One technique used since the 1980s is called the Wizard of OZ prototyping (2009), where beta testers employed user interaction for hi-tech development. The user perceives they are verbally and haptically interacting with technology, e.g., an interactive voice messaging system (IVM) and cell phone semiotics. Yet, behind the scenes, humans respond to their selections, unknown to the user. This technique tested software user-friendliness in a naturalized situation. Data were recorded on the human user's responses to refine the HCI technology in question.

In their studies (Kim, 2015; Lee, 2020; Radianti et al., 2020; Rau, 2020), these researchers emphasized that good HCI design purports to be both exceptionally promising as well as generally challenging. As Kim (2020) expressed it,

> …because it is a multi-objective task that involves simultaneous consideration of many things, such as the types of users, characteristics of the tasks, capabilities and cost of the devices, lack of objective or exact quantitative evaluation measures, and changing technologies, to name just a few. (p. 3)

As haptic technologies advance, they blur the distinction between tangible objects held in hand and virtual objects represented on a screen, manipulated via text commands, mouse movement, hand controllers, or touchscreen action (Rau, 2020). More and more, technology can copy our movements in real-time. For example, the Apple iPhone can see the human face and record an animated avatar mirroring their facial expressions and voice while simultaneously taking dictation, all in a simple texting application.

AR and HAvatar

AR intelligence allows a remote user to draw virtual objects onto objects in a live environment. From the XR domain, remote livestreaming via AR comes the closest to the HAvatar technical configuration because a physical venue projects to the online user through a special headset with AI-glasses.

As such, in this concluding theme, I explored the technological configuration of HAvatar and how it might fit into an AR solution with remote control, as illustrated in Figure 15. The latter is a technology developed by Scope AR named WorkLink (2021). Its purpose enables instruction of hands-on applications in real environments yet controlled remotely with the aid of overlaid virtual objects.

As the cited video illustrated (Scope AR, 2021), a remote expert directed a user through AR-enabled glasses to understand and repair a generator. The expert could draw instructional semiotics virtually adding text and instructions right on the video-focused object in the physical location of the generator. This construct was the closest simile I found to the HAvatar configuration; the remote expert can touch the live objects via virtually drawn indicators so that the online learner can view the object in close proximity.

Whether the avatar is wearing an action camera or a more advanced scenario with AI-glasses, the strategy is the same. However, the experience might be different. Fowler (2015) described the difference between AR with 3D capability with AI-glasses versus just a desktop screen as "semi-immersive VEs versus embodied and immersive truly 3D environments" (p. 413).

Figure 15

AR Remote Control to a Live Site Object (Scope AR, 2019)

Figure 15 provides an idea of the fidelity of using the representational AR. AR such as this example might make it easier for the avatar to understand instructions because they allow semiotic drawings to enhance verbal commands, yet more complex for the learner to orchestrate with the AR instructions. The latter enhancement would require a longer initial learning curve, but the transfer of learning might be more successful.

Section 2. Summative Reflections

I investigated a sampling of publications on XR microworlds, distilled in this study through the iron triangle of quality, affordability, and accessibility. In summary, within the volume of XR empirical research I reviewed, the literature revealed consistent benefits and consistent constraints in providing real-life microworlds at this time.

Various domains of education and leadership discussed their concern about the inaccessibility of XR to upskill the populace (e.g., Gregory et al., 2016; Laurillard, 2012; Paxinou et al., 2018; Radianti et al., 2020; Rauh, 2017; Zemliansky & St.Amant, 2008; Zhou et al., 2018). Every study deploying XR for training that I reviewed alluded to the cost and logistics barriers. Those reports that spoke of extensive progress with exciting results for implementing XR training solutions were inevitably constituents of the medical, military, aerospace, or gaming domains with the luxury of extensive L&D funding.

The other conclusion warranting attention was the scarcity of solutions for hands-on learning in XR. Even virtual microworlds with virtual objects mirroring real objects are limited in their fidelity and sophistication, still far from a whole human tactile experience. Haptic gloves are the rudimentary beginnings of cloud affordances that can somatically touch virtual objects. Notwithstanding, these are not real objects. AR shows the most promise when combined with AI-glasses which allow overlays of virtual drawings and semiotics on real objects in a physical venue.

A predominant message throughout the Section 2 literature was the absence of instructional design principles or alignment with researched learning theories. In the Significance section in Chapter 6, I further discuss this disparity within the Pedagogical-Technological Change Continuum.

Chapter 2. Summary

In Section 1 of the Literature Review, I discussed the history of real-world active learning followed by a discussion of the principles of task-centred learning praxis. In Chapter 5, these vetted principles serve as evaluation criteria to analyze the research questions regarding the quality of the HAvatar intervention. In Section 2, I explored cloud-based immersive technologies vis-à-vis real-life learning in hands-on applications. Barriers to quality, affordability and accessibility in technical solutions for approximating hands-on learning online emerged clearly and consistently.

Chapter 3. Research Design

Research undertakes to expatiate knowledge through a structured inquiry or systematic investigation (*TCPS 2: CORE*, n.d.). As this is a developmental study based on a technological intervention, it falls into the systematic investigation category, suitably applying a pragmatic DBR methodology (Krathwohl & Smith, 2005).

The previous two chapters, the Positioning and the Literature Review sought to establish the need, the purpose, the theoretical considerations, and the significance of researching HAvatar— they have paved the way for this research design chapter.

There are five major sections:

Section 1: The Research Approach further deepens the theoretical framework in setting the stage for the operationalized portion of the research.

Section 2: The operationalization of the HAvatar intervention with DBR methodology is pointedly mapped in Figure 16, labelled DBR Baseline - HAvatar Detailed Schematic. It guides the reader in understanding how the sections fit together.

Section 3: The Data Analysis Evaluation Criteria and Tools explain the relationship between the data collection and the data analysis with research procedures and instruments.

Section 4: The Accountability Framework explains the strategies used to ensure due diligence and ethical alignment required by the Research Ethics Board (REB).

Section 1. Research Approach

In Chapter 1, Figure 4, I set the theoretical framework in concentric rings from the big picture paradigm of pragmatism to the locus of this query (Arthur et al., 2012; Cousin, 2009; Krathwohl & Smith, 2005; Neuman, 2002).

Research Lens

From a learner-centric approach, I see learning and education in juxtaposition: the learner's personal expectations facing education on the one hand, and the educational providers facing the learner on the other. The HAvatar study, viewed from the perspective of education serving the learner, resides at the micro-level of instructional design. Van Merriënboer (1997) defines three levels of scope: micro, meso, and meta. The micro-level of instruction is at the individual student level in a singular sequence of examples and practice. Merrill (2002) asserts that this level of granularity is where the most remarkable improvement of a design takes place. Up-close, visceral, and defined tasks, carried out by interested learners seeking to achieve knowledge, form a detailed and pertinent lens for examining an education intervention. Knowles et al. (2005) differentiate the roles of education versus learning similarly:

> Education is an activity undertaken or initiated by one or more agents designed to effect changes in the knowledge, skill, and attitudes of individuals, groups, or communities. The term emphasizes the educator, the agent of change who presents stimuli and reinforcement for learning and designs activities to induce change. The term learning, by contrast, emphasizes the person in whom the change occurs or is expected to occur. (p. 10)

My research questions inform the perspective of education organizations seeking change in serving learner needs.

The Paradigm of Pragmatism

Kuhn (2012), the seminal author of paradigms, suggests that we form personal belief systems and ways of making sense of the world and our place in it from our experiences and relationships. My ontology of how learning comes about stems from my experience of solving hands-on/brains-on problems in actual work settings in situated just-in-time scenarios.

Pragmatism appeals to me as a paradigm: from a philosophical stance as centred on the real-world application of learning, "Reality is what is useful, is practical, and 'what works'" and from a practical stance by finding "solutions to real-world problems" (Creswell & Poth, 2016, p. 35). Its hermeneutical worldview supports research principles and methods applied in context to an actual situation, selecting from a medley of methods, instruments, and data analysis techniques as needed. In this way, pragmatism could be termed an anti-paradigm, a stance where the researcher may be looking at the research situation through an interpretive lens, with "situational specificity and contextual dependence...[which] prevents the traditional concept of causation from being useful or appropriate" (Arthur et al., 2012, p. 40). The HAvatar study is a developmental intervention looking to investigate reaction. Reaction denotes a positivist lens (Krathwohl & Smith, 2005). However, Gage (1989) contends that one can have a realist ontology but still use an interpretive approach centring on the meanings that participants derive, observed naturalistically in situ, "softened by the adoption of qualitative methods and the inevitable acceptance of subjectivity they imply" (Arthur et al., 2012, p. 40).

The HAvatar study has a further differentiation as drawn out in both books, Arthur et al. (2012) and Krathwohl and Smith (2005), that is, the distinction between intervention studies and descriptive studies. As an intervention, the research "actively sets out to introduce some change into the educational world, then studies the reaction" (Arthur et al., 2012, p. 43). In contrast, a descriptive study only aims to provoke change. Informed by Reigeluth and Carr-Chellman (2009), Ives (2010) provides another perspective, "Design theory, according to Reigeluth, depends on research to improve, while descriptive theory emerges from research to prove" (p. 220).

My Ontology of Change

Pragmatism is fundamentally about change and real-world learning (Morgan, 2007). As per Arthur et al. (2012), “Persons are constantly adapting to new situations in the light of previous experiences” (p. 245). Consistent with a lifetime of monumental changes in people, places, careers, and ways of life, my ontological assumption is that change is an essential and overriding premise, requiring sustained learning and effort to keep pace with. I suggest that the following triad of ‘ologies is an evolving change paradigm. When something challenges *what I value*, my axiology, I have to re-consider my accepted norm of *what is worthy of reality*, my ontology; that means comparing my knowledge to *what is known*, my epistemology. Do my ‘ologies need to change as a result of a new experience? As my core ontology is grounded in the change mindset, I am open to shifting circumstances that can cause an unsettling evolution, sometimes a personal revolution (Laurillard, 2012).

Disruptive innovation has become commonplace in society due to technological advances and global connectedness (e.g., Christensen & Johnson, 2008). “Change is in the air” is an appropriate axiom for our times—the thinking of Knowles and his colleagues (2005) aptly expresses this relationship between change and learning,

> Learning occurs as a result of a change in cognitive structures produced by changes in two types of forces: (1) change in the structure of the cognitive field itself or (2) change in the internal needs or motivation of the individual. (p. 30)

Appropriately in sum, Arthur et al. (2012) express the ontology of change as, “We can only really fully understand the world if we understand how to change it” (p. 43). A wide swath of author-educators, including UNESCO researchers as mentioned in Chapter 1, claim that nothing short of a wholesale re-work of education is needed, a revolution (e.g., Christensen &

Johnson, 2008; Laurillard, 2012; Reigeluth & Carr-Chellman, 2009; Reigeluth et al., 2017; Reigeluth & Karnopp, 2013, 2020; UNESCO, 2014). This study is an enactment of my contribution to this revolution.

The Epistemology of Task-Centred Learning Praxis

For clarity of taxonomy, I have used the term task-centred learning praxis throughout this paper to represent the theoretical neighbourhood of learning-by-doing: situational, practice-based, project-based, task-based, experience-based, problem-based, evidence-based, professional task development-based, maker-based, and more. Learning-by-doing augments learning through language and symbolism with a visceral, tactile component (Laurillard, 2012). The principles of task-centred learning theory (Francom & Gardner, 2014) are also found in the task-centred learning instructional design theory (Francom, 2017; Merrill, 2002; Reigeluth & Carr-Chellman, 2009; Reigeluth et al., 2017); ergo, as mentioned in Chapter 1 and 2, my use of the word praxis to represent both theory and practice.

The Methodology of DBR

Borrowing from engineering and software methodologies, DBR appropriately operationalizes education research as a developmental initiative focusing on the design, construction, implementation, and adoption of an intervention (Anderson, 2008a). Shattuck and Anderson (2013) describe an intervention as a possible solution to an identified problem, including the activities and processes involved. In general, DBR is commonly chosen to help unpack an initial idea with the instructional approach identified in an analysis and discovery phase, informed by a literature review or extant theory, and followed by developmental and implementation iterations (2013). In the Shattuck study (2013), the project in question was already mature and had undergone several implementation iterations. Shattuck's DBR orientation then served the purpose of “an independent research mircocycle within an ongoing research project” (p. 60), an iteration which explored the effectiveness and impact of the designed program on the specified demographic. Shattuck’s study (2013) further informed me and underpinned my use of the DBR methodology in that it illustrated the flexible nature of DBR applied in localized contexts twinned with its greater purpose of contributing warranted design principles to the field of education.

Barab and Squire (2004) connect DBR to the change ontology described earlier as a personal axiology, “As such, design-based research suggests a pragmatic philosophical underpinning, one in which the value of a theory lies in its ability to produce changes in the world” (p. 6). With its “the end justifies the means” stance, DBR borrows from multiple methodologies as needed and unhesitatingly employs mixed methods in any combination – a “hybrid methodology” as per Wang and Hannafin (2005, p. 6).

For example, DBR goes beyond formative evaluation. Although both share tenets as iterative improvements of a localized designed artifact, DBR reaches further to, “uncover, explore, and confirm theoretical relationships” (Barab & Squire, 2004, p. 6). Shattuck (2013) argues that DBR straddles the domains of research and evaluation, where research seeks empirical new knowledge rather than solely evaluating the outcome of how it solves a problem. DBR delves deeply into the local context, embracing the messiness of unpredictable outcomes, yet stretches to seek broader applicability in other contexts to enhance the knowledge field (Collins, 1992).

Part of the significant medley of elements in DBR is the interactivity and collaboration amongst all stakeholders who are encouraged to help evolve the design (Collins, 1992; Palalas, 2012; Wang & Hannafin, 2005). Wang and Hannafin (2005) posit that DBR projects, “are neither easy nor intuitive to implement; indeed, they require a shift in perspective of the traditional ID/ISD [instructional design/instructional system design] enterprise and a sustained commitment to advancing theory and practice" (p. 20).

Four main tenets align DBR with the HAvatar study:

(1) Interventionist in an in-situ educational context (the exact context of HAvatar)

(2) A series of iterations building on formative revisions (four iterations of HAvatar called rounds)

(3) The expansion of a recognized theory (refining task-centred learning praxis for DE)

(4) Designers, participants, technicians, practitioners working together in a real-world context (multi-role collaboration with supervisory faculty, researcher-facilitator, HAvatar technician, and participant-learners)

Ives (2010) concurs with these tenets and further linked my understanding of the methodology of DBR to the theory of task-centred instructional design as well as the paradigm of pragmatism, through the centrality of situational context. Cueing off Reigeluth and Carr-Chellman (2009), she notes the usefulness of grounded realistic experience in learning-by-doing scholarship to shape the practices of researchers, theorists, teachers, and instructional designers alike. This real-life connection between paradigm, theory, and methodology lends credence to my chosen theoretical framework of pragmatism, task-centred learning praxis, and DBR.

Mixed Methods

In Chapter 1, I introduced mixed methods as part of the theoretical framework. Now with more context, I explain how mixed methods serve the DBR methodology appropriately in this study by utilizing some quantitative and qualitative instruments (Arthur et al., 2012; Barab & Squire, 2004; Creswell & Poth, 2016; Frey, 2018; Morgan, 2014). With a practical orientation towards a technical solution (Arthur et al., 2012), as per pragmatism, the instruments serve as conduits for the collection and analysis of the data with the goal of garnering confidence in the breadth and depth of the results generated. Informed by Arthur et al. (2012) and Denscombe (2010), methods define the tools and resources to do the research undertaking – the means used to collect and analyze pertinent data. Methods also include the research participants whose feedback furnishes the data.

Qualitative (QUAL). QUAL research is suited to exploring humans and education (Arthur et al., 2012; Cousin, 2009; Neuman, 2002) whereas experimental science is ill-suited to the complexities of humans and real-life phenomena (Gilham, 2010). Occurrences of specific criteria within events or prior research may quantifiably inform research outcomes, but to truly understand the enigma of the human learning experience, QUAL methods can reveal a further dimension of broader meaning (Arthur et al., 2012; Cousin, 2009; Denzin & Lincoln, 2008).

QUAL data is collected in the form of an initial semi-structured interview, descriptive questions at the end of each session, my journal reflections, as well as video footage of the HAvatar sessions. These narratives, whether oral, visual, or written, engender the story of an experience, a personal judgment call on that experience, and a provision of “vivid, illuminative, and substantive evidence of such behaviour and experience” (Cousin, 2009, p. 31). Verbal interactions are up-close and personal due to the small sampling.

Quantitative (QUAN). HAvatar seeks to solve a practical problem. It makes sense to derive data that offers practical solutions and concretely reify theory. For this reason, a QUAN lens serves to clarify aspects of the intervention with charts, graphs, and statistical representations that the QUAL perspective lacks.

In general, QUAN research involves a more extensive sampling (Cohen et al., 2018; Terrell, 2016). In this instance, the QUAN instruments serve to gather ratings from a small-group sampling.

As introduced in Chapter 1, Theoretical Framework, my use of mixed methods falls into the concurrent triangulation (Cohen et al., 2018), where QUAN and QUAL data are collected and analyzed together. The QUAN component of this study aims to enrich the QUAL data with visual charting and gradient-type scaling.

This concludes the discussion on the theoretical underpinnings of the study. Section 2 comprises the DBR Baseline design for the HAvatar intervention.

Section 2. HAvatar Intervention – DBR Baseline

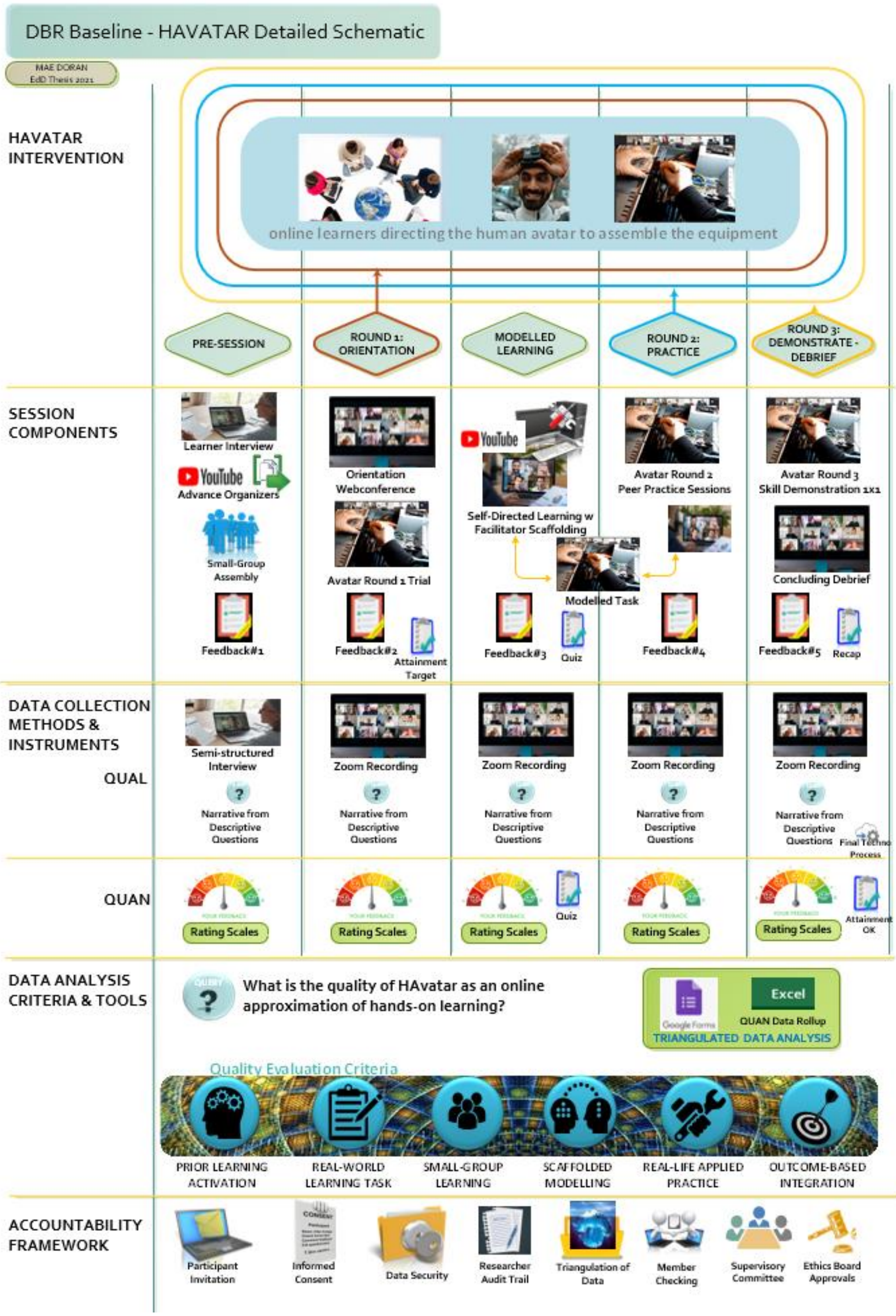
In Chapter 1, Figure 6, I introduced the high-level Conceptual Framework schematic. Here in Section 2, I have pulled out the DBR methodology portion of that schematic to reveal its details. Thus, Figure 16, the DBR Baseline - HAvatar Detailed Schematic, informs this chapter. I refer to it as the DBR Baseline from now on.

Commonly, an image informs the words of a discourse, but in this case, the words inform the image.

DBR Baseline – Detailed Schematic

Figure 16

DBR Baseline – HAvatar Detailed Schematic



Note. [Link to a printable, scalable version]

Like a roadmap, the explanations follow the schematic, with labels italicized in the text:

(1) The five sessions of the *HAvatar Intervention* form the heart of this project. Each round of HAvatar interaction is an iteration of DBR with specific characteristics building on one another as shown with the red, blue, and yellow outlines.

(2) The *Session Components* show the contents inside each session.

(3) *Data Collection Methods & Instruments* are applied formatively in parallel with the sessions.

(4) *Data Analysis Criteria and Tools* analyze the data against theory to answer the research questions.

(5) In the *Accountability Framework*, ethics methods and instruments monitor and maintain the integrity of the research, described last.

DBR Baseline

DBR has characteristics paralleling the Agile software design lifecycle (SDLC) (Altvater, 2020). With Agile, each cyclical iteration contains all the SDLC phases: needs analysis, plan, design, develop, test, evaluate. In fact, ADDIE, a model known to develop education curriculum, follows the stages of the SDLC quite closely (Bates, 2015).

A DBR intervention such as HAvatar has a distinct standalone pedtech design paralleling a software app prototype. As such, I have used the present tense to describe “what it is in general” as is common practice in SRS (Ionocom, 2022; TechTarget, 2022). When referring to elements that belong only to this instance of the study, I use the past tense. Also, once the HAvatar moves into the research activities, which is reported on in Chapter 4, Findings, every iteration parallels a testing cycle and becomes “what happened” in the past tense.

For further rationale about this approach, using the research design as the baseline for a DBR, see Chapter 6.

Roles

The Facilitator-Researcher

In the DBR Baseline, I allocate two roles for myself: facilitator of the HAvatar sessions and DBR researcher. I am also the designer of the HAvatar intervention. As discussed in Chapter 1, this small social research project posits the researcher's role as multipart (Denscombe, 2010; Palalas, 2012). My list of responsibilities is defined in the project as follows:

- ensure the meticulous collection of data through the instruments
- ensure the HAvatar concept is truly understood by stakeholders
- plan the project and lead the rollout of the sessions
- maintain the ethical methods
- facilitate the HAvatar sessions at the planned points
- re-evaluate the design after each round of HAvatar and collaborate next steps with the participants and the avatar
- encourage collaboration and participation
- ensure data collected on the technological affordances
- relate the practice to the theory of task-centred learning consistently
- take reflective notes
- lead the group debrief session to maximize feedback
- analyze the QUAN data rating scale selections by participants
- thematically analyze the QUAL data for task-centred learning qualities
- write the findings and results

The Human Avatar

In its existing definition in XR, the avatar is the user within a virtual world and "through its appearance and actions becomes identified with the actual user…contribut[ing] to the sense of presence and co-presence" (Fowler, 2015, p. 414). The human avatar stands in for the user at the learning venue and becomes the "puppet" for the learner's commands as they practice or demonstrate the skill. The HAvatar provides an intriguing circularity because the concept of the human avatar is modelled after a gaming avatar in virtual worlds, which is modelled after human behaviour.

In the design, an elearning and media technician with computer hardware and videography expertise takes on the role of the human avatar.

The Participant-Learners

Terrell (2016) labels the sampling of participants as purposive when it meets specific selection criteria. Denscombe (2010) informs the definition of a small sampling with specific participation conditions as a non-probability purposive selection. As Silverman (2005) avers, "qualitative research design tends to work with a relatively small number of cases…sacrificing scope for detail" (p. 9). Denscombe (2010) further defines the small research project sampling as exploratory, based on gathering new insights from participants in an intervention. The project researcher uses a small-scale sampling with a pragmatic (what works) approach constrained by costs and difficulty in meeting all the logistical criteria of involvement.

In achieving the goal of the study, to determine the quality of the HAvatar intervention in approximating real-world, hands-on learning, I chose a PC computer assembly task. Matching the above definition, the study encompasses a small purposive non-probability sampling of six participants chosen with six conditions to match the task:

- an interest in basic computer hardware assembly
- little knowledge of the said skill
- excellent and clear diction in English
- belonging to the demographics of younger Millennials and older Gen Z learners (Pew Research Center, n.d.) (i.e., under the age of 35 but older than 17)
- tech-savvy comfort with cloud-based technology
- accessibility to robust broadband connectivity

Exclusions are defined as the visually challenged (due to the level of detail needed to scrutinize on-screen) and the verbally or linguistically challenged (due to the articulation requirements to command the English-speaking avatar).

In line with the Literature Review, Section 1, discussing the needs of twenty-first century learners, the above sampling seems fitting.

Non-Human Roles

The hardware and software affordances listed below are selected as the technological means for the design iterations.

(1) GoPro Camera Hero 8 with head and chestmounts – action camera provides visceral closeness to objects, handles movement as a specialty

(2) Secondary still camera to focus on the detail of the objects

(3) GoPro webcam connectivity to Zoom software as a webcam – a Zoom paid account subscription

(4) Zoom conferencing with recording capability on the avatar’s login

(5) Camera switching software to swap livestreaming views

(6) Computer hardware to assemble – dismantle – reassemble repeatedly

(7) Studio setting with strong lighting

Data Collection Instruments

The following list explains the nature of the mixed method instruments used to collect the data during the HAvatar sessions.

QUAL

Semi-Structured Interview. See Appendix C for the Pre-Session interview questions. I hold this interview one by one with each participant at the outset of the project. The semi-structured interview questions provide rich QUAL data around learner readiness.

Concluding Debrief. See Appendix D for the questions in this summative focus group. The purpose and structure of the Concluding Debrief are housed and described in the HAvatar Sessions and Data Collection, Demonstrate – Debrief, Section 3.

Descriptive Questions. See Appendix E for the formative questions. These are feedback questions at the end of each session (Feedback #1 to #5) which have been matched to the QUAN rating scales described. Participants choose to write or record their answers. In keeping with the spirit of continuous DBR, the questions punctuate the end of each session, rather than solely as a summative questionnaire at the end of the whole project.

Recorded Videos. The recordings of the sessions provide visual data.

Memoing. Ongoing comprehensive notes throughout the DBR action chronicle my thoughts.

HAvatar Final Techno Process. This QUAL instrument is a description of the final technological setup for the HAvatar and its hardware affordances and software apps. Each iteration has a description of the adjustments to the camera equipment, the webconference connections, the laptop configuration, and the broadband connectivity as they evolve.

QUAN

Semantic Differential Rating Scales. This rating scale format provides an adjective at either extreme of the scale with rating selections between 1 and 5 where 1 is the least and 5 is the most. Here is an example:

How prepared did you feel for the intervention with the avatar from the interview with the facilitator?

Insufficiently Prepared 1 2 3 4 5 Well Prepared

Cohen et al. (2018) aptly describe rating scales as offering a greater sensitivity in the level of response to the feedback, far beyond a binary response. “They afford the researcher the freedom to fuse measurement with opinion, quantity, and quality” (p.327). They afford me this same opportunity to gather nuanced opinions and to create graphs and charts from the scales’ feedback ranges.

Task Attainment. Although the targeted attainment task does not meet the ideals of learner-centric personalized goals as per task-centred learning praxis (Reigeluth et al., 2017, p. 13), the study is brief and laser-focused on the completion of one small task. A generous allotment of time for mastering the skill independently or working together is characterized in the design.

The task attainment is a straightforward binary metric:

Did the participant assemble the computer so that it successfully booted up to the bios?

Terminology Quiz. This QUAN instrument is a formative assessment at the end of the Modelled Learning session. Its purpose is to ensure the participants use the terminology of the computer parts to direct the avatar. Although this quiz provides some QUAN data, the participants self-report their readiness to practice with the avatar which is the main criteria for initiating the next session.

HAvatar Sessions and Data Collection

As introduced, Figure 16 didactically informs the DBR Baseline with labels in italics in the text.

The top horizontal channel, *HAvatar Sessions*, re-depicts the intervention configuration introduced in Chapter 1, Conceptual Framework, Figure 6. The next channel labelled *Session Components* depicts the activities configured for each session. The channel below that, *Data Collection Methods & Instruments*, shows the simultaneous research process.

Pre-Session

In the *Pre-Session* column, the one-on-one *Learner Interview* with each participant-learner (shortened to “participant” in this section) serves a dual purpose as the onboarding welcome and learning activation for the HAvatar sessions as well as the initial data collection pulled from the interviews and *Feedback #1*. Through their response to the initial invitation, the signed consent form, and the *Learner Interview*, each participant needs to show willingness and interest in taking part in all four following HAvatar sessions. The goal of the *Pre-Session* is for each participant to feel heard, respected, welcomed, and readied for the HAvatar experience, as well as to confirm the research sampling.

Session Components. This involves discussing the purpose of HAvatar, how the sessions roll out, and the importance of their voiced contributions to the development of HAvatar. Once they return the informed consent, I send out a synopsis of the research study and the DBR Baseline schematic as *Advance Organizers*. If the participant sees a need, I send them publicly available *YouTube Videos* teaching Zoom conferencing. Once we are in the interview, I make sure to inform them about the purpose of the research, their role in it, and how to interact with the avatar. We discuss their peer group as represented by the label *Small-Group Assembly*. See the interview questions in Appendix C.

Table 1 continues the DBR Baseline data collection depiction in column 1, Figure 16.

Table 1

Data Collection Methods and Instruments: Pre-Session

	Pre-Session column icons	Representing
QUAL	*Semi-structured Interview*	1x1 Zoom webconferencing
	Zoom Recording	Text from the interview
	Narrative from Descriptive Questions	Written responses to intro and preparation activities
QUAN	*Rating Scales*	Quality of the interview Quality of the advance organizers

Orientation

The *Round 1: Orientation* column, with a red line connector, circles the HAvatar intervention image, symbolizing the first round with the avatar. This session aims to familiarize the participants with all the engagement components, create a collegial atmosphere, and garner feedback about their first avatar experience. I agree with Lane (2014) who suggests an orientation with preparedness activities to foster confidence before engaging in the learning.

Session Components. The cohort meets online for the first time in the *Orientation Conference*. I take time to introduce our interaction touchpoints, our roles, and our backgrounds. I facilitate the orientation to the strategy of HAvatar, the research process, their involvement, the learning materials for the computer assembly, and the scaffolding avenues for reaching out to each other and the facilitator. The *Attainment Target* of assembling the computer is clearly articulated. The participants fill out *Feedback #1*, post webconference.

Avatar Round 1 – Trial

The cohort also trials an avatar interaction and views the computer studio for the first time through Zoom webconferencing. Each participant has a chance to command the avatar to perform a simple task from a selection of choices, such as drawing a picture or putting screwdrivers in a carry case.

The session concludes with a discussion and feedback from the participants. As per DBR methodology, *Feedback #1* engenders refinements to the next session with the avatar.

Table 2 continues the DBR Baseline data collection depiction in column 2, Figure 16.

Table 2

Data Collection Methods and Instruments: Orientation

	Orientation column icons	Representing
QUAL	*Zoom Recording*	Group webconference
	Zoom Recording	Avatar round 1 trial
	Narrative from Descriptive Questions	Written response to the experience of the avatar and the orientation on feedback #2 form
QUAN	*Rating Scales*	Quality of the orientation session and Quality of the avatar trial

Modelled Learning

The column entitled *Modelled Learning* provides modelling of the assembly of the computer. The goal of this session is for the participants to learn enough to practice the task with the avatar.

Session Components. I send links to *YouTube videos* of computer assembly symbolized by the cluster of icons labelled *Self-directed learning with facilitator scaffolding.* The cohort reviews demonstration videos with computer terminology. An online *Quiz* serves the dual purpose of readiness for the avatar and a QUAN formative checkpoint tool. Participants can seek clarity with me, the facilitator, for additional coaching. I also take note of weaknesses in the pedagogy.

Table 3 continues the DBR Baseline data collection depiction in column 3, Figure 16.

Table 3

Data Collection Methods and Instruments: Modelled Learning

	Modelled Learning column icons	Representing
QUAL	*Zoom Recording*	Example of a participant's assembly
	Narrative from Descriptive Questions	Written response to the YouTube learning materials on feedback #3 form
QUAN	*Rating Scales*	Quality of the modelled learning
	Quiz	PC assembly terminology

Practice

The *Round 2: Practice* column with a blue line connector circling the HAvatar intervention image symbolizes the second round with the avatar, illustrating progressive iterations of the HAvatar intervention as per DBR. The goal of this session is for the participants to practice hands-on learning with the avatar. **This avatar session is the most critical in the intervention and the research.**

Session Components. The activity centres on the *Peer Practice Sessions* with participants practicing their skill through the avatar standing in to construct the computer. The explanation below further details the HAvatar strategy introduced in Chapter 1.

Avatar Round 2 – Peer Practice Sessions

As shown in *Round 3: Practice*, each participant demonstrates readiness to assemble the computer through a formative terminology *Quiz*. The cohort reconvenes on Zoom. The learning venue is equipped with the PC's component parts and the assembly tools at the ready, with the technician as avatar. By livestreaming the worktable through the avatar's wearable action camera plus a static angle camera, the equipment to direct the human avatar is ready. The cameras stream the venue to the fully-maximized, pinned screen of Zoom. As the avatar screen is also the host screen, it is possible to pin the screen persistently. The rest of the cohort is visible with video on in minimized cameo windows, provided the Internet connection is strong enough to both live stream the HAvatar and the participants' profile cameos.

It is of note that I, as the facilitator, do not stay present for this session. I need to ensure the session is recorded. This round with the avatar embodies the crucial act of solving an ill-defined problem as a small independent cohort. There is no facilitation, although there may be discussion, given this is a DBR seeking to pinpoint improvements in real-time. The group has studied the assembly requirements and parts. The hardware assembly parts are very similar to the learning videos but not exact, in order to stimulate problem-solving. I estimate that the small-group dynamics (introduced in the Literature Review, Section 1, and incorporated in the pre-session and orientation sessions) come into play intensely at this point in the process. Through the intervention logistics, timings pre-determine the average speed of assembly. Each cohort member directs the avatar through verbal commands using the learned taxonomy. If the cohort encounters a problem, they can call a timeout to consult with each other. A further escalation to the facilitator is available. This takes the form of reflective questioning rather than simply furnishing answers. The learners are encouraged to reference the learning materials when needed.

The cohort decides whether they have time for each peer to work individually. The session is complete either at the end of the amply allotted time slot or when the cohort has successfully assembled the computer. The latter should boot up to the bios screen with no error messages. Contingencies for various unexpected occurrences are anticipated.

The session concludes with a *Q&A with facilitator* and the participants, an important debrief. As per DBR methodology, this iteration offers refinements in anticipation of *Avatar Round 3.*

Table 4 continues the DBR Baseline data collection depiction in column 4, Figure 16.

Table 4

Data Collection Methods and Instruments: Practice

	Practice column icons	Representing
QUAL	*Zoom Recording*	Avatar round 2 peer practice 1X1
	Narrative from Descriptive Questions	Written response to the avatar experience on feedback #4 form
QUAN	*Rating Scales*	Quality of avatar sessions

Demonstrate – Debrief

The *Round 3: Demonstrate- Debrief* column with a yellow line connector circles the HAvatar intervention image symbolizing the third round with the avatar. The goal of this summative session is twofold: to mark the conclusion of the learning via a demonstration of skill and to provide a reflection time about the entire experience of HAvatar. Thus, the *Demonstrate-Debrief* session and *Avatar Round 3* serve a dual purpose as a summative assessment as well as the final DBR iteration.

Session Components. The activity centres on the participants showcasing their learning via a *Skill Demonstration 1x1* with the avatar, revisiting the learning as a dialogue with the group and facilitator, and writing about their learning experience.

Avatar Round 3 – Skill Demonstration

Each participant demonstrates competence via the original *Attainment Target* from *Round 1: Orientation* in completing the goal to assemble a working computer via the human avatar. This round of avatar happens one by one, with each participant guiding the avatar individually.

The *Avatar Round 3* is a performance-style activity, optional in case a participant does not feel confident to complete the task. They can choose to have another practice round or omit the session. This list checks off each participant's successful /non-successful task completion, whereby the computer boots up as the outcome. An anonymous tally of overall success rates is part of the data collection.

Concluding Debrief. The cohort, the avatar, and the facilitator convene to reflect on the HAvatar experience, the learning, the interaction, the conclusions, and most notably, the iterations of the DBR. The avatar also takes part in this.

Table 5 continues the DBR Baseline data collection depiction in column 5, Figure 16.

Table 5
Data Collection Methods and Instruments: Demonstrate-Debrief

	Demonstrate - Debrief column icons	Representing
QUAL	*Zoom Recording*	Avatar round 3 demonstrate skill
	Zoom Recording	Webconference concluding debrief
	Narrative from Descriptive Questions	Narrative response to the experience of the avatar and the concluding debrief on feedback #5 form
QUAN	*Attainment OK*	Successful outcome check
	Rating Scales	Quality of avatar round 3 sessions
		Quality of whole HAvatar experience

Section 3. Data Analysis Criteria and Tools

Chapter 1 positioned the criteria for judging the iron triangle's quality vector, and Chapter 2 deeply explored them. Reigeluth et al. (2009) state, “The quality of the instruction will improve with each principle that is added: demonstration, application, task-centered, activation, and integration” (p. 43). Seale and Silverman (2018) extend this position by stating, “The simple answer is that any analysis depends on the use of certain theory-dependent concepts” (p. 26). The analysis uses the theoretical principles of task-centred learning praxis as themes.

In Chapter 1, Theoretical Framework, I characterized the HAvatar data analysis as a fit with Cohen et al.’s (2018) concurrent triangulation, that is, the QUAL and QUAN data are analyzed together. With the theoretical criteria already linked to the intervention, the data analysis plumbs the collected data in all their forms, both QUAL and QUAN.

Data Analysis Tools

As illustrated in Figure 16, under *Data Analysis Instruments*, I select *Google Forms* (GF) to gather and analyze both QUAL and QUAN research. These data allow *Triangulated Data Analysis* rolled up by question responses within an *Excel* spreadsheet from which I draw graphs and tabulations. I set the questions from the GF Feedback forms #1 to #5 to answer the *Quality Evaluation Criteria*.

The data analysis is triangulated via the continuum of adjectives or metrics from the QUAN rating scales, further enriched by the QUAL written comments. This format of mixing the methods offers an opportunity for analysis, albeit with results constrained by the small sampling (Cohen et al., 2018).

Research Questions Reiterated

The responses to the high-level question are aggregated and analyzed from the data drawn from the collection process described above and queried against the honed-in research questions (1) to (5). I analyze research questions (6) and (7) against the *Quality Evaluation Criteria* of *Task-Centred Learning Praxis.*

What is the quality of HAvatar as an online experience approximating real-world, hands-on learning via task-centred learning praxis?

(1) *…in learning a task involving tactile skills?*

(2) *…in the experience of guiding the avatar with verbally-mediated instructions to accomplish tasks at a distance?*

(3) …with respect to solving tasks in a small-group format to direct the avatar and learn the skill?

(4) *…with respect to adding motivation and interest to learning online through the avatar to accomplish this task?*

(5) *Was the skill attained correctly according to the attainment task prior to ever touching the physical objects?*

(6) How important to the avatar experience is the task-centred learning pedagogy that organized it?

(7) *What are the impacts or refinements to task-centred learning praxis and learning-by-doing theory in this online format?*

Criterion Themes

As stated, I draw on the task-centred learning praxis to derive the themes of criterion analysis.

I begin with the results of the last session, demonstrate – debrief, which provide the summative feedback. The preceding four sessions furnish formative feedback specific to each session.

See Appendices D and E for the detailed summative and formative rating scales and questions.

In Figure 16, the *Final Techno Process* icon represents the best configuration achieved at the end of the DBR iterations for the HAvatar technology setup.

Section 4. Accountability Framework

The bottom channel of Figure 16 displays a series of icons representing accountability concerns of transparency, confidentiality, trustworthiness, and ownership (Arthur et al., 2012; Bell & Waters, 2014; Cohen et al., 2018; Cousin, 2009) aimed to protect the participants, the researcher, and the intellectual property. There are both explicit and implicit implications within this claim: requirements to ensure due diligence in the conduct of the research and the choice of methods; requirements in the tone, the language, the facilitative and inclusive attitude towards others involved; and caveats to avoid putative assumptions (Cousin, 2009). There is a moral undertone inimitably conveyed. Shank (2002) informs the researcher's moral compass as "do no harm", "be open", "be honest," "be careful" (p. 97).

In the following paragraphs, I explain these icons in the *Accountability Framework* channel which depicts practical instruments and strategies as requisites of this research study.

Participant Invitation

Appendix A shows the invitation letter worded in a way that encourages participation for those who might fully commit and discourages those who otherwise might not. By being transparent and clear up-front, potential participants can understand what is required of them and make an informed decision (Cohen et al., 2018). See Appendix A.

Informed Consent

Prior to interviews or data collection, careful preparation, permissions, and consultation with the key stakeholders about the research strategies are de rigueur. For example, regarding interviews, Cousin (2009) states, “An interview requires that the interviewee consents to a sustained dialogue on an agreed topic and consents to the interviewer to use the resulting transcript” (p. 78).

Involvement of stakeholders warrants a signed exculpatory informed consent (see Appendix B). I understand this to be an agreement, advisably a mutually signed contract of specification. It clarifies the relationship, assures the participants of confidentiality and opt-out choices, and protects the researcher and the participant from liability. Further, within this dissertation, I lay out the expectations, objectives, and limitations of the intervention, the required commitment to achieve success, the ownership of ideas, the storage and retrieval permissions of data, as well as the dissemination of write-ups and artifacts (Bell & Waters, 2014). The researcher's full contact information and their regulating body are also provided to the participants.

Data Security

As the HAvatar project takes place entirely online, the management of digital data is paramount. Therefore, I have divided it into three phases. The first phase is pre-and-during the DBR which represents the data collection; the second is the post-intervention phase which represents the data analysis; the third phase shows the long-term storage strategy after the dissertation has been approved and published.

In the first phase, the data collected from video recordings in the Zoom webconferences, any online documents, emails, question descriptions, the semi-structured interview transcripts, and focus group transcripts reside in a private folder. Dropbox is my storage service which has a good reputation for data security (Dropbox, n.d.). Every effort is made to protect personal information and feedback through passwords, encryption, two-step sign-in authorization, and cloud-based storage security.

All data referred to is anonymized to the initials of the participants. In the second phase, QUAL data sourced from the participants is removed from GF and kept in PDF format. Any QUAN or QUAL data aggregated in Excel has no identification details.

In the third phase, once the project is complete, any identifying data, including video footage, is moved from my PC and stored for five years on a thumb drive in my possession before destruction.

Audit Trail

”The strategy needed to ensure dependability and confirmability is known as an audit trail” (Korstjens & Moser, 2017, p. 3). The audit trail refers to the journal reflections about my decisions during the HAvatar iterations, emerging findings from the data, and all else of note. The audit trail provides transparency to the research reliability and a view of the unfolding research project from my subjective perspective (Cousin, 2009).

Triangulation and Rich Data

When the collection of mixed methods data happens simultaneously, it is labelled concurrent triangulation because different avenues are examined simultaneously (Arthur et al., 2012). As per Walker (2012) in their nursing simulation study, “Triangulation attempts to explain the phenomena being studied more fully by studying it from more than one point of view and, in the case of this research study, making use of both quantitative and qualitative data" (p. 64). As such, the triangulation coalesces the mixed methods through the Discussion, Chapter 5. Ultimately, this data substantiates Chapter 6, Conclusions, which derives insights from the HAvatar experience.

Member-Checking

Chapter 4, chronicling the involvement of the participants, is shared with them before the draft moves forward to the formal approval process. It is assumed that my role as a researcher of the data is inherently biased and influenced by my positionality. Consciously or unconsciously, the selection process privileges some aspects and excludes others (Cousin, 2009). The process of member-checking of interpreted data helps to neutralize this bias.

Supervisory Committee

As this research project is a doctoral study, the writing is overseen by a committee of four expert faculty. One of my responsibilities is to ensure continuous relevant communication to absorb their advice and keep them up to date on progress.

Ethics Board Approval

The segue into the actualized research action comes about through the following acceptance: the approval of the proposal through a candidacy exam and further approval by the research ethics board (REB) of Athabasca University (Bainbridge, 2019), depending on some of these accountability factors being addressed appropriately. These procedures are overseen by the Athabasca Faculty of Graduate Studies (FGS), informed by Canada's Tri-council Policy Statement (GOC Panel on Research Ethics, 2018). The formal bodies ensure the study addresses the accountability factors appropriately and the research project attains a quality that surpasses ethical scrutiny and allows public dissemination.

Chapter 3. Summary

I planned out the application of the concepts and theories introduced in Chapter 1 throughout Chapter 3, the Research Design. Section 1, the Research Approach, furnished a deep look at the proposed pragmatic and theoretical underpinnings of this study and further situated the research into its methodology of DBR. Section 2, the HAvatar intervention, described how the microcourse was designed. A central schematic guided the writing about the detailed roll-out of the experiential sessions. The schematic concurrently specified the mixed method data collection instruments at different points along the process. Details of the roles of human and non-human entities followed suit. Section 3, the Data Analysis – Evaluation Criteria, explained how research questions about the quality of HAvatar aligned with task-centered learning criteria. Section 4, the Accountability Framework, discussed essential strategies and instruments for maintaining integrity and trustworthiness.

The following chapter reports on the DBR Baseline as it was operationalized into iterations.

Chapter 4. Findings

I introduce this chapter by reflecting on Reeves' (2006) stance: success in technology-assisted learning and teaching occurs through cycles of identifying problems, prioritizing reflection, and trying new answers – viz., iterations of refinement. Named the Findings chapter, it reports on the journey of iterations as the active research rolled out. I used the DBR Baseline, Figure 16, from Chapter 3 as a blueprint for the operationalization of the research. A version number denoted each subsequent iteration when significant changes in the process occurred. Although three iterations were planned, four iterations occurred in actuality, encompassing the DBR action from August 17th to September 17th. Any date references assume the year 2021.

You can see the chronological and logistical flow of the DBR action with the help of this schematic, Figure 17, the HAvatar DBR Timeline & Rollout (T&R). It provides a high-level directional and chronological map that a reader can follow in a flow from left to right.

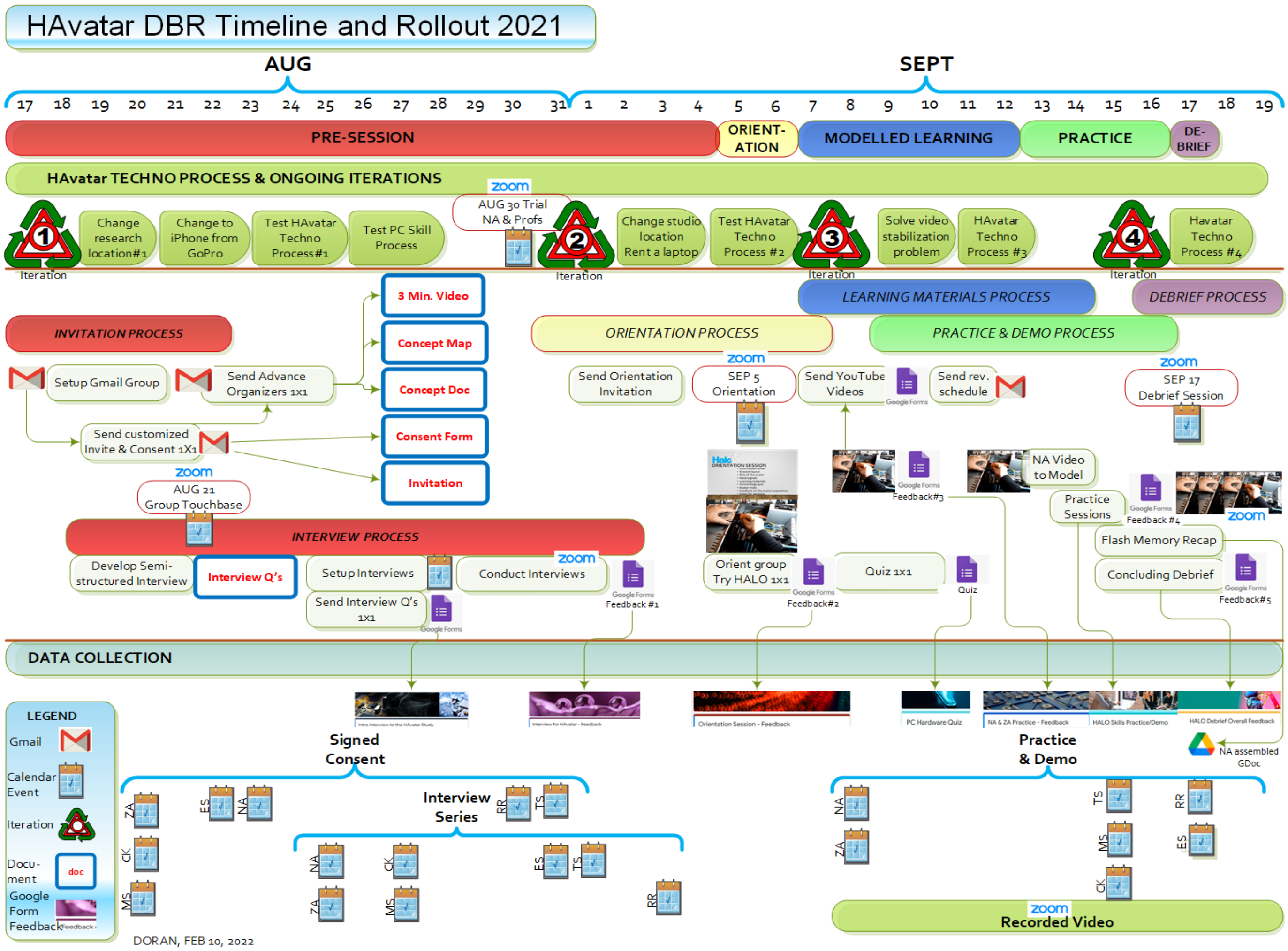
Throughout the chapter, I vertically spliced the DBR Baseline (Figure 16) and the T&R (Figure 17) by iteration and aligned them side by side as a united graphic to illustrate the correlation between the design and the actual. These images mapped out the action research in each iteration. The findings were further informed by journal reflections in which I have included my thoughts and decision-making based on what was happening in the moment, shown in the bifurcated text.

As per Chapter 3, I developed GFs as the de facto instrument for gathering the mixed method data in rating scales and descriptive questions. These are referred to and accounted for within GF feedback forms #1 to #5. The participant-learners were involved and responsive throughout the action research. For variety, I sometimes refer to them as learners, sometimes as participants.

DBR Timeline and Rollout Schematic

Figure 17

DBR Timeline and Rollout Schematic (T&R)



Note. [Link to a printable, scalable version]

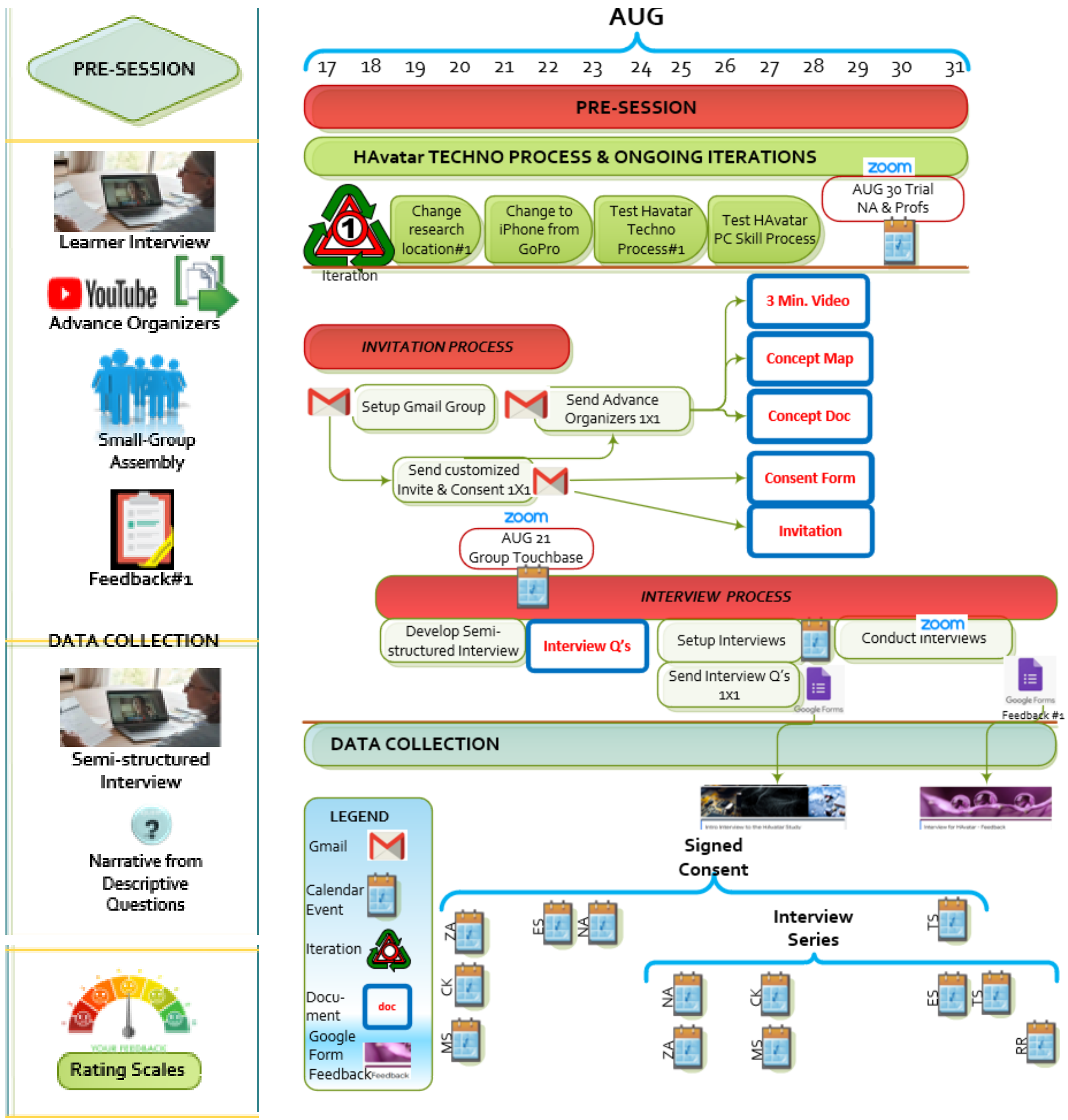
The intensity of the technological setup and refinement modifications of HAvatar pre-empted the importance of the pedagogical structure of task-centred learning praxis in my experience. That said, I found the pedagogical principles informed by Chapters 1 to 3, which I had carefully embedded into the baseline design, were recognizable in every session and carried the whole experience. As such, the task-centred learning praxis provided a steering mechanism and guiding philosophy throughout the iterations. The technology played out either supporting the learning with dazzling video interaction or deterring it with poor connections, downtime, or unstable visibility issues – shaping the quality of the HAvatar experience. HAvatar techno process descriptions for each iteration tracked the technological evolution of strengths, weaknesses, and refinements.

The following sections illustrate the iterations as the controlling categorization. These do not entirely match the timing of the sessions and their processes. There was some overlap as can be evidenced in the schematics showing three major channels of action rolling out simultaneously: the iterations, the intervention sessions, and the data collection.

Iteration 1

Figure 18

Iteration 1. Excerpt – Pre-Session DBR; T&R Processes



Note. DBR Baseline – Pre-Session Timeline & Rollout – Iteration 1

Figure 18, Iteration 1, shows a splice of the DBR Baseline and T&R. Extending from August 17th to August 31st, Iteration 1 spanned the invitation process and the interview process with some unexpected overlap to September 2nd. A seventh member of the team joined late.

This iteration veered tangentially from the DBR Baseline due to the sudden change away from a technician and studio staging the avatar in Toronto, Ontario to my own location in rural Victoria, British Columbia. This radical change instantly brought on a plethora of equipment and videography implications and a new role adoption for me as the avatar – in addition to my existing roles of facilitator and researcher.

HAvatar Techno Process #1

As introduced above, by mid-August, it became clear that the pre-planned hosted avatar computer assembly sessions to be livestreamed in Toronto from a technician's studio were not going to be tenable. On August 17th, I began to assemble the pieces to host the avatar on my premises posthaste.

> **Journal Reflection.** *On August 17th, my colleague in Toronto phoned to say he had hurt his back. It was a rush situation, and I was unconfident in my ability to produce livestreamed, good quality video of the avatar. I also had little experience in building or tearing down computer hardware which was the task for the intervention. My background in ICT has always been in software use. Some suggested I wait and take more time. Numerous factors were pushing me to go ahead anyway, not the least of which was the availability of my participants who had already agreed to take part in the late summer. I decided to proceed, as I had been advised it was a simple configuration and that assembling a computer was like lego for adults. I found out that the technical setup for the HAvatar strategy was straightforward but had to be carefully checklisted and sequenced so nothing would be missed.*

I sought advice at a local computer shop and bought a used desktop computer for the PC assembly pictured in Figure 19. I also sought an app to turn my iPhone into a webcam for streaming the avatar to Zoom conferencing, as well as studio lighting options.

The Action Camera

The DBR Baseline stipulated an action camera to provide the video conduit, no older than a Hero GoPro 7, which was not immediately available new or secondhand. I obtained a new GoPro 10 as a trial, but I soon realized its functionality was more aligned to wide-lens fast-moving action, with a tiny screen and no finger-tip zoom-in-zoom-out functionality. It was also not wireless to the laptop for livestreaming to Zoom. The GoPro was eliminated from the design because the Apple iPhone 12 provided all of this missing functionality. That said, the camera stability in the iPhone for quick movement was in question. The headmount caused motion nausea for the viewer in webconferencing, so a chestmount was chosen instead. Provisional holders available in local stores had to replace a proper chestmount for the iPhone while I waited for an online order.

It was August 23rd before I had all of the pieces organized for the HAvatar studio. After numerous rounds of practicing, I arrived at a checklist for the setup process of all the components both for the avatar and the task, although the order changed almost as fast as I could write it down.

Most notably, upon practicing the PC assembly and disassembly, I concluded that a complete teardown and rebuild was far beyond the scope of the learning time allotted for the DBR, the length of the sessions, and the time constraints in maneuvering the PC while livestreaming.

Figure 19

The Computer for PC Assembly

Journal Reflection. *This reduction in assembly logistics was a surprising outcome. I did not realize how much tinkering it took to attach these parts and pick the correct cables. Further, it took time to take everything apart in preparation for the next assembly round. The list looks simplistic to me, but it was plenty for the scope of this DBR. In addition, there was a sequence to the setup for the session that had to be done in a particular order, which I had to practice. Again, this took time and frequently required correction on the fly, mid-session.*

Pared Down Assembly Procedure for PC Components

- Clean the CPU
- Insert the CPU
- Apply thermal paste
- Clean the CPU cooler fan
- Install the CPU cooler fan
- Plug the PSU cable
- Install the GPU
- Hook up the CD with IDE cable
- Insert the DIMM
- Plug the SATA cables
- Connect the keyboard
- Connect the mouse
- Connect the VGA monitor cable
- Switch on the PSU
- Switch on the monitor
- Switch on the system

I gathered a checklist of 47 steps done in sequence to provide the complete setup strategy for HAvatar. For example, the laptop connectivity had to be on and in place before the iPhone webcam software could be activated. The secondary cell phone provided another Wi-Fi link via mobile hotspot to enable the stationary camera to be considered another participant in the Zoom webconference. I attached external speakers to project the sound. Inevitably, there was tinkering with the lighting and the positioning to provide the best visibility.

Trial Tests

On Saturday, August 28th, I held an informal trial with colleagues, experimenting with the avatar configuration and interaction with tasks of pouring coffee, sharpening pencils, and other common activities.

> **Journal Reflection.** *An outcome reflection from this trial led me to be explicit about the level of knowledge the avatar would come with. Keeping in mind the benefits and efficiency of an adult human avatar who is already fully knowledgeable of millions of objects, it can be assumed that they do not have to be "programmed" like a virtual avatar would have to be! For instance, the avatar does not need to be taught that a seven-inch wooden stick with a core of lead and a sharpened point is a pencil. As such, in any given course, the avatar needs to know the taxonomy of the equipment. The other reflection I noticed was that I, as the avatar, broke the silence frequently and spoke to explain how the strategy worked. I think that was natural, given this study was not a clean run, but a test run.*

Their feedback helped me prepare for the trial on August 30th, organized with my supervisors, Dr. Ally, Dr. Palalas, and the lead participant, NA. NA guided the avatar to draw a picture and some other simple tasks, with Dr. Ally observing. Dr. Ally and NA indicated the functionality, understandability, and visibility of the HAvatar session were acceptable to proceed.

The next day, August 30th, I set a demo again for Dr. Palalas. Unfortunately, the video app on my laptop suddenly malfunctioned when I ran the webcam app IRIUN through the iPhone and failed the trial. This mishap resulted in a trip to the computer repair shop to discover the PC's video app had been disabled and stored as a hidden device. I uninstalled IRIUN, looking for new webcam software.

> **Journal Reflection.** *I was concerned with the possible problems of connectivity in my rural location as well as access to computer stores if I needed equipment or repair in a hurry. I experienced both of these issues in the past week. I began to entertain the idea of moving the HAvatar studio to downtown Victoria, renting an office in a friend's house. I purchased extra lighting. This new upheaval took place at the same time I was conducting the interview process.*

Pre-Session

As shown in Figure 18, the pre-session aligned with the DBR Baseline, with its processes illustrated in the T&R.

Simultaneous to the HAvatar techno process shown in green across the top of the T&R, the invitation process and interview process with feedback #1 were all contained in the pre-session. The goal of the pre-session was to prepare the participants for the HAvatar experience. For the participants, the consent forms, the emails, the advance organizers, and the individual interviews all had the intention of providing information on what to expect, to give them confidence that this was a worthwhile project, to help me get to know them individually, and to create a united bond of focus.

The HAvatar Participant Group

Originally, I had a connection with NA from Ghana, who had taken part in the initial demonstration of HAvatar in April 2020. NA contacted participants who were friends or acquaintances interested in technology solutions to form the participant group. It could be said that this was an extreme DE trial, as the avatar was located on the Pacific coast of Canada, and the participants were located in Ghana, Africa. Apart from NA and ZA, the group was dispersed, some in different cities. I have a different English accent than they do, so there was some linguistic challenge to add to the streaming audio difficulties.

NA provided leadership in many forms throughout the project and can be commended for the smooth-running and encouraging positivity that characterized this group and helped the project immeasurably.

The participants embodied all the characteristics required for the sampling as per Chapter 3, twenty-first century learners. The group worked cohesively despite connectivity issues, filling and returning all the feedback forms to 97%. This dedication compensated for the lack of sophistication in our computer equipment and net-connected affordances, both in my studio and Ghana. I had stipulated desktops or laptops as a requirement in the consent form, but this was not attainable in some cases. Smartphones and tablets were thus also used, which proved less conducive, not only in size but functionality as well, just as the original research design had indicated.

Invitation Process

As shown on the T&R in Figure 18, I began this process on August 18th when I obtained a list of the interested participants from NA. The purpose of the email was to invite them to participate in the HAvatar DBR and gather their informed consent as per the ethics approval.

Once I had four returned consents from the six, I sent a group touchbase email on August 21st, which provided them with advance organizers, informed them of the upcoming interviews to be scheduled, and asked them about dates for their interviews. One of the participants did not respond to the informed consent. I sent an email to NA, suggesting I invite one of the backup participants he had provided. With his selection suggestion, I contacted TS, who agreed and sent in her consent immediately. However, several days later, the participant (RR) who had not responded so far, was able to join and provided their consent. The group grew to seven learners.

Advance Organizers

I started by sending the participants the DBR Baseline as an attachment as soon as I received their informed consent. I later sent them a summary of Chapters 1 and 3 of the research proposal and a three-minute video about HAvatar.

> **Journal Reflection.** *As I gathered the replies to the touchbase email, I thought to ask them if they would like a written description to accompany the schematic as mentioned above. Several participants replied yes. Later it became apparent that I should have created and sent this written excerpt of the project along with the schematic to help their understanding, all at once. The schematic was not enough. All of the participants asked for the written version. I realized that just a copy of Chapter 3 from the dissertation proposal was confusing, so I created an excerpt from Chapter 1, the Introduction, and Chapter 3 combined, to provide more background to HAvatar. After the first few emails, I wondered why I had not included the three-minute HAvatar video from the outset. The latter became the most popular of all the advance organizers, so I discovered in the orientation feedback responses, as it really comprised the whole picture in a nutshell.*

I asked NA to create a group on WhatsApp, the social media app, to provide a way for the group to talk with each other without including me. The significance of this social media group in the research is alluded to in Chapter 5.

> **Journal Reflection.** *I was nervous about the scheduling, not wanting to move too fast, and not wanting to fall behind. RR and CS were preparing for mid-term exams, and ES was waiting for clearance to fly to Spain to begin their master's degree. I delayed the orientation session to Sunday, September 5th. RR who joined late ended up with the interview and orientation combined, separate and later than the others. This delay turned out to be a fortunate break as I struggled to improve the technology in iteration 2. Some juggling of dates happened, but the group was always flexible and willing to adapt, always respectful of me and each other. I felt very grateful for these great qualities that would smooth the way to a cheerful ambiance in all of the HAvatar sessions despite the technical problems.*

Interview Process

I began the first interview on August 21st; the process extended to September 2nd to include all seven participants and the time to receive their GF feedback #1. The purpose of the one-by-one semi-structured interview aligns with the task-centred learning praxis principle of prior learning activation as described in detail in Chapter 3. As such, I included questions to create a sense of safety and appreciation, to build relationships amongst us, and to clarify the

HAvatar purpose. I also sought to ensure everyone that this outcome was not a performance measurement of how well they learned the skill but was primarily focused on determining the merits of the HAvatar intervention. I asked them to recount their most satisfying learning achievement to remind them of their strengths in facing a strange new venture. I knew that most of the group had little computer assembly background, which is what I had requested. Nevertheless, beginning learning can be awkward, and the interview helped mitigate discomfort. Appendix C shows the semi-structured interview questions.

Data Collection – Pre-Session

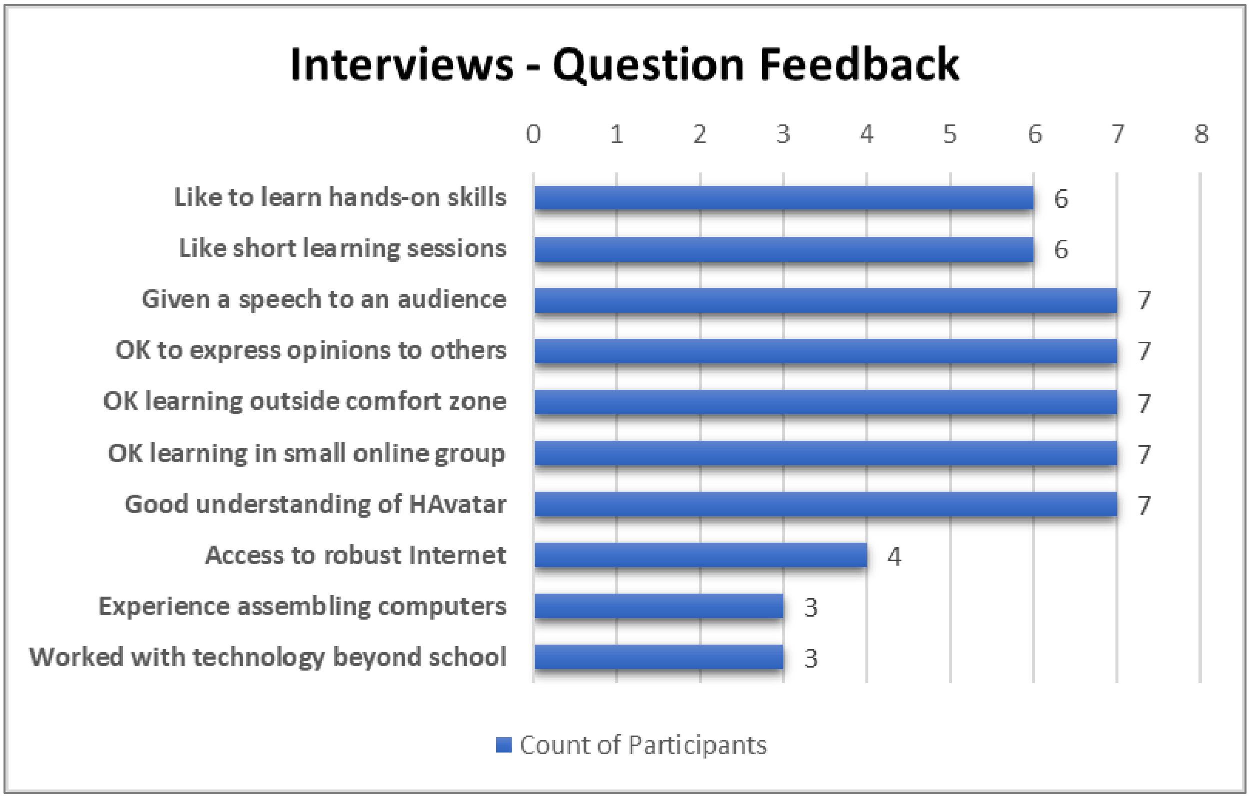
Semi-Structured Interview Synthesis

Keeping the goal of this interview in mind, which was to prepare the participants for the HAvatar learning experience with the proper understanding, the right motivation, and the social bond, I have summarized the outcomes of the interviews. The first two questions were of a personal nature. Questions three through twelve are graphed and discussed below in Figure 20.

There was great diversity in the backgrounds and chosen fields of the participants. Of the seven, NA worked in ICT consistently in his career and had initiated several startups. Two of the other participants were in technology, working with NA as developer colleagues in Python. ZA currently works with NA to develop a mobile app for food ordering. CK, RR, TS, and ES are full-time students at colleges or universities in midwifery, travel and tourism, community development, and agriculture. MS works in financial marketing.

Figure 20

GF Non-Personal Interview Questions



Note. This chart is a binary yes/no depiction counted by affirmatives or negatives.

All group members except one enjoyed hands-on learning and had experience in skills or hobbies. Everyone liked short formal learning sessions; two learners explained how they then liked to reflect, review, observe, and think about their learning over a longer period. All members of the group had had experience in public speaking and would be willing to voice their opinions to others even if that meant some disruption. From everyone, I heard a strongly affirmative response towards trying new experiences even if these were outside their comfort zone. For example, one had led their team to victory in a regional debate contest; another had achieved a master's degree scholarship to Spain; another had chosen to leave a strong family cultural path to living independently in a distant city; another had started a technology computer company involving apprentice programmers; another had worked helping local communities;

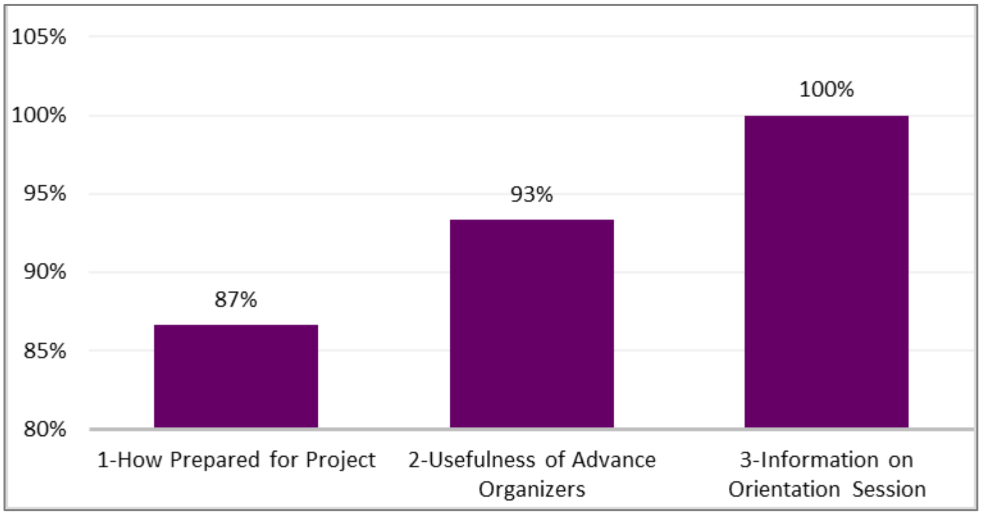
another had been instrumental in making changes in the banking industry. I asked the learners to explain their understanding of HAvatar, and I was pleased by the group members' depth of thought and applicability. Finally, I asked them what they thought of small-group learning. Their strongly positive response had me wondering if it is a culturally comfortable ethos to work and learn together. I found out just how strong this social bond was throughout the DBR sessions and from the feedback forms.

Feedback #1 – Pre-Session

Feedback #1 was an icon on the DBR Baseline and T&R in Figure 18 and illustrated below in Figure 21, issued one-be-one after each interview.

Figure 21

GF Pre-Session Summative Rating Scale



In the first feedback question, the QUAN rating scale showed that one participant felt the materials had prepared them to 66% readiness and the other five to 100% readiness. QUAL comments conveyed the hope that HAvatar would make a difference by rendering trade skill acquisition more engaging and accessible. Others were satisfied that their questions were answered about the problem HAvatar seeks to solve. Other comments expressed enthusiasm to trial the HAvatar strategy, work with the others, and gain a skill.

The second question showed 83% of the six respondents were satisfied with the advance organizers in understanding their role with one of the respondents at 60%. The comments pointed out that the three-minute video was the prominent advance organizer, with only one mention of the other two documents, the schematic, and the research summary document.

That said, I received emails stating the other two documents did help them to comprehend the project. One participant commented on missing a full animated video clip of HAvatar-in-action to better understand what they would be experiencing.

In question 3, I asked them to acknowledge they had read the preparation for the orientation Session.

Modifications Summary Moving into Iteration 2

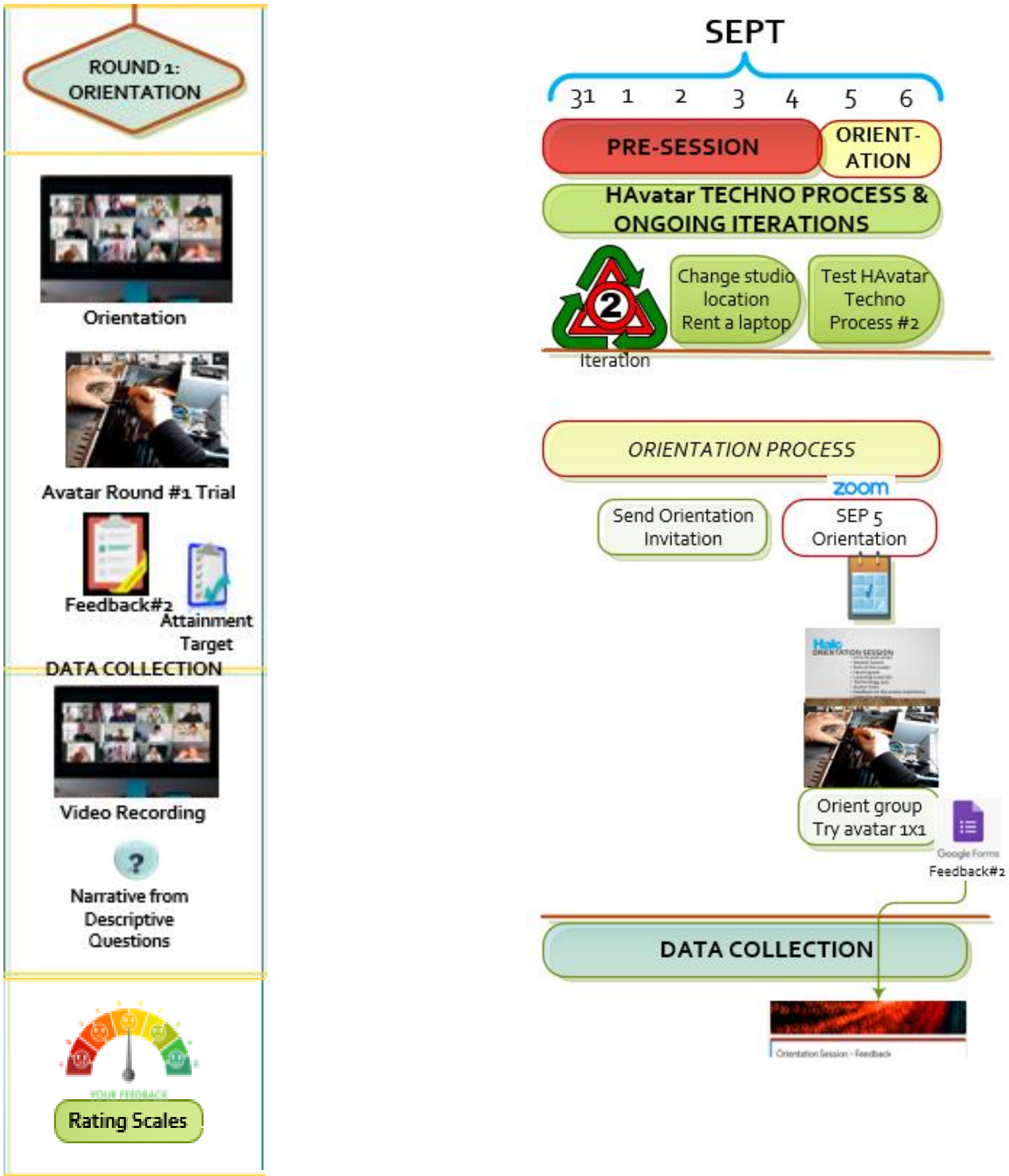
The following bullets list the modifications that needed resolving in Iteration 2.

- Stationary camera keeps hijacking first place on Zoom. Login on the same Zoom account has some contagion between host capabilities and participant. Best to log in the second cell phone as a separate user, using a non-paid zoom account as a participant.
- iPhone keeps rotating when the avatar moves. Lock only provided for portrait mode – need landscape orientation to use the full screen with the avatar.
- Better webcam software is needed as it keeps dropping the connection.
- The avatar in pinned mode going through the webcam does not record the gallery view. Logging into the stationary camera causes other problems (see bullet 1).
- Remove the speakers – not necessary and not wireless – pulling system resources.
- Need to ensure Zoom continues to record the meeting when the host changes, which frequently occurs due to lost signals.
- Hand signals are needed for the avatar to provide silent feedback.
- Keep seeking better connectivity - ask participants to use a desktop.

Iteration 2

Figure 22

Iteration 2. Excerpt – Orientation DBR; T&R Process



Note. DBR Baseline – Orientation Timeline & Rollout – Iteration 2

Figure 22, Iteration 2, shows a splice of the DBR Baseline and T&R. Transpiring between August 31st and September 6th, Iteration 2 spanned the orientation process lead-up to and follow-up after the orientation session held on September 5th.

The orientation process spawned the next DBR set of modifications to HAvatar. The design changed tangentially again. In Iteration 1, the HAvatar techno process revealed the dilemma of too many delicate factors governing the stability of the sessions. By August 30th, it became clear that I should re-locate the studio to downtown Victoria.

> **Journal Reflection.** *The move logistics were intense as I had to organize everything – lighting, positioning, connectivity, audio factors, packing, transporting, and re-assembling – once again, posthaste.*

HAvatar Techno Process #2

As introduced, I moved the studio to downtown Victoria, renting an office in a colleague's house. This move allowed more room to set up better lighting, which I purchased explicitly, and allowed quick access to local computer repair and supplies, as well as backup Wi-Fi. As the project rolled on, I understood how vital this decision had been to the success of the project.

I shifted the webcam iPhone-to-laptop capability to EPOCAM, a paid webcam app.

The chestmount specific to the iPhone arrived.

One of the questionable connections was the iPhone app linked to the Zoom account on the laptop. They both needed to be on the same Wi-Fi network. Although fast and reliable, I used hotspot data as backup, requiring a phone to act as the modem/router with mega data affordances. However, whenever I connected a second camera to Zoom on a second account, the webcam software would let the second camera hijack the iPhone webcam. I experienced permutations of this occurrence throughout the two weeks even though I used my second cell phone account on a different cellular network. This was so the webcam software could "see" two Wi-Fi connections in the list of networks for the laptop and the iPhone.

Trial Tests for Orientation

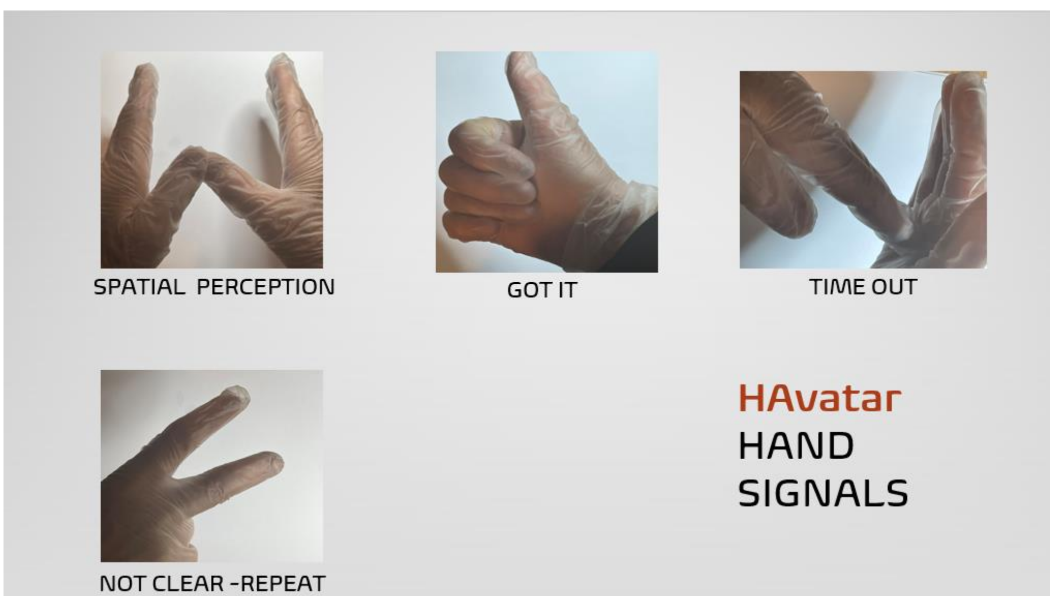
On the day before the orientation session, NA once again generously gave me time and feedback to practice the setup to end-state acceptable for the orientation. He had also set up his own avatar scenario with a Sony SLR camera. As a result, I asked him to be the avatar for some of the trials during the orientation session. We decided on several activities for the first HAvatar trial that everyone could simply instruct the avatar to do, such as draw a picture or assemble a small toolbox.

Hand Signals

Some modifications to the task-centred learning praxis emerged to smooth the communication with the avatar. I concluded that hand signals should be standardized. The avatar needed a way to communicate various simple messages without speaking. These few seemingly elementary signals shown in Figure 23 simplified the communication profoundly as time went on. I presented the hand signals guide to the group.

Figure 23

Avatar Hand Signals Guide



Orientation

As shown in Figure 22, the orientation aligns with the DBR Baseline, with its process illustrated in the T&R.

Pulling from the tenets of task-centred learning praxis, the orientation set out the real-world task and introduced the learning sequence. This prepared the learners to know what to expect so they could see the achievement path. The actual webconference on September 5th was the go-live of the HAvatar. Preparation and follow-up before and after are detailed in the orientation process below.

Orientation Process

As shown on the T&R, Figure 22, the orientation process spanned August 31st to September 6th, matching Iteration 2, with September 5th as the actual webconference. It took some time to establish a date via email exchange. Following the September 5th event, I sent feedback #2 and the YouTube video links for the learning materials.

Orientation Webconference – September 5

Figure 24

Orientation Session Slideshow

As listed in Figure 24, the agenda of the webconference was to explain the project, discuss the proposed roll-out of the scheduled sessions, and point out some collaboration guidelines, followed by a HAvatar trial experienced one-by-one.

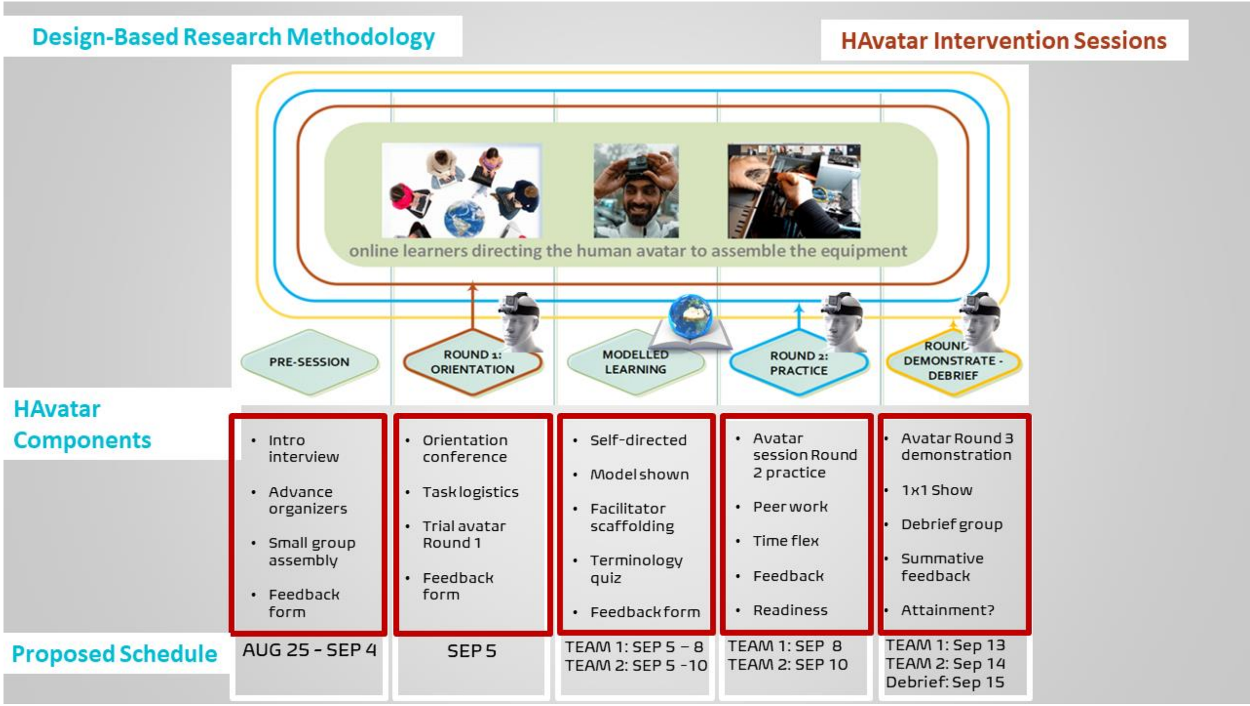
The event started with a round of introductions. Some of the group knew each other; some were meeting for the first time. The initial part of the session was informational, following the slides. The interaction section began with a scheduling discussion and the avatar trials. It was essential to the small-group that the achievement goal was clear, that is, to assemble the computer to a working state. Notably, this achievement had less to do with their performance and more to do with the efficacy of HAvatar. Next, I explained the semantics of the rating scales, which would be used throughout the feedback forms, based on a scale of 1 to 5, where 1 is poor and 5 is excellent. Then I explained the descriptive questions that accompanied the scales.

Regarding group collaboration, everyone vocalized their readiness to learn together, to practice HAvatar together, not individually. This decision invoked another iteration change to the DBR Baseline because the participants unanimously chose to practice and demonstrate in the presence of each other. NA had set up a WhatsApp group for them to keep in touch. I discuss one-by-one learning and group learning in more detail in Chapter 5.

Six learners took turns commanding the avatar to do some simple tasks. It became apparent that intrinsic learning of logical steps was occurring. For example, if a learner asked the avatar to draw something, they had to ask the avatar to remove the pen cap. Drawing pictures was particularly assiduous because it required spatial coordinates. For example, if you asked the avatar to draw a straight horizontal line, the length needed to be specified and at what spot on the paper it began. The learners adapted by giving estimated measurements.

Figure 25

Proposed Schedule – Version 1



On the other hand, it was unnecessary to describe an object – the avatar understood it by name. For example, it is more efficient to ask the human avatar to "draw eyes" than to "draw two circles parallel to each other of the same size".

The meeting concluded by settling on some dates for the practice sessions, as shown in Figure 25. This schedule changed significantly over the coming two weeks. I repeated the orientation individually with TS on the 7th due to connectivity issues during the event.

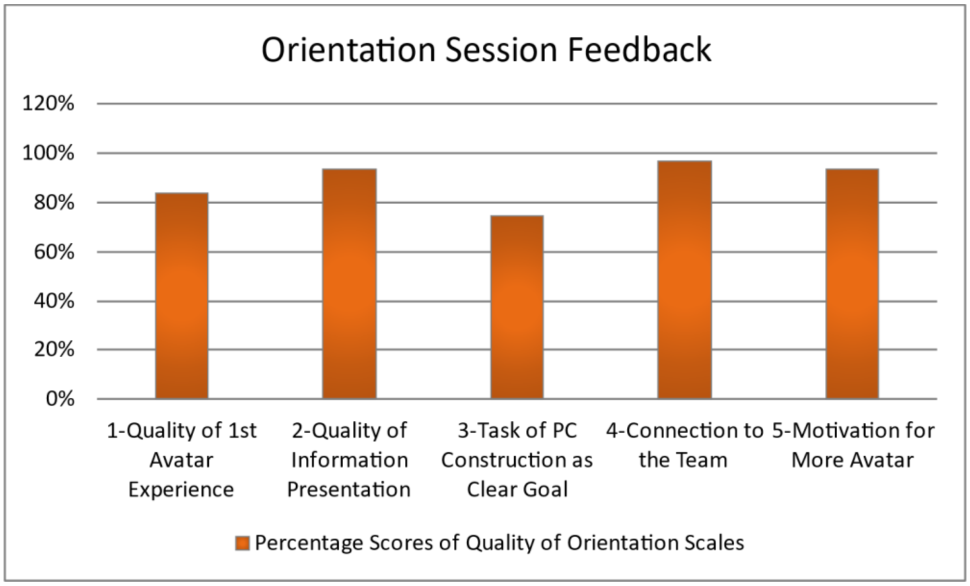
Data Collection - Orientation

Feedback #2 – Orientation Session

Feedback #2 was an icon on the DBR Baseline and T&R in Figure 22 with results graphed below in Figure 26.

Figure 26

GF Orientation Session Summative Rating Scale



In question 1, the quality of the first avatar experience was given an 83% average by six participants. The written narrative was positive, emphasizing the avatar experience was effective, as expressed in these quotes, "I felt as though I was doing the tasks myself"; "Overall, my experience with the avatar is super amazing". Others mentioned a better understanding of their role and what challenges to anticipate. Several mentioned the Internet slowness.

The second question provided a 93% average score centred on the quality of the presentation in informing them about the organization of the HAvatar session. The written responses showed enthusiasm for the upcoming sessions and confirmed that the goals and the task were clearly stated.

The fourth question asked for comments about the technology and connectivity of HAvatar. These quotes gave succinct feedback, "Network connectivity and speed could pose a challenge to the success of the research"; "The technology and connectivity of HAvatar is a go just that the bandwidth from different countries isn't helping but so far so good". Another participant worded it as" loving the idea" with a need to work on the fluidity of the avatar and the network connectivity.

The fifth question asked whether they felt connected to the team with a 97% positive average which spoke for the social strength of this group of learners. Although not everyone knew each other on the team, everyone was connected in some way to NA. I experienced constant kindness and respect towards myself and each other. Some commented on good communication and connection. I share this quote to illustrate this sense of community, "I like the idea that Mae makes sure that everyone is engaging in the sessions that she's conducting with us. It's interactive. Different ideas are brought up by the members of the team and it makes me feel a part of the team and I hope we can work together on other projects after HAvatar".

The last question queried to what extent they felt motivated to do more sessions with the avatar with a 93% average. The comments expressed hope for the difference HAvatar could make to education and that it could make online study feel like face-to-face. Optimism was present in all the responses about moving forward into the HAvatar sessions, as per these two quotes, "It's really educative and fun instructing the avatar to perform a task"; " I feel motivated because I'm learning new skills and also getting ideas in assembling".

Modifications Summary Moving Into Iteration 3

In summary, the new urban location, new Wi-Fi connection, new studio, new lighting, new EPOCAM software, and the new chestmount holder and stationary phone holder made a significant improvement to the avatar experience. These modifications reduced the 47 steps in iteration 1 to 31 on the HAvatar session preparation checklist. However, many issues remained, not the least of which was the number of call drops on the Zoom webconference when more than three participants were present.

The following list details the issues that still required attention with suggested modifications:

1. The video stability and focus needed improvement. The onus was partly on the camera and partly on the avatar in modulating movement.
   - Seek a better camera with video stabilization
2. The Zoom recording feature could be trusted. Even at times when I had to log back into Zoom, the recording could be relied on to download from the Zoom.us site. In addition, less software running in the form of backup screen recording reduced the drain on the power to deliver without a secondary recording on different software.
   - Adjust Zoom settings to allow others to record the meeting so NA can make a copy
3. Time and convenience were lost looking for the Zoom meeting ID sent out before the meetings, as it required everyone to open their email and link to it. Further, when someone disconnected from the panel, they had to return to their email again to link.
   - Change to using my Zoom personal ID which has a static meeting ID matching my phone#; use an easy passcode for all. This way, the group could just keep these written down close by and use the Join a Meeting box in Zoom when prompted for the meeting ID and passcode instead of searching email.
4. I was playing both roles serially; there were delays in switching roles between the avatar and the facilitator.
   - When the avatar and facilitator are the same person, the webcam software should be on and the iPhone already in the chestmount to reduce the delay in the role switching from my profiled screen and the avatar's iPhone profile.

5. When I am in the avatar role, I can only see the streaming webcam screen in the chestmount, and my focus is on the avatar activities. There was a conflict between the webcam software and Zoom settings for recording full meeting screens to include the cameos of the participants, yet I need the avatar to host the meeting.
6. Several times the network slowed down to unacceptable streaming speeds. When the Wi-Fi went down during the first HAvatar trials, I lost time switching networks to mobile data or re-attempting the Wi-Fi connection.
    - Have the mobile hotspot already running on my other phone, the Android, connected to the Rogers network, in case the Wi-Fi connection goes down. It is also better not to use the Bell Mobility network of the iPhone, given it should not be tampered with mid-session with the avatar's webcam screen running.
    - When the WiFi slows, do a timeout with the group and address the issue rather than letting the livestreaming continue in a delayed response.
7. There was some disruption from learners dropping off Zoom and having difficulty coming back on, for logistical reasons (See 2. above) or for technical reasons.
    - Include questions about their opinion about connectivity in the feedback form.
    - Check with NA, who can easily communicate with the others about the situation in Ghana and their equipment.

Journal Reflection. *One or the other of us kept dropping off the call. I wondered if the bandwidth issues may have something to do with the number of people watching the livestreaming on a different continent. It had been fine when there were only two or three. I wondered about the pre-requisites for the hardware.*

8. Some of the participants were using tablets or smartphones on Zoom. The advance organizers, as mentioned, did not include a Zoom how-to. During the interviews, I

made a judgment call about whether they needed coaching based on how comfortable they were on Zoom. There were discrepancies between a smartphone connection and a desktop connection on Zoom because the features were organized differently and some were missing on the tablet. I neglected to consider the unexpected situations such as re-connecting after a dropped call or pinning the avatar screen to be full size instead of gallery view on their systems. I also did not test the differences between a desktop version of Zoom, a cloud-based version, a tablet version, or a smartphone version for my devices.

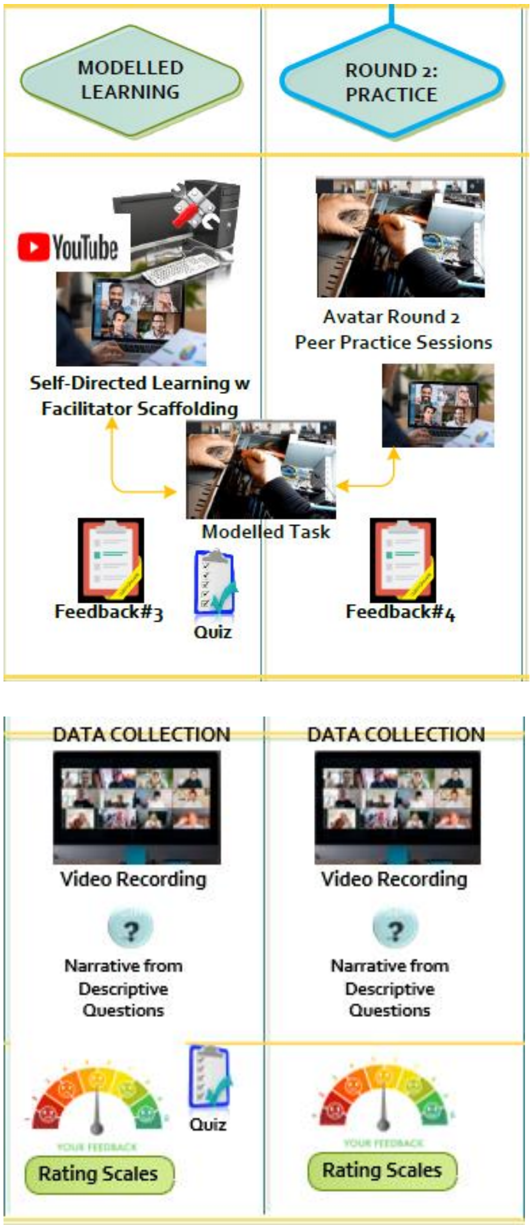
- In future projects, prepare for and include a Zoom coaching call as part of the advance organizers to practice all the different connectivity scenarios with unique connections.

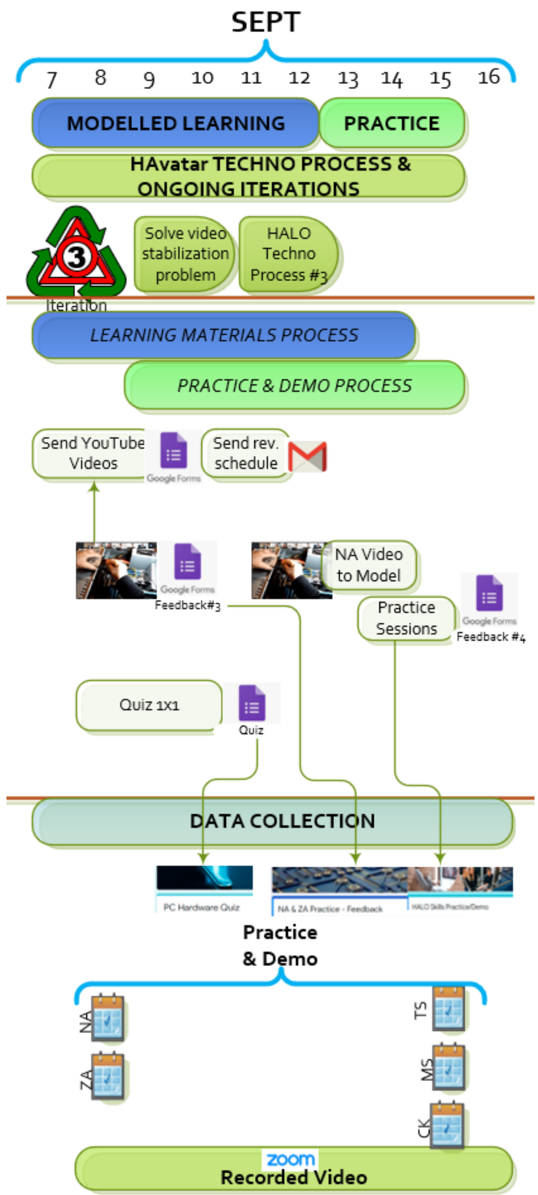
9. Although the iPhone was on the Do Not Disturb setting, various notifications were still happening during the session. Notifications that continued to pop up on the avatar camera screen interrupted the avatar's focus, a clear disadvantage in using a working smartphone as the camera for the avatar.
   - Turn Focus to off on the iPhone.

Iteration 3

Figure 27

Iteration 3. Excerpt – Modelled Learning and Practice DBR; T&R Processes





Note. DBR Baseline Modelled Learning, Practice

Timeline & Rollout – Iteration 3

Figure 27, Iteration 3, shows a splice of the DBR Baseline and T&R. Transpiring between September 6th and September 16th, Iteration 3 spanned the learning materials process and the practice and demo process as shown on the T&R.

I sent a collection of YouTube links on computer assembly represented on the schematic as self-directed learning with facilitator scaffolding. The DBR Baseline plan was to send the terminology Quiz (see Figure 27 above) one by one as soon as a learner was ready and then offer support in the form of a question-and-answer (Q&A) session.

HAvatar Techno Process #3

As a result of the issues listed in the orientation and further exacerbated in the first practice session on the 8th, I decided to do everything I could to improve the technology from my side of cyberspace. As a result, the technology modifications in this iteration were extensive.

First, I rented a higher-end laptop from a local shop, bringing my computer power configuration from 2.60 to 3.80 GHz and the Random Access Memory (RAM) from 4 gigabytes (GB) to 8 GB. With these affordances, the laptop could manage more livestreaming demand and simultaneous software demands.

Second, I began to home in on the best answer for the video stabilization. I had obtained the right chestmount, but I still added a waist belt to prevent slight shaking. As mentioned at the beginning of Chapter 4, the GoPro was rejected as an avatar option. The iPhone had been near ideal, acting as a webcam. I could easily see what the learners could see on their Zoom screens by looking down into the screen in its chestmount (see Figure 30) and using swipe finger features to zoom in and out – an apparent mandatory feature for the avatar. As a result, I gravitated towards specifications claiming the iPhone Pro 12 had improved video stabilization and went to a cell phone shop to do some comparison testing with the iPhone 12. As a bonus of the new model, the auto-rotation feature was not frenetic and stayed in landscape orientation steadily; it also notably improved speed of response due to having more power and being clean and unencumbered with installs and use.

At the same time, I returned the assembly computer for repair. It was not booting up after the fourth tear down and re-build. I realized that buying an older computer had its risks: the plastic was brittle, and CPU interiors were delicate under the best of conditions. I obtained a static wrist band to mitigate a static charge.

Satisfied the iPhone Pro 12 was the solution, I waited until the 12th for delivery. I then tested the new equipment with NA and ZA on September 13th.

> **Journal Reflection.** *The rented laptop was awkward to work with due to its hard-keyed French-Canadian keyboard and with no Office 365, which meant I had to run my own laptop. I frequently needed access to Office files mid-session with the avatar. The setup step for the HAvatar session had to be tested and adjusted yet again with the new equipment.*

Modelled Learning

As shown in Figure 27, modelled learning aligns with the DBR Baseline, with its learning process illustrated in the T&R.

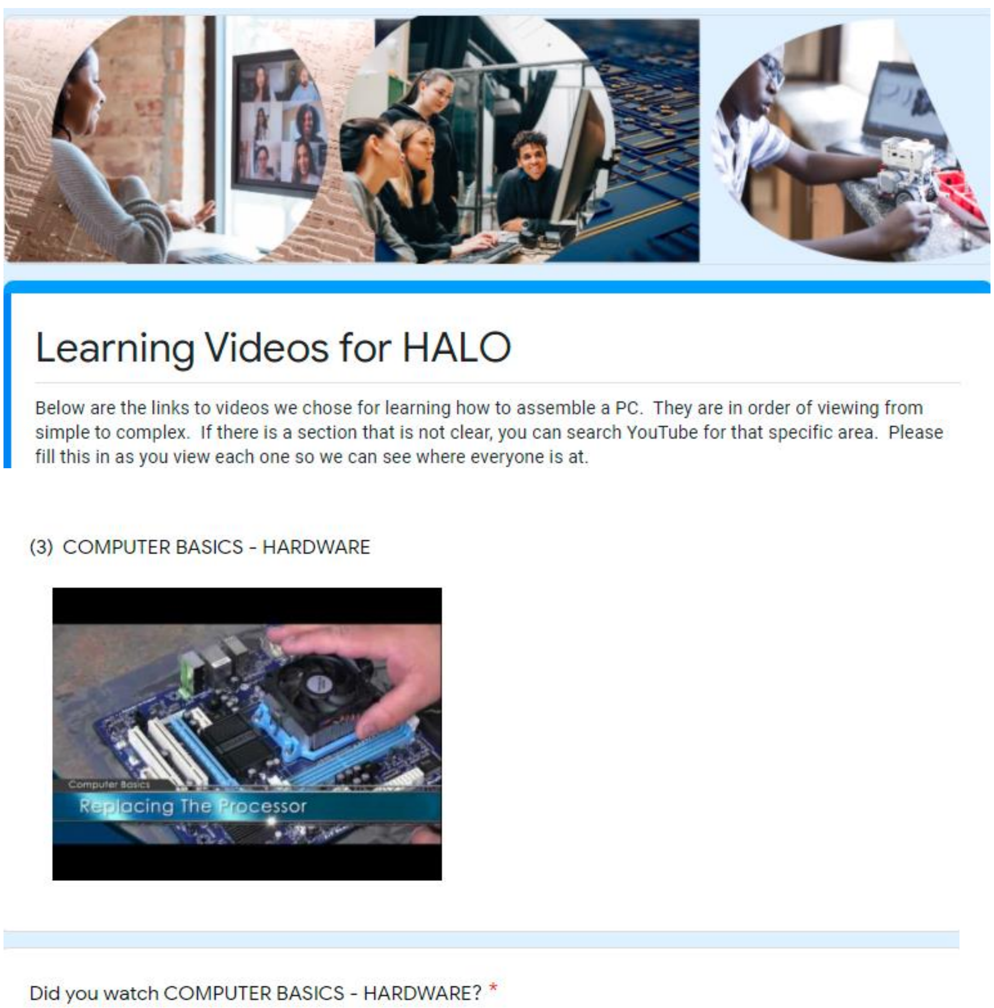
Pulling from the tenets of task-centred learning praxis, modelled learning addresses the modus of transferring the task requirements to the learners so they can understand the skill. The goal was to provide the learners with enough knowledge to direct the avatar to assemble the computer components. I sent the learners a GF with a checkbox to mark each one viewed (see a crop of the GF learning video form in Figure 28). These were for self-directed learning with my facilitation at the ready should they request it. Once I was notified by the GF that they had watched the videos, I sent them the GF terminology quiz – at least that was the DBR plan. However, it did not happen this way, in a serial fashion, as I described below.

Learning Materials Process

Journal Reflection. *I realized too late that the videos were a bit complex for this short learning cycle. NA and ZA returned their quizzes immediately and were up for a mid-week practice session. The others, who were mainly new to computer hardware, were not ready. Coming out of the session on the 8th made me realize there was work for me to do to improve the technology and give time for the learners to look at the videos. I needed some feedback from them about the session with NA and ZA. We were also waiting for ES (now in Spain) to be available. As such, the T&R moved into the week of September 13th. Two of the participants were in exams that week, so the schedule looked unfavourable. Regardless, they came to the sessions and were ready to play with the avatar.*

Figure 28

Excerpt of GF Learning Videos



Spanning from September 6th, when I sent out the YouTube videos, to September 16th, the day before the final debrief, the learning materials process went hand-in-hand with the practice and demo process. The learning materials process on the T&R illustrates the changes rolling out organically in a merger between learning and practicing.

On September 8th, the plan for a Q&A was supplemented by the session with NA and ZA, who were ready. They led the way, working with the avatar in their practice sessions while the rest of the group observed. A discussion and Q&A ensued, which invoked feedback #3, discussed below in the Data Collection. This exchange prompted the hunt for better technology, as I described in the HAvatar techno process.

It had become quickly apparent, a few days after I sent the videos, that the learners also needed a focused modelled demonstration of the assembly for the HAvatar computer.

Notwithstanding, I noticed the learners using the terminology correctly when addressing the computer parts in the practice sessions. Over the coming week, all learners returned their terminology quiz, and four learners returned GF feedback #4 on the learning videos. A mixture of informal learning unfolded where the rest of the team watched and listened to those assembling the computer as well as studying the YouTube videos. I discuss this phenomenon in Chapter 6.

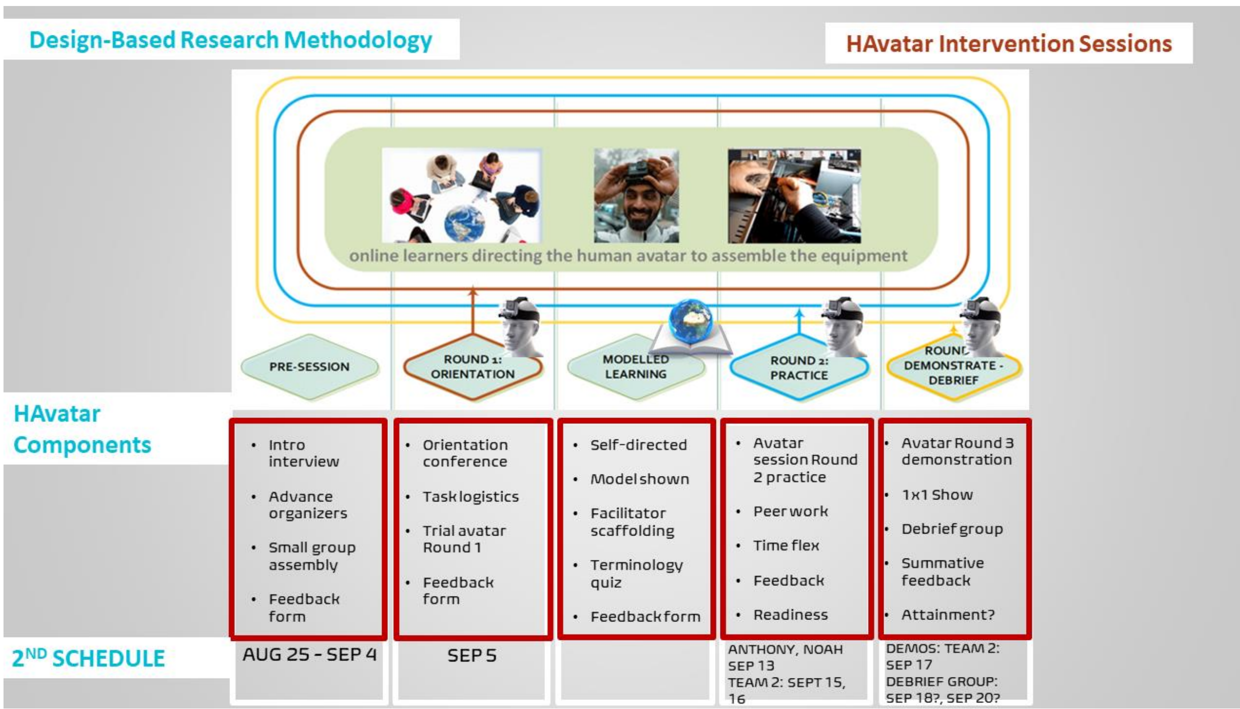
Because I served the dual role of avatar and facilitator, I was always present, organically included in all the learning and practice sessions. This experience proved useful and is discussed further in Chapter 6, Constraints and Recommendations, Relationships.

> **Journal Reflection.** *I began to notice a relationship between the avatar and the learner when they were speaking to me. There was something about being asked to do those commands by one person who is talking in your ear…there are just the two of you – one asking and the other responding builds relationship. I do not yet understand the why behind this.*

Learning, practicing, and demonstrating had melded together. The group had various commitments, including exams for two of them. On September 12th, I wrote an email to the group to suggest a new schedule for the coming week, the final week. The new schedule meant that each learner would have a chance to assemble the computer once with leeway to try a second or third time if desired. It turned out that the vicarious learning by watching had positively affected the skill acquisition. I discuss observational learning in Chapter 6, Relationships.

Figure 29

Proposed Schedule – Version 2



On September 13th, I spent an hour with NA and ZA, tweaking the iPhone Pro 12 I had just obtained and all the other modifications and improvements I had been working on since feedback #2. A revised setup process ensued, and the schedule was set for everyone. The session with NA and ZA morphed into a spliced video of NA performing the computer assembly, which I distributed to the group as a model to learn from. To maintain some challenge, I removed the audio.

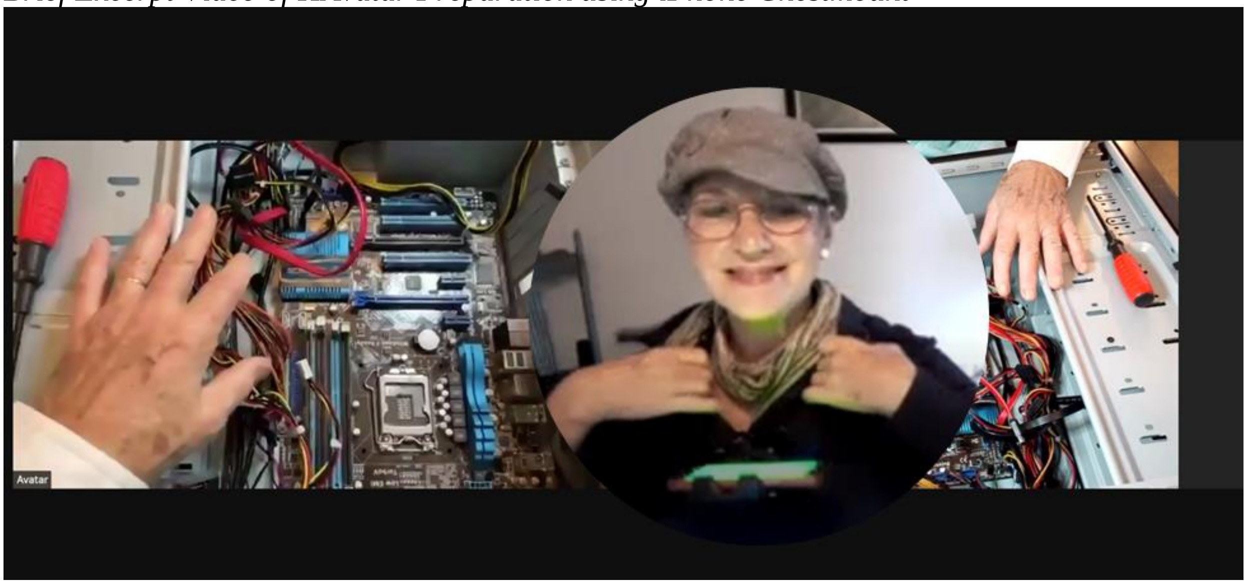
Data Collection – Modelled Learning

HAvatar Video Excerpt

Figure 30 is a link to the short clip of ZA, NA, and I working on the setup of HAvatar after iteration 3 upgrades.

Figure 30

Brief Excerpt Video of HAvatar Preparation using iPhone Chestmount



Note. Link to YouTube video

Feedback #3 – Modelled Learning

Feedback #3 was an icon on the DBR Baseline and T&R in Figure 27 with results graphed below in Figure 33, modelled learning, where I sought initial feedback about the avatar exchange. In this quote, I have included the entire comment by one learner, which succinctly summed up the feedback from numerous participants:

> After the first session with the hands-on experience with the avatar, I observed that the avatar receives commands based on the terminologies that were communicated with it. The avatar did well in doing that, but I recommend that the camera should be well-positioned to enable the participants to scan the computer system. Secondly, I also observed that the avatar found it a bit difficult to focus on where the participants want the avatar to focus on. It made the assembly process a bit longer. But overall, it was a good experience.

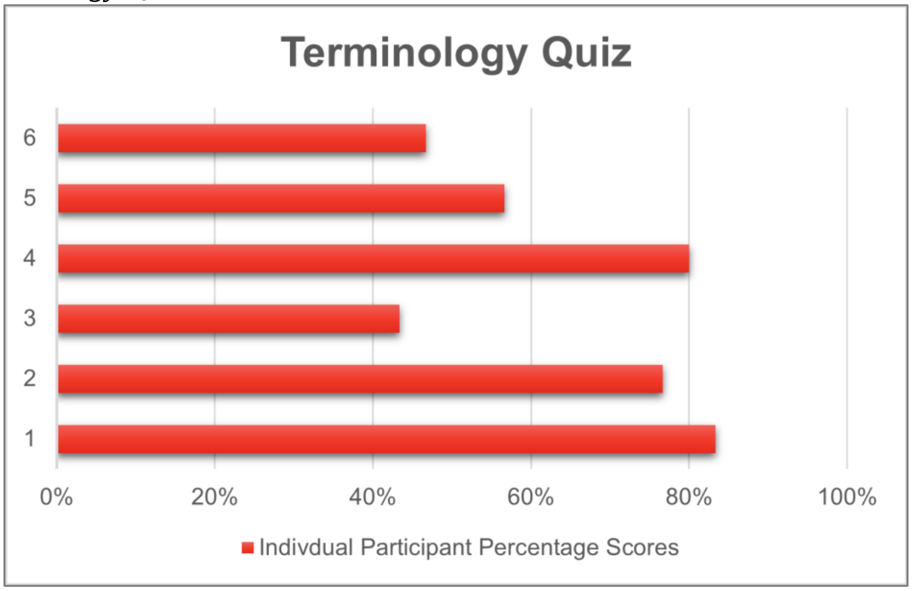
Other comments recommended delaying a few days to make the experience better by improving the technology for the next team. This included better camera stability and better Internet. A participant commented on the excellent interaction between NA and ZA. These final quotes leant a positive note, “It was very awesome and made me understand that anything is possible if we put our mind to it and work towards achieving it”; “Teamwork between ZA and NA was well coordinated even though there were some connection hitches at some points. Kudos to the team”.

Terminology Quiz

As explained in the research design, this QUAN instrument is a formative assessment at the end of the modelled learning. Its purpose is to ensure the participants grasp the terms of the computer parts to direct the avatar. Although this quiz provided some QUAN data, as shown in Figure 31, the participants self-reported their readiness to practice with the avatar and gradually completed the quiz even after the practice and demo process was over.

Figure 31

GF Terminology Quiz Scores



Practice

As shown in Figure 27, practice overlaps with modelled learning, with its practice and demo process illustrated in the T&R, showing that the practicing and demonstrating activities merged.

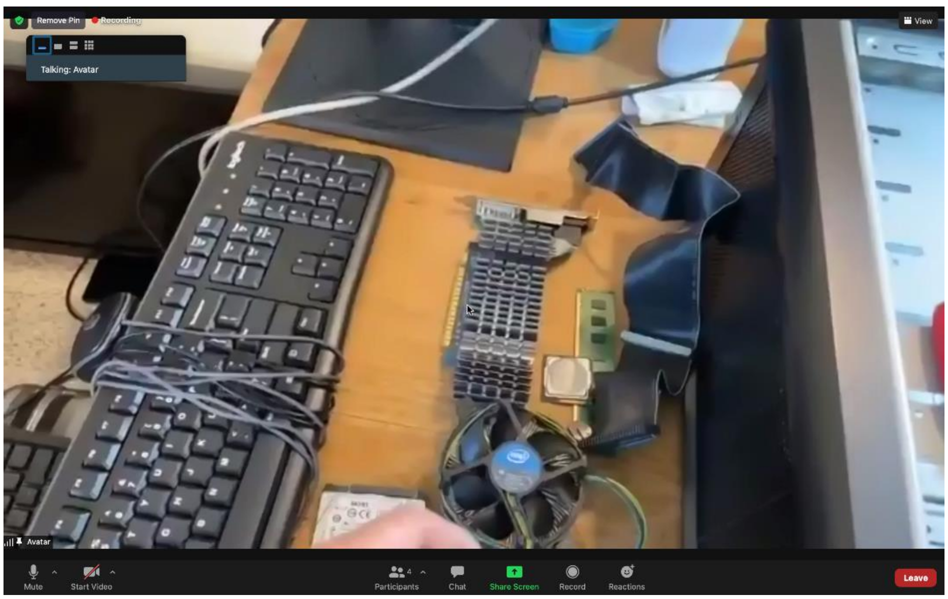
The overlapping processes included feedback forms #3 and #4, both evaluating the HAvatar experience. As described in modelled learning above, the learning materials process organically integrated into the practice and demo process because the learners watched the videos and practiced with the avatar over the same period.

HAvatar Video Excerpt

Below is a video link to ZA assembling the computer with the avatar. I chose this excerpt because it illustrated several themes I have discussed. One was the development of the hand signals. I realized we needed a hand signal to indicate something is missing, as compared to the signal for not understanding the request. ZA chose thumbs down. The second illustrated the trial-and-error practice principle discussed in Chapter 3 where the learner has to go back and find out what they are doing wrong while the avatar stays in idle mode. The third illustrated the relationship with the avatar as more interactive than I originally planned, given that I was both the tester for the avatar intervention as well as playing the role. Lastly, it shows the iteration 3 improvements – there was hardly any lag time – the picture was clear and steady with the iPhone Pro 12. Later in the video though, when I was moving around, there were some skips and jerking. The avatar needs to move slowly and eliminate unnecessary movement. Some of this action can be seen in the YouTube video in Figure 32.

Figure 32

Video of Avatar Interaction



Note. Link to YouTube video

Practice and Demo Process

The practice and demo process was almost simultaneous to the modelled learning for all the learners except NA and ZA, who had already shown mastery in the previous week. Therefore, through the week of September 13th to 17th, each learner was assigned a timing as shown on the T&R.

The practice sessions invoked a notable and organic modulation of iteration 3. As only one learner can work with the avatar at a time, it naturally unfolded that the other learners watched, in fact, most of the learners showed up for each session to watch voluntarily. The group moved as one, with the most experienced learners leading the way. There was no question of awkwardness in the attempts. The group demonstrated solidarity of support for each other in their quiet presence then by cheering each learner as they successfully assembled all the parts and observed the computer booting up to the monitor screen. No learners coached the one demonstrating unless they needed help. I, as the avatar, sometimes asked for NA to give a hint during a demonstration.

> **Journal Reflection.** *I started to feel uncomfortable with the repetition. I had not expected the group to show such solidarity for each other, attending as auditors at every scheduled time. As I have written numerous times, learning was happening intrinsically by watching the others with the avatar. We were also running out of time. It was the final week. Three of the learners were dealing with demands in their own schooling. I made a command decision and combined the practice and demonstration sessions into one.*

There were five reasons for merging the practice and demonstrate sessions.

First, the learning material had transitioned to a silent video of NA modelling the assembly, which I had only sent on September 15th. The learners needed time to watch that and learn from it. However, we were already in the last week of the research, and Friday was the final day, September 17th. Third, the learners were ready to do the assembly on the first round, overall. ES had been unavailable to prepare due to moving to Spain, but she was able to do the assembly after watching the sessions ahead of her. Fourth, the dissected computer circuits were becoming less and less responsive. It is uncommon to take apart delicate computer circuitry repeatedly. NA and I conferred and decided that NA would be the judge if the process was done correctly (if the PC did not boot up to Windows) accompanied by the visible startup of the fans, the monitor, and the CPU lights.

Data Collection – Practice

Feedback #4 – Practice Session

Figure 33

GF Practice Session Summative Rating Scale

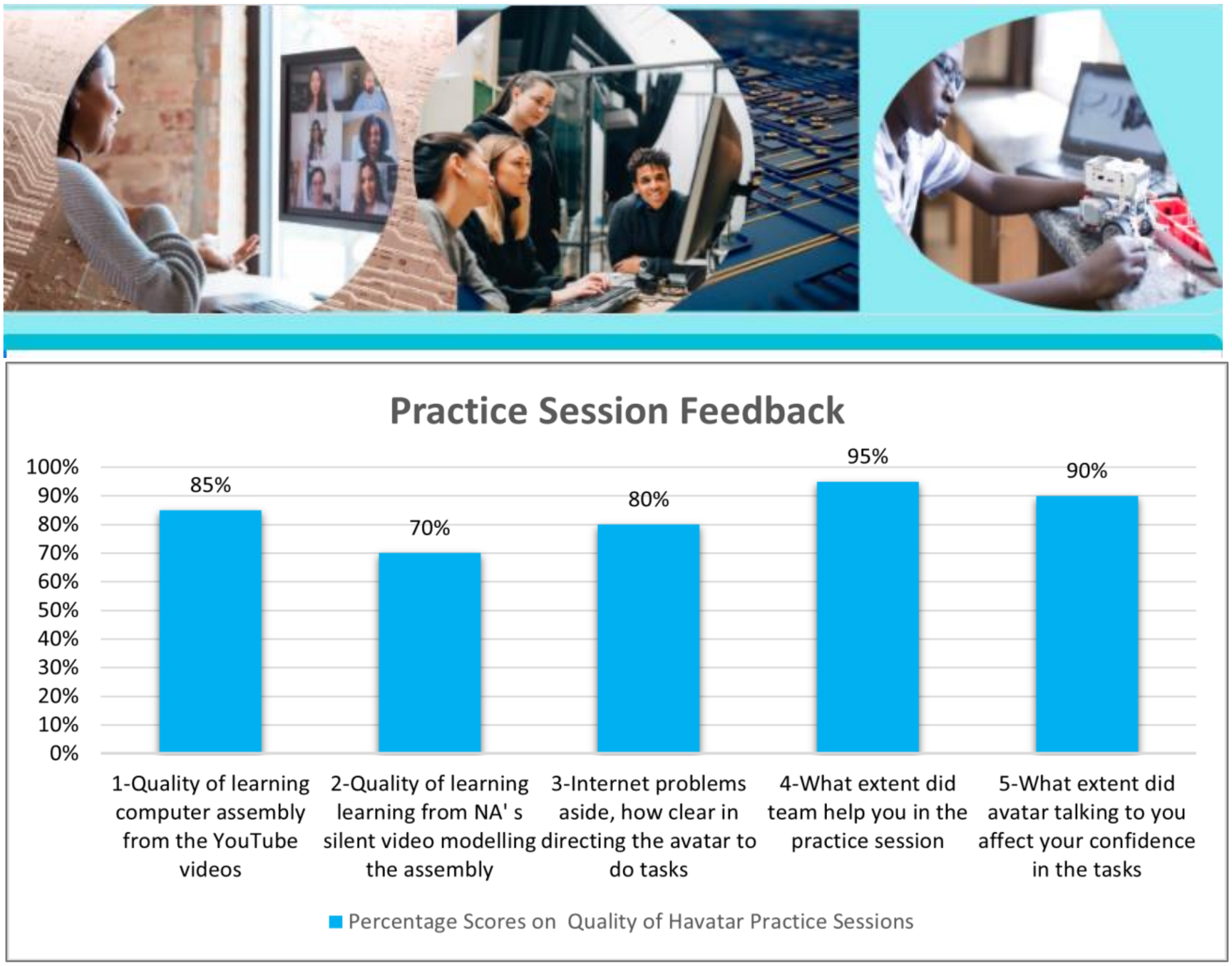


Figure 33 graphs the roll-up of the practice session, feedback #4. Unintentionally, the feedback from this GF was solely provided by the four female members of the seven-person group.

There was a range of ratings in the first question, with one response at 3, one at 4, and two at 5, providing an 85% positive average. A quote from the written descriptions stated, "The YouTube videos actually helped me a lot especially as a beginner. The video gave a detailed description of the parts, and it was not really very difficult locating them". The other comments complimented the high quality of the videos as very educative with a general message that the YouTube videos prepared them, despite little prior experience.

The second question provided a 70% positive average with two responses at 3 and two at 4 on the rating scale. After watching the silent video to see how the assembly was done, the written description was positive with an additional comment that it complimented the YouTube videos.

The third question about how clear it was to direct the avatar to do tasks was given an 80% average with one response at 3, two at 4, and one at 5 on the rating scale. Some of the comments were strongly positive, such as, "At a point, I could not actually remember which part goes where, but with the steps I knew, it was very very clear commanding the avatar". There were two mentions of the network connectivity problems affecting the experience, but despite this, “the experience was smooth and clear".

In the fourth question, I asked their thoughts about having the rest of the team with them in the HAvatar session and the response was very positive with a 95% average, three ratings at 5 and one at 4. Out of four written responses, three used the word helpful to describe how supportive it was to have the team there, as well as impactful and assistive. "Our collaborative effort was perfect".

In the fifth question, I wondered how the group felt about the avatar speaking to them sometimes. Throughout the sessions, the hand signals helped to indicate “correct”, “unclear”, “timeout”, etc. The answer was a clear 90% positive, with three responses at 5 and 1 at 4 on the rating scale. The written words supported this average indicating a boost in confidence, positively motivating them to be alert to what they were doing when the avatar signaled to them. "I was focused, which made me finish successfully".

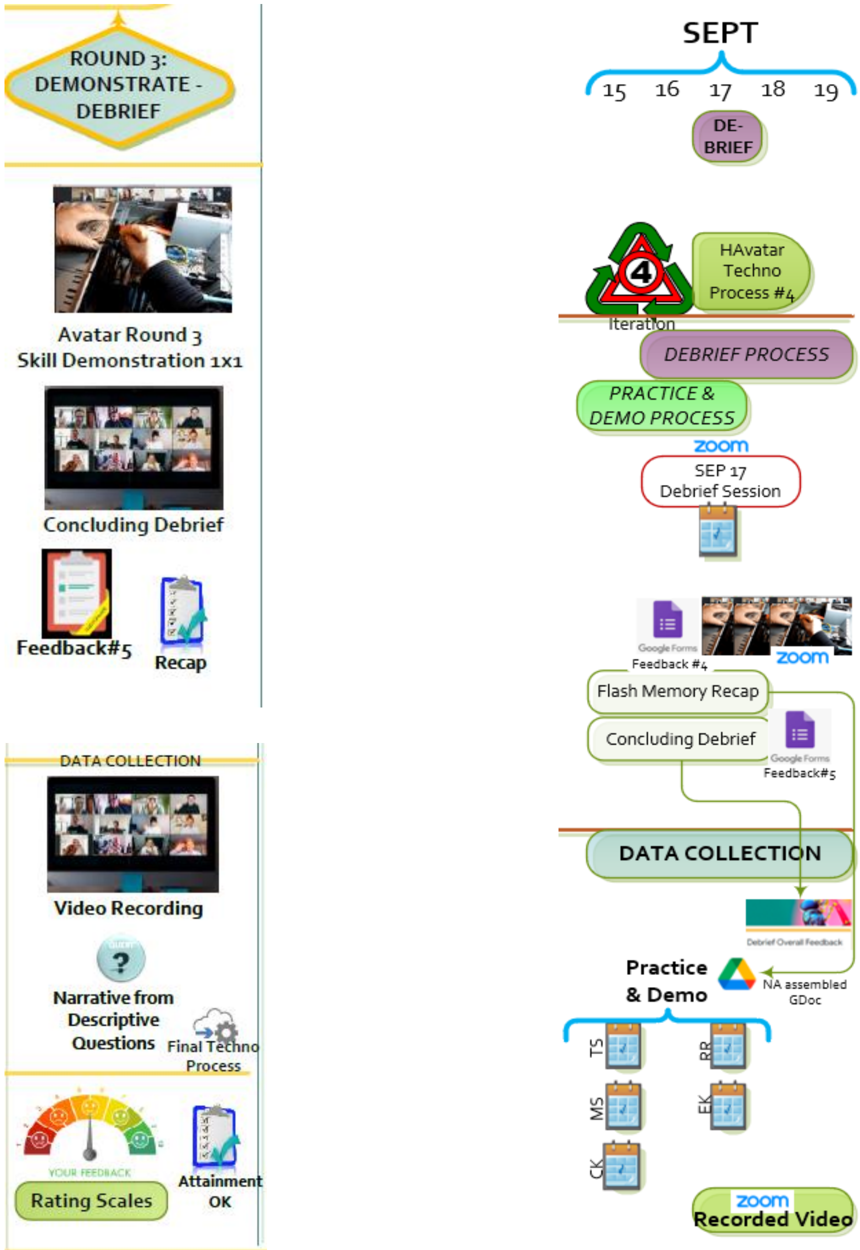
The last question asked for freeform feedback about their experience. Two responses expressed the wish to have more chances to work with the avatar; all four responses were optimistic about the experience, summed in these words, "It was a great experience, definitely looking forward to this research replicated in other fields".

> **Journal Reflection.** *I note that the disconnect between the overly sophisticated videos was not really a problem apart from the time coordinated to the sessions. The learners mostly sent the feedback form about the practice in tandem with the closing session. I think that the sequencing was off. Did we need more time? Or would the repetition of watching and doing sessions become boring? They are not actually having much on time with the avatar. It is late to ask if they had enough time to repeat the session.*

Iteration 4

Figure 34

Iteration 4. Excerpt – Demonstrate – Debrief Session DBR, T&R Processes



Note. DBR Baseline Demonstrate & Debrief Timeline & Rollout – Iteration 4

Figure 34, Iteration 4, shows a splice of the DBR Baseline and T&R. Transpiring between September 15th and September 19th, Iteration 4 spanned the debrief process with the final concluding debrief webconference attended by all the participants on September 17th.. This iteration also marked the end of the progressive DBR iterations for this study. The analysis of HAvatar as a quality intervention for DE derives most of its criteria from Iteration 4.

HAvatar Techno Process #4

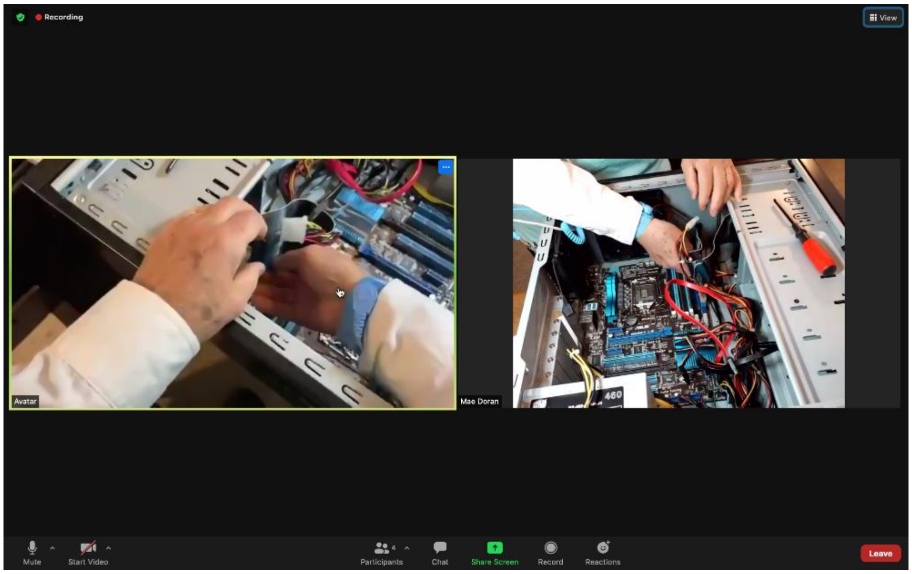
This last iteration brought us to a place where all but three of the learners had assembled the computer. On the day of the concluding debrief, RR and EP demonstrated their assembly. Although RR had been delayed and had had trouble with connectivity when watching the other sessions throughout the week, on this day she was located on a computer with robust broadband and good connectivity. RR performed a flawless walkthrough of the assembly, using near-perfect terminology throughout.

HAvatar Video Excerpt

In the YouTube clip in Figure 35, the background noise was from RR’s Internet situation and the video was not high quality. Despite this, the audio from her voice was clear.

Figure 35

Video Excerpt of RR



Note. [Link to YouTube video]

ES then did her final assembly practice/demonstration.

Journal Reflection. *During ES's session, EPOCAM dropped the connection to Zoom. I could not reconnect despite a dead air pause taken to fix this. Surprisingly, I could still see the cameo of the iPhone in the Zoom Gallery. I simply shared the avatar's screen with everyone as a contingency solution. The video quality was acceptable, but there was no functionality to magnify or zoom out the scene.*

See Chapter 6 for the HAvatar Final Techno Process in the Constraints and Recommendations section.

Debrief

As shown in Figure 34, debrief on the T&R aligns with demonstrate-debrief on the DBR Baseline, with the debrief process overlapping with the practice & demo process.

Debrief Process

The debrief process spanned the preparation and scheduling time leading up to the concluding debrief meeting. It extended into the collection of feedback #5. Missing feedback forms were completed. We exchanged thank-you's and wrap-up thoughts. I had separate conversations with ZA and NA regarding future steps for HAvatar.

Concluding Debrief Webconference – September 17

After RR and EK completed their computer assembly practice/demo, it was time for me to change roles from avatar to facilitator for the final meeting.

Journal Reflection. *This switch took 15 minutes because I had to sign off, offload the avatar gear and webcam, bring up my facilitation notes, and sign back into Zoom as a different participant. In addition, I had trouble with the webcam software reconnection. EPOCAM and the laptop would still not converse with each other. The group brought out guitars and began to sing. I found this very touching and a testament to their bond….and patience!*

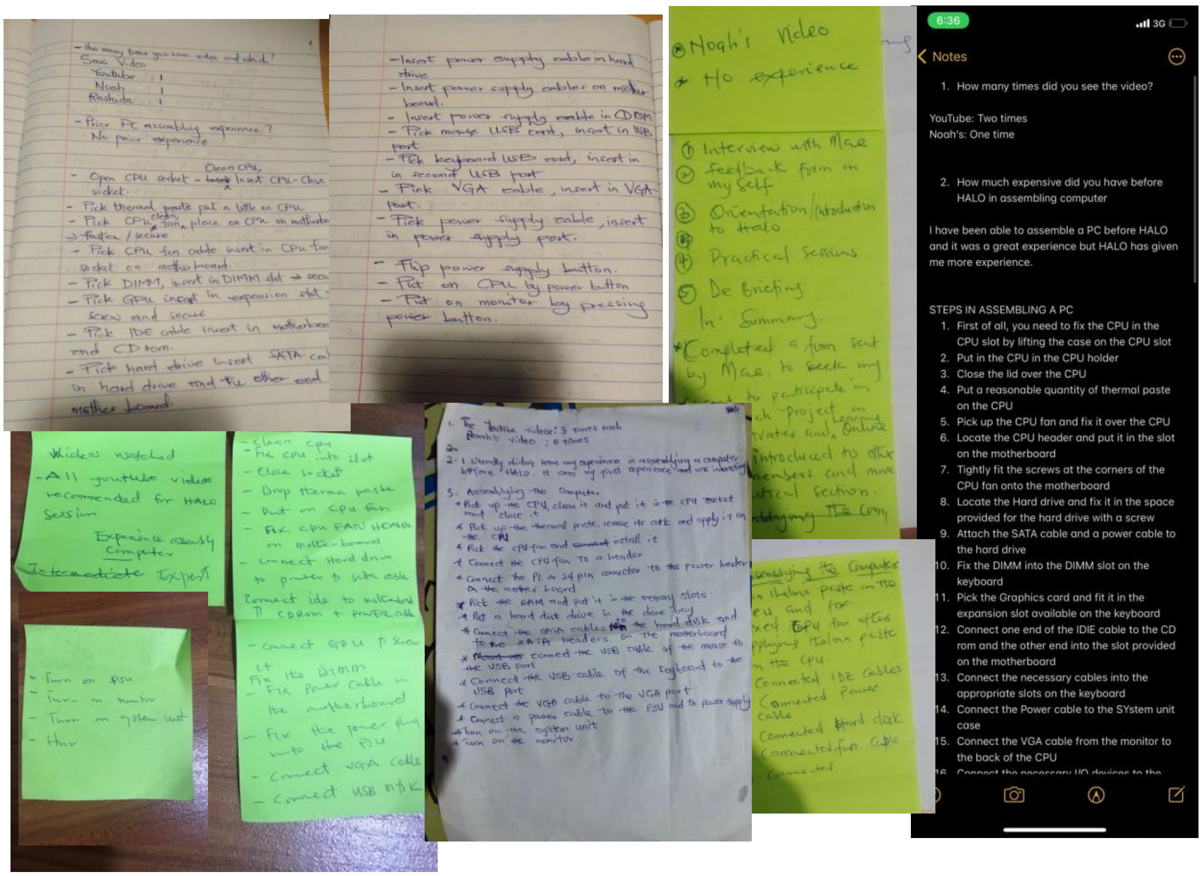
In the Zoom webconference, I asked them the same questions as in feedback #5 which they filled out post-meeting. I sensed we were really a team and that the HAvatar experiment was important to them as an experience, as was our mutual bond. Feedback #5, which was lengthy, has captured these sentiments intermingled with the mixed method data. The group spontaneously agreed to do a flash memory recap described below during the meeting to see how many steps they could recall of the PC assembly.

Data Collection – Demonstrate & Debrief

Flash Memory Recap

Figure 36

Capturing the Flash Memory Recap



In the DBR Baseline, I had not anticipated that the assembly computer would break. Since the PC had stopped booting up to the Windows operating system by the sixth tear down and rebuild, I devised an instrument called the flash memory recap for the concluding debrief. Each participant took a piece of paper or used a screen to type. I asked them to write how much experience they had had prior to HAvatar in assembling computers and how many times they had watched others in the team build the computer. They then wrote down everything they could remember about the assembly procedure over 20 minutes. In the end, they took a picture of their writing with their phones or sent a file to NA via the WhatsApp HAvatar group so it would remain an anonymous collection. NA assembled the results and sent them to me via Google Drive. This instrument replaced the attainment target set out in the data collection of the DBR Baseline. As the attainment target was a pass-fail instrument, the results of the flash memory recap were a pass for every participant.

In the quoted text below, I have shown one learner’s flash recap. Some terminology is missing, but given how little time I gave them, I suggest this is representative of solid skill acquisition.

> *Steps in Assembling PC*
>
> 1. *Firstly, you have to pick the CPU, clean it and slot it into its slot after that; you close it and use Thermal Paste to seal it.*
> 2. *Pick the CPU fan and clean the Thermal paste and put it on the CPU*
> 3. *Pick the GPU and slot it into its slot, after that you screw it.*
> 4. *Pick the IDE cable and slot it into the IDE slot and the other end into the power slot.*
> 5. *Locate the red cable and slot it into the right slot of the hard disk.*
> 6. *Locate the power cable and slot into the power slot.*
> 7. *If there’s any unfix cable, it should be slot into its slot close to the CPU.*
> 8. *Fix the fan cable into the white slot available.*
> 9. *Pick the VGA and slot it into the VGA slot*
> 10. *Pick the Keyboard cable and slot it into the USB port on the system unit*
> 11. *Pick the Mouse cable too and slot it into the USB port on the system unit.*
> 12. *Move to the power supply and slot in the power supply cable.*
> 13. *Ensure if there’s electricity and turn on the switch.*
> 14. *Turn on the system unit.*
> 15. *Turn on the monitor.*
>
> *I have watched all the YouTube videos, PC parts explanation, motherboard explanation, Computer Basics – Hardware Explanation, How to build PC tutorial, How to Glue CPU, on the 6th, 7th, 8th of September, and the videos were helpful and resourceful. I also watched the Silent Video on how to build the PC by NA; that one too was resourceful.*

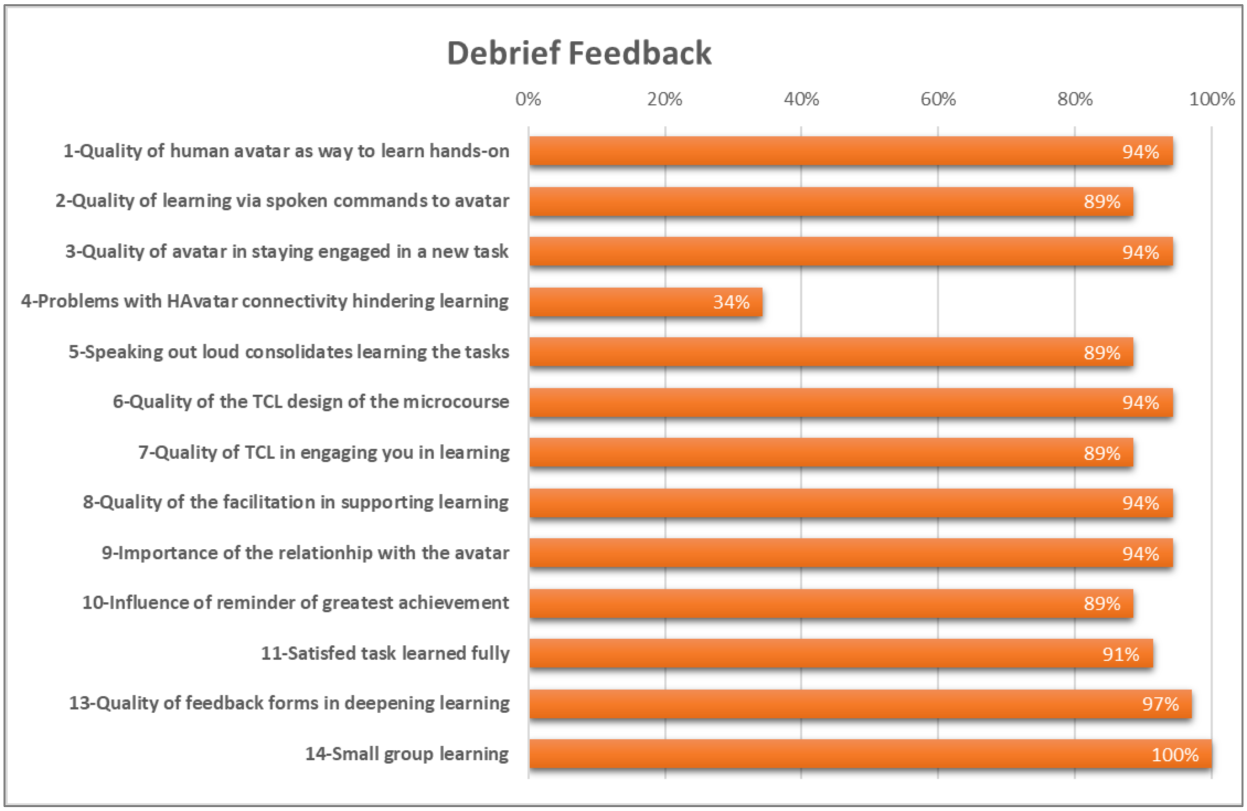
> *My experience in assembling PC was better one with the help of the YouTube videos I watched I have learnt a lot and many skills, knowing the hardware components of the PC and what they do and where it's located. It was impressive and awesome working on the HAvatar Project.*

Feedback #5 – Concluding Debrief Session

Feedback #5 was an icon on the DBR Baseline and T&R in Figure 22 with results graphed below in Figure 37.

Figure 37

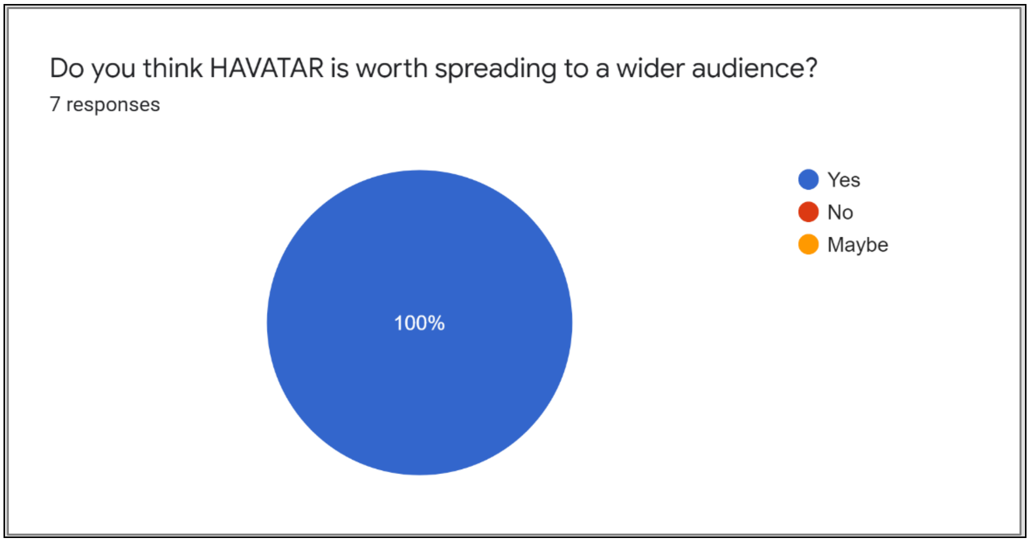
GF De-Brief Summative Rating Scale



In the first feedback question, the response was 95% positive with a 5 rating from five learners and a 4 rating from two for the quality of the avatar experience as a way to learn hands-on. Four out of seven responses gave a 4 rating in the second question, and three gave a 5 rating (89%). In comparing a task learned with hands-on the actual objects vis-à-vis the quality of the learning via spoken commands; comments came back about the connectivity problems taking away from the quality of the "touch", as well as missing the feeling of the object. Others commented that they did not see much difference in the learning, "either virtual or physical, the goal was the same"; "HAvatar does make it feel as though you are interacting with the devices yourself". The third question asked about the quality of the learning in staying engaged in a new task using the avatar with a 5 rating from five responses and a 4 rating from two responses (94%). Two of the learners said, "My experience with the avatar was superb. The engagement and response to commands were impeccable"; "It made the whole assembly process interesting and easy to follow". Another commented on the endemic broadband issues, "Yes. The experience was awesome yet, the breaking in connectivity made it a little boring". Several others mentioned the downtime as well. The fifth question sought more feedback about the technology issues and delays and whether they hindered their learning – returning 34%: one respondent with a 1 no-problem rating, one with a 2 rating, four at a 3 rating, and one at a 4 rating as problematic. This quote aptly described the experience in the avatar sessions, "Having to go back and forth due to Internet connectivity makes the learning a little bit boring because I don't want to miss any steps regarding the learning process". All respondents mentioned an issue with the technology and connectivity. The fifth question was a repeat of the second question with better wording; this redundancy was actually an oversight on my part. The group still returned informative responses with the same percentage (89%) encapsulated in these quotes, "I am able to enjoy learning, and everything consolidates in my mind. There is something about commanding that puts you in charge and dedicates a level of authority" and "Speaking the commands out loud made it easier to learn and follow the entire process". Question six asked about the quality of the task-centred instructional design of the whole HAvatar microcourse, with two at a rating of 4 and five at a rating of 5 (89%). One response stated, "The methodology HAvatar implemented is one of a kind. A task-centred instructional design approach, when implemented in our respective classrooms, would actually prepare students for jobs, not learn on the job when they graduate. The process and quality of the methodology are top notch". All other answers were positive. In the seventh question, I asked how necessary the task-centred instructional organization was, surrounding the avatar experience in engaging them in the learning. Alternatively, I could have sent the YouTube videos, and we could have just done the task. One responded as follows, "The necessity of the instructional organization surrounding the avatar was to ensure that the objective of HAvatar does not remain a fiction. The instruction organization helped in visualization of the entire process". Three further comments indicated a similar opinion, with two ratings at 4, four at 5, and one at 3 (89%). The latter commented that it would have been enough if the YouTube videos had exactly matched the systems and components used for the assembly. The eighth question addressed the quality of facilitation, with two responses at a rating of 4 and 5 at five. An interesting comment was addressed explicitly in the Chapter 5 analysis, "More facilitation kept the enthusiasm and attention of the students resulting in the rapid completion of the process. Less facilitation, on the other hand, would have made the process adventurous, probably resulting in the development of a new product aside HAvatar". The other comments ranged from asking for more facilitation to feeling it was enough. Question 9 sought to discover how meaningful the relationship was with the avatar or whether they would rather have had no relationship. The responses were strongly positive about the relationship with the avatar, with a mention of the efficacy of the five hand signals we developed as a gesture language. One response reflected the original role designed for the avatar in the baseline, "It was good to have a relationship with the avatar, however in subsequent research, I would like to suggest more practice time and no relationship with the avatar to allow students to think on their feet. That result could be compared to this to see which is more effective". From this response, thoughts about the iteration 2 change of role from the baseline are addressed in Chapter 5 analysis. In question 10, I reminded them of the pre-session interview about recounting their greatest achievement and whether it influenced their confidence in taking on the HAvatar challenge. Six respondents gave a 5; one gave a 1. I did not ask for a written description of this answer due to its personal nature, but it provided key information for the evaluation criteria. Question 11 centred on whether the learners felt they had learned the component assembly task satisfactorily. The general message showed a strong positive with three responses at 4 and four at 5 (91%). The following quotes illustrate this rating, "I was able to fully understand the concept of the computer components assembly very well. Not only that but was able to learn the names of the various components and where exactly to fit them in order to perform the task it is supposed to perform"; "I feel really satisfied because I moved from someone who had no knowledge about hardware to someone who could assemble computer parts with little support, and it worked". Due to its significance, Question 12 has been pulled out of the chart and highlighted in Figure 38.

Figure 38

Feedback on Future Application of HAvatar



Question 12 was rated with a 100 % positive response from all seven participants to spread the HAvatar strategy to a broader education audience. I have included the full quotes from six participants writing freeform comments about the HAvatar experience.

Quotes from Participants

About the HAvatar Experience.

- It was perfect.
- HAvatar is a great product and I can't wait to see its success in the years to come.
- Great work done by the avatar. It was an amazing learning experience.
- It was very exciting learning and practicing something new.
- I hope the concept of HAvatar won't end after the Doctorate degree?
- This was an interesting experience and will definitely help improve education all around the world if used widely by several industries.

Question 13 asked how vital the feedback forms were in deepening their learning, returning a 97% positive rating. Finally, Question 14 asked the group about their take on small-group learning. With a rating of 100% and strong positive comments, the group learning cohesion was apparent. Their words were also collaborative and varied, so I have gathered them below.

About Small-Group Learning.

- Members of the group tend to be more focused and put in more effort as compared to a bigger group. It is also time saving.
- It helps in learning from others to build up knowledge
- Small-group learning makes sure that everyone is able to contribute to the discussion at hand and it makes the learning very interactive.
- The diversity of opinions helps to properly assimilate and digest the subject of discussion and come up with almost a perfect solution.
- It creates an enabling environment for the learner to contribute to discussions and also ask questions if something is not clear from his peers or instructor.
- Small-group learning allows the input of more than one person and helps correct mistakes you otherwise would not have noticed.
- It helps you learn a lot.

Question 14 requested their opinions about two direct applications of HAvatar in learning organizations or companies. The list below has collected these thoughts. As per NA, Ghana could have better connectivity by paying specifically for an exclusive service available at a cost. If HAvatar is implemented in a paying organization or through a grant, this could be part of the budget items.

About Applications for HAvatar.

- Manufacturing companies to fix machines
- Nursing and midwifery for practical learning
- Banking industry – ATM custodians
- K12 schools learning computer assembly
- Rural students learning IT
- Driving lessons – direct a driving avatar who controls safety
- Science experiments
- Lab practicums
- Corporate training for workers
- Engineering or agricultural students seeking practice where they are missing the tools

Chapter 5. Discussion

Drawing from the findings in Chapter 4, Chapter 5 discusses the research questions (RQ 1 – 6) about the quality of HAvatar as an online experience approximating real-world, hands-on learning, the main research question. As a follow-on to RQ6, I have detailed how HAvatar met the evaluation criteria from Chapter 3 in the section below named Themes of Quality Criteria. For the last question, RQ7, I addressed future recommendations for task-centred learning praxis in an online format in Chapter 6 under Constraints and Recommendations.

Research Question Discussion

Keeping the overarching research question in mind, *What was the quality of HAvatar as an online experience approximating real-world, hands-on learning via task-centred learning praxis?* the sub-questions are synthesized as follows.

RQ1. HAvatar and Tactile Skills

…in learning a task involving tactile skills?

RQ1 was addressed in feedback #5 within several questions. Summarizing these Chapter 4 findings, the first question queried the quality of the avatar as a way to learn hands-on, with a 94% rating; question eleven asked if the learners were satisfied that they had fully learned the skills, with a 91% rating. The learners supported these ratings by writing how they were able to fully understand the process of the computer components assembly, as well as understanding the purpose of the different parts. One expressed satisfaction they had moved from no knowledge to someone who could assemble computer parts with little support. Further, written narratives reported the learning was smooth and clear with an 80% positive rating despite technical difficulties. Confirming the capability to learn tactile skills virtually (Rauh, 2017), the 100% positive rating on question twelve (see Figure 38) to promote HAvatar to a broader audience in education, ratified its high ranking as a solution. It also indirectly answered the iron triangle requisite for DE interventions with accessibility (Daniel et al., 2009).

RQ2. HAvatar and Verbally-Mediated Commands

…in the experience of guiding the avatar with verbally-mediated instructions to accomplish tasks at a distance?

RQ2 explored opinions about guiding the avatar with verbally-mediated learning compared to learning in person. Question two returned an 89% rating about learning via spoken commands to the avatar; question five returned an 89% also about how speaking out loud consolidated learning tasks. These results support the task-centred learning premise of articulation as a means to deepen learning as espoused by Brown and Duguid (1991), Brandt et al. (1993), and Francom (2011). The learners also supported the ratings in their writing about how it put them in charge with a level of authority, as well as making it easier to learn and follow the entire process. These responses suggested that HAvatar was high enough quality to be considered a viable approximation of hands-on learning.

RQ3. HAvatar and Small-Group Learning

…with respect to solving tasks in a small-group format to direct the avatar and learn the skill?

From Chapter 4, answers to RQ3 question reported strong positivity about working together in a small cohort throughout all session feedback forms. For example, in feedback #5, the last question about the quality of small-group learning received a 100% rating. Comments ranged over feeling supported, having peers help you when needed, demonstrating how to do the task, and being part of a team. The importance of small-group collaboration came to the fore in the experience of this study, aligning with numerous authors (e.g., Brandt et al., 1993; Gagné & Merrill, 1990; Reigeluth & Karnopp, 2020). I discuss this phenomenon in more detail in the evaluation criteria under small-group learning below with a further reflection in Chapter 6, Constraints and Recommendations, Relationships.

RQ4. HAvatar and Adding Motivation to Learning Online

...with respect to adding motivation and interest to learning online by adding the avatar experiences to this task?

With answers to RQ4 about motivation and interest from Chapter 4, I drew on various feedback questions. In feedback #2, question five, responses around motivation to learn more were 94% positive. In feedback #5, question three, I asked about the quality of avatar in staying engaged in a new task with a 94% rating and comments with words such as "superb", "impeccable"," interesting", "easy", “exciting”. Question seven explored what the quality of the task-centred learning praxis was in engaging them in learning with an 89% return and the use of the word “top-notch” to describe the pedagogy. Inversely, in question four I asked if the connection problems hindered their learning, with a 34% return. The learners reported some issues with boredom as the connection problems delayed the progress, some worried it might affect the success, but they did not want to miss any sessions. As such, the learners demonstrated patient politeness as we reattempted connections, then moved to full engagement once connected.

Motivation, engagement, and interest are learning tenets of enormous concern in all areas of education whether online or face-to-face (e.g., Dewey, 1938; Reigeluth & Carr-Chellman, 2009; Reigeluth et al., 2017). The high ratings for HAvatar in holding interest in learning were promising.

RQ5. HAvatar and Attaining the Skill

Was the skill attained correctly according to the attainment task prior to ever touching the physical objects?

Summarizing from Chapter 4, addressing RQ5, the quality of the flash memory recap confirmed how much the group had retained of the task procedures. In feedback #5, question thirteen, their answer was 96% satisfaction that they had learned the task. This question further confirmed the overarching quality question about HAvatar. Even though there were problems with the technology, the rating scale showed it only hindered them from learning by 34%. This quote confirmed, "I am very excited to have learned and accomplished this task in a field very different from my own and within such a short time". Referring back to the literature on task-centred learning (Francom, 2017) in Chapter 2, proficiency and efficiency in learning are priorities; learner success is surely the goal of every educator. Thus, the HAvatar showed promise in this area as well.

RQ6. HAvatar and Task-Centred Learning Praxis

How important to the avatar experience was the task-centred learning pedagogy that organized it?

As garnered in Chapter 4, in feedback #5, the RQ6 question about the quality of the microcourse returned an 89% with comments about how these methods could transform classrooms to actually prepare people for the workplace. Further, into feedback #5, question seven addressed the pedagogy about keeping them engaged in the learning with an 89% rating and returned comments on how it was a unique methodology in making the objective clear.

RQ#6 is deeply addressed in the Themes of Quality Criteria explicated in the next section. These criteria, used as instruments to evaluate the research, highlight the benefits of building robust learning theory into and around education interventions. The task-centred learning praxis pedagogy was evaluated principle by principle to explore the quality of HAvatar.

RQ7. Task-Centred Learning Praxis and Modifications for Online Learning

What were the impacts or refinements to task-centred learning praxis and learning-by-doing in this online format?

RQ7 addressed a larger question in fulfilling the DBR mandate of relating the research to the learning theory. I have included this discussion in the Constraints and Recommendations section in Chapter 6.

Themes of Quality Criteria

Figure 39 re-depicts these six criteria themes. As argued, the task-centred learning praxis represents the validated principles of quality in an education intervention. I have taken each criterion and broken it down by the task-centred learning principles described in Chapter 4.

Figure 39

Quality Evaluation Criteria

Criterion Interest. Prior Learning Activation

Merrill's (2002) quote and my paraphrasing from page 32 reiterate the principle of prior learning activation as a criterion to engage and prepare learners for the task at hand. I looked for the quality in the data that promoted known experience to form a foundation, even though I had requested that the participants have little prior knowledge of computer assembly. Intrinsic to this principle was its role in situating the learner in the task and engendering confidence to take on the challenge of the learning.

Further, emerging from the study of Honeboin (2019) in the literature review and informed by the tenets of appreciative inquiry (Whitney & Trosten-Bloom, 2010), I sought to encourage emotional commitment and ease. I intentionally included activities in the pre-session to meet the quality criteria of prior learning activation. These required the participants' verbal and written commitment and consent to the goals of the project description, their articulated curiosity and comprehension of HAvatar via advance organizers, their sense of safety in the small group, their preparedness for the upcoming HAvatar sessions, and the interactive familiarization that came with a one-on-one conversation. Drawing on strength-based experience in appreciative inquiry, I added an interview question about recounting their most outstanding achievement where they had voluntarily taken on a life and learning challenge (Cooperrider, 1990). I also wanted to make sure they would not hesitate to express their opinion of HAvatar. In debrief feedback #5, I circled back to ask them if recounting their most outstanding achievement had given them confidence in moving through the HAvatar project – six responded with a 100%. Feedback #1 ratified an overall stance of positivity towards the interview, the advance organizers, and the small-group in preparing them for the HAvatar project.

Coming away from the pre-session of personal one-to-one connection, I felt in relationship with and in appreciation of my participants and them with me. The learner-centric aspect of "setting off on the right foot" was addressed (Reigeluth & Karnopp, 2020). The data in the previous paragraph substantiates this conclusion and provides HAvatar with a good quality checkmark favouring the prior learning activation principle.

Criterion Interest. Real-World Learning Task

In this evaluation criterion, the real-world learning task of HAvatar did follow the principle of task-centred learning praxis; it did mimic an authentic, complete real-world task (Merrill, 2002) (further paraphrased on page 34), that of assembling hardware for a computer to working state. I simplified the activities required to assemble the computer through the iteration cycles, bounded by the timeframe and logistics. In the orientation, each participant had a chance to command the avatar to perform simple tasks to become familiar with how that felt before they learned the actual task for the project. Further, the orientation provided a clear learning trajectory, session-by-session, with input from the participants as to timings and scheduling that would work for them. Feedback #2 showed a 93% appreciation of the presentation, which had detailed the DBR plan to them in slides with some scheduling (see Figure 25). Further, the rating was 83% positive about the initial experience of the avatar, despite technical difficulties, and a 93% motivation for the next avatar session. The above data substantiate this conclusion and provide HAvatar with a good quality checkmark favoring the real-world learning task.

Criterion Interest. Small-Group Learning

As described in Chapter 4, informed by Merrill (2002) on page 35 which purports that peer work can be successful, the small-group cohesion was strong from the outset. This was confirmed via high rankings in all the rating scales and descriptions about this format for learning. Everyone elected to practice and demonstrate in the presence of each other as per this quote, “I chose that because the team is very lovely to work with and I just feel that connection”. Along with the iteration change that merged modelled learning sessions with applied practice sessions, the Demonstrate element also connected with the applied practice. I had offered to do these sessions one by one in the DBR Baseline. However, our group fully modelled Gokhale's words (1995) cited earlier that small-groups involving students at various performance levels working toward a shared learning goal foster responsibility for one another's learning beyond their own. The small-group learning criterion received a high-quality checkmark.

Criterion Interest. Scaffolded Modelling

Merrill's (2002) quote and my paraphrasing from page 35 reiterate the principle of scaffolded modelling as a criterion to engage and prepare learners for the learning task at hand. It rolled out through the learning of the PC assembly task via representative YouTube videos. An iteration change became evident – I needed an assembly model showing the actual HAvatar computer. Initially, I miscalculated that it would be too easy to have a model of the exact steps. Still, I quickly realized it was challenging for the initial phase of a skill when all activities were new, including commanding the avatar. I was also a beginner learner in assembling computers, so the correction was swift when I challenged myself to meet the requirements I demanded. Following Van Merriënboer's (1997) recommendation that the first elementary task in a series be preceded by an example of the task in a completed state, the first round of learning requires an exact model at the very least, not an associated model.

Another development in the iteration cycles moved the modelled learning in tandem with the applied practice. It was no longer serial but a naturally occurring learning and practice sequence. NA and ZA did the computer assembly first because they were already familiar with computer hardware. This served as an example to the others, and I used NA's assembly recording to create the model video. As mentioned earlier, I maintained the challenge to a degree by removing the audio, so the footage explicitly showed the avatar's actions. Due to these needed modifications, it took a week for the rest of the team to have practice sessions. The practice sessions also turned into their demonstration sessions, marking another iteration modification. At every session, the whole group of learners showed up to watch and support the others. I had sent messages that it was optional, fearing that the interest would wane if they repeatedly observed. However, the natural motivation to watch “over the shoulder” served the dual purpose of bonding the group as a team and giving the learners repeated viewing of the task protocol. Between the two methods, the YouTube tutorials and the model video, the data reported about the modelled learning were positive, eventually arriving at a good quality checkmark.

Criterion Interest. Real-Life Applied Practice

As mentioned in Chapter 3, the adage "practice makes perfect" is still ever-green in achieving quality learning outcomes. This criterion was the most crucial in judging the quality of the HAvatar experience, informed by Merrill (2002) and paraphrased on page 38. However, the HAvatar DBR suggested three intriguing aspects of applied practice outside the actual hands-on verbal exchange with the avatar.

First of note, each participant only had one round of practice/demonstration of the computer assembly except for NA and ZA who demonstrated modelled learning early in the first week. I had expected numerous rounds or repeated attempts, as articulated in the DBR Baseline. As mentioned in Chapter 4, the delay engendered by the initially more associative rather than directly modelled learning from the YouTube videos had complexified the learning and squeezed the timelines for practice.

That said, every learner who could connect showed up to watch their peers, naturally triaging the turns from the most adept to those who had the least exposure to the process. The apparent skill with which the learners assembled the computer via the avatar when it was their turn suggested that intrinsic learning was occurring. Watching their peers command the avatar, hearing the steps out loud, studying the videos, taking notes, being part of the group, perhaps some WhatsApp texts to each other had solidified the protocol. These informal aspects of learning arose mainly from the camaraderie in the group.

Second, another intriguing outcome was the facilitation factor. I am discussing it here, although it applies to both criteria, real-life applied practice and scaffolded modelling. I, as the avatar, was more involved in giving feedback than the original DBR Baseline planned. Initially, the avatar role was designed as non-verbal but just follow commands, stop if something was incorrect, yet not offer any directives. This was done to remove the stigma of the authority of the teacher. One participant agreed that it would be interesting to see what emerged if the avatar did not speak while they were practicing, as voiced here:

> Erm, both examples are relevant. More facilitation kept the enthusiasm and attention of the students resulting in rapid completion of the process. Less facilitation, on the other hand, would have made the process adventurous, probably resulting in the development of a new product aside HAvatar.

Yet those who had no experience with computer assembly were glad of the facilitation and relationship with the avatar, as shown in Chapter 4. The conclusion I came to from this regards the task-centred learning praxis principle of ever-increasing complexity of cycles as explained in Chapter 2, the Literature Review. Scaffolding is faded as a learner gains confidence from elementary understanding to competency. Therefore, the avatar could offer more involvement at the initial stages and become increasingly silent with each new cycle as the learners become more proficient (Francom, 2017).

In Iteration 2, I added the hand signals sheet. Through these simple gestures, this provided formative in-the-moment feedback about the activity without breaking silence, which reduced the need for the avatar to speak while keeping the activity moving. If the learner was still stymied, I would eventually give a verbal hint. Obviously, the avatar needed to know the next step in this situation. In a future case where the learner's choice might lead to something dangerous, it would be imperative for the avatar to know the outcomes and stop responding on an erroneous cue.

The study's third most intriguing emergent construct was the intimacy of the interrelationship between the learner and the avatar. There is a powerful direct connection between them speaking to you and you enacting their instructions. As surmised in the risks of the study in Chapter 1 (p. 20), the most challenging concept of this intervention was to conduct the role of avatar-as-puppet to the learner, especially if they know more than the learner. The avatar needs to take to heart the philosophy of the try-and-fail benefits of learning. Teachers tend to lecture their knowledge to correct the learner. Here they need to give the learner enough information to work with an ill-defined task protocol, so there is room to fail and repeat, rather than lead them out of the problem. That said, I experienced the learner's frustration and growing impatience when they could not get the answer followed by relief and satisfaction when I could give them the thumbs up on their choices. As the avatar, you can also sense when a learner wants to give up and loses motivation. An inanimate object or a computer program does not feel the learner as a fellow struggling human being. The hand signals provided a conduit for the avatar to communicate without speaking. This went a long way in providing formative feedback without losing the integrity of the avatar interaction design. That said, I wonder if the learner in future avatar sessions will feel that the "avatar is breathing down their neck" and feel inhibited to try and fail, especially if the avatar is an instructor. This quote is germane, restated from p. 36, "Rigor is enhanced when students have the opportunity to struggle with a problem before teachers provide them with directive hints or solutions" (Condliffe, 2017, p. 29).

Another nuance regarding the relationship with the avatar was that of the dual role of facilitator and avatar. The simultaneous role made it challenging to differentiate them, to my mind. In point, if you are conversing with the group and then abruptly switch roles to a silent one, it is hard for the spoken role not to bleed into the silent one. For this reason, I would suggest these two roles be separate. Nonetheless, I felt it was of great importance that I experienced the implications of being the avatar.

Without question from all the rating scales and written feedback responses, the real-life applied practice of the avatar can be checked off as a good quality learning experience.

Criterion Interest. Outcome-Based Learning

In this evaluation criterion, outcome-based learning, the quality sought was whether the learning became firmly integrated into the learner's world as per the task-centred learning praxis principle (Merrill, 2002) paraphrased from page 39. In Chapter 3, I explained this as the crucial revisiting element, reflection. Throughout the DBR, there were both formative and summative integration activities. At the end of the sessions, each of the four feedback forms queried their most immediate experience through a range of formative questions, with the fifth as a summative reflection of the whole experience. The terminology quiz and the flash memory recap of the assembly added further integration activities. The goal of the HAvatar task was set firmly at the beginning and was clearly mapped to the outcome. Evidence of the quality of the learning integration showed in the learners' recaps of the assembly process and the 97% importance rating they gave to the feedback forms in deepening their learning. Further, their written and oral reflections throughout the formative questioning about the significance HAvatar could bring to education and the workworld showed evidence of higher-order thinking. They were projecting the generalizability of HAvatar. Based on the feedback about this criterion, HAvatar received a high-quality checkmark.

Chapter 6. Conclusions

In this chapter, I have combined the constraints with the recommendations both of this study and of the HAvatar intervention – a constraint invokes the change process that naturally leads to a recommendation which further leads to future research implications. The overall significance of HAvatar combined with these implications forms the summative conclusion of this study.

Constraints and Recommendations

Bias

The participants and I derived individual meaning about the quality of HAvatar based on our session experiences, interactions, hidden biases, and mindsets. Rating scales as QUAN instruments were also subject to the nuanced selections of the learners' experience. Further, given that this is not a longitudinal study, its brevity with the HAvatar learning intervention cannot claim a blanket solution or substantive veracity for hands-on learning online. As per Seale and Silverman (2018), the variables were too complex to make such a claim:

> As used here, models, concepts, and theories are self-confirming in that they instruct us to look at phenomena in particular ways. This means that they can never be disproved but only found to be more or less useful. (p. 36)

I have sought to enhance the field of DE supported by the recognized epistemology of learning-by-doing with an intervention that addresses a need in online education. As such, I was not trying to prove a truth, but to furnish warranted beliefs as consistent results, revealed in the research activities, and assessed through feedback.

Small Research Project

The constraints of this study fall into the category described by Denscombe (2010) as a small pragmatic social project, with a limited budget, carried out over approximately one year, with a single researcher conducting the intervention implementation, data gathering, and analysis. In addition, a doctoral study includes research reporting and dissertation authoring. For this reason, I scaled the HAvatar intervention within these constraints of time and funding, "the resources available for designing, developing and implementing instruction" (Reigeluth et al., 2017, p. 24).

In the spirit of this small social research project, detailed analysis of time and cost in comparative gestalts to microworlds, or status-quo costs of curriculum delivery compared with online engagement costs, are outside the study's scope (Lane, 2014). However, future implementation projects of HAvatar, once hosted within an organization or institution, could provide broader learning analytics and cost analyses.

Intervention Constraints

It is an understatement that HAvatar has a full-on limitation in haptic capability. The manipulation of the objects originates from the verbally-mediated commands spoken to the human avatar by the learners through an online venue. Although the objects are at near-field range with visual, hands-on spatiality to the screen similar to gaming controllers, and the learning environment is real and uncontrived – in this case, a physical computer worktable – the objects are not touchable. They, therefore, do not provide a tactile sensory experience for the learner.

HAvatar Final Techno Process

There were two major technological drawbacks in working with the human avatar in this study. The first was the broadband weakness and subsequent bandwidth starvation evidenced in some dropped calls and intermittent poor videography. By Iteration 4, I had improved the technology considerably, although not without variability. I warrant the HAvatar techno process could be expedited with more funding. According to NA, better broadband could be purchased for a price in Ghana. In general, better quality webcam software, a dedicated business IP, and a higher-end laptop would dramatically and instantly ameliorate these connectivity issues. Optionally, moving to an even higher-end experience, more funding could employ videography technicians. An organization could offset costs if it intends to move large blocks of curriculum online to reach thousands more remote students while lessening their current physical venue constraints. Typically, physical learning venues can only host a limited number of students for hands-on practice. The HAvatar could mitigate this constraint.

The second was the livestreaming movement tracking of the avatar. There was feedback from the participants and evidence from my experience that it was sometimes hard to focus on the exact spot of the learning. Unfortunately, the secondary static camera was not as helpful as intended because it would hijack the webcam as soon as there was a glitch in the avatar's camera connection. Further, the static camera position was juxtaposed to the avatar's view of the objects, which was disorienting (see Figure 30); yet when brought alongside the avatar's perspective, the second camera was awkwardly in the way. A flexible magnetic mount did help to position the secondary camera but had to be manually moved by the avatar several times to different parts of the computer to focus in. The chestmount was the best solution to get the iPhone close. The iPhone's zoom-in-and-out capability was an important option for the learners to command the avatar to zoom closer or widen the perspective of their line of vision.

Although I made numerous additions to higher-powered lighting, I found the videos too dark. Better lighting options would enhance visibility. Too much lighting caused overexposure and shadows. Videography expertise might mitigate this issue.

It is a testament to the quality of this intervention that despite the intermittent visibility problems, the downtime lost during technical glitches, and the occasionally missed focus on the object, the participants were still enthusiastic about commanding the avatar and learning skills in this way. As reported in Chapter 4, good outcomes in competency acquisition were achieved. That said, much more time on task with the avatar is recommended for the next design.

The current HAvatar focuses on an up-close learning environment with micro-detail. However, another HAvatar project might require an avatar with gross motor movement, such as building carpentry or handling larger equipment. Therefore, the HAvatar could contextually change its quality depending on the scene it is streaming. That said, the task-centred learning praxis session structure with its embedded avatar role should be verifiable across multiple domains, anywhere where people need to learn equipment protocols.

In conclusion, refinements to and investment in the technological configuration need to occur but would be well worth the effort moving forward.

DBR

Reiterating Barab and Squire's (2006) thought that avers the propensity of research based on design to invoke changes in the world, I would conclude that the HAvatar stayed true to this mission. I guided the micro-logistics in the struggle to improve the intervention in DBR iterations, while simultaneously exploring the merits of task-centred learning praxis theory in learning online.

Contextuality. There is no question that DBR research is contextual. The learners' time availability bounded this study as well as the time allotted for each session, the nature of the participants, the level of skill required, the way the task was practiced, the actual task that was chosen, and the Internet quality at each session. Each of these factors impacted the results.

Duality. One of my thoughts about the evolution of DBR methodology in education practices arises from this study centred around the duality of the intervention design and the research design. This duality can be evidenced with DBR studies, either online or face-to-face (Palalas, 2012; Shattuck, 2013). In my reading, I found DBR methodology makes it difficult for the social scientist to distinguish between two parallel but differentiated channels of activities. One channel is running a prototype of the intervention – a design configuration of the end-product or curriculum. The prototype is embedded in its situation, organizational culture, outcome goals and purposes, session structure, specific taxonomy, design perspective and history. The second channel, the research design, has its own configuration belonging to the methodology chosen with its extensive epistemological taxonomy. For example, the curriculum is designed around a learning praxis with distinct phases and sequences and accompanying nomenclature. The instructional design necessarily focuses on including and logistically identifying all the theoretical elements and design elements belonging to the intervention seated in its home context (in this case, a microcourse on PC assembly). The parallel construct, the DBR design, requires identifying the iteration points, the data collection instruments, the involvement touchpoints of the participants, the means of triangulation, the analysis instruments, the ethics accountability plan, and the justification of all activities documented in research stringency. I struggled to make a clear differentiation between these two parallels.

Finally, I clarified this differentiation by separating the two constructs into disparate channels depicted in the schematics I used in this study. The DBR *observes* the action, while the intervention prototype *is* the action. For example, the pre-session included an interview, falling in the prior learning activation principle of the task-centred learning praxis. At the same time, it twinned with the semi-structured interview, a data collection instrument belonging to the DBR design. Further, the elements do not always correlate conveniently as these two did. Even in the case of a design-from-scratch, as many DBR projects are (Barab & Squire, 2004), the methodology builds around an initial rough design concept of the desired outcome. Future researchers might consider using this DBR methodology shift to research education interventions more clearly.

Educationalists often use the analyze-design-develop-implement-evaluate (ADDIE) (Bates, 2015) model to design instruction; a model derived from the SDLC. The issue persists with this model because the intervention points-of-reference may not fit into the ADDIE taxonomy or sequence, as in the case of HAvatar. Even if it did, there are two taxonomies in play – one for the ADDIE, and one for the education intervention. For example, "learner-centric" is not a term used in ADDIE; "Community of Inquiry" (Garrison et al., 2001) is a separate curriculum strategy from ADDIE. The complexity of the product or curriculum could be much more extensive and sophisticated, far beyond the HAvatar construct in this study. Attempts at the holistic merging of the taxonomies exacerbate the confusion.

DBR Methodology as Baseline. To illustrate the previous point more deeply, the methodology chapter typically describes the design of the research based on its tenets in a dissertation. If it is in the family of action research, then the participatory activities generally are recounted in this chapter, merging the projected design and the lived occurrence into one.

Figure 40

DBR Intervention Baseline – DBR Iterations Findings

Note. DBR Intervention Design in the Methodology chapter

DBR Iterations – Iterative testing in the Findings chapter

DBR is different with its cycles of iteration (Wang & Hannafin, 2005). First and foremost, there is an intervention design. The specifications for that design are drawn up as represented by the left side of Figure 40. Once the design is established it becomes the baseline. Then the baseline design is operationalized into a testing phase, selecting freezeframe moments in its development called iterations. Iterations track the ongoing changes, design solutions, and modifications. These are gathered, recorded, decided upon, and either triaged into the next more evolved iteration or parked. The right side of Figure 40 illustrates a design being operationalized in action.

In this study, DBR was informed by the works of Anderson (2008a), Barab and Squire (2006), Palalas (2012), Shattuck and Anderson (2013), and Wang and Hannafin (2005). The following is my recommendation for DBR studies involved in exploring pedtech interventions in the future.

As illustrated in Figure 16, DBR Baseline – HAvatar Detailed Schematic, the initial design of the intervention forms the baseline or iteration "zero", described in the present tense. I renamed the chapter normally labelled Methodology to Research Design. The baseline design comprises the HAvatar intervention, selected DBR data collection instruments, ethical considerations, and sampling choice. This baseline precedes the operationalization of the research, which describes the participatory rollout in the following chapter, Findings, reported in the past tense. I showed this operationalization in Figure 17, Timeline and Rollout. In ICT, this would be labelled the testing phase. In this way, the decision-making on changes when the action research reveals them can springboard from the baseline and form the first iteration. The baseline design referencing the original configuration with the changes marked at each iteration provides a full audit trail of the design to its end-state.

Schematics

This recommendation about schematics is biased toward the strategy I used in the study, as well as experience from major software projects. Supported by Mauch & Park (2003), I am a strong proponent of schematics. In their germane words, "Illustrations can help greatly as visual descriptions and explanations for the devices, concepts, ideas, processes, and data in proposals and reports. Informational graphics, both in images and statistics, promote clarity and foster insight for both writer and reader" (p. 244). A schematic can clarify words and even eliminate over-explanation. This helps a reader step through a complex process while following the map. Visuals can solidify learning and provide a reference reminder when the learner understands the bulk of the concept. In the case of DBR's duality, it can separate channels of definition with clearly delineated borders as illustrated in the DBR Baseline schematic, helping prevent contagion of confusion between simultaneous processes as described in the Duality section above.

Task-Centred Learning Praxis as Instructional Design Pedagogy

I chose task-centred learning praxis as a label to collectively include all the principles I had thoroughly verified in the theoretical and pragmatic literature of learning-by-doing. The excellent longitudinal works of Dewey (1916), Francom (2017), Merrill (2002), Reigeluth and his many associates (e.g., 1989, 2009, 2015, 2017) guided me and provided a robust foundation for instilling the right learning ingredients into the HAvatar's instructional design and underpinning philosophy. Given the positive feedback and my own experience, I conclude that task-centred learning principles have the qualities they claim. Therefore, I recommend that the HAvatar sessions continue to be grounded in task-centred learning praxis pedagogy.

Applying task-centred learning praxis to embody its learning principles adapts well to a virtual learning venue – prior preparation, orientation, and clarity of the end goal of the task, scaffolded modelling through media-enhanced instruction, applied practice with the HAvatar, and outcome-based integration and reflection conducted in small learning groups. These whole tasks can be chunked into cycles of increasing complexity with faded scaffolding. I would allocate the online quizzes and gamification to the scaffolded modelling element where the initial understanding of the skill is born, and multimodal learning materials can be offered. Online learning affordances are particularly well-suited to providing variety in engaging the learner far beyond a book and a notebook. Here XR could shine.

However, as emphasized in the HAvatar strategy, nothing replaces the deeper thinking involved with the applied practice element. As Clark and Mayer (2016) attest, the transfer of knowledge to the ownership of the individual learner does not need slick graphics or programmed videography so much as a learning venue set to promote play, practice, and messy trial-and-error efforts. The debrief built into every task-centred learning praxis cycle and pinnacled in the integration phase provides robust assessment techniques adeptly designed to let the learners demonstrate in a webconference or electronic artifact what they have learned.

Based on these reflections, I endorse using task-centred learning praxis in this online format to reify future implementations.

Relationships

Worthy of note for future HAvatar research, I have three thoughts around the centrality of social connections.

Ubiquitous to the entire project, the relationships amongst us on the team were experienced and rated as very important. Scales were strongly positive when any questions concerned the group interaction. There was an unsolicited comment from the participants about how effective learning is in a small-group online versus a large class. From Chapter 4, feedback #4, I repeat this quote, "Our collaborative effort was perfect". Numerous other supportive words suggested trust and care for each other and me. I personally also experienced this bond and this participatory ethos that carried the project along. It was easy for me to form a connection with each participant, despite some of the interview time being broken by call drops and audio issues. Further, every interview question about taking on a challenge was answered positively; I experienced the lived truth of this throughout the HAvatar sessions.

As a result, I wonder if a small group of North American twenty-first century learners, laser-focused on a HAvatar task, would have the same outcome. Was this natural ease with each other a result of the group having met each other? Was it because of NA’s leadership? Was it because of the people NA chose to be on the team? Did it come from a culture where respect for seniors is a systemic social principle? Did it come about because I did due diligence in ensuring everyone was onboarded with care, modelled by prior learning activation epistemology and my teaching experience? This apparent social presence further begs the question of cultural bias. Ghana has a different culture than North America, placing a high value on “family unity, cooperation, and understanding among members” (Salm & Falola, 2002, p. 150). You could say that the HAvatar project warranted this old Ghanaian proverb, “One who climbs a tree worth climbing gets the help he deserves” (p. 150). I ponder how effective the HAvatar study would have been if this relationship ethos had been weak.

The second relationship outcome from the HAvatar study worthy of note was the one that occurred between the human avatar and the learner. As mentioned in Chapter 4, an invisible bond with the learner occurred for me as avatar when I followed their spoken instructions. Comments from the participants confirmed they felt a relationship with the avatar and welcomed some on-task scaffolding from the avatar. Was this influenced by the fact that we were united in the trial of HAvatar to improve it and that we took time-outs from the assembly process to discuss the next steps? Was it because, intrinsically, a connection happens when the learning occurs in a substitute kinesthetic role, up-close yet digitally distanced?

The third reflection for future research projects centres around observational learning. Learning was happening intrinsically by observing each other working with the avatar, as reported in the feedback and evidenced by the repeated witnessing of others commanding the avatar. As small-group learning is part of the HAvatar strategy, observational learning will necessarily be a part of any implementation. I query how much learning occurred by simply watching others versus by actually commanding the avatar.

An effect of a WhatsApp group that allowed participants to chat with each other throughout the HAvatar experience may also have contributed to the extrinsic learning. That said, in a workplace scenario, non-canonical, untracked informal learning is an endemic factor in the success of the enterprise, as averred by Brown & Duguid (1991) and Eraut (2004). It may not need to be differentiated in the HAvatar experience.

Future projects in different organizations could build a focus on the social and non-verbal dynamics in the evaluation of their success (C. Ives, personal communication, March 11, 2022).

The Affective Realm

In the rising research tying emotions to learning success and failure, I applied my learning-by-doing ethos concurrently informed by affective realm authors (e.g., Dirkx, 2008; Goleman, 1996; Illeris, 2014), the appreciative inquiry movement (Cooperrider, 1990; Whitney & Trosten-Bloom, 2010), and indigenous epistemology (e.g., Marsden, 2021; St. Denis, 2008; Tanaka, 2009). The simplified message is to put the human relationship first before, during, and after the learning. Most educators and learners desire a sense of ease and belonging with each other, void of conflict, with a purposeful motivational goal in their education. This philosophy takes both attitudinal self-work as well as good elemental planning to form a ubiquitous presence of inclusion and appreciation.

My recommendation is to ensure the learner-centric motivational aspects of HAvatar projects are incorporated: (1) pre-course, by applying the principle of prior learning activation where the learner becomes situated not only in the task ahead but in their own person, followed by self-reflection on their own strengths and ability to take on challenges; (2) in the applied practice, by allowing the learner to be in charge of the avatar; and (3) post-course, by giving importance to the debrief and reflective integration of the learning outcomes.

Summary of Key Points for Future Configurations

The following list provides a benchmark for the design of all future HAvatar projects:

- Give priority to building rapport, purpose, and clarity of task at the outset at prior learning activation and revisit them continuously throughout the project.
- Provide formative feedback instruments at every session.
- Combine modelled learning, applied practice, and demonstration of skill in a learner-centric strategy.
- Separate the role of avatar and facilitator.
- Try group format in different configurations with more or less facilitation.
- Have students stand in for the avatar who can access the physical lab or workshop.
- Make sure learners are matched to the skills and provide appropriate advance organizers to bring them to readiness level.
- Use a movement tracking device with full articulation to follow the avatar's movement.
- Develop a bonafide assessment demonstration as the outcome metric either individually or as a group.
- Tune the learning materials to the skill level of the learners at the given task level.

Significance for the Future

The strategy of HAvatar staged in existing facilities could reach many more learners than just those who can travel to a college, university, or place of work. It might benefit learners to participate in a skills-relevant learning venue they could not otherwise reach, yet with much more of a hands-on involvement than as a passive spectator.

From a meta-view, HAvatar might have a beneficial bearing on global skills mismatch (UNESCO, 2014), enabling the upskilling of hemmed-in demographics through a venue located anywhere in the world, using readily available retail technology and broadband connectedness. This high-end aspiration of implementing HAvatar into DE organizations remains to be explored. According to Ives (2005), pedtech innovations need to be costed out to guide organizations "where to invest institutional resources for technology in the future" (p. 76). The cost accompanying new research will doubtless drive the viability of HAvatar.

Judging the current situation of the exponential surge in online education away from in-person learning, I see movement towards virtual immersive learning venues as accelerated. There is a need to enable online learning sites to control objects manually. HAvatar, as a quality intervention, could positively impact DE. The results could indicate a scalable model for teaching tactile skills online in myriad contexts. The potentiality within the research questions suggests:

(1) Learners might find it appealing and feasible to learn hands-on skills through HAvatar. Even if the outcome of the data analysis from the intervention shows an incomplete mastery of the skill prior to physically handling the objects in person, it might signify a way to prepare online learners to master a significant portion of said skill.

(2) Informed by cognitive apprenticeship theory (Brandt et al., 1993), articulating the skill aloud can enhance the learning. As well, the act of instructing another person on how to perform a task accurately and clearly develops verbal communication capabilities.

(3) Informed by positive research about learning-by-doing real-world tasks and the results of this study, HAvatar might motivate learners to learn.

(4) Applying the principles and instructional theory of task-centred learning praxis as criteria to judge this online intervention could augment or add refinements to learning-by-doing online.

(5) In addition, continuously identifying challenges and limitations of HAvatar could further inform reworks and future research.

Pedagogical-Technological (Pedtech) Change Continuum

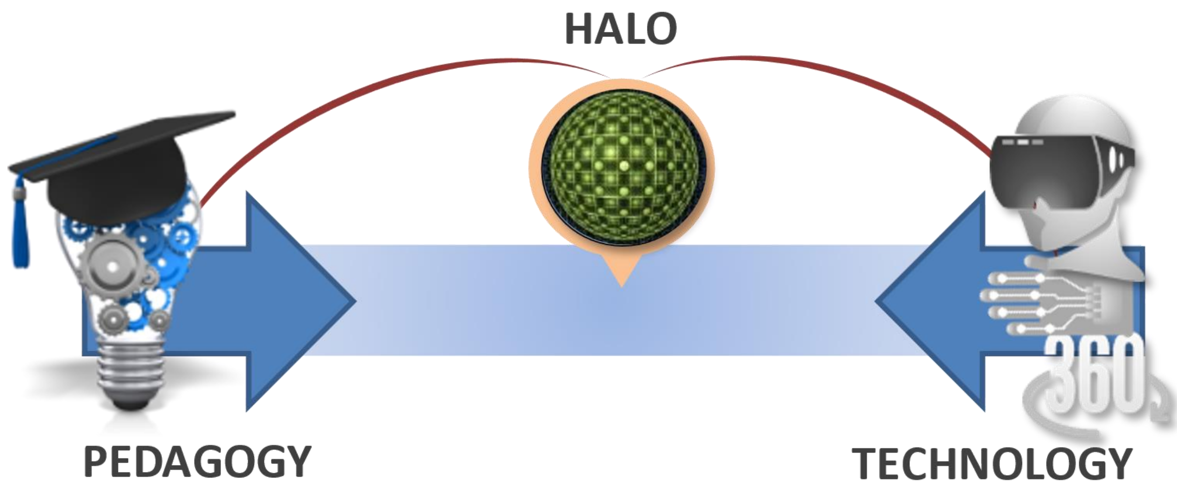
As Zhou (2018) states, "Current learning theories and models either mainly take into account the technology perspectives or focus more on the pedagogy" (p. 239). The HAvatar intervention might be considered a facilitating midpoint on a pedtech change continuum where two disparate domains seek to gradually move towards each other (see Figure 41). On one side of the continuum are the educational organizations revamping classroom curriculum and pedagogy towards an online learner-centric, engaging, multimodal learning model (Cohen et al., 2018). On the other side of the continuum are state-of-the-art technology and gaming companies improving immersive cloud-based experience (Naranjo et al., 2020).

XR has been growing in popularity as its technology advances and adds new applications. XR intelligence provides colorful and intriguing life-like microworlds with immersive capacity now at a reasonable cost in the retail market, as can be experienced with Oculus Quest 2 (n.d.) technology. Users sign in as virtual avatars in a virtual microworld, equipped with hand controllers to move their avatar "selves" around. Now "the sensation of being there no longer necessitates a physical presence" (Lan, 2020, p. 1).

That said, Radianti et al. (2020) in summarizing their systematic review of VR use in higher education indicated that a HAvatar solution could help mature the industry. In their words, “Future VR development for higher education needs to build on existing experiments (rather than being exploratory from scratch) and to provide results that allow for generalization” (p. 147).

Figure 41

The Pedtech Continuum and HAvatar



The HAvatar intervention proposes to address both domains - the education domain because HAvatar could scaffold the redesign of outdated curriculum models to virtual education with minimal transitional disruption; the cloud domain because HAvatar could offer an operating model to prototype AI avatar intelligence. In addition, education organizations could benefit from a practical, immediate solution to gear up their existing physical labs to DE. Laurillard (2012), concerned with the education field not moving fast enough towards the other side of the continuum, warned how digital technologies are powerful enough to change education unbidden, urging the field of education to make efforts to ramp up edtech strategies to mitigate this risk. Ten years after her caveat, the two worlds still seem disparate, although the unregulated online course creation world is growing at an exponential rate.

Each HAvatar project needs to be customized to the context. Due to its broad applicability to many industries and training organizations, a HAvatar DBR in a new work-world context would need to be revisited.

Simulation-based education is on a growth trajectory. The words metaverse and microworld are becoming common terms for labelling the future of global technology in simulating “real-world” experiences. The technology of AI-glasses, mentioned as an example in the literature review, is reputed to signal a vastly wider application than microworlds by overlaying semiotics and virtual images over real physical scenes. A user can even continue using other computers simultaneously. The Pokemon Game is an example of an AR experience spreading virally where millions of users physically wandered their neighbourhoods holding their smartphones, looking for virtual characters. The HAvatar provides organizations a cost-effective segue into these AR technologies by shifting existing curriculum into interactive microcourses, acclimatizing users to experience learning-by-gaming all the while maintaining serious gaming content and outcomes. Thus, the HAvatar would benefit from and be suited to AR; together they could enable a transition from twentieth century to twenty-first century education with some ease for our technologically-beset learning institutions.

Closing Summary

In Chapter 1, I grounded the HAvatar intervention within the theoretical framework of pragmatism as the paradigm, task-centred learning praxis as the learning theory, DBR as the methodology, and mixed methods for the data. Throughout this framework, I chose a consistent message from macro to micro; from paradigm to theory to practice; each element revolved around the learning-by-doing ethos. I illustrated the design of the entire project in a conceptual framework schematic.

I recommended that the methodology chapter for a DBR be considered the baseline design and that the findings chapter report on the DBR action in a series of numbered iterations which describe the departure from the baseline design. This would help to align a pedtech intervention with systems design. Further, I recommended considering the use of process schematics to help visualize the difference between the stages of DBR iterations from the stages of the instructional design.

The enactment of the action portion of the research rolled out within the DBR framework described above. True to its iterative process, from a baselined version through four iterations, HAvatar was taken through its paces, both in its technological design and in its instructional design. The research sought to answer the quality question of HAvatar as an intervention for learning online. Although not labelled directly as a proof-of-concept, the research was very much the initial test of an innovation. The study went deep rather than wide. This depth happened thanks to seven dedicated participants. They answered five feedback forms totalling 55 questions combining ratings (QUAN) and descriptions (QUAL), responded to a quiz of 20 multiple choice questions, spent hours learning the skill from a collection of videos, took part in a debrief, wrote a flash memory recap, and averaged an hour of time-on-task working directly with the human avatar in addition to several more hours spent watching others command the human avatar.

In the HAvatar study, I have attempted to honour the requisites for twenty-first century learners informed by the author-educators I paraphrased.

My summative remarks about the pedtech continuum, informed by a repeated message throughout the literature I read, suggested that learning theories and applied instructional design theory are a low priority in edtech where fidelity and graphic appeal take precedence.

Thanks to the participant feedback and the analysis of data via task-centred learning praxis criteria evaluation and research questions, HAvatar passed the quality scrutiny as a valuable online intervention for hands-on learning with a unanimous recommendation to move it forward into a more comprehensive application in education and training organizations. A quantitative in-situ study on its efficacy would be the next step.

A future DBR research project could explore the recommendations and constraints that have been revealed from the HAvatar intervention as presented in this chapter, housed within a real-world technical college or vocational training organization and applied to a current tactile equipment skill course as a comparative analysis.

The HAvatar intervention could contribute to the field of distance education by providing a viable solution for virtual hands-on learning. Educators might use the virtual model of the HAvatar to prepare curriculum for delivery in the metaverse.

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Appendix A: Participant Invitation Information Letter

August <#>, 2021

Researcher	Supervisors
Mae Doran Candidate, Doctor of Education in Distance Education Cell: (250) 686-7737 Email: emaebe@gmail.com	Dr. Aga Palalas Associate Professor, Distance Education Faculty of Humanities and Social Sciences Cell: (780) 977-6390 Email: agapalalas@athabascau.ca Athabasca University 1 University Drive Athabasca, AB T9S 3A3, Canada Dr. Mohamed Ally Professor and Program Director, Doctoral Program Faculty of Humanities and Social Sciences Researcher, Technology Enhanced Knowledge Research Institute (TEKRI) Commonwealth of Learning (COL) Chair Email: mohameda@athabascau.ca Athabasca University, Canada

Dear <>,

My name is Mae Doran, and I am a student from the Doctor of Education in Distance Education Program at Athabasca University, Alberta, Canada. As a requirement to complete my degree, I am conducting a research study seeking feedback about an online education intervention. My supervisors' names are Dr. Ally and Dr. Palalas who can be contacted at any time via their contact information above.

What is the purpose of this study?

This study proposes to explore the pilot of an innovation named the Human Avatar (HAvatar) which approximates hands-on learning entirely remotely. I am seeking to obtain feedback about the quality of HAvatar as an online education solution.

For this trial, the objective of the learning task is for you and a few other participants to assemble a computer at a distance using the avatar. Computers are fairly easy to assemble nowadays. I will prepare you for this involvement and make sure you are ready to be present online in Zoom webconferencing.

What will be expected of me?

Participation is **entirely voluntary.** Familiarity with participation in webconferencing such as Zoom is needed. Good Internet connection with video capability is needed. An interest in computer hardware assembly is essential, also, an interest in expressing your opinion to others, both spoken and written. Clear, slow enunciation will be necessary for the avatar to understand your commands. We will teach you the terminology as part of the course materials. The time commitment is estimated at six to ten hours, but this will be confirmed more accurately as we get closer to the launch.

You may withdraw from the project at any time until the end of the last HAvatar session without giving a reason and without consequence. All recordings and writing about your experience will be removed from the data if you so choose prior to the end of the last HAvatar session.

The data will be rendered anonymous once the last session is complete.

What is the plan?

The time frame is the last two weeks of August and possibly extending to the first two weeks of September (to be confirmed based on other time impacts).

We will start with an online chat, the two of us, so we can get to know each other. I will explain how things will proceed together through the HAvatar sessions. You will be asked to participate in Zoom video web conferencing in four sessions, with one extra as optional, and with three of them in the form of avatar online hands-on practice. Each session will conclude rating scales for each session and a written or recorded vignette of your experience and your opinion. I will review the transcript with you via shared documents in google drive to ensure I have captured your thoughts correctly. For the first four sessions, I will request a two-day turnaround to review, clarify, or revise your contribution; for the last session which is the wrap-up, the timeframe will be a week to review, clarify, or revise your contribution. Throughout the sessions you will be working with the whole group of participants, collaboratively taking turns with the avatar until the last session. Here you will get a chance to demonstrate the assembly of the computer without the rest of the group (voluntarily). There will be a focus group where we will discuss the quality of HAvatar and your experience.

What are the risks and benefits of participating?

Your participation could shape an innovation in distance education that is new to the field of online learning. You will be compensated $100 CAD for your contribution via PayPal. As a benefit, you might acquire a skill in assembling a desktop computer to a working state.

There are no known risks associated with participating in this research. If at any time you should feel uncomfortable answering any questions, you can omit the question or discontinue your participation in this research.

In the context of the peerwork sessions and the focus group, you can be assured that I will keep your responses confidential and that the other participants will be asked to refrain from discussing each other’s responses outside the group.

How will the information collected be used?

Your responses will be reported as part of a group and your name will not be associated with any of your responses.

Every effort will be made to protect your personal information and feedback through passwords, encryption, two-step sign-in authorization, and cloud-based storage security. Once the pilot is complete, the analysis of the qualitative data with your information will be brought into a central software and removed from other sources. Once the project is written up, the sensitive data will be moved to a thumb-drive in my possession and destroyed after five years.

The existence of the research will be listed in an abstract posted online at the Athabasca University library's Digital Thesis and Project Room and the final research paper will be publicly available. A copy of the final dissertation will be made available to you.

Further, to communicate the richness of the sessions, some video vignettes from the avatar sessions will be required to be published as well. You will be shown the vignettes which include your voice directing the avatar and a cameo of your face in the web-conference. In the zoom sessions, you will be asked to rename your log-in to a fictitious name so that your real name is not displayed on-screen in the recording.

What do I need to do to participate?

If you would like to participate, please sign the attached Consent Form and return it to me at emaebe@gmail.com. I welcome you to reach out to me with any questions. I can also be contacted via cell phone or WhatsApp at 1 (250) 686-7737. Thank you for your consideration in exploring the Human Avatar project. I look forward to working with you!

Mae

This project is supervised by Dr. Palalas agapalalas@athabascau.ca and Dr. Ally mohameda@athabascau.ca and has been reviewed by the Athabasca University Research Ethics Board. Should you have any comments or concerns regarding your treatment as a participant in this project, please contact the Research Ethics Officer by e-mail at rebsec@athabascau.ca or by phone at (780) 213-2033.

Appendix B: Participant Informed Consent

For further information:
Mae Doran
Cell: (250) 686-7737
Email: mdoran1@athabasca.edu

August <#>, 2021

A Virtual Education Intervention to Approximate Hands-on learning (named HAvatar)

I, (please print)____ have read and understood the information on the research project by Mae Doran regarding HAvatar, A Virtual Education Intervention to Approximate Hands-on Learning. All questions have been answered to my satisfaction. I agree to voluntarily participate in this research and give my consent freely. I understand that the project will be conducted in accordance with the Invitation Information Letter, a copy of which I have retained for my records. I understand I can withdraw from the project at any time, without penalty until the last of the HAvatar sessions and do not have to give any reason for withdrawal.

I consent to:

Using my own computer and high-speed Internet connection to access Zoom conferencing
Allow video recording of all sessions and for those video recordings to be used as a data source for the research. Some video vignettes will be shared publicly anonymously
Provide feedback on the quality of HAvatar by completing the questions each session and taking part in group debrief sessions
Participate in an interview at the beginning to share my unique qualities, experiences, and goals about learning
Fill out a quiz on terminology for the computer assembly

Print Name: ________________________________

Email: *Cell:* ________________________________

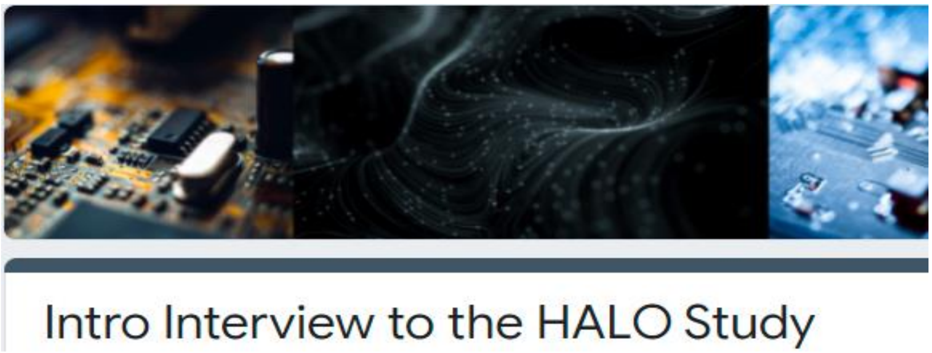
Signature: ________________________________

Date: ________________________________

This project is supervised by Dr. Palalas agapalalas@athabascau.ca **and Dr. Ally** mohameda@athabascau.ca **and has been reviewed by the Athabasca University Research Ethics Board. Should you have any comments or concerns regarding your treatment as a participant in this project, please contact the Research Ethics Officer by e-mail at rebsec@athabascau.ca or by telephone at 780.213.2033.**

Appendix C: Participant Semi-Structured Interview – Pre-Session

The purpose of this interview is to provide an open discussion while setting the stage for the participant through prior experience and understanding of the project yet reciprocally helping me to assess the fitness of the participant for the HAvatar sessions.



(1) Tell me about your most triumphant moments of achievement?

(2) Are you interested in computer hardware?

(3) Tell me about your experience with technology? The cloud?

(4) Do you like to learn skills hands-on? Why is that?

(5) What kind of skills have you learned hands-on and are still using?

(6) Do you like short learning sessions or do you like to spend long periods studying something?

(7) Have you ever given a speech to an audience?

(8) Do you like to express your opinions to others?

(9) How interested are you in unusual experiences outside of your comfort zone as long as they are safe?

(10) What do you understand about the HAvatar sessions you have volunteered for?

(11) Have you ever worked in a small online group of learners before?

(12) Do you have access to robust Internet service and a laptop or desktop computer?

Appendix D: Concluding Debrief Session – Cohort Questions

The participants provided feedback #5 to these questions at the conclusion of the project. The import of their final responses provided key data for the viability of HAvatar.

1. *Overall, how would you rate the quality of the avatar experience as a way to learn hands-on skills online?*

    Poor Quality 1 2 3 4 5 High Quality

2. *In comparing a task you have learned with your hands on the actual objects, what was the quality of the learning via spoken commands to a human avatar online?*

    Poor Quality 1 2 3 4 5 High Quality

    Would you say a few words about the difference between learning in the HAvatar experience versus actual hands-on learning you have experienced?

3. *How would you rate the quality of commanding the avatar in keeping you interested and engaged in learning a new task?*

    Poor Quality 1 2 3 4 5 High Quality

    Tech problems aside, do you have a comment about the quality of the avatar experience in keeping you engaged?

4. *How did delays with the technology and the connectivity hinder you from learning?*

    Not Hindering 1 2 3 4 5 Very Hindering

    Please describe why you chose this option about delays with the technology and the connectivity hindering you from learning?

5. *To what extent did speaking the commands out loud to the avatar consolidate your learning about the tasks?*

    It made no difference 1 2 3 4 5 it consolidated them in my mind

Do you have a comment about speaking the commands out loud in consolidating learning?

6. *What was the quality of the task-centred instructional design of the whole HAvatar microcourse for you?*

   Poor Quality 1 2 3 4 5 High Quality

   Please describe why you chose this option for the quality of the instructional design of the whole HAvatar microcourse for you?

7. *In terms of the quality of the avatar experience, how necessary was the task-centred instructional organization surrounding the avatar experience in engaging you in the learning? (I could just have sent the YouTubes and then we could have just done the task)*

   Not necessary 1 2 3 4 5 Very Necessary

   Please describe why you chose this option about the necessity or lack of necessity for this instructional organization surrounding the avatar experience.

8. *What was the quality of the facilitation in supporting your learning?*

   Poor Quality 1 2 3 4 5 High Quality

   Is there anything you would have changed? For example, would you have liked more practice with the avatar without any feeling of achievement required? Would you have liked more or less facilitation from Mae?

   How important was the relationship with the avatar – would you rather have had no relationship with the avatar?

9. *In the interview, one of the questions was what your greatest achievement was. Did this question influence your confidence in taking on the HAvatar challenge?*

   No Difference 1 2 3 4 5 Reminded me of my Strengths

10. To what extent do you feel satisfied you learned the component assembly tasks?

Not Very Well 1 2 3 4 5 Really Well

Please describe why you chose this option about the extent you feel satisfied you learned the component assembly tasks?

11. Do you think HAvatar is worth spreading to a wider audience?

Yes No Maybe (explain)

12. If yes, please mention 2 direct applications you see for HAvatar in learning organizations or companies.

13. How important were the feedback forms and questions in deepening your experience with HAvatar?

Not Important 1 2 3 4 5 Very Important

14. What do you think about small-group Learning?

15. If not mentioned in the above questions, do you have any comments or questions about the experience of HAvatar?

Appendix E: Formative Feedback

Research Questions (6) and (7) pertain to the pedagogical underpinning of the avatar sessions. Answers to research questions are collected in the formative feedback at the end of each session as shown below.

Pre-Session

Criterion Interest: Prior Learning Activation

The questions for this session are the semi-structured interview questions found in Appendix C

Orientation

Criterion Interest. Real-World Learning Task

1. *What was the quality of the first avatar experience for you in understanding the whole idea of this project and the role of the learner?*

    Poor Quality 1 2 3 4 5 High Quality

    Please explain why you chose this rating about the quality of this first avatar experience. Would you do things differently?

2. *What was the quality of the presentation in informing you about the organization of the HAvatar sessions?*

    Poor Quality 1 2 3 4 5 High Quality

    Please comment on the rating you gave the organization of the project.

3. *Was the task of constructing the computer presented as the clear goal for the HAvatar Sessions?*

Not Clear 1 2 3 4 5 Very Clear

Please comment why you chose this rating about the task of constructing the computer and any other thoughts.

What are your comments about the technology and connectivity of HAvatar?

4. *Do you feel connected to the team?*

Not Connected 1 2 3 4 5 Very Connected

Please comment why you chose this rating about your connection to Mae and the team.

5. *To what extent do you feel motivated to do more sessions with the avatar?*

Not Motivated 1 2 3 4 5 Very Motivated

Please comment why you chose this rating about feeling motivated to do more sessions with the avatar. Do you have any improvement advice?

Modelled Learning

Criterion Interest. Scaffolded Modelling

The following questions were feedback for the session with NA and ZA

6. *Here you can make comments on the changes needed in the technology for HAvatar after being part of the first practice*

Please add comments on the changes needed in the plan layout for HAvatar sessions.

Please add any other comments about this HAvatar session with ZA and NA

Practice

Criterion Interest. Real-Life Applied Practice

7. *What was the quality of your experience connecting what you learned from the materials with solving the hands-on task by directing the avatar?*

Small Cohort

Criterion Interest. Small-group Learning

The following questions were mixed into the other feedback forms with each session:

8. *How inclusive and comfortable was the work in the small-group cohort? At the Orientation phase? At the Practice the Skill phase? At the Demonstrate - Debriefing phase?*

   Please describe your experience briefly in each session.

9. *How was the quality of your learning with the others in contrast to learning by yourself?*

Demonstrate - Debrief

Criterion Interest. Outcome-Based Integration

See Appendix D, Summative Feedback for this final session.

Appendix F: Ethics Certification

Athabasca University
RESEARCH CENTRE

CERTIFICATION OF ETHICAL APPROVAL

The Athabasca University Research Ethics Board (REB) has reviewed and approved the research project noted below. The REB is constituted and operates in accordance with the current version of the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans (TCPS2) and Athabasca University Policy and Procedures.

Ethics File No.: **24422**

Principal Investigator:
Ms. Mae Doran, Graduate Student
Faculty of Humanities & Social Sciences\Doctor of Education (EdD) in Distance Education

Supervisor:
Dr. Mohamed Ally (Supervisor)
Dr. Agnieszka Palalas (Supervisor)

Project Title:
A Virtual Education Intervention to Approximate Hands-on Learning: via Task-Centred Learning Praxis

Effective Date: August 18, 2021 **Expiry Date**: August 17, 2022

Restrictions:

Any modification or amendment to the approved research must be submitted to the AUREB for approval.

Ethical approval is valid *for a period of one year*. An annual request for renewal must be submitted and approved by the above expiry date if a project is ongoing beyond one year.

A Project Completion (Final) Report must be submitted when the research is complete *(i.e. all participant contact and data collection is concluded, no follow-up with participants is anticipated and findings have been made available/provided to participants (if applicable))* or the research is terminated.

Approved by: **Date: August 18, 2021**

Michael Lithgow, Chair
Faculty of Humanities & Social Sciences, Departmental Ethics Review Committee

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Athabasca University Research Ethics Board
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