Abstract

During the past decade, there has been increasing attention to second/foreign language teaching and learning in virtual worlds. The purpose of this study was to explore affordances of a 3D virtual world platform designed as an immersive language teaching and learning environment.

Focusing on designing virtual worlds as a catalyst for change, three design phases (development of artifact, low fidelity prototyping, and high fidelity prototyping) were detailed and documented in this study. Nineteen students from a pre-service teacher cohort, two technicians and eight language learners from high schools in Vancouver as well as eighty language learners from universities in China were involved in this study; participants were asked to immerse themselves in the virtual language learning environment designed for the study. Participants’ interactions in the virtual world were videotaped and avatar interactions were recorded.

Group discussions, observations, survey questionnaires and the video-stimulated post interaction interviews provided complementary data for understanding affordances of virtual worlds in designing immersive second/foreign language learning curriculum. Analysis of the feasibility study, low fidelity design, and high fidelity design suggested a more robust design for immersive virtual language learning environments. Three design cycles revealed primary design factors of immersive second/foreign language learning in virtual worlds (embodied avatar, co-presence, and simulation) and their relative significance in the process of learners’ meaning-making and knowledge construction.

Findings showed that embodiment through an embodied avatar, community of practice through co-presence, and situated learning through simulation had a greater
impact on the immersive virtual learning design. Building on a theoretical framework of embodied mind, situated learning and distributed cognition, this study documented features of learning theories key to language learning curriculum design in virtual worlds.

The findings and techniques resulting from this study will help designers and researchers improve second/foreign language curriculum design in virtual worlds. It also prompts designers and researchers to achieve a better understanding of how virtual worlds can be redesigned by rethinking learning theories. The refinement of design-based research stages into low and high fidelity prototyping provides researchers with empirically tested and nuanced understandings of the design process.
Preface

The research presented in this dissertation has been approved by the University of British Columbia Behavioural Research Ethics Board (Certificate Number H06-80670).
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Acknowledgements

A journey of a thousand miles begins with a single step.

_Lao-tzu, The way of Lao-tzu_

My journey to become a researcher as of today has just begun beneath my feet. My supervisor Dr. Stephen Petrina, many scholars, colleagues, friends and family members contributed to my journey to become an educator and a researcher. The completion of this dissertation is only possible due to their support and encouragement.

First and foremost, I wish to acknowledge my supervisor and friend, Dr. Petrina, for his tremendous support of my own research interests and for his insightful scaffolding and advice on the research design and thesis writing. His emotional support has helped encourage me to overcome many challenges throughout my journey. Without his care, help and support, my thesis would have been impossible.

I thank Dr. Franc Feng for his expertise, support and incisive comments on my research design and Dr. Ling Shi for her expertise and insights at my MA defense and throughout my PhD research. I thank Jennifer Zhao and Robert Hapke for their continuous support with systems design.

I appreciate help from my colleagues You Liang, Mirela Gutica, James Gauthier, and PJ Rusnak in the HWL Lab for their support of the data collection and dissertation defense.

I also would like to give my thanks to Basia Zurek, who has provided significant help for completion of the program.

I thank my husband Ji Gang Wang for his continuous support of my studies at the University of British Columbia. He is always reliable, responsive and helpful with my
career and education. I also thank my parents, Gui Qin Chen and Yu Wang for always supporting me throughout my education, and for my family’s support of my wonderful daughter Olivia Zi Xi Wang.
Dedication

To my mother
Gui Qin Chen

To my father
Yu Wang

To my husband
Ji Gang Wang

To my daughter
Olivia Zi Xi Wang
Prologue

My research interests lie at the intersection of learning, design and new media. Throughout my career, I designed innovative and effective educational technologies, rethinking their value in authentic learning environments. In particular, drawing from my experience and expertise in linguistics and technology, I have been interested in designing educational technologies to enhance second/foreign language teaching and learning.

In 2005, I started working with Dr. Stephen Petrina on the “Emotech: Emotion and Technology” project. In collaboration with colleagues in education and computer science, I designed a chatbot to enhance language learners’ communicative competence. My initial focus was on programming the chatbot’s brain rather than its interface, founded a priori with a hypothesis that the essence of such an intelligent chatbot was not the interface but the brain.

I began the project with optimism toward AI technology in education. I believed that “language learners would love it.” Hence, initially I thought the challenge would be primarily the AI technology – how to program an intelligent chatbot and make it function as a language instructor. Due to my cognitive linguistic background, the design relied heavily on Chomsky’s universal grammar theory. The chatbot was designed based on a semantic analysis of language, to reveal a linguistic notion of the meaning of a given sentence. It functioned as a facilitator that could provide help to non-native speakers’ grammar and target language sentences. For example, the chatbot typically started a conversation where the learner attempted to reply to the chatbot according to coherence and meaning:

Chatbot: May I help you?

Learner: Sentence 1 – There is something wrong with my room

Sentence 2 – What is wrong with you

Sentence 3 – I need some help
The learner could select one of four options to respond to the chatbot. If the answer made sense, the chatbot would continue; otherwise, it would wait. My design did not stop at this level. I moved to the implementation and evaluation phase. The initial studies of the chatbot language facilitator were conducted in strictly controlled laboratory settings.

After four months’ testing at British Columbia Institute of Technology (BCIT), I began to question the initial design, in which a graphical interface was neglected. Data suggested that ‘the blank interface’ hindered learners’ participation: interacting directly with a machine was not as compelling to learners as learning directly with language instructors. Faced with low participation, I realized a design change was necessary, where I needed to place an equal emphasis on graphical interface design and place as much weight as on chatbot brain programming. No longer ‘the blank interface’, I made a decision to add avatars, animations and background environments as well as a speech recognition system. This shift was not limited to a design change. It also represented an evolution in our conception of human-computer interaction, in which the two parties, learners and chatbot, had to be considered equally. My initial rather abstract design notion that the chatbot technology itself (computer-driven) would be a strong draw to learners gave way to the appreciation that learners were indispensable in human-computer interaction and the interaction could only happen when learners feel comfortable in their interactions with computers.

As I was starting to put all my efforts into the second iteration of the design process to include the graphical interface, a commercial language tutor – chatbot Lucy – was tested for our study. With nearly perfect graphical design and similar ideas of a programmed brain, I used Lucy instead of our customized graphical design. During the implementation and evaluation, I employed an ethnographic laboratory study, in which fifteen ESL learners interacted with Lucy’s five modules. The findings revealed the promises of chatbot technology in terms of its
communicative function for creating an interactive learning environment. My investigation shifted to the classroom, where in contrast to my initial study in the laboratory, I studied the chatbot’s communicative function in naturalistic settings and noticed that the communication involved social interaction, although it appears the classroom settings are not typical of most research of second/foreign language learning with technologies. My above observation made me aware that I should take into consideration the dynamic role of social contexts. As a result, when studying Lucy, I gave more attention to the messy naturalistic settings than before.

The preliminary results suggested that in order for the chatbot’s communicative function to be meaningful to language learners, they had to satisfy language learners’ particular needs: either with helping learners survive in the target culture or facilitating learners reading and writing in the target language. I noticed that there was a gap between chatbot Lucy and our research participants’ learning requirements, in how chatbot Lucy, like those expatriate instructors in Shi (2009), failed to meet learners’ particular needs. Hence, our further design focus had to stress something of immediate value to learners’ needs.

The lesson I learned from this study is that switching back and forth from laboratory settings and naturalistic settings enhance and enrich understandings of a particular phenomenon in-depth. Due to the problem of existing methods situating research primarily in laboratory settings that did not evolve to capture learning in situ, I considered design-based research in my studies in light of theoretical changes.

The above appreciation led me to the third iteration of the design change with my doctoral dissertation toward an idea that human language instructors were indispensable – a move from human-computer interaction to human-virtual world interaction— interaction mediated through virtual worlds.
The appreciation of the idea of human-virtual world interaction for second language acquisition led me to research how technologies or affordances of a 3D virtual world platform might be shaped as an immersive language teaching and learning environment.

My dissertation research has been ongoing for the past three years and is part of a larger project and lab mobilized around How We Learn (Media and Technology Across the Lifespan) (http://blogs.ubc.ca/howwelearn) within the Department of Curriculum and Pedagogy at UBC. The HWL lab, funded through various agencies, including the Social Sciences and Research Council of Canada (SSHRC), sponsors and supports a range of undergraduate, MA, MEd, and PhD research theses.
Chapter One: Introduction

In a global economy and increasingly connected society, the acquisition of a second/foreign language has become more and more important. Foreign language learning typically takes place in the learners’ home countries, while second language learning primarily happens in an environment where the target language is spoken. Foreign language learning and second language learning share much—acquiring vocabularies, grammar, and pragmatic features—but differences exist. The surrounding environment, which is rich with linguistic and spatial clues, is often missing in foreign language learning. It is through immersion that foreign language learning most approaches second language learning. Immersion allows foreign language learners to more fully immerse themselves in language learning through intensive exposure to the target language. It has been shown that foreign language learners obtain greater benefits through an immersive language learning environment, which “promotes language learning by enabling the student to use the new language, not analyze or translate it” (Hamburger & Maney, 1991, p. 81).

Virtual worlds may offer foreign language learners opportunities to go beyond context boundaries to learn a target language, as in the target language speaking culture, without physically stepping out of their home countries. The specific instructional design of virtual worlds may blur boundaries between foreign language learning and second language learning by providing an opportunity for foreign language learners to experience the target language speaking culture without physically being in those targeted countries.

1.1 Statement of the Problem

Two critiques of learning in virtual worlds shaped this research: 1) many virtual worlds were designed as places where three-dimensional contextual objects and buildings did not invite
meaningful participation and interaction (Zheng & Zhao, 2009); and 2) “activities and approaches (in virtual worlds) – for example, task-based activities, role-play, vocabulary and grammar games – resembled those used in real world second language (L2) classrooms” (Zheng & Newgarden, 2012, p. 14).

Since Second Life, first released in 2003 and now one of the most popular virtual worlds in education, there has been an exponential rise in the number of language educators investigating the use of virtual worlds for language teaching and learning. However, as practitioners and researchers such as Dongping Zheng, Yong Zhao and Kristi Newgarden further explored current design practices in virtual worlds, they reported two challenges of using virtual worlds for language teaching and learning in terms of instructional design activities and approaches (Zheng & Newgarden, 2012; Zheng & Zhao, 2009). Writing of their experiences of exploring educational islands in Second Life, these scholars were concerned with the untapped affordances of virtual worlds for language teaching and learning. How might affordances of a 3D virtual world platform be shaped as an immersive language teaching and learning environment?

1.2 Research Questions

In this research, I was interested in exploring how the most powerful affordances of a 3D virtual world platform might be shaped as an immersive language teaching and learning environment. In order to address the design of immersive language teaching and learning in virtual worlds grounded in a embodied, situated and distributed theoretical design framework, three specific questions were formulated and explored:

Question 1:

What affordances do virtual worlds for language teaching and learning provide?

Question 2:
How should we design immersive language teaching and learning activities in virtual worlds to engage language learners?

- How do embodiment and avatars in a virtual world support second language acquisition?
- How can virtual world platforms support legitimate peripheral participation and engagement in communities of practice that are relevant to language learners’ needs through co-presence?
- How can virtual worlds be designed as places where three-dimensional contextual objects and buildings invite meaningful participation using a sculpted prim?

The third question aimed to test the effectiveness of an immersive language teaching and learning environment designed in virtual worlds. Experiments were conducted to statistically test specific hypotheses.

Question 3: Do language learners learning in the specific designed virtual environment feel real?

- Does a chatbot learning artifact increase language learners’ presence in the specific designed immersive virtual language teaching and learning environment?
- Does a time machine learning artifact increase language learners’ presence in the specific designed immersive virtual language teaching and learning environment?
- Does the combined use of a chatbot and time machine increase presence more than either learning artifact alone?
1.3 **Purpose of the Study**

Building on research literature (e.g., Zheng & Zhao, 2009; Zheng & Newgarden, 2012) of using virtual worlds for language education, I draw upon open source virtual world platforms to explore potential effective ways of designing immersive language teaching and learning environments in virtual worlds. I argue that virtual world adopters, language teachers, and instructional designers need to examine not only just the virtual world, the technological system, but also the broader embodied, situated and distributed concepts of language teaching and learning. Such an embodied, situated and distributed view of language teaching and learning, in contrast to the long-held information processing view, generates a new framework to design virtual worlds as effective technologies that might engage language learners.

Focusing on designing virtual worlds as a catalyst for change, three design phases, development of artifact, low fidelity prototyping, and high fidelity prototyping, were detailed and documented in this study. Design-based research and mixed methods, used to test and evaluate design, provided complementary data for understanding knowledge construction in immersive virtual learning environments.

1.4 **Theoretical Framework**

Central to my argument is a rethinking of language teaching and learning as embodied, situated and distributed throughout the socio-technical system, which implies a nonlinear progression from an initial state to a goal state. Language teaching and learning in virtual worlds calls for a design framework that prioritizes an embodied, situated and distributed view of language, enabling language learners to “steer their way through their zone of proximal development” within a language learning environment rather than transferring knowledge from teachers to students in a linear way (Angeli, 2008, p. 271). Theorization of language in terms of
embodied, situated and distributed activity allows researchers and practitioners to understand that language depends on being in a world that is inseparable from our bodies, our social history and our cultural traditions. My exploration of affordances of virtual worlds for designing immersive language learning environments was grounded in a rethinking of language teaching and learning as embodied, situated and distributed. These three concepts will be briefly introduced and defined in this section and elaborated in Chapter 2, the review of literature.

1.4.1 Embodiment

Cognition as an embodied action reflects an enactive approach in cognitive science. Enaction is one of the possible ways of organizing knowledge and one of the forms of interaction with the world. Enactive knowledge comes through action and doing, that is, as Bruner suggested, learning by doing (Bruner, 1966). Therefore, as Varela, Thompson and Rosch (1993) ask what cognition is, they say that cognition is “enaction – a history of structural coupling that brings forth a world” (p. 206).

Findings of embodied cognition and language acquisition were reviewed and summarized by Atkinson (2010, p. 605), and researchers such as Barsalou (2008), Gibbs (2006), Glenberg (1997), Iverson and Thelen (1999):

- The brain’s language areas activate during sensorimotor action (Bonda, Petrides, Frey, & Evans, 1994)
- Brain motor areas activate during speech (Hauk, Johnsrude, & Pulvermuller, 2004)
- Verbalization of memory is facilitated when assuming original body posture during recall (Dikjstra, Kaschak, & Zwaan, 2007)
- Linguistic tasks are facilitated when accompanied by action (Reiser, Garing, & young, 1994)
• Descriptions of spatial associations are comprehended faster than those of spatial
dissociations (Glenberg, Meyer, & Lindem, 1987)
• Words with high body-object interaction ratings are recognized faster than those
without (Saikaluk, Pexman, Aguilera, Owen, & Sears, 2008)
• Speech and gesture emerge together in infancy (Iverson & Thelen, 1999)

These points reiterate some of the findings of researchers on the interrelationships between
tenativism or complexity and learning (Brennan, Feng, Hall & Petrina, 2007; Davis & Sumara,
2006; Davis, Sumara & Luce-Kapler, 2000; Sumara & Davis, 1997).

The ability to be embodied in a virtual world differentiates virtual worlds from other
digital media. The embodied state of the avatar blurs the boundaries of our bodies and physical
environment (Zheng & Newgarden, 2012). Embodied in avatars, language learners may be fully
immersed in the simulated virtual life and go beyond context boundaries to learn a foreign
language without physically stepping out of their home countries. As Zheng (2012) summarized,
the embodiment enables language learners to move from space to space, to interact with objects,
to be with others and to do things with others. The embodiment makes virtual worlds potentially
ideal spaces for language teaching and learning.

1.4.2 Situated Learning

I also take cognition to be situated activity, as argued by Lave and Wenger in Situated
Learning: Legitimate Peripheral Participation, which places learning in social relationships,
situations of co-participation. Learning happens not merely in the heads of individuals but
involves participation in a community of practice (Lave & Wenger, 1991).

Language learning seen as the internalization or the acquisition of a body of linguistics
dominated the language education field for decades. It emphasizes that learning is a process
located inside an individual’s brain. However, current research and practice in language teaching and learning calls for a particular attention to the importance of “the social contexts in which a second language is learned, the learners’ relations with other participants in the community and their different modes of participation” (Mari-Haneda, 1997, p. 12). The situated character of language education offers a new framework to understand language learning involved in a community of practice. Under this notion of language teaching and learning, “the second language learner is seen not as internalizing the second language, but rather as a newcomer beginning to participate in the practices of a particular community” (Toohey, 1996, p. 553).

Virtual worlds are potentially ideal places where communities of practice supporting language learners go beyond the limitation of a physical environment in real life, collaborate to generate ideas, share interests and needs as well as learn from peers. Furthermore, virtual worlds are platforms that encourage relationships among learners. In virtual worlds, learning is seen as relationships among people. Language learners become participants in a community based on their common shared interests, as evidenced in the Dogme Language Teaching Movement among language educators in Second Life.

1.4.3 Distributed Cognition

Distributed cognition provides a framework for understanding knowledge and learning in techno-cultural contexts. Distributed cognition, as theorized by Edwin Hutchins in Cognition in the Wild, considers the significance of social and material structures in the process of knowledge construction. It is “a new branch of cognitive science devoted to the study of the representation of knowledge both inside the heads of individuals and in the world” (Flor & Hutchins, 1991, p. 37). It is concerned with “the structure – representations inside and outside

the head – and the transformations these structures undergo and emphasizes on “understanding the coordination among individuals and artefacts, that is, to understand how individual agents align and share within a distributed process” (Nardi, 1996, p. 39).

My understanding of a distributed view of language learning originates from discussions and publications of the Distributed Language Group\(^2\) and our research within the HWL project (Petrina, Feng & Kim, 2008). Applied at the new LINGUAPOLIS Language Institute at the University of Antwerp, distributed language learning is a methodological and conceptual framework for designing competency-oriented and effective language education. It emphasizes the design of a language learning environment for a specific language learning situation (Colpaert, 2007). The design is based on a thorough analysis of various actors, learning places, channels, content types, and media in the learning situation. The core of the design is goal-oriented conceptualization and ontological specification (Colpaert, 2007). Distributed language learning requires a detailed description of “the architecture of the language learning environment, defined as the network of interactions between learners, co-learners, teachers, content, native, etc, inside or outside the learning place” (Colpaert, 2007, p. 1). It also “specifies the role of technology as a set of activities defined as forms of interaction, communication and information, mediated or not” (Colpaert, 2007, p. 2).

In virtual worlds, learning is not confined to an individual (being in the mind), rather, it is distributed across objects, individuals, artifacts and technologies in the environment. Virtual worlds, when integrated into the flow of language learning environments “not only amplify what humans do, but also shape human cognition by facilitating the construction of mental representations of abstract concepts and phenomena through the use of advanced computer visualizations and simulations” (Angeli, 2008, p. 271).

\(^2\) http://www.psy.herts.ac.uk/dlg/
The embodied, situated and distributed view of language teaching and learning constitutes the theoretical grounding for this research. The theoretical focus is on how language teaching and learning is embodied, situated and distributed throughout the socio-technical system, which includes teachers, students, virtual world technologies, and various artefacts in virtual worlds and on how language teaching and learning depends on both internal and external representations. I hold a belief throughout the dissertation that culture, context and history are “fundamental aspects of human cognition and cannot be comfortably integrated into a perspective that privileges abstract properties of individual minds” (Hutchins, 1995, p. 354).

1.5 Conceptual Framework

Figure 1 summarizes the conceptual framework for this study, which highly values openness – open content, open source, open learning and open access. The conceptual framework demonstrated that a commitment of this study was to the free flow of information and an unprecedented capacity to share. I shifted from proprietary products to open source for all chosen technologies used in this research project due to the core value – freedom. This research project shifted from 2D to 3D as well.
This research was associated with three types of openness – social, technical and methodological. The social openness consists of four freedoms: the freedom to run the designed learning system for any purpose; the freedom to study how the designed learning system works, and adapt it to users’ needs; the freedom to redistribute copies so peers may help peers; and the freedom to improve the designed learning system in this study, and release improvements to the public, so that the whole community benefits.

The technical openness makes interoperability and functionality possible. Technical interoperability allows us to independently develop systems to interact and co-exist. Technical functionality allows new systems to be incorporated into existing infrastructure.

Methodological openness makes the cyclic research design possible. There is not an ending point of the cyclic research design. Each phase is the refinement of the previous research. The iterative design process pushes forward the more robust design of the intervention.

Social openness, technical openness and methodological openness played an extremely important role in the design and development phase of the project. These iterative design processes involving openness are discussed further in Chapter Three.

1.6  Dissertation Overview and Its Structure

Guided by findings of researchers such as Zheng, Zhao and Newgarden, my dissertation responded to and built upon two critiques reported: many virtual worlds were designed as places where three-dimensional contextual objects and buildings did not invite meaningful participation and interaction (Zheng & Zhao, 2009) and “activities and approaches (in virtual worlds) – for example, task-based activities, role-play, vocabulary and grammar games – resembled those used in real world second language (L2) classrooms” (Zheng & Newgarden, 2012, p. 14).
Informed by openness, I mapped four potential open source virtual world platforms, namely, *Open Cobalt, Open Wonderland, OpenSimulator* and *RealXtend* for developing an immersive virtual language teaching and learning environment, because they were freely available over the Internet and had licenses that allowed modification and redistribution. Based on the feasibility study, I selected the *OpenSimulator* platform, because it not only had the largest communities sharing artifacts for helping each other but also could be used with Moodle, an open source learning management system.

Consistent with the embodied, situated and distributed theoretical design framework and the value of openness, this research project aimed to investigate the most powerful affordances of a 3D virtual world platform that might be shaped as an immersive language teaching and learning environment.

Design-based research as a context sensitive methodological approach was employed to develop pedagogical innovations in virtual worlds due to its ability to bring together theory and practice to understand how, when and why a particular design worked. Throughout the research project, I argued that design was a process, which, as opposed to summative research, dealt with complexity through “progressive refinement” and multiple iterations (Collins, Joseph, & Bielaczyc, 2004, p. 18). These multiple iterations made it possible for a design to function beyond its initial conditions of development. A revised Middleton’s cyclic design-based research model, incorporating a prototype fidelity design loop from human-computer interaction, was used to collect data.

The dissertation is divided into five chapters. Chapter One was an introduction of the research including purposes, problems, questions, theoretical framework – embodied, situated and distributed and conceptual framework (open access, open learning, open content and open source). Chapter Two is a literature review, in which I present a solid foundation to ground the design and research. It provides a critical review of current practices of virtual worlds designed
for language teaching and learning informed design practices in this research, which are
grounded in an embodied, situated and distributed view of language teaching and learning.
Unique features of virtual worlds such as avatar, co-presence and sculpted primitive, are
discussed with the underlying theoretical design framework of rethinking language teaching and
learning as embodied, situated and distributed activities.

Chapter Three presents the methodology used for the purpose of design and data
collection. I describe characteristics of design-based research and discuss my revision of
Middleton’s cyclic model of design-based research as a way to conduct design experiments.
Every procedure in each design phase – development of the artefact, low fidelity prototyping and
high fidelity prototyping – is detailed and documented so that others who are interested in the
work might replicate the design and generate their own assertions of the affordances of virtual
worlds for language teaching and learning.

Chapter Four analyzes data and reports findings. This chapter includes three data
analysis phases. The first data analysis phase was feasibility study data analysis. A feasibility
study was conducted to test the initial design of the artefact. Synthesizing data from literature
(overview of Open Cobalt platform, Open Wonderland platform, RealXtend platform and
OpenSimulator platform), the design was pushed to the low prototyping phase. The second data
analysis phase, field study, was conducted in pre-service teacher education cohort to
preliminarly explore the design of the chosen virtual world platform – OpenSimulator.
Grounded in the embodied, situated and distributed view of language teaching and learning,
design principles were generated and theorized by participants. These design principles again
pushed the design to the next high fidelity prototyping phase. The design in the third data
analysis phase arrived at a higher level and design experiments both qualitative and quantitative
were conducted to further explore powerful design features of a 3D virtual world platform for
creating an immersive language teaching and learning environment.
Chapter Five concludes the study by reporting conclusions, discussions, implications, and future research directions of using an open source virtual worlds platform to design immersive language teaching and learning environments.
Chapter Two: Literature Review

This chapter traces the research literature related to language teaching and learning in virtual worlds. I begin with a review of characteristics of virtual worlds, including synchronicity, persistency, simulation, co-presence, and interactivity. This is followed by a review of empirical practices for designing, language teaching and learning in virtual worlds. I then proceed with an extended analysis of the theoretical framework for the research, including embodiment, situated learning, and distributed cognition. I conclude with challenges to rethink design practices in these virtual worlds.

2.1 Characteristics of Virtual Worlds

“Developers can build their own small streets feeding off the main one. They can build buildings, parks, signs, as well as things that do not exist in Reality…”

“The only difference is that since the Street does not really exist – it’s just a computer-graphics protocol written down on a piece of paper somewhere – none of these things is being physically built. They are, rather, pieces of software, made available to the public over the world-wide fiber-optics network…”

“When Hiro goes into the Metaverse and looks down the Street and sees buildings and electric signs stretching off into the darkness, disappearing over the curve of the globe, he is actually staring at the graphic representations – the user interfaces – of a myriad different pieces of software that have been engineered by major corporations…”

“They are audiovisual bodies that people use to communicate with each other in the Metaverse…”

“It takes a lot of practice to make your avatar move through the Metaverse like a real person. When your avatar has just lost its legs, all that skill goes out the window…”

“The Metaverse – the entire Street – exists by virtue of a network that I own and control…”

“Where are you” Hiro says.

“In Reality or the Metaverse?”

“Both.”

“Where do they work?”

“One in Israel. One at the British Museum. One in Iraq. One at the University of Chicago. One at the University of Pennsylvania. And five at Rife Bible College in Houston, Texas.”

“Nice distribution.”

— Neal Stephenson, 1992
The above excerpts are from Stephenson’s novel *Snow Crash*, in which Stephenson describes a world that has become a very different Earth in a near future. There is not only the real world but also the Metaverse, which humans can access through networked computers and where humans as avatars can interact with each other in a three-dimensional earth. The line between human and machine, between natural and artificial, as well as between the real world and the Metaverse is blurred as Hiro stays both in Reality and the Metaverse.

The scientific imagination of the Metaverse in Stephenson’s *Snow Crash* inspired many creators of current virtual worlds such as *Active Worlds*, *Second Life* or *OpenSimulator*. As Stephenson envisions, virtual worlds, the Metaverse, attract a growing number of people in this digital era (Book, 2004; Cooper, 2009; Hayes, 2006).

Then, what exactly are virtual worlds? At present, there is no agreed-upon definition of virtual worlds\(^3\) due to the great diversity to name media variables such as interface, goals, systems, technological agency, user autonomy and social environment (Schroeder, 2008). Among numerous informal and formal definitions of virtual worlds, four of them are particularly influential. Bartle defined virtual worlds as places where the imaginary meets the real” (Bartle, 2004, p. 1). In Designing *Virtual Worlds*, Bartle explained that “virtual worlds are implemented by a computer (or network of computers) that simulates an environment…because several such people can affect the same environment simultaneously, the world is said to be shared or multi-user. The environment continues to exist and develop internally even when there are no people interacting with it; this means it is persistent” (Bartle, 2004, p. 1). Bartle’s definition drew out five essential

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\(^3\) Terra Nova blog provides a debate about definitions of the virtual world: [http://terranova.blogs.com/terra_nova/2004/06/a_virtual_world.html](http://terranova.blogs.com/terra_nova/2004/06/a_virtual_world.html)
characteristics of virtual worlds – networked, simulated, simultaneous, shared and persistent.

Castronova considered virtual worlds as synthetic worlds – “crafted places inside computers that are designed to accommodate large numbers of people” (Castronova, 2005, p. 4). Castronova introduced a new concept, “synthetic,” into these digital environments, by which he meant “combination.”

Schroeder defined a virtual world as “a computer-generated display that allows or compels the user (users) to have a sense of being present in an environment other than the one they are actually in, and to interact with that environment” (Schroeder, 2008, p. 2). Schroeder’s definition emphasized the concept of “being present” more than other characteristics of virtual worlds. Alternatively, Bell’s definition focused on avatars, which was lacked by other definitions, as he regards a virtual world as “a synchronous, persistent network of people, represented as avatars, facilitated by networked computers” (Bell, 2008, p. 2).

Growing out of the Metaverse from Stephenson’s novel *Snow Crash*, seven characteristics that represent virtual worlds were summarized in this research, namely, synchronicity, persistency, simulation, avatar, co-presence, interactivity, and networked communication. These seven characteristics of virtual worlds constituted the perceived and actual properties that determined why virtual worlds could be used to design an immersive language learning environment.

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4 Bartle uses the word “simultaneous” (see above discussion).
5 Both Bartle and Bell’s definitions include the “persistent” characteristic of virtual worlds.
6 Bartle includes simulation concept when he defines virtual worlds (see above discussion).
7 Bell uses the term “avatar” to refer to human inworld.
8 Schroeder uses the term “being present”.
9 I add interactivity to the definition of virtual worlds from the excerpts of *Snow Crash*.
10 Bartle, Castronova and Bell all include “networked people”.
2.1.1 Synchronicity

Virtual worlds make all forms of synchronous communication available – voice, instant message (IM), group chatting and group voice. The sense of synchronicity represents a special type of interaction – verbal communication that can be of benefit to foreign language learners. Warschauer (1996) reported that the greatest advantage of synchronous computer-mediated communication in foreign language learning was that language learners tended to produce more target language output than in normal classroom settings. Even quiet students who did not usually speak up much in class participated more in a synchronous computer-mediated communication setting (Warschauer, 1996). Furthermore, a number of research studies showed that synchronous computer-mediated communication did facilitate negotiation of meaning (Blake, 2000; Fernandez-Garcia & Martinez-Arbelaez, 2002; Kitade, 2000; Pellettieri, 2000; Smith, 2003). For example, Fernandez-Garcia and Martinez-Arbelaez (2002) conducted a study on the Open Transport chat group format on Macintosh computers with native speakers of English in their third year of studying Spanish as their L2 (second language). They concluded that synchronous computer-mediated communication in the L2 classroom not only gave learners opportunities to negotiate meanings but also enabled them to do so at their own paces. Also the synchronicity produced positive effects when it came to the sociolinguistic aspects (Kitade, 2000; Schwienhorst, 2004; Smith, 2003; Warschauer, 1996). Kitade’s research (2000) explored quiet speakers in L2 learning. The results showed that quiet speakers were more expressive in synchronous computer-mediated communication (Kitade, 2000). Another example was learning Chinese in Second Life conducted by Henderson, Huang, Grant and Henderson (2009). Their results showed that the synchronous interaction such as text chat and voice in Second Life increased learners’ self-efficacy beliefs (Henderson et al., 2009). At present, the understanding of the synchronicity of virtual worlds to facilitate language learning is primarily based on
synchronous computer-mediated communication such as chat-room or MOOs. Hence, more empirical further studies are required.

2.1.2 Persistency

Persistency suggests that virtual worlds continue to exist regardless of whether individual users log in or not. Such a persistent world may provide users with an asynchronous learning environment. The system (e.g., the Chinese restaurants designed on Chinese Island in *Second Life* by Monish University) and learning artifacts (e.g., videos / menus on Chinese Island in *Second Life*) exist with or without users’ presence. Learners can return to the system at any time at any place and interact with these pre-designed learning environments and artifacts. Schwienhorst (2002) argued that the persistent record in virtual worlds not only provided learners with “personally meaningful authentic material in the target language but also allowed them to critically examine their own performance, or rather, the performance of their virtual selves” (Schwienhorst, 2002, p. 202).

2.1.3 Simulation

Simulation, a visual component of virtual worlds “redefines the landscape of online interaction away from the text and toward a more complex visual medium” (Thomas & Brown, 2009, p. 38). Virtual worlds have an ability to simulate scenarios in real life. These simulations “can be used to facilitate learning tasks that lead to the development of enhanced spatial knowledge representation of the explored domain” (Dalgarno & Lee, 2010, p. 18). That means, language learners are allowed to interact with objects in virtual worlds to construct a personal understanding of entities. They may benefit from the special knowledge representation provided by simulations. For example, language learners, especially foreign language learners may encounter difficulties in imagining foreign words that do not exist in their home language. Due to
some imaginary learning entities that are difficult to reach in real life, language learners, especially foreign language learners, can experience 3-D conceptual models of objects and through simulations get some sense of the concept that does not exist in their mother language.

Furthermore, the simulated scenarios may facilitate experiential linguistic practices that are impractical to undertake in the real world for foreign language learners. For example, ESL instructor Nergiz Kern\textsuperscript{11} used a kitchen fire simulation language lesson in Second Life. Kern simulated a fire starting in the kitchen while preparing the meal. Language learners would learn expressions and communication skills in this realistic simulation in order to work together to ensure the group’s safety.

Last but not the least, simulation may provide language learners a knowledge transfer moment, which something learned in one context (e.g., role play in virtual worlds) can be performed in a different context (e.g., real life).

\textbf{2.1.4 Avatar & Co-Presence}

Away from text-based online interaction navigated through text-hyperlinks, virtual worlds provide for the embodiment of learners in the form of an avatar (Thomas & Brown, 2009). Through the navigation of an avatar, learners may be fully immersed in three-dimensional content through touching and manipulating. Their avatars make it possible that although learners’ physical bodies are spread out all over the world, they can co-present in a shared geographical virtual space. Avatars and co-presence together provide learners an ability to interact with each other in real time. In virtual worlds, real-time interactions create a game culture rather than a predefined game narration. Meanings, instead of being pre-built in, may emerge from such complex real-time interactions. This characteristic of virtual worlds “give a sense of authenticity, which can be manipulated in a language learning context” (Deutschmann

\textsuperscript{11} Please see the detailed description of the project: http://slexperiments.edublogs.org/
of giving directions to a physical location in *Second Life* is not a make-believe scenario, but can actually be translated in the real action of walking your avatar to the place in question” (p. 312). This means, in virtual worlds, unlike real life classrooms, language learners can physically follow the direction in question and get to the place in person through manipulating an avatar as they learn to ask for directions.

Furthermore, “virtual presence can result in reduced apprehension and embarrassment”, which Henderson refers to as an “affective filter” (Henderson et al., 2009, p. 466). Such an “affective filter” lowers language learners’ levels of anxiety, “a beneficial factor in language learning contexts” (Deutschmann & Panichi, 2009, p. 312).

### 2.1.5 Interactivity

Interactivity in virtual worlds gives learners an ability to alter, develop, build or submit customized content. It is learners who shape and to a large extent create the world they inhabit (Book, 2004; Thomas & Brown, 2009). Transition into virtual worlds allows learners to bring many of their physical world attitudes, dispositions, and beliefs into the virtual space. As a result, these three-dimensional spaces, to a large degree, are culturally imagined and are continually infused with new meanings (Thomas & Brown, 2009). Such a contextual interactivity between learners and the environment and between learners from one culture and learners from another provides language learners opportunities to disclose themselves to understand who they are and who they are talking to. As a result, they may then communicate with ‘others’ based on mutual understanding. Ma’s investigation showed that there was a greater level of self-disclosing and intercultural awareness in text-based virtual worlds than in face-to-face exchanges between East Asian and North American college students (Ma, 1996).
2.1.6 Network Communication

Virtual worlds provide a high degree of collaboration and co-construction of the environment. Similar to the WWW, shared interests and networks tie together notions of community in virtual worlds. Virtual worlds’ communities are more than online communities, where shared interests unite people from different physical places and engage learners to do group work with high degrees collaboration.

2.2 Current Design Practices of Language Teaching and Learning in Virtual Worlds

This section describes current design practices of language teaching and learning in virtual worlds. Projects reviewed in the dissertation depend on the fact that technology is constantly changing. New projects that we may take for granted in future years would have been the stuff of science fiction today. My dissertation research project built upon these previous projects and I highly respect findings from these early adopters’ practices of virtual worlds for language teaching and learning.

An earlier research project, Kamimo Education Islands,12 sponsored by Norgesuniversitetet, Norwegian Open University, provided language teachers a virtual space to teach foreign language in Second Life. The project aimed at testing and evaluating how good the selected virtual environment (Second Life) was as a learning platform from a lifelong learning perspective. The one-year pilot study allowed the project to conclude that Second Life had enormous educational potential to increase learning due to its immersive nature and social networking facilities (Hundsberger, 2009). This pilot study resulted in the birth of AVALON13

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12 http://home.himolde.no/~molka/about-kamimo-islands.htm
13 http://www.avalonlearning.eu/
project (Access to Virtual and Access Learning Live Online), a two-year project funded by the European Commission.

AVALON described good practices in the teaching and learning of languages using Second Life and had a number of objectives: create and test out exemplar language learning tasks and activities designed to promote communication amongst learners, create and pilot a training course for teachers who would like to extend their teaching skills to include working in virtual worlds, store all the 2D and 3D materials produced during the project for the use by any organization wishing to use these materials and create technological solutions to enable teachers and students to more easily access the materials created in the project.

Another EU-funded NIFLAR project (Networked Interaction in Foreign Language Acquisition and Research) explored language learning in virtual environment OpenSimulator and Second Life. NIFLAR OpenSimulator / Second Life virtual world had four voice-enabled regions: reception region, Projectlandia, Asterix village and an open area that represent the city of Landia. Fourteen Dutch students of Spanish (at B1 proficiency level) from Utrecht University and 7 pre-service teachers of Spanish from the University of Valencia participated the NIFLAR Project with a focus on intercultural aspect of language exchanging from February to April 2010. The project found that virtual environment OpenSimulator and/or Second Life allowed students to be able to do things that they could not do in the classroom. Also, the opportunity to talk to a native speaker augmented Dutch learners' learning Dutch.

One of NIFLAR project’s contributions was the development of a set of design principles for interaction tasks aiming at maximizing authentic social interaction and

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14 http://cms.hum.uu.nl/niflar/index.php?page=experiences
15 http://131.211.194.110/site1/SilverlightPlayer/Default.aspx?peid=49f8cf238e3d463e809ebe70461d75d2
16 See the article for design principles for communicative competence and intercultural competence p. 78-p.79
intercultural awareness, while exploiting the specific affordances of the virtual environment being used. A case study was conducted to test these design principles, in which two foreign language learners of Spanish and two pre-service teachers carried out four interaction tasks in the virtual world of Second Life (Jauregi, Canto, Graaff, Koenraad, & Moonen, 2011). The results showed that the virtual setting was not artificial for the participants to focus on intercultural issues, but there were few opportunities for intercultural interaction with unknown or anonymous avatars in Second Life. They reported that passers-by were not present, or not interested in communicating. The case study also found out that the more participants carried out Second Life specific tasks, the less oral communication took place. This case study contributed to the creation of tasks when using virtual worlds for language teaching and learning.

Virtlantis,17 sponsored by Oxford School of English and the University of Western Australia, was a free open community for language learners and teachers in Second Life. Virtlantis was stimulated by the idea of knowledge sharing— you teach me your language and I will teach you mine. It provided language learners and teachers with about 30 launch rooms used as classrooms. Virtlantis also offered free informal language learning activities for language learners such as reading in English, English conversation practices through teatime, French conversations, campfire English for practicing listening and English pronunciation. Its members grew very fast with more than 500 language learners from different countries within a year. However, unlike the AVALON project, the ongoing language learning activities at Virtlantis provided few research reports available for reference.

Another project was the 300,000 square meters of Chinese virtual island18 in Second Life designed by Monash university to facilitate Chinese learning. A quantitative study was conducted to investigate how virtual learning in Second Life could sustain or improve students’

17 http://www.virtlantis.com/
18 http://www.virtualhanyu.com/
self-efficacy beliefs (Henderson et al., 2009, p. 464). This study focuses on engaging students in a collaborative activity to learn Chinese in contexts such as identify and order food in a Chinese restaurant. One hundred undergrad students enrolled in Chinese language course participated the study. The Chinese language course ran every first semester of each year and was designed for learners who had essentially never formally studied Mandarin before. Apart from using Second Life, this course also consisted of the traditionally weekly lectures, tutorials, and independent study based on textbooks and other materials. The purpose of using Second Life was to provide students authentic opportunities to read and write in Mandarin (e.g., read a menu, order food) and to participate in a dynamic, semi-spontaneous scenario. The quantitative results from the pre and post questionnaires supported the research hypothesis that there was a statistically significant increase in students’ self-efficacy beliefs when learning Mandarin in Second Life.

A one-year pilot case study of instructional design in Second Life, conducted by Mayath, Traphagan, Heikes and Trivedi (2011), aimed at exploring challenges of implementing Second Life in higher education. A mixed-method evaluation approach was used to understand students’ Second Life experiences. The pilot study examined two types of instructional activities using Second Life to learn English in an undergrad course at a South Western University in US. Eighteen freshmen, six male and twelve female students, none of whom had used Second Life prior to the pilot study, participated the study. The professor who had 20 years’ experience using technology taught this writing and rhetoric course. Second Life was chosen because it “provided a higher level of graphical fidelity, communication and interaction” (Mayrath et al., 2011, p. 128). “Building activity” was implemented in the first semester, in which the teacher required students to integrate visual and verbal rhetoric design in Second Life. Students first explored the university’s physical campus and studied various styles of architecture. Then they chose an ideal style for a new campus building and created a model of their vision using building tools in Second Life. The building activity culminated with a persuasive essay arguing why their
buildings were ideal. The second activity was in the second semester, which aimed to explore leadership through role models. Students started to customize their Second Life avatars to look like their role models and then wrote short essays on role models of their choice. The results of the study showed that the use of virtual worlds must be directly relevant to the course context and closely tied to course learning objectives. In the study, students viewed the role models activity as more successful because it was directly linked to learning objectives and fit the context of the course, while the building activity was not quite successful because it was only tangentially related to learning objectives and class context (Mayrath et al., 2011). The role models activity also supported the idea that “virtual world activities can increase collaboration and allow students to learn about alternative perspectives and identities” (Mayrath et al., 2011, p. 136). This pilot study added to the existing literature on instructional uses of virtual worlds by demonstrating best practices of designing Second Life instructional activities.

2.3 **Rethinking Design Practices of Language Teaching and Learning in Virtual Worlds**

To study new media is not only to study exclusively today's but also to study a variety of media in their historic contexts. Such an exploration helps us to recover past senses of media in transition. Those moments of transition may deepen our historical understanding of all media and thus sharpen our critical awareness of how media and technologies go beyond their initial innovation to acquire their new meanings and power (Gitelman & Pingree, 2003).

The point here is when we look at the historical contexts of all new media technologies, we understand the transition of how new technologies are treated like the old ones when they are not yet fully defined and their significance is still in flux. The historical development of new technologies also informs us why they have been recreated based on
familiarity. One example from *New Media 1740-1915* explains the importance of examining the historic contexts of new media technologies. Tracing the history of how we looked at the new media technology of the phonograph, we understood why the logo was His Master’s Voice not His Master’s Music (Figure 2).

![Figure 2. “His Master's Voice” logo with Nipper](http://en.wikipedia.org/wiki/Victor_Talking_Machine_Company)

When the phonograph was first introduced into our society, it was initially used to record human voices. The emphasis was on voice. Following our conventional lines, a phonograph would be only involved in recording. It took only a short while before it was understood that the phonograph could be used for music. Using a phonograph to record music basically reanimated and archived our live performances, which no one had done before. The historic contexts of the phonograph allowed us to understand how it went beyond its initial innovation to acquire its new meaning and power.

The reason I introduced this aspect of the historical development of new media and technologies was to suggest a critical philosophical understanding of the two critiques that
sparked my interest in this project: 1) many virtual worlds were designed as places where three-dimensional contextual objects and buildings did not invite meaningful participation and interaction (Zheng & Zhao, 2009); and 2) “activities and approaches (in virtual worlds) – for example, task-based activities, role-play, vocabulary and grammar games – resembled those used in real world second language (L2) classrooms” (Zheng & Newgarden, 2012, p. 14).

Currently, virtual worlds are relatively novel for formal learning. We do not fully understand how to use them in a truly innovative way. We recreate what we’ve created because the familiarity provides continuity and security. Figure 3 depicts how learning typically unfolds in virtual worlds. Here, virtual classrooms are something like real life classrooms, where three-dimensional contextual objects and buildings did not invite meaningful participation and interaction (Zheng & Zhao, 2009). Avatars are sitting around virtual tables, watching virtual PowerPoint presentations. A presenter avatar is standing and talking in the middle of the virtual classroom. The design of the virtual learning environment in Figure 3 is a familiar recreation of a dynamic real-life learning environment. One question here is why do we use virtual worlds if we replicate real life activities?

Figure 3. Presentation in virtual worlds

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20 The picture is from John Lester’s presentation for 2012 Virtual Enterprise Conference at Glyndwr University
Is this the best we can do with virtual worlds? Before we can answer what is the added value of virtual worlds for language teaching and learning, we ought to know the affordances of virtual worlds. For me, the biggest role of virtual worlds is their ability of to fully embody people in places, not people per se, not places per se, but people in places. Hence, best design practices should rethink how the embodied character of virtual worlds can be integrated into the current reservoir of design principles. Such a rethinking of design practices in virtual worlds based on an embodied, situated and distributed activity throughout the socio-technical system may allow us to get full potential use of virtual worlds. As a result, three concepts for language education (enaction, communities of practice, and distributed learning) should gain our attention when using virtual worlds to teach / learn a second/foreign language.

2.3.1 Why Rethink Language Learning Theories Behind Design Principles?

Theory frames how we look at and think about a topic. It gives us concepts, provides basic assumptions, directs us to the important questions, and suggests ways for us to make sense of data. Theory enables us to connect a single study to the immense base of knowledge to which other researchers contribute. To use an analogy, theory helps a researcher see the forest instead of just a single tree; or helps one see the single tree in different light and shades. Theory increases a researcher’s awareness of interconnections and of the broader significance of data (Neuman, 2003, p. 65).

Neuman calls for a careful attention to theory, which may frame what we see and think. A distributed cognition approach to examining the design of immersive language learning environments does not emerge out of nowhere. Dissatisfied with a theoretical tradition in

https://docs.google.com/presentation/d/1_GF9O6Qmm1hFevaYdTa0oNBxI4GTKIfdF-vbhLg9jLE/edit#slide=id.g1306e9a_1_53
studying cognition, distributed cognition sheds light on the situated, context-dependent, socially
and culturally distributed nature of mind (J. S. Brown, Collins, & Duguid, 1989; Hutchins, 1995;
Lave & Wenger, 1991; Salomon, 1993). Furthermore, the collaboration of individuals and
computers cannot easily be accounted for by individual cognition (Salomon, 1993). Technology
plays a different role “in handling intellectual tasks” (Salomon, 1993, p. xiv). It becomes part of
the cognitive process and should be accounted for in the learning process.

The point of departure for the discussion of dissatisfaction starts from the consideration
of a variety of theoretical approaches to language learning with technologies. Researchers seek
ideas for “how SLA (second language acquisition) happens that can be used as a basis for
decisions that go into the design and evaluation of technology for language learning” (Chapelle,
2009, p. 742). “Over the past 20 years, SLA theory has been productively mined for insights into
the design of materials and for the design and interpretation of research” (Chapelle, 2009, p.
751). The pragmatic goal of practitioners and researchers to create learning opportunities pushes
them to consider a variety of theoretical approaches to second language acquisition.

Dissatisfaction with the Behaviorist Tradition

In the 1950’s and 1960’s, language learning was based on a behaviorist tradition, in
which the learner’s external environment served as a stimulus for the processes of learning.
Language learning was essentially regarded as a “habit formation,” the process of making a link
between stimuli and responses (Bloomfield, 1933, pp. 29-31). That is, language learning was a
process to produce a response to a stimulus and receive a positive or negative reinforcement. A
certain amount of positive reinforcement might form a habit. Two theories, the contrastive
analysis hypothesis theory and error analysis theory were popular under this tradition.

The contrastive analysis hypothesis theory, based on the structural linguistic theory,
had two versions – *a priori* and *a posteriori*. The *a priori* version was a prediction of all areas of
difficulty in learning a language in advance, while the *a posteriori* version was the process of comparing languages after the actual problem occurred. In general, the contrastive analysis hypothesis theory focused on the difference between the first language and the target language. “Those elements that are similar to his native language will be simple for him, and those elements that are different will be difficult” (Lado, 1957, p. 2). Hence, the observed differences paid more attention to the goal of preventing wrong habits. Making errors was regarded as “the negative transfer of the learner’s first language habits to the target language habits” (Johnson, 2004, p. 24).

With dissatisfaction with the role of errors, the contrastive analysis hypothesis theory underwent a major revision. Errors were considered indispensable for language learning (Corder, 1967). They were different from mistakes and did not need to be avoided. As a result, error analysis theory was reconsidered. This theory, instead of comparing the observed learner’s errors with the learner’s native language, compared the observed learner’s errors with the target language. Hence, error analysis pushed the learner’s errors to the foreground as the focus of scientific investigation.

The first dissatisfaction of the behaviourist view is researchers’ sole interpretation of language learners’ manipulated behaviour and response. Here, language learners’ mental processes were disregarded due to being inaccessible to external observation. Their minds, viewed as too subjective and hidden from observation, measurement and verification, were least considered. That is, learners’ thoughts and feelings, their own interpretation of their behaviours elicited during the experiment, were ignored. Subjective data were considered unscientific and unreliable. Hence, only researchers could interpret learners’ behaviours according to testing or experimental hypotheses.

The second dissatisfaction with this tradition is its strong emphases on statistical relations between stimuli and responses. Within this research tradition, learners were examined
in a laboratory experiment under the control of researchers. Their behaviours were manipulated and measured in a way to test requirements of a research hypothesis determined in advance. There was little individuality of learners’ intentions. Whenever their performances fell outside the group’s behaviours, they were often eliminated from the study.

These dissatisfactions, together with Chomsky’s attack on Skinner’s behaviourism contributed to shifting the behaviouristic approach to the second language learning background. The cognitive tradition with an emphasis on the learner’s mental world emerged to centre stage.

**Dissatisfaction with the Cognitive Tradition**

Dissatisfied with the behaviorist tradition, the cognitive tradition, which was strongly embedded in Cartesian philosophy, placed a strong emphasis on the human mind that includes thoughts, emotions and mental processes. In the cognitive tradition, the mind was considered to be superior to the body and became the main focus of scientific investigation. In contrast to the behaviorist tradition, the learner’s own interpretations of the elicited behavior and understanding of the investigated mental phenomena were the primary focus.

Noam Chomsky’s linguistic theory became the exemplar in the cognitive tradition. Chomsky’s theory of universal grammar placed the focus on a set of abstract innate principles that could apply to all natural language (Chomsky, 1981a, 1981b). Although Chomsky’s universal grammar theory shed its light on native language acquisition, it would “add both clarity and explanatory power to the research being carried out in SLA” (Gregg, 1989, p. 34). Researchers within Chomsky’s tradition acknowledged that a set of formal logical rules governed any cognitive system (Gregg, 1989). Although Chomsky’s universal grammar was applied to one’s native language learning, second language learning also needed “a set of formal and logical rules that describe and explain L2 (second language) linguistic competence”
Chomsky’s linguistic theory had a profound impact on most existing information processing models such as Krashen’s monitor model.

Krashen’s well-known monitor model consisted of five hypotheses: the acquisition-learning hypothesis, the monitor hypothesis, the natural order hypothesis, the input hypothesis and the affective filter hypothesis. The acquisition-learning hypothesis made a distinction between acquisition and learning. According to Krashen, there were two ways of getting knowledge about language: the subconscious processes that resulted in acquired knowledge—acquisition—and the conscious processes that resulted in explicit knowledge about the grammatical properties of a second language—learning. Krashen claimed that “our ability to produce utterances in another language comes from our acquired competence, from our subconscious knowledge. Learning, conscious knowledge, serves only as an editor, or monitor” (Krashen, 1985, p. 1). The third hypothesis, the natural order hypothesis, set the stage for the information-processing model. That is, the second language is developed in a predetermined way due to an innate, universal, and rule-governed system. The input hypothesis strongly supported Chomsky’s position and extended it to second language acquisition. This hypothesis allowed us to admit the individual variation on the surface – different sources of comprehensible input, different strategies for obtaining input, different messages, and of course different languages, however, “deep down, the mental organ for language produces one basic product, a human language, in one fundamental way” (Krashen, 1985, p. 3). The affective filter hypothesis is associated with the mental block, which “prevents acquirers from fully utilizing the comprehensible input they receive for language acquisition” (Krashen, 1985, p. 3).

Krashen’s monitor model focused on the mechanism responsible for the processing of language learning, which came from the view of information processing. This model borrowed terms frequently used in information processing theory such as input, output, short-term memory, long-term memory, storage of information, intake and container. The main assumption
behind was the belief that mental processes were rule-governed, evident in Chomsky’s universal grammar.

Dissatisfied with the notion of innate predisposition, in which social, historical, cultural and institutional aspects of human learning processes were missing, human internal cognitive processes were questioned. The notion that the individual is solely responsible for his or her cognitive development was pushed into the background. The communicative social interaction and goal-oriented collective activity were brought to the foreground. Social-cultural and cultural-historical theories were emphasized.

2.3.2 Embodiment

*Embodied Mind*

I take cognition to be embodied action, as strongly argued by Varela, Thompson and Rosch in *The Embodied Mind*—“knowledge depends on being in a world that is inseparable from our bodies, our language, and our social history—in short, from our embodiment” (Varela, Thompson & Rosch, 1993, p. 149). Questioning prevalent assumptions throughout cognitive science, in which cognition is a mental representation of a pregiven world, embodiment is deeply rooted in its fundamental assumption that “cognition is not the representation of a pregiven world by a pregiven mind but is rather the enactment of a world and a mind on the basis of a history of the variety of actions that a being in the world performs” (Varela, Thompson & Rosch, 1993, p. 9). Embodiment starts from the idea that the world is independent of the knower and is internally recovered in a representation to that of “knower and known, mind and world, stand in relation to each other through mutual specification or dependent coorigination” (Varela, Thompson & Rosch, 1993, p. 150). Embodiment, as strongly opposed to the notion of the body as peripheral to understanding the nature of mind and cognition, has considered that the nature of the
dependence of cognition is on the body, on the accumulation of experiences and on the type of action that is being performed (Stanford Encyclopedia of Philosophy, 2011; Varela, Thompson & Rosch, 1993).

Cognition as an embodied action poses an enactive approach in cognitive science. Enaction is one of the possible ways of organizing knowledge and one of the forms of interaction with the world. Enactive knowledge comes through action and doing, that is, as Bruner (1966) suggested, learned from experiences and learning by doing. Therefore, as they answer what cognition is, they say that cognition is “enaction – a history of structural coupling that brings forth a world” (Varela, Thompson & Rosch, 1993, p. 206).

My Thoughts on Avatars in Virtual Worlds

What is an avatar? What is the relationship between an avatar and a real being? Penny (1994) argued that virtual worlds, a mathematical Cartesian grid, gave primacy to the eye because it was primarily experienced through screen technology. Virtual worlds “reinforce Cartesian duality by replacing the body with a body image, a creation of mind. As such, it is a clear continuation of the rationalist dream of disembodied mind, part of the long Western tradition of the denial of the body” (Penny, 1994, p. 243). In line with Penny, Hillis emphasized that virtual worlds became a means for the mind to rise above the corporeal body. He wrote: “virtual technologies encourage belief that they constitute a transcendence machine within which the imaginative self might escape its privatized physical anchor and live in an iconography of pleasure” (Hillis, 1999, p. 172). Against Penny and Hillis, Stewart and Nicholls argued a distinctive form of embodiment of virtual worlds. They claimed the virtual world was “an expansion of our body scheme” (Stewart & Nicholls, 2002, p. 87). Hence, “in this way, avatars become extensions of self within virtual space where interactivity, creativity and commerce can
derive real meaning rather than simply being a Cartesian mind loosed in the ether” (Jones, 2010, p. 14).

My understanding of the relationship between a real being and an avatar built upon my Eastern appreciation of reality. We act in a virtual world like in real life enabled by an avatar. Avatars, as a means of embodiment for the learners, make learners’ engagement with virtual worlds real. We do not just exist in virtual worlds but construct our identities through avatars. Avatar bodies in virtual worlds can be changed at will by choosing body parts or changing clothes in the inventory. Many daily accessories (e.g., hats and jewelry etc.) and objects (e.g., coffee mugs, knife/fork etc.) can by used by avatars as well. The embodied avatar offers new affordances of virtual worlds where the physical body/mind can act, that is, the mutual indwelling between an avatar and a real being allows learners to learn by doing in a fully immersive learning environment. Unlike the disembodied notion of avatar, which draws a line between the virtual body and physical mind, embodied avatars are particularly powerful artifacts to consider.

The relationship between an avatar and a real being determines what we’ve learned in virtual worlds can / cannot be transferred to our real life. The key point is “What is real?” Our perception of reality is a process that occurs in a complex interaction with the world. Virtual worlds have opened a new visual world, created new ways of experiencing the world around us and shaped the way we interact with our environment and each other. These new technologies have fostered a new range of perceptual skills we required since the world around us is never familiar— it changes in the individual over time and within society.

Writing as an Easterner, in traversing cultures, I have sought a better comprehension of what a deeper appreciation of occidental traditions/philosophies might mean for my understanding of the relationship between the avatar and the self. I start my journey of rethinking
the relationship between the self and the avatar by “crossing,” in the evocation of Descartes’ dreaming argument to another shore – Zhuangzi’s dream of a butterfly.

My understanding of the western dreaming argument starts in the philosophy of Descartes, in which a clear distinction is drawn between the subject, which contains the ‘consciousness’, and the object (outside world). As a result, the subject is seen as a radically self-sufficient being independent of all things external to it, including other human beings, in turn, such subjectivity enforces the idea of radical human freedom. This point is clearly elaborated in Descartes’ reason:

For I now notice that the two are vastly different, in that dreams are never linked by memory with all the other actions of life as waking experiences are. If, while I am awake, anyone were suddenly to appear to me and then disappear immediately, as happens in sleep, so that I couldn’t see where he had come from or where he had gone to, I could reasonably judge that he was a ghost or an hallucination rather than a real man. (Descartes, 1639, p. 40)

According to Descartes, human beings should not trust the senses to distinguish reality from illusion. Hence, any statement from senses needs to be carefully examined or rigorously tested to determine whether it is “real”. Descartes made a clear distinction between the illusion and the real.

However, Eastern Philosophy did not applaud such separation of reality from illusion. Zhuangzi told us a story: he once dreamt that he was a butterfly, flying and enjoying himself. Suddenly, he woke up. He did not know whether he was Zhuangzi who dreamt he was a butterfly or the butterfly that dreamt it was Zhuangzi. The philosophical idea behind this dream story is that there are differences between things in their ordinary appearances, but in dreams, one thing can be transformed to another. Zhuangzi called it the Transformation of Things.
According to Zhuangzi, the self does not exist in isolation and must form relationships with others. Zhuangzi can be the butterfly, and the butterfly can be Zhuangzi. There must be some relationship between Zhuangzi and the butterfly: the butterfly is a cultural construct of Zhuangzi. It is a representation of Zhuangzi himself who enjoyed living in total freedom. The butterfly he dreamt of was what he wished to be. Such a mutual indwelling opens up a new space where the boundaries between real worlds and virtual worlds blurred, a space where the self and the avatar co-emerge, a space where body and mind are together in a journey of constructing new forms of life.

In summary, the two dreams – Descartes and Zhuangzi – entail very different views of human subjectivity. Modern objective knowledge, defined as value-free knowledge, supports radical subjectivity and “is constructed through various forms of binary thinking” (Eppert & Wang, 2007, p. 15). However, Zhuangzi supports inter-subjectivity, in which “knowledge is necessary and possible only in so far as it aids one in the process of self-cultivation” (Hahm, 2001, p. 36). Wandering back and forth, I make a sense of the clear distinction between Zhuangzi’s transformation of things and Descartes’ reasoning. These two thinkers, Descartes and Zhuangzi coming from a different intellectual and personal background, focus on the notion of illusion/reality from different traditions. Descartes argues “whatever I have accepted until now as most true has come to me through my senses. But occasionally I have found that they have deceived me, and it is unwise to trust completely those who have deceived us even once” (Descartes, 1639, p. 1). Zhuangzi, on the other hand, emphasizes the wholeness. Unlike Descartes, Zhuangzi followed a different approach to theorize dream and reality: “Now I do not know whether I was then a man dreaming I was a butterfly, or whether I am now a butterfly, dreaming I am a man.” This is “the melding of the physical and virtual into one phenomenal body” (Stewart & Nicholls, 2002, p. 86).
Design Practices of Embodied Avatar in Virtual Worlds

The notion of embodied avatar in virtual worlds supports the idea that learning comes from action and doing. Several works of ESL/EFL teachers informed the embodied design principle for action-based language teaching and learning in virtual worlds. One of the most recognized works was a demo lesson using a kitchen fire simulations given by Nergiz Kern.\textsuperscript{21} It was a session of teaching languages in virtual world, a Swiss project, aiming to support German academy training for fire workers in Second Life. A simulation room was developed where a meal was prepared in a simulated kitchen. After some time, there was a fire starting in the kitchen (as shown in Figure 4.). Now it was the learners’ turn to put out the fire. But of course, how? Learners needed to know as many expressions related to fire as possible such as fire extinguisher, smoke, put out a fire, fire brigade, fire department and fire blanket etc. The teacher divided the whole class into small groups. One group went into the kitchen first. Others outside could hear what was being said and could use their camera controls to observe what was happening inside. They were also asked to take notes to give language feedback later.

The embodied avatar in the demo lesson allows language learners to learn vocabularies through action. It enables language learners to truly go beyond context boundaries to learn language without physically stepping out of their physical contexts. It makes language learners’ interaction with others and a digital object possible in virtual worlds. Furthermore, the embodied avatar makes language learners present to themselves and to others. Language learners embodied in avatars, making virtual worlds and a variety of phenomenon, foster real, legitimate experiences.

\textsuperscript{21} http://slexperiments.edublogs.org/2010/01/25/its-burning-what-now/: the blog has a detailed explanation of the lesson plan with pictures.
Another example can be found at Chinese Island designed by Monash University in Second Life. Chinese learners may understand musical instruments by playing them inworld (Figure 5). Through their embodied avatars’ interaction with virtual musical instruments, learners can have an opportunity to experience how these instruments may work.

Figure 4. Kitchen fire simulations in Second Life

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22 http://www.virtualhanyu.com/
23 Pictures are from http://slexperiments.edublogs.org/2010/01/25/its-burning-what-now/
2.3.3 Communities of Practice

*Situated Learning*

I also take cognition to be situated activity, as argued by Lave and Wenger in the book *Situated Learning: Legitimate Peripheral Participation*, which places learning in social relationships, situations of co-participation. Learning happens not in the heads of individuals but involves participation in a community of practice (Lave & Wenger, 1991).

Lave and Wenger coined the term situated learning, in which learning is a process of social participation rather than the acquisition of knowledge by individuals. Under the condition of legitimate peripheral participation, newcomers become part of a community of practice. Initially newcomers join communities and learn at the periphery. As they become more competent they move more to the center of the particular community (Lave & Wenger, 1991).

Learners inevitably participate in communities of practitioners and… the mastery of knowledge and skill requires newcomers to move toward full participation in the socio-cultural practices of a community. “Legitimate peripheral participation” provides a way to speak about the relations between newcomers and old-timers, and about activities, identities, artifacts, and communities of knowledge and practice. A person’s intentions
to learn are engaged and the meaning of learning is configured through the process of becoming a full participant in a socio-cultural practice. This social process, includes, indeed it subsumes, the learning of knowledgeable skills. (Lave & Wenger, 1991, p. 29)

The situated learning perspective brings about two shifts in understanding knowledge and learning. Firstly, situated learning shifts away from the notion of learning as the simple acquisition of decontextualized, abstract or general knowledge to the idea of learning as a mode of participation in the social world. Secondly, situated learning shifts away from a traditional focus on new knowledge internalized in individuals’ brains to an emphasis on new knowledge constructed in a community of practice.

Lave and Wenger further explained that legitimate peripheral participation could be applied to any educational setting: Learning through legitimate peripheral participation takes place no matter which educational form provides a context for learning, or whether there is any intentional educational form at all (p. 40).

Language learning seen as the internalization or the acquisition of a body of linguistics dominated the language education field for decades. It emphasizes that learning is a process that develops inside an individual’s brain. However, current research and practice in language teaching and learning calls for a particular attention to the importance of “the social contexts in which a second language is learned, the learners’ relations with other participants in the community and their different modes of participation” (Mari-Haneda, 1997, p. 12). The situated character of language education offers a new framework to understand language learning involved in a community of practice. Under this notion of language teaching and learning, “the second language learner is seen not as internalizing the second language, but rather as a newcomer beginning to participate in the practices of a particular community” (Toohey, 1996, p. 553).
Communities of Practice in Virtual Worlds and Technology

Virtual worlds are potentially ideal places where communities of practice support language learners to go beyond the limitation of physical environment in real life, collaborate to generate ideas, share interests and needs as well as learn from peers. Furthermore, virtual worlds are platforms that encourage relationships between learners. In virtual worlds, learning is seen as relationships among people. Language learners become participants in a community based on their common shared interests, as evidenced in Dogme Language Teaching Movement\(^\text{24}\) in Second Life.

Communities of practice of language learning in virtual worlds change the way that we investigate second language acquisition (SLA). Classic language learning research started with the student’s behaviour or his/her mind as the unit of analysis. Such examination is apart from the social nature of humans and apart from the historical development of the language learning process, therefore, is inadequate for understanding the complex and dynamic interrelation among language acquisition, environment and technological artefacts over time. Communities of practice call for a situated view of language learning, in which language does not steadily “lie in people’s heads waiting to be actualized through cognitive processes” but is dynamic and exists in the flow of an individual’s participation in the changing environment across multiple time frames (S. A. Barab, Hay, & Yamagata-Lynch, 2001, p. 66).

Communities of practice along with Lave and Wenger’s notion of technological transparency (p. 104), applied here to virtual worlds, also change the way that we understand how technology functions historically and currently in language learning. A majority of SLA research sees technology functioning as a tool, which may provide a support to language learners. Salaberry (2001) demonstrates how these reductions to technology as a tool historically

\(^{24}\) http://en.wikipedia.org/wiki/Dogme_language_teaching
occurred in language learning and teaching. As with other subjects, he points out that technology-driven innovation often superceded the objectives of language learning, which hampered success. At least one of Salaberry’s four major questions (p. 51) frames my research: “What technical attributes specific to the new technologies can be profitably exploited for pedagogical purposes? (e.g., coding options specific to each medium)?” Historically, terms such as computer assisted language learning (CALL), technology-supported or technology-assisted language learning were coined. Similarly, literacy was defined as a tool or technology.

Some scholars from outside of SLA, such as educational technology researchers, criticize the notion of “technology as a tool” (e.g., Arntzen, Krug & Wen, 2008). For example, Clark’s famous manifesto: as long as technologies were seen as “delivery vehicles for instruction there would not be any differences between experts and technology” and “media would not influence learning” (Clark, 1983, p. 453). Furthermore, rather than being a tool, technology is seen as something in-between. It functions as a medium between learners and teachers. This notion, as the term technology-mediated learning indicates, emphasizes the mediated role of technology rather than being part of the learning system. Such a mediated role of technology contradicts what virtual worlds can provide to learners.

Hence, the term “technology-augmented learning” is another way to re-conceptualize how technology functions with learning in virtual worlds. “Augmented” explained in the Collins English Dictionary originally refers to “added to or made greater in amount or number or strength.” In academics, this word is originally associated with special education, in which assistive or augmented technologies provide differently abled people with help. With the development of innovative technologies, “augmented” is also used in the term “augmented reality”, which is a variation of Virtual Environments (VE), or Virtual Reality as it is more commonly called. VE technologies completely immerse a user inside a synthetic environment.
While immersed, the user cannot see the real world around him. In contrast, AR allows the user to see the real world, with virtual objects superimposed upon or composited with the real world. (Azuma, 1997, p. 356)

Technology-augmented learning refers to both of these situations. Language learners when learning a foreign language need augmented technology to simulate the target social and cultural context as someone who cannot walk needs a wheelchair. Virtual worlds, one of many possible technologies, may allow language learners to have more access to an authentic targeted cultural context. Virtual worlds such as Second Life, a “desktop virtual reality,” augment reality technology and supplement reality rather than replacing it (Moore, 1995, p. 91). In other ways, these virtual worlds provide alternate realities or a continuum, as in Zhuangzi explanation, between physical and virtual worlds. Different from other technologies, virtual worlds with communities of practice may blur the line between what is real and what is computer-generated by enhancing what we see, hear and feel. Zhao & Frank’s (2003) analysis of ecosystems of learning provide a similarly holistic or systemic way of framing technology in language learning. Perhaps once introduced as an invasive species, technologies for virtual experience may at some point seem fully accommodated or naturalized into communities of practice for language learning. Virtual worlds are not something sitting in-between and not the extension of the real world, but can be understood as part of an ecosystem that includes virtual and real world components and species (Zhao & Frank, 2003).

**Design Practices of Communities of Practice in Virtual Worlds**

The notion of communities of practice in virtual worlds supports the idea that learning comes from social participation. Several ESL/EFL projects informed the communities of practice design principle for situated language teaching and learning in virtual worlds. One of the most
recognized projects was VIRTLANTIS\textsuperscript{25} in \textit{Second Life}. VIRTLANTIS is an open community of practice for language learners and teachers in the virtual world of \textit{Second Life} (Figure 6) Its fundamental pedagogical design is language exchange – you teach me and I teach you. VIRTLANTIS islands in \textit{Second Life} offer informal language learning activities for a growing number of languages including English, French, Spanish, German and more.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure6}
\caption{Communities of practice of VIRTLANTIS in Second Life}
\end{figure}

On VIRTLANTIS islands in \textit{Second Life}, learning is not confined to the classroom. The central concept of VIRTLANTIS practice is newcomers to a community are engaged in peripheral tasks and activities and gradually are exposed to the community’s experts. Over time,

\textsuperscript{25} http://www.virtlantis.com/index.html
group members move from the outer periphery to the core of the learning community where they take on a central role. Foreign language skills are transferred through situated learning that is inseparable from practice with experts (Teach You Teach Me, Figure. 6). VIRTLANTIS communities of practice of foreign languages place the learner at the centre of the instructional experience and make no distinction between practice and learning. Three key components – context, community and content – of VIRTLANTIS communities of practice distinguish its learning environment from others.

**Context**

VIRTLANTIS allows foreign language learning to take place through the activities of daily life, with and through other people and artifacts (e.g., The Chinese New Year @ VIRTLANTIS, Figure 7). Communities of practice on VIRTLANTIS in *Second Life* facilitate the sharing of real language experiences by enabling language learners to engage in communication based on their common interests and objectives.

**Community**

Through a number of synchronous / asynchronous tools, VIRTLANTIS in *Second Life* enables the formation of a virtual community that is not physically constrained but exists within a common space of shared interests – learning a foreign language. Foreign language learners from all over the world may participate in activities in a common learning domain on VIRTLANTIS in *Second Life*. VIRTLANTIS creates the virtual space and virtual learning artifacts for the formation of a community of practice.
Content

VIRTLANTIS provides learners a very detailed calendar\textsuperscript{26} for learning activities, which emphasize interactive learning, rather text-based materials, and learning content at VIRTLANTIS is co-constructed (Figure 7).

\textit{Figure 7.} Chinese New Year at VIRTLANTIS\textsuperscript{27}

2.3.4 Distributed Learning

\textit{Distributed Cognition}

Distributed cognition involves learning in techno-cultural contexts. Distributed cognition, as theorized by Edwin Hutchins in \textit{Cognition in the Wild}, considers the significance of

\textsuperscript{26} https://www.google.com/calendar/embed?src=virtlantis%40googlemail.com
\textsuperscript{27} http://how-2-learn-spanish.com/chinese_new_year_partyvirtlantis/
social and material structures in the process of knowledge construction. It is “a new branch of cognitive science devoted to the study of the representation of knowledge both inside the heads of individuals and in the world” (Flor & Hutchins, 1991, p. 37). Its goal is “understanding the coordination among individuals and artefacts, that is, to understand how individual agents align and share within a distributed process” (Nardi, 1996, p. 39).

Distributed cognition studies “the propagation of knowledge between different individuals and artefacts” and “the transformations which external structures undergo when operated on by individuals and artefacts” (Flor & Hutchins, 1991, p. 37). By investigating how cognitive processes transcend the boundaries of the individual within a functional system, it focuses on the functional relationships among the elements that participate in a particular cognitive process (Hollan, Hutchins, & Kirsh, 1999a).

It treats a cognitive system composed of individuals and the artefacts they use as the proper unit of analysis. The focus is on an individual in coordination with a set of tools or a group of individuals in interaction with each other and a set of tools. Within each functional system, humans are closely coupled causally with agents, artefacts and environments so that cognition is effectively distributed over mind, agents, artefacts and environments (Hollan et al., 1999a; Hutchins, 1995).

1. Historical Evolution of the Distributed Nature of Cognition

The distributed nature of cognition is not something new, rather, it is “a recognition of the perspective that all of cognition can be fruitfully viewed as occurring in a distributed manner” (Halverson, 2002, p. 248). Many theorists from different domains have used the concept of “distributed” to mark differences from traditional approaches to cognitive science (J. S. Brown et al., 1989; Cole & Engestrom, 1993; Halverson, 2002; Hutchins, 1995; Norman,
The origins of the distributed nature of mind can be found in writings of Wundt and Munsterberg (Cole & Engestrom, 1993). Wundt, the father of experimental psychology, claimed that there existed two levels of mental phenomena – lower and higher mental functions. The higher mental functions in Wundt’s writings are about the distributed nature of mind, in which the truly human and symbolic aspects of experience can only be understood within a social context and be studied by a non-experimental methodology such as ethnography, folklore, and linguistics (Cole & Engestrom, 1993; Sato et al., 2007; Wundt, 1921). Munsterberg, the father of applied psychology, argued that cognition occurred not only in the head, but also outside of the individuals themselves such as a letter, a newspaper or a book (Munsterberg, 1914).

Brown, Collins and Duguid (1989), in “Situated Cognition and the Culture of Learning,” pointed out that knowledge was situated, being in part a product of the activity, context, and culture in which it was developed and used. This is similar to Lave and Wenger’s (1991) finding that learning was a process of becoming a member of a sustained community of practice.

Furthermore, Cole and Engestrom, cultural-historical theorists, claimed that cognition was distributed in different fundamental loci of an activity system – in the person, in the medium of culture, in the social world and in time (Cole & Engestrom, 1993). They shed light on the mediated role of culture within the distributed nature of cognition, arguing that cognition was distributed in different parts of the brain process. According to Cole and Engestrom (1993), the distribution of mind depends on tools through which one interacts with the world and cognition is distributed in the combination of goals, tools and settings. Here, Cole and Engestrom described distributed cognition in the activity theory tradition. They invited us to think about the distribution of cognition “between an individual, a mediating artefact, and the environment” (Cole & Engestrom, 1993, p. 17).
Like Cole and Engestrom, Pea also explored the distributed nature of mind from the socio-cultural perspective, in which he mentioned that human cognition aspired to efficiency in distributing intelligence across individuals, environment, eternal symbolic representations, tools and artefacts, as a means of coping with the complexity of activities we often call “mental” (Pea, 1993). Salomon, too, from the socio-cultural perspective, mentioned that the product of the intellectual partnership that results from the distribution of cognition across individuals or between individuals and cultural artifacts is a joint one, which could not be attributed solely to one or another partner (Salomon, 1993).

Last but not least, unlike Cole, Engestrom, Pea and Salomon from the socio-cultural perspective, Hutchins discussed the distributed nature of cognition from a socio-technical perspective, in which he found that cognitive processes were distributed across people and artifacts (Hutchins, 1995).

2. Distributed Cognition from the Socio-Technical Perspective

Dissatisfied with the disembodied view of knowledge and learning, Hutchins developed distributed cognition to seriously consider the significance of social and material structures in the process of knowledge construction in the mid 1980s. It is “a new branch of cognitive science devoted to the study of the representation of knowledge both inside the heads of individuals and in the world” (Flor & Hutchins, 1991, p. 37). It contributes to studying “the propagation of knowledge between different individuals and artefacts” and “the transformations which external structures undergo when operated on by individuals and artefacts” (Flor & Hutchins, 1991, p. 37). It attempts to show how cognitive processes in human activity transcend the skin of the individual agent.

Departure from the inside/outside cognitive distinction and the culture/cognition dichotomy, distributed cognition aims to explore “how intelligence is manifested at the systems
level, as opposed to the individual cognitive level” (Flor & Hutchins, 1991, p. 37). According to Hutchins, “the representational media may be inside as well as outside the individuals involved” (Hutchins, 1995, p. 373). That is, the idea of studying the distributed nature of mind is to make sense of how cognitive processes transcend the boundaries of the individual within a functional system. Thus, cognitive activities can be best understood as both internal and external resources. Therefore, the focus of distributed cognition is on the functional relationships among the elements that participate in a particular cognitive process (Hollan et al., 1999a).

Unlike socio-cultural approaches that take activity system as their unit of analysis, distributed cognition treats a cognitive system composed of individuals and the artifacts they use as a proper unit of analysis. Within each functional system, humans are closely coupled with agents, artifacts and environments so that cognition is effectively distributed over mind, and these agents, artifacts and environments (Hollan et al., 1999a; Hutchins, 1995).

For example, Hutchins, with a focus on a navigation system, showed how external structures play roles in real world tasks. Through a detailed description of activities to steer a ship into a harbour, Hutchins demonstrated that individuals were merely human components in a complex cognitive system, and the completion of cognitive tasks involved coordination between humans and artefacts. The successful completion of steering a ship into a harbour required cultural-cognitive coordination instead of individual agents alone (Hutchins, 1995). At a micro-level, Hutchins described the detailed coordination among members of the navigation team taking and plotting bearings, at regular intervals of every three minutes or so, of the ship as it came into a harbour. At a macro-level, Hutchins explained how coordinated activities provided a structured experience for the team members and enabled their individual learning procedures and their cultural practice of navigation. Hutchins claimed that the ship navigation as it was performed by a team on a bridge of a ship could only be understood when we understood the contribution of the individual team members in the system and the coordination among the team.
members, the hand-bearing compass, the landmark, the printed scale on the gyrocompass card, digital representation, hairline and the telescopic sight etc. involved (Hutchins, 1995).

To summarize, distributed cognition is concerned with “the structure – representations inside and outside the head – and the transformations these structures undergo” (Nardi, 1996, p. 39). As the example shows, this theoretical framework emphasizes “understanding the coordination among individuals and artefacts, that is, to understand how individual agents align and share within a distributed process” (Nardi, 1996, p. 39). When this approach was applied to the study of human activity in natural settings, Hollan (1999a, p. 3) identified three types of distribution of cognitive processes:

- Cognitive processes may be distributed across the members of a social group
- Cognitive processes may involve coordination between internal thought and external artefact
- Cognitive processes may be distributed through time in such a way that products of earlier events can transform the nature of later events.

Here, each theory brings certain ideas, issues or constructs into the foreground and pushes others into the background. For example, cognitive theory brings the learning process of the individual into the foreground and casts the social aspects as background (Levy & Stockwell, 2006). “It is not that cognitive theory specifically denies the role of the social… it is more a matter of where the priorities are placed, and the territory over which the theory may be effectively applied” (Levy & Stockwell, 2006, p. 111). Hence, the dissatisfaction with traditional theories in studying cognition and the discussion about distributed cognition does not deny each theory but pushes the socio-technical system into the foreground.
Distributed Language Learning in Virtual Worlds

My understanding of distributed view of language learning originates from discussions and publications of the Distributed Language Group. Applied at the new LINGUAPOLIS Language Institute at the University of Antwerp, distributed language learning is a methodological and conceptual framework for designing competency-oriented and effective language education. It emphasizes the design of a language learning environment for a specific language learning situation (Colpaert, 2007). The design is based on a thorough analysis of various actors, learning places, channels, content types, and media in the learning situation. The core of the design is the goal-oriented conceptualization and ontological specification (Colpaert, 2007). Distributed language learning requires a detailed description of “the architecture of the language learning environment, defined as the network of interactions between learners, co-learners, teachers, content, native, etc, inside or outside the learning place” (Colpaert, 2007, p. 1). It also “specifies the role of technology as a set of activities defined as forms of interaction, communication and information, mediated or not” (Colpaert, 2007, p. 2).

In virtual worlds, learning is not confined to an individual (the mind), rather, it is distributed across objects, individuals, artifacts and technologies in the environment. In this way, learning is distributed across the type of ecosystem so thoroughly described by Zhao and Frank (2003). Virtual worlds, when integrated into the flow of language learning environments “not only amplify what humans do, but also shape human cognition by facilitating the construction of mental representations of abstract concepts and phenomena through the use of advanced computer visualizations and simulations” (Angeli, 2008, p. 271).

Design Practices of Distributed Language Learning Artifacts in Virtual Worlds

http://www.psy.herts.ac.uk/dlg/
The notion of distributed language learning in virtual worlds supports the idea that learning is distributed across individual, mediating artefacts, and the environment. Several ESL/EFL projects informed the design principle for distributed language teaching and learning in virtual worlds. As indicated, one of the most recognized projects was CHINESE ISLAND\textsuperscript{29} designed by Monash University in \textit{Second Life}.

Chinese Island is an initiative by the Chinese Studies Program at Monash University in Melbourne, Australia designed to complement traditional classroom-based learning with context-based, hands-on learning in the virtual environment of \textit{Second Life}. The island is primarily designed for enrolled Monash University students, but it ends up with opening to the public for exploring Chinese language and culture in \textit{Second Life}.

Chinese Island is an exemplar of distributed immersive Chinese language learning environment. One of the distinguished designs of its cognitive system composes not only Chinese learners but also meaningful learning artifacts. Figure 8 is Tongfu Inn at the North-East end of the island.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{tongfu_inn.png}
\caption{Tongfu Inn}
\end{figure}

\textsuperscript{29} http://www.virtualhanyu.com/
When learners first enter into Tongfu Inn, there is an information board containing all information of activities. Learners use this board to activate simulations (Figure 9).

Inside of Tongfu Inn, language learners may communicate with the waitress Jingjing, a special programmed chatbot (Figure 10). Jingjing can carry out a conversation with Chinese learners in Mandarin inworld. She is an avatar based non-player character (NPC). She welcomes learners to Tongfu, takes food orders, and gives the dishes ordered to learners (dishes are placed on the table for learners). Besides chatbot Jingjing, Tongfu Inn allows learners to learn Chinese characters through ordering simulated food (Figure 11). Learners not only order food at the table (Figure 12), but they can also pick up their own food in front of the food counter. When learners point to the food, its Chinese name appears above the food.
Figure 10. Chatbot Jingjing at Tongfu Inn

Figure 11. Food counter at Tongfu Inn
Tongfu Inn also offers learners an opportunity to cook Chinese food by themselves. Learners may have instructions for putting ingredients together to make their own favorite Chinese dishes (Figure 13).

Learning activities designed at Chinese Island engage learners in many contexts such as hotels, market places, shops, gardens, airport, railway stations or virtual residents’ apartments (Figures 14-21). Learning at Chinese Island happens not only within an individual but also within the interaction with learning artifacts in contexts. Within each functional system, learners are closely coupled causally with these learning artifacts and environments so that learning is effectively distributed over mind, and these learning artifacts and environments.
Figure 13. Cooking Chinese foods in the kitchen at Tongfu Inn

Figure 14. Virtual hotel on Chinese Island
Figure 15. Virtual market places on Chinese Island

Figure 16. Virtual shops on Chinese Island
Figure 17. Virtual gardens on Chinese Island

Figure 18. Virtual airports on Chinese Island
Figure 19. Virtual railway stations on Chinese Island

Figure 20. Virtual train on Chinese Island
2.4 Conclusion

Language teaching and learning is now encountering a frontier of virtual worlds. Language educators are seeking positive ways to design immersive virtual learning platforms for more effective and engaged learning experiences. Although these platforms are challenged by meaningful learning or a replication of real life classrooms, which to some extent characterizes language teaching and learning in virtual worlds, we cannot deny their power to create immersive language learning environments. Here, I quote Balkin (2005) to conclude this chapter: “In the future, virtual worlds platforms will be adopted for commerce, for education, for professional, military, and vocational training, for medical consultation and psychotherapy, and even for social and economic experimentation to test how social norms develop” (p. 2044). Chapter three discusses design-based research methodology, the design of the research and procedures for data collection.
Chapter Three: Research Design

The purpose of this study was to investigate design practices for virtual worlds for language teaching and learning. It contributes to the design of virtual worlds to help make foreign language teaching and learning meaningful and immersive. The framework I used to understand design practices precipitated a use of design-based research and unique ways to deal with “progressive refinement” of multiple design iterations (Collins et al., 2004, p. 18). The progressive refinement offered in this research made it possible for the design to function beyond its initial conditions of development.

Consistent with the theoretical framework – embodied, situated and distributed learning – the research design of this study, in which a revision of Middleton’s cyclic model was employed in the process of data collection, aimed at providing a holistic description of design cycles. To achieve this goal, the research design considered: 1) the iterative processes of design-based research; 2) a revision of Middleton’s cyclic model; and 3) the application of a revision of Middleton’s cyclic model for data collection.

3.1 Design-Based Research: Conceptualizing Its Application for Scenario-Based Language Teaching and Learning in Virtual Worlds

The term design-based research emerged in the early 1990s after the notion of a “design experiment” was introduced by Ann Brown and Allan Collins (A. L. Brown, 1992; Collins, 1992). It is a context sensitive methodological approach with the main focus on the development of pedagogical innovations. This approach to design/research attempts to bring
together theory and practice to understand how, when and why educational innovations work in practice (Yutdhana, 2005).

“Design” used in design-based research refers to the creative process in which designers generate a hypothetical solution to a problem in their field of expertise (Middleton, Gorard, Taylor, & Ritland, 2008). Recognizing design as a process has implications for how design-based research functions. Such a design process, as opposed to summative research, deals with complexity by “progressive refinement” that involves multiple iterations (Collins et al., 2004, p. 18). These multiple iterations make it possible for a design to function beyond its initial conditions of development.

The following discussion contributes to the five characteristics of design-based research: iteration between laboratories and classrooms, iteration between the nomothetic approach and the idiographic approach, iteration between the cross-sectional design / the longitudinal design and the microgenetic analyses, and iteration between qualitative methods and quantitative methods.

### 3.1.1 Iteration between Laboratories and Classrooms

What separates design-based research from earlier research methodologies of second language acquisition (SLA) that followed a psycholinguistic tradition is the iterative research process between the laboratory and the classroom. The more extreme examples (see Salaberry, 2001) of SLA favored laboratory contexts, in which subjects are treated objectively under the control of researchers. Such research conducted in the laboratory required that behavior fell inside the established norms of the study. Laboratory experiments were manipulated, controlled, and measured by researchers in order to satisfy research questions determined in advance (Johnson, 2004). These controlled laboratory conditions, on the one hand, avoid contaminating
effects but on the other hand simply examine the subject’s learning behavior as isolated variables: stimuli were treated as independent variables selected, manipulated and controlled by the researcher, and responses were treated as dependent variables. Therefore, these laboratory results were critiqued as they led to an incomplete understanding of meanings, but can find use in informing how to implement a particular variable or theory within the context of real-world practice (Barab, 2006; A. L. Brown, 1992; Collins, 1992).

Design–based research, on the other hand, extends researcher-controlled experiments conducted in laboratories and follows examples of more current, naturalistic and observational research in SLA (see Salaberry, 2001). It fills a niche for investigating learning in the messy naturalistic context. Classrooms and other learning spaces (which may not be the natural habitat of the majority of SLA research) are given more attention in order that “learning in situ” can be captured (A. L. Brown, 1992, p. 152).

Within a design-based research paradigm, empirical educational research is conducted iteratively between strictly controlled lab settings and socially sanctioned settings. The laboratory work informs the classroom observations and the classroom work can motivate laboratory practice (A. L. Brown, 1992). That is to say, the laboratory experiences enable researchers to see a developmental pattern emerging in classroom dialogues; trends discovered in spontaneous classroom discussions can be tested in the laboratory under more controlled conditions (A. L. Brown, 1992). Switching back and forth from both types of research settings enriches researchers’ understanding of a particular phenomenon. Following Brown’s (1992) suggestion, the routine procedure of design-based research is to set up controlled laboratory studies to evaluate whether the developmental trend can be reproduced under experimental control and then to watch for its occurrence in actual classroom practice. It is precisely this iterative research context between the laboratory and the classroom that distinguishes design-
based research from other research methodologies such as (quasi) experimental research or ethnography.

### 3.1.2 Iteration between the Nomothetic Approach and the Idiographic Approach

The mainstream of SLA research in the late twentieth century tended to be restricted to the nomothetic approach that aimed to gather data from groups of people in order to arrive at the similarities between individuals. With the assumption that an individual is a complex combination of many universal laws, the nomothetic approach to SLA attempted to study a single variable in many subjects for the purpose of discovering general laws or principles of behavior that could be applied to everyone (A. L. Brown, 1992).

Although the nomothetic approach is more typical in studying SLA developmental changes determined by group average, another approach – the idiographic approach is equally important. With the assumption that each individual is unique, the idiographic approach involves the intense study of within-individual differences in order to provide a complete global understanding of the individual’s characteristic traits (A. L. Brown, 1992; Leenaars, 2002). Like the nomothetic approach, the idiographic approach also treats the individual as the unit of analysis. However, the idiographic approach does not aim to study all but attempts to understand an individual in particular. That is, instead of analyzing data at a group level, such an empirical individual-oriented approach concerns the task of collecting extensive time-series data from a single person and analyzes them case-by-case. “Results from each individual are then later summarized or aggregated to show the overall pattern of within and between-individual differences in development” (Lavelli, Pantoja, Hsu, Messinger, & Fogel, 2005, p. 54).
Design-based research reconciles and subscribes to these two possible approaches to knowledge: nomothetic and idiographic. This methodology is able to provide a joint description of both similarities and differences among individuals to understand both the general and the particular. Design-based research argues that in addition to general laws there are also unique variations; there are not only general methods but also single case methods (Runyan, 1983). It calls for the investigation of both the individual and the general.

3.1.3 Iteration between the Cross-sectional Design/Longitudinal Design and the Microgenetic Design

One of the fundamental aspects of studying language learning processes is to measure change over time. SLA research favors the cross-sectional or longitudinal studies to investigate change across multiple time frames, in which the product of change is examined, not the process: cross-sectional designs basically compare different subjects’ learning behaviors; while longitudinal designs compare the same person’s behavior at various ages. Both designs analyze statistical differences to indicate that a change has occurred: cross-sectional designs provide information on changes of the target behavior among individuals, while longitudinal studies yield important information on changes within cases (Lavelli et al., 2005). However cross-sectional designs emphasize group data and treat individual variation as statistical noise, and longitudinal studies are difficult to capture the ongoing process of change due to the long time intervals between observations (Flynn, Pine, & Lewis, 2006; Lavelli et al., 2005). But the individual variation and the ongoing process of change hold important information about the underlying mechanisms of change. As a result, the cross-sectional/the longitudinal designs are inadequate for understanding how language learners make a transition in a specific domain (Lavelli et al., 2005).
Hence, the choice of a microgenetic approach is promising for “study[ing] individual differences in development” (Lavelli et al., 2005, p. 41). The term microgenetic originates from Vygotsky’s genetic approach to a developmental study of a problem. According to Vygotsky, the process rather than the product of development should be the focus. That is, in order to understand the nature of cognitive development, researchers should scrutinize an individual over a period of transition (A. L. Brown, 1992). It is the transition, catching the turning point of the processes where radical alterations emerge that provides detailed information about the cognitive change over time. Such a transitional process may occur within fractions of a second, a few minutes, days or weeks (You, 1992). In another words, individuals are observed through a period of developmental change including the initial, shaping, and the final comprehension stage. The dynamic flow of the entire developmental process involves repeated moment-by-moment measurement of the process of change in learning from the same participants within the course of transition (Calais, 2008; Lavelli et al., 2005). The repeated moment-by-moment measurement requires that observations should be conducted before, during and after the transition periods of a rapid change in learning instead of observing only a pre- and post-change. Within the transition period, a relatively short (weeks or months) observational time but a rapidly changing developmental period is necessary. The time intervals of the observations must be considerably shorter than the time intervals necessary for a developmental change to occur (Siegler, 1996). Also observed between-participant variability and within-participant variability throughout a span of developmental change is intensively analyzed both qualitatively and quantitatively. As a result, the changing individual becomes the basic unit of analysis.

Vygotsky considered the inadequacies of association and introspective methods, in which “analysis is essentially description and not explanation as we understand it” (Vygotsky, 1978, p. 62). He believed that “mere description does not reveal the actual causal-dynamic relations that underlie phenomena” (Vygotsky, 1978, p. 62). Therefore, he argued for an
approach that is not only a description of the phenomenon but also an explanation of the actual origin, process, and the causal dynamic relations (Vygotsky, 1978).

Following Lewin, we can apply this distinction between the phenotypic (descriptive) and genotypic (explanatory) viewpoints to psychology. By a developmental study of a problem, I mean the disclosure of its genesis, its causal dynamic basis. By phenotypic, I mean the analysis that begins directly with an object’s current features and manifestations. (Vygotsky, 1978, p. 62)

It was these two primary principles that led Vygotsky to formulate what he called the genetic method, in which four domains were proposed: phylogenesis (development in the evolution of the human species), sociocultural history (development over time in a particular culture), ontogenesis (development over the life of an individual) and microgenesis (development over the course of, and resulting from, particular interactions in specific sociocultural settings) (Voutsina & Jones, 2004; Wells, 1994; Wertsch & Stone, 1985). These four domains aim to describe and explain the cognitive processes a learner engages in when acquiring knowledge. That is, they examine how internalization takes place. Hence, the analysis of the genetic method focuses on “the learners’ cognitive processes when they question their current knowledge, when they update their knowledge, when they reorganize their knowledge, and then they independently use their knowledge to solve a problem” (You, 1992, p. 47). As Wertsch and Stone (1985) claim,

1. Human mental processes must be studied by using a genetic analysis that examines the origins of these processes and the transitions that lead up to their later form;
2. The genesis of human mental processes involves qualitative revolutionary changes as well as evolutionary changes;
3. Genetic progression and transitions are defined in terms of mediational means (tool and signs)

4. Several genetic domains (phylogeny, sociocultural history, ontogenesis, and microgenesis) must be examined in order to produce a complete and accurate account of human mental processes;

5. Different forces of development, each with its own set of explanatory principles, operate in the different genetic domains. (Wertsch & Stone, 1985, pp. 55-56)

In discussing microgenesis, Vygotsky claimed that child cognitive development was an ongoing process of radical alteration, response in new ways and replacing one psychological functioning by another. This process, according to Vygotsky, was “periodicity, unevenness in the development of different functions, qualitative transformation of one form into another, intertwining of external and internal factors, and adaptive processes in overcoming impediments” (You, 1992, p. 46).

Such a close examination of change processes in learning over time is extremely useful to test potential control parameters, which indicate how a person’s knowledge or ability progresses from one level to another, often more sophisticated level (Calais, 2008; Flynn et al., 2006). There are two types of microgenesis as Wertsch and Stone (1985) claimed,

The first type of microgenesis concerns the short-term formation of a psychological process. The study of this domain requires observations of subjects’ repeated trials in a task setting. Thus one could think of it as a very short-term longitudinal study… The second type of microgenesis is the unfolding of an individual perceptual or conceptual act often for the course of milliseconds. (Wertsch & Stone, 1985, p. 55)

These two types of microgenesis provide a detailed description of an individual’s progression throughout the whole period of change. Such a microgenetic approach emphasizes five dimensions of a change – path, rate, breadth, variability and source (Siegler, 2006). The path of
change focuses on how learners/children sequence their predominant behaviors to gain competence: is the change qualitative or quantitative? The rate of change refers to the difference between the initial application of a novel strategy and its consistent application in terms of time and experience invested in the process: is the change sudden or slow? The breadth of change concerns how extensively the novel strategy generalized or transferred to different problems and contexts: is the change domain-specific or generalizable across domains? The source of change pertains to the causes that catalyzed the change. The variability of change concerns how learners differ amongst each other: how does one’s behavior vary across comparable tasks within a specific domain and can similar patterns of change exist across individuals (Siegler, 2006)? This approach reveals not just what children know but how they get there (Granott & Parziale, 2002, p. 12). Besides its application to the study of learners’ cognitive development, Flynn (2006) suggested that the microgenetic analysis might also apply to adults acquiring new skills.

The way that design-based research deals with changes over time involves the iterative research design between the conventional cross-sectional designs/longitudinal study and the microgenetic approach. The conventional cross-sectional design provides snapshot of individual differences in different experimental groups; longitudinal studies take multiple measurements over time to investigate whether a change has occurred or not; and the microgenetic approach sheds light on how the change occurs as it is actually happening. Switching back and forth among conventional cross-sectional designs, longitudinal studies and the microgenetic approach allows researchers to have a complete understanding and prediction of the whole rather than the sum of its parts (A. L. Brown, 1992).
3.1.4 Iteration between Quantitative & Qualitative Method

Design-based research combines quantitative and qualitative analyses to fully investigate new theories, artifacts, and practices that potentially impact learning and teaching in the messiness of real life. The iteration of design-based research, as Collins suggested, involves the large-scale studies and in-depth ethnographic studies.

Design experiments bring together two critical pieces in order to guide us to better educational refinement: a design focus and assessment of critical design elements. Ethnography provides qualitative methods for looking carefully at how a design plays out in practice, and how social and contextual variables interact with cognitive variables. Large-scale studies provide quantitative methods for evaluating the effects of independent variables on the dependent variables. Design experiments are contextualized in educational settings, but with a focus on generalizing from those settings to guide the design process. They fill a niche in the array of experimental methods that is needed to improve educational practices. (Collins et al., 2004, p. 21)

Collins’ iterative model of design-based research is a typical cross-sectional designs/longitudinal study. In response to Brown’s call of microgenetic design, Lavelli’s model (2005) provides another option of iterative analysis between quantitative and qualitative method through the combination of quantitative measures of real-time change and qualitative description of the historical emergence of change.

Here, quantitative methods are used to understand how behaviors are related in real time. These statistical methods focus on measures of the overlap/co-occurrence between two behaviors, measures of the frequency with which one behavior occurs during another and measures of the sequencing of two behaviors (Lavelli et al., 2005). The example of mother

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smiling and infant gazing at mother’s face illustrated by Lavelli (2005) perfectly exemplifies such measures of the overlap/co-occurrence of two behaviors.

The relationship between the two behaviors – mother smiling and infant gazing – can be documented by “comparing the percentage of time in which mothers are smiling and infants are gazing at their mothers’ faces with the percentage of time in which mothers are not smiling and infants are gazing at their mothers’ faces” (Lavelli et al., 2005, p. 56). This comparison of co-occurrence demonstrated an existence of a pattern unifying two behaviors – mother smiling and infant gazing may or may not occur simultaneously.

However, the degree of overlap/co-occurrence between two behaviors does not indicate how a pattern forms. “To understand how co-occurrence forms, it is useful to examine how frequently one behavior begins or ends during a different behavior” (Lavelli et al., 2005, p. 56). Such a frequency analysis indicates which behavior is most directly responsible for creating the co-occurrence of another behavior. Both co-occurrence analyses and frequency analyses can “provide complementary perspectives on real-time interactions” (Lavelli et al., 2005, p. 56).

Furthermore, one behavior can be embedded in the other or can begin during another and then outlast it. Different sequences of behavior indicate the degree to which a subject sequences actions into a specific pattern. Documenting complicated sequences involving two different behaviors can be conducted by hand or by using the display function of specialized software (Lavelli et al., 2005).

In all, the co-occurrence analyses, frequency analyses and sequential techniques “create summary measures of real-time behavior” (Lavelli et al., 2005, p. 57). Calculating measures of relationship between two variables yield in-depth information about how development occurs for an individual. “When measures of association are calculated repeatedly (as in a microgenetic design) they can be subjected to the longitudinal analyses (Lavelli et al., 2005, p. 57).
Besides quantitative measures of real-time change, the qualitative description of the historical emergence of change is necessary since such a description documents the developmental investigations of learning behaviors. It is “the procedure through which the researcher organizes the data elements into a coherent developmental account” (Polkinghorne, 1995, p. 15). Lavelli (2005) suggests six analytic steps to analyze qualitative data. The first step involves watching and re-watching each of the videotaped records of the interaction. By doing this, researchers develop initial impressions and interpretations of the unfolding interaction between the two related behaviors. The second step consists of writing sequence narratives, which transforms the observational data into text. Due to the impossibility of depicting every detailed interaction occurring at the level of real-time, the interpretation in the sequence narratives is guided by the research questions. The third step begins with iteratively constant comparison of each frame of interaction described in the main data – sequence narratives. The forth step includes creating short stories “that synthesize the meaningful elements of each session” by rereading the sequence narratives (Lavelli et al., 2005, p. 58). The fifth step is to “emplot these short stories into a narrative that synthesizes the history of communication development for individual dyads” (Lavelli et al., 2005, p. 58). The final step seeks to capture the regularities, in which multiple historical narratives are characterized into a complete and meaningful story.

3.2 The Design Model: A Revision of Middleton’s Cyclic Model

The multiple iterations in design-based research, as discussed above, heavily influence the classic research sequence advocated by conventional scientific researchers. Many scholars have already proposed design-based research models to study design cycles (Amiel & Reeves, 2008; S. Barab, 2006; Middleton et al., 2008). Among these models, Middleton’s cyclic model best exemplifies the iterative process of design-based research. As shown in Figure 22, the model
claims that design-based research starts with producing a researchable question to be tested (Grounded Models). At this phase, the review of existing literature is necessary in order to gain a greater preliminary understanding of the problem.

Unlike the second step of classic research that involves designing a testable solution to the problem, the second phase of Middleton’s model involves the initial design of the intervention grounded in a theoretical framework. Qualitative evaluation of the intervention is conducted during the transition between the second phase and the third phase – the feasibility study. Such a qualitative evaluation involves interviews, focus groups, observation and case studies to identify how the intervention is working, barriers and facilitators to its implementation and how it may be improved.

The third phase, the feasibility study, is the beginning of the design experiment. In this phase, the intervention should be sufficiently well developed and be tested for acceptability. The

Figure 22. Middleton’s cyclic model of DBR
results of phase three will yield information on whether the intervention should proceed to the next phase or whether it is necessary to return to the initial phase in identifying the research problem and developing the theoretical framework from which the intervention is originally based.

My revision of Middleton’s cyclic model starts from Phase Four as shown in Figure 23. The fourth phase, prototyping and trialing is a process of iteration between the testing and further modification of the intervention. This phase includes pilots of small-scale multiple prototypes of the intervention. Borrowing a term from human-computer interaction, I named this phase the low fidelity prototyping design phase. Qualitative data is collected during the transition between the phase four to the phase five. Field study in phase five yields information on whether the intervention should proceed to the next phase – high fidelity prototyping design – or whether it is necessary to reconsider the low fidelity prototyping design.

Figure 23. Wang’s revision of Middleton’s cyclic model of DBR
As the iterations between testing and further design become more sophisticated, advances are made in the interventions’ propositional framework and in outlining its plausible causal models. The more robust design of the intervention at phase six pushes the research to the next phase – high fidelity prototyping design. The more satisfactory design of the intervention is ready to move on to the seventh phase – field study that aims at testing the usability of the more robust design of the intervention in order to be implemented in full. The evaluation phase continues to collect more data to further carry out “definitive testing of the solution” (Middleton et al., 2008, p. 28).

The last phase is the intervention’s transportability. It is at this phase that researchers take the result from the seventh phase and the eighth phase and disseminate the findings to the rest of the teaching and learning community. A design of instructional sequences will be conducted in order to show the community how the intervention works.

3.3 The Research Design

This dissertation research extended through the creative design process, from the initial conceptualization stage of using virtual worlds through to the final dissemination of a robust design of the intervention, a virtual world for scenario-based language teaching and learning. Again, the three overarching research questions were:

RQ1:

What affordances do virtual worlds for language teaching and learning provide?
RQ 2:

How should we design immersive language teaching and learning activities in virtual worlds to engage language learners?

• How do embodiment and avatars in a virtual world support language acquisition?

• How can virtual world platforms support legitimate peripheral participation and engagement in communities of practice that are relevant to language learners’ needs through co-presence?

• How can virtual worlds be designed as places where three-dimensional contextual objects and buildings invite meaningful participation using a sculpted prim?

RQ 3:

Do language learners learning in the specific designed virtual environment feel real?

• Does a chatbot learning artifact increase language learners’ presence in the immersive virtual language teaching and learning environment?

• Does a time machine learning artifact increase language learners’ presence in the specific designed immersive virtual language teaching and learning environment?

• Does the combined use of a chatbot and time machine increase language learners’ presence in the specific designed immersive virtual language teaching and learning environment?

• Does the combined use of a chatbot and time machine increase presence more than either learning artifact alone?
The design process involved multiple iterations between prototyping and testing, and my revision of Middleton’s cyclic model of design-based research was used to organize a robust design of the intervention.

Over a period of 24 months between 2010 and 2012, the research team of Dr. Stephen Petrina, Dr. Franc Feng, Yifei Wang, a technician and instructional designer (both invited as participants in the research) from the University of British Columbia (UBC) investigated best design practices of immersive language teaching and learning environments in virtual worlds. The research was funded by the SSHRC sponsored How We Learn (Technology across the Lifespan) project. Our team investigated four major open source virtual world platforms – Open Cobalt, Open Wonderland, RealXtend and OpenSimulator and selected OpenSimulator to explore further due to the design and research criteria of the project: 1) the chosen virtual platform must be hosted on the users’ own server so students’ information, course related materials and data could be stored on a Canadian server, 2) virtual platform could be connected with Moodle, our course management system, and 3) 3D artifacts designed in Second Life could be imported into the chosen virtual platform. Once a virtual world platform was selected, we started setting up the system. When the virtual world platform was built, Linda Kellie’s design, a chatbot and notecards were merged together to create an immersive language teaching and learning context for further testing. The next section, describes decisions made for hardware and software considerations: platforms, systems, utilities, etc.

3.3.1 Phase One: Grounded Models

Through reviewing the existing literature, researchers at phase one should gain a greater preliminary understanding of the problem. The following data are presented as a series of
dialogues describing the design-based research process utilized (pseudonyms employed with record of exchange and translation slightly edited for grammar):

The generation of researchable questions really began several years ago...

YIFEI: In 2008, I was entering my first year of the doctoral program under the supervision of Dr. Petrina at UBC. Continuing my master’s research in the field of language teaching and learning with technologies, I struggled towards how an immersive learning environment can be best designed for language learners. I worked my way through the technology world. I reviewed literature about designing immersive learning environments with technologies. By chance, I met an instructional designer, LINA, who was from the School of Nursing at UBC at one of meetings offered by the Faculty of Arts.

LINA: I encouraged Yifei not to give up. I had a strong feeling that if the two of us could together make a special team, we would make a design for sure, since Yifei and I approached instructional design from two very different perspectives – a researcher’s insight and a practitioner’s practice.

YIFEI: It was at this moment that LINA explored simulations in the School of Nursing. I was inspired by the simulation that her team designed, yet always felt there was something missing. Right! The 2D flash-based simulation couldn’t “undertake to engage language learners in a two-medium (spatial as well as linguistic) communication process: a conversation supplemented by graphical interaction in an ordinary scene on the computer screen” (Hamburger & Maney, 1991, p. 81). The spatial and linguistic communication process of an immersive learning environment, which were missing in the 2D flash-based simulation, provided language learners opportunities to go beyond context boundaries to learn the target language as in the target language speaking culture without physically stepping out of their hometown.
LINA: I was really intrigued by such an immersive learning environment, which could blur boundaries between foreign language learning and second language learning and boundaries between the real life and the digital life. I suggested that we could try 3D MMORPG.

YIFEI: However, MMORPG had strong predefined fictions and leveling, which hindered a learner roaming in a far broader design space. Was there anything similar as MMORPG but without pre-defined game rules and game leveling? Second Life, at this point, came into our sight.

LINA: At the time there were already a few simulated immersive language learning islands in Second Life, so nothing was new. We reviewed literature about Second Life for language education and traveled as many inworld islands as possible. Two critiques sparked our interests in this study: many virtual worlds were designed as places where three-dimensional contextual objects and buildings did not invite meaningful participation and interaction (Zheng & Zhao, 2009) and “activities and approaches (in virtual worlds)— for example, task-based activities, role-play, vocabulary and grammar games— resembled those used in real world second language (L2) classrooms” (Zheng & Newgarden, 2012, p. 14).

YIFEI: How should we design virtual worlds as an immersive learning environment for scenario-based language teaching and learning? How are affordances of virtual worlds shaped for scenario-based language teaching and learning? These two questions were the beginning of our further investigation of virtual worlds in the following years and became the backbone of this study.

3.3.2 Phase Two: Development of Artifact

This phase involves the initial development of artifact grounded in a theoretical framework.

Second Life was our first thought...
**YIFEI:** Early on, we approached *Second Life* as a platform for designing immersive language learning environments. We investigated *Second Life*, because at the time, even now, it was the most popular educational platform among all virtual worlds.

**LINA:** We also explored learning spaces, especially language learning spaces, in *Second Life*. We found that the two critiques were true that language learning in most of *Second Life* public learning spaces solely happened through conversations, which were no different within MSN or SKYPE. The beauty of virtual worlds, simulation, was under-utilized.

**YIFEI:** Simulation was the key reason that we considered virtual worlds as an immersive language learning platform. After reviewing literature, we had a preliminary thought about the design that simulated scenarios might allow language learners to learn a foreign language through experiencing.

**LINA:** Yifei was right; simulation was important: simulation provided learners a real-life geographical space. The simulation bridged the virtual and the real, the machine and the human, the body and the mind as well as the avatar and the self. *Second Life* could have the ability to provide simulation scenarios to language learners, but most of current designs on the public regions did not invite this feature.

**YIFEI:** Our second concern was a complete control over the 3D virtual world. Such a complete control allowed us to give permissions to learners. It is important because most of the time, we might not expect interruption from the public. Visitors with a variety of language proficiency levels might confuse the in-class language learners.

**LINA:** *Second Life* might help us with setting up a private region to achieve this goal. But who hosted the virtual world became an issue for us. Canadian universities had to use computer servers in Canada for data storage. That meant no Canadian data such as student name or student ID was allowed to be stored on U.S. server. *Second Life* was hosted by Linden Lab, which is located in the US.
YIFEI: Right. This was one of the biggest problems that we encountered if we used the Second Life platform.

LINA: We also should consider the cost. The cost of Second Life land itself was based on demand and could fluctuate with the market. As a research institution, we could afford a private region but we did not like the fluctuation of the price with the market. Is there other platform that we could think about?

YIFEI: Our unique situation led us away from Second Life. We began an extensive research journey and examined four major open source platforms – RealXtend\textsuperscript{30}, OpenCobalt\textsuperscript{31}, OpenWonderland\textsuperscript{32} and OpenSimulator. During the investigation, we beared in mind all the limitations imposed by the nature of this study such as data on Canadian servers, low cost, and privacy issues.

LINA: The ideal platform should allow us to have complete control over our own virtual world. Such a control had many advantages: we might have more freedom to set parameters and unlimited lands; we might have full access to students’ information and most important, all data could be saved on Canadian servers.

YIFEI: We also took into consideration of maintenance service of open source platforms. If unpredictable bugs crashed the system, could we find enough support from the community to figure out reasons so that we could reduce learners’ frustrations as soon as possible.

LINA: We decided to conduct a feasibility study on the four open source virtual world platforms – RealXtend, OpenCobalt, OpenWonderland and OpenSimulator.

\textsuperscript{30} http://realxtend.wordpress.com/

\textsuperscript{31} http://www.opencobalt.org/

\textsuperscript{32} http://openwonderland.org/
3.3.3 Phase Three: Feasibility Study

The feasibility study aims to determine which open source virtual world platforms mature enough to be easily applied to our immersive language learning environments. Technical feasibility, in particular, was investigated through scrutinizing the RealXtend, OpenCobalt, OpenWonderland and OpenSimulator. The feasibility aimed to answer:

- Which open source virtual world platform with current release versions made immersive language learning environments possible?
- What technical risks were there when using different platforms?
- Which platform was the best fit for our needs – complete control, low cost, and privacy?
- Which platform could be connected with learning management systems such as WebCT (Blackboard) or Moodle?

The feasibility study was conducted through a literature review of four open source virtual world platforms and a testing of each system by researchers. A comparison of RealXtend, OpenCobalt, OpenWonderland and OpenSimulator was summarized to help researchers to decide which platform would be best fit for their special needs. Our particular situation – linking with Moodle and importing 3D virtual artifacts designed in Second Life prompted us to choose OpenSimulator.

3.3.4 Phase Four: Prototyping and Trialing: Low Fidelity Prototyping

The low fidelity prototyping and trialing phase is a process of piloting small-scale multiple prototypes of the intervention. Qualitative data were collected during the transition between phase four to five in this study. A technician and a cohort of pre-service teachers participated in the low fidelity prototyping.

**Setting Up OpenSimulator...**
The *OpenSimulator* platform is situated historically within the development of *Second Life* (Weber, Rufer-Bach, & Platel, 2008). *OpenSimulator* is composed of two key components: a server that hosts a virtual world and a client viewer that runs on the user’s computer and communicates with the server. It has three major modes: standalone, grid and hypergrid. The standalone mode is completely disconnected from the Internet, that is, users run their own worlds on their own computer. The strength of this scenario is that all of users’ assets are stored on their own computers and not on someone else’s server.

The grid mode provides the user the grid service, the asset service, the inventory service and the messaging service. The entire grid, composed of regions, comprises the world. A grid can be hosted on a third party grid server or users’ own servers. A third party grid server helps users maintain the virtual world. The disadvantage of the commercial grid hosting is the cost and data security. Hosting *OpenSimulator* on users’ own servers reduces the risk of data security and the cost of hosting.

A hypergrid mode allows users to link their *OpenSimulator* to other *OpenSimulators* on the Internet. That is, when running in a hypergrid mode, a standalone *OpenSimulator* becomes networkable.

**YIFEI:** We first decided to build a hypergridded standalone to test *OpenSimulator* internally for various reasons such as security, firewall, privacy etc.

**LINA:** *OpenSimulator* provided several distributions such as binary packages of the latest release, Diva distribution, OSGrid distribution, and NewWorld Studio distribution.

**YIFEI:** Compared with each of these distributions, Diva distribution\(^3\) stood up for a preconfigured hypergridded standalone with WIFI enabled. It could be installed on both Windows and Linux/Unix system (Figure 24).

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\(^3\) http://opensimulator.org/wiki/Download
LINA: Our first thought was the Windows operating system. We consulted with JASON, the most experienced technician in our department, about using Windows operating system to host OpenSimulator platform.

![Figure 24. Diva distribution of OpenSimulator](image)

JASON: We understood that Windows XP was a kind of platform that everything could work on. However, Windows XP was no longer supported by Microsoft, that meant, we were using yesterday’s operating system versus today’s and tomorrow’s. It was important to use an operating system that continuously updated. When you were doing a project trying to develop something for the future, you did not want to go back in time and then end up with something running hassles with operating systems. So if you considered Windows operating system, a logical step was to run Windows 7. From the OpenSimulator website, it seemed that OpenSimulator might function well on Windows 7 operating system. However, we early on found out that Moodle appeared not to work on Windows 7 operating system. If you hoped to try Moodle, OpenSimulator and SLOODLE, you’d better consider another operating system.

YIFEI: Could you please suggest one?

JASON: Open source Linux had pretty good stuff. There was no cash cost for it. I suggested CentOS as opposed to other distributions. When my former colleague Ryan and I were experimenting with Linux a number of years ago, we downloaded many different distributions of it. We found out that CentOS had a very best visual tool to manage server and hardware. I also recommended Webmin tool installed for managing your website. It’s an open source too.
**YIFEI:** I noticed that there were many versions of CentOS. Which one did you recommend us to start with?

**JASON:** I tried 32bit version of CentOS 5.7 on AMD processor 64bit CPU computer. It appeared to have problems of Moodle installation. I couldn’t have php configured correctly. I also had another problem of 32bit version of CentOS 5.7, which seemed to be Java updates. After installing webmin, in order to get the file manager running, Java needed to be updated. But the Java applet that ran the file browser inside webmin on CentOS 5.7 was behind the current distributions of Java. I could not really get them working properly together.

Since we had a 64bit chip in the computer, I recommended 64bit CentOS 6.2\(^3\) newest version. It was easy to be updated with Yum. Yum stood for “yet another update manager”. It downloaded the needed updates from the repository and gave you an installation tool working extremely well. You did not need to do all of your compiling on your machine. The brilliant to do that was you could have a kind of standardized installation for what you were doing, a kind of development work. You need something standardized and you did not want to compile everything initially. It was an easy starting point if you wanted to go on to another production base or go on buying a new server later on.

**YIFEI:** We decided to install Centos 6.2 on a 64bit CPU computer. As Diva distribution explained, we installed Mono, which was a tool that allowed Linux operating systems to interpret the Microsoft .net framework that *OpenSimulator* was written to. What else did we need to pay attention to when installing Diva distribution on Linux Centos 6.2?

**JASON:** You need to correctly configure Opensim database in MySQL. I suggested you should consider visual manager to manage your MySQL database such as Navicat.

\(^3\) CentOS 6.2 can be downloaded from [http://mirror.its.sfu.ca/mirror/CentOS/](http://mirror.its.sfu.ca/mirror/CentOS/)
YIFEI: Together working with JASON, we installed Opensim database in MySQL. We also set up an Opensim database user at local host (Figure 25). And then we ran Diva distribution with WIFI enabled (Figure 26). Learners might register their accounts using HWL homepage.

Figure 25. OpenSimulator database with Opensim user at local host

Figure 26. WIFI homepage

Inworld Design…

We did not design our world from scratch. After surveying a number of virtual world design tools such as Holodeck and researching possible artifacts for inclusion within our world, we designed our HWL OpenSimulator world, building our learning environment based on
merging original files from Linda Kellie’s design. After reviewing all of Kellie’s design, we selectively downloaded the following five oar files and imported them into our Diva distribution OpenSimulator (Figure 27). We found an excellent fit between our learning objectives and all of the following designs, installed on our LAN Linux server. However, due to the limitation of preconfigured Diva distributions, we were only able to install 4 of these five oar files at one time. As a consequence, we were obliged to selectively substitute from these five oar files to test combinations of our design.

1. [http://www.lindakellie.com/oar.htm](http://www.lindakellie.com/oar.htm) (Total sim)
2. [http://www.lindakellie.com/oar6.htm](http://www.lindakellie.com/oar6.htm) (City)
4. [http://www.lindakellie.com/oar15.htm](http://www.lindakellie.com/oar15.htm) (Freebie Mall Sim 2.0)

In addition, we made further inworld design changes after testing combinations of Kellie’s oar files. In particular, we selectively retained inworld artifacts from Kellie’s design such as buildings, grasslands, gardens, malls and streets while deleting irrelevant contents. We also selected and imported chatbots to communicate course related information to language learners, designed inworld notecards explaining each of scenarios, learning objectives and activities and create time machine teleporting learners to targeted regions without using maps.

**Choosing a Viewer...**

Comparing viewers from different parties, Imprudence best fit our OpenSimulator platform with its very handy grid manager (Figure 28). Imprudence was a fantastic third party viewer that allowed users easily to connect to both the Second Life grid as well as OpenSimulator grids. Imprudence had a simple grid manager pull-down menu pre-populated with a list of grids including the Second Life grid and all the major OpenSimulator grids where our learners can access at by clicking on a button, New. OpenSimulator grid was easily added to the viewer as

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35 [http://www.lindakellie.com/myoars.htm](http://www.lindakellie.com/myoars.htm)
copying and pasting a URL to the grid manager. We downloaded the Imprudence viewer from Kokua website and installed on our participants’ computers. Our participants used Mac and PC, so stable version 1.3.2 Imprudence for both Mac and PC was installed as shown in Figure 29.

**Participants Logging in...**

Due to the capacity of the Intranet server, no more than four users at the same time could be logged into Diva preconfigured *OpenSimulator*. We made five groups of 19 participants from a pre-service teacher cohort with four participants in four groups and three in one. We had an hour hands-on workshop of the Imprudence viewer and the *OpenSimulator* platform. Two hours were spent on learning activities using the Imprudence viewer and the *OpenSimulator* platform.

*Figure 27. Virtual language learning worlds based on Linda Kellie’s design*
3.3.5 Phase Five: Field Study – Low Fidelity Prototyping

The journey began, but we still had a long way to go before our design was carried out…

The field study at this phase aimed to evaluate our low fidelity design. Suggestions of the further improvement of the design became the focus of the field study. Case study methods were employed. We conducted a preliminary evaluation of our OpenSimulator design with a group of cohort pre-service teachers to determine the effectiveness of the OpenSimulator platform for designing immersive language teaching and learning environments.
Nineteen pre-service (K-9 grade level) teachers participated in our preliminary evaluation of OpenSimulator platform. None of them had previous experience in virtual worlds. Participants did not have initial training using this platform, but they had a video demo showing them what this platform looked like and how this platform could be designed as a potential immersive teaching and learning space.

Our participants were not language teachers but they were teachers across a range of curriculum subjects. We purposefully made this choice because we were not only interested in how this platform could help language learning and teaching, but on a larger picture, we hope that the OpenSimulator platform could be used across the curriculum. As a result, a larger group of teachers from different subject areas could benefit.

During the preliminary evaluation, we first invited nineteen pre-service teachers to install standalone 0.7.2 version of OpenSimulator (16 macs and 3 pcs). We observed the participants interacting with the OpenSimulator-supported virtual environment. We then asked them to work in groups (3 to 4 students per group) brainstorming ideas of using OpenSimulator across subjects—math, language, social studies, science, and technology. We used group discussion techniques with open questions to identify strengths and weaknesses of designing immersive learning environments in virtual worlds.

**Research design…**

1. **Participants**

   Nineteen pre-service teachers (ages between 20 and 35) were selected from an undergraduate teacher education course offered by our department. They were selected entirely by volunteering. Participant consent was gathered before the study.

2. **Site of Research**

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The field study was conducted in a lab in the Education building. The Diva preconfigured *OpenSimulator* platform with a combination of four designed regions was installed on a LAN system with four participants (maximum) logging in at the same time. Nineteen participants were divided into four groups (four groups with 4 pre-service teachers and one group with 3 pre-service teachers). They came to the lab once a week from 4:00 pm - 7:00 pm. They spent two sessions (each session 3 hours) exploring the world.

3. **Instrument for the Study: the OpenSimulator Platform**

   We did not install voice-enabled communication on the *OpenSimulator* platform. Since all participants were in the same lab, they could communicate face-to-face. Hence, if the *OpenSimulator* platform was hosted on a server, the voice should be enabled by installing Freeswitch / Whisper or alternative VOIP service. Camtasia was installed on participants’ computer to capture their interactions inworld.

4. **Methods**

   4.1 **Participant Observation**

   To see the actual moment-to-moment interaction among participants, virtual artifacts and the *OpenSimulator* platform required participant observational studies. The use of the participant observation method reflected the conviction that there were essential details of everyday, situated human activities and interactions that would always be missing from interview data (Suchman & Trigg, 1986). The meanings of action were grounded in the context of activity (Hollan, Hutchins, & Kirsh, 1999b). The method of participant observation, with its virtue of direct experiential and observational access to the meanings and interactions in everyday life, offered the opportunity for researchers to understand and capture moment-to-moment participants’ actions when using the *OpenSimulator* platform (Jorgensen, 1989). In addition, direct observation also enabled researchers to see things, which were often overlooked,
and learn things that participants were unwilling to discuss in the interview (Patton, 2002). To that end, participant observation provided an overview of progress of interaction with the OpenSimulator platform.

4.2 Participant Group Discussion

Data collection also occurred in two stages over a three-hour period group discussion. For the first hour and a half saw a small group of four to five pre-service teachers were led through an open discussion by researchers. Each group took turns of the discussion in a private room. The small group discussion was not so large and participants were not left out. For the second hour and a half the whole group (19 pre-service teachers together) generated a rich discussion. Researchers nurtured disclosure in an open and spontaneous format. The goal was to generate a maximum number of different ideas and opinions from as many different participants in the time allotted.

3.3.6 Phase Six: Prototyping and Trialing: High Fidelity Prototyping

The high fidelity prototyping and trialing phase was a process of the more robust design of the intervention. The more satisfactory design of the intervention is ready to move on to the seventh phase – field study that aims at testing the usability of the more robust design of the intervention in order to be implemented in full. The evaluation phase continues to collect more data to further carry out “definitive testing of the solution.” Quantitative data and qualitative data were collected during the transition between phase six to eight. English language learners from local institutions and overseas participated in the high fidelity prototyping.

Inworld Design...

English Grammar 101
One of modules, verbs, for English grammar 101 was detailed designed using the *OpenSimulator* platform. This module was based on sharable online learning resources offered at BC campus.38 We downloaded the course portal from sharable online learning resources (SOLR) of BC campus, added one of the modules, Verbs, to our learning modules hosted in the department Moodle course management system (Figure 30).

**Immersive Virtual Learning Environments Walkthrough**

Based on four design principles discovered in the field study at the low fidelity prototype stage, we further developed our immersive virtual language teaching and learning environments to be role-playing scenarios. Four learning regions were designed for Module 2, Verbs (Figure 31). This included an orientation area for briefing, debriefing and general class work; a role-playing area of modern city and old time western town; and a shopping mall for teachers and learners customizing their avatars.

![Image of lesson plan](http://urls.bccampus.ca/1z)

*Figure 30. Sample of unit three*

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38 [http://urls.bccampus.ca/1z](http://urls.bccampus.ca/1z)
Virtual 3D objects, scripts and animation were created by researchers, technicians and instructional designers. When the OpenSimulator server was initially installed, it only had one avatar, four islands and sea. We realized that a ‘world’ should be built. We took advantage of free and reusable 3D objects shared via the Internet. Kellie was one who provided us with lots of help with the virtual world design. Assets were assembled in the virtual world to create scenes and scenarios. Non-player characters (NPC), a chatbot and time machine, were created in the design to facilitate learning in different scenarios.

Language learners played roles such as customers in a real estate company (Figure 32), a clothing store (Figure 33), a shoe store (Figure 34) and a supermarket (Figure 35). These environments provided learners contexts to practice conversations using an appropriate verb format such as I am/was, you are/were or he is/was etc. (Singular and plural verbs should match the format of subject. Tense should be appropriately used with the chosen learning environment). The use of the “time machine” and NPC “chatbot” scaffolded learners to understand the right
verb format according to their encountered situations in the virtual learning environment through role-taking.

*Figure 32.* A real estate company

*Figure 33.* A clothing store
1. Briefing in the Orientation Area
Teachers and learners were first asked to register their virtual world accounts through the HWL WiFi webpage (Figure 36). When learners and teachers logged into the virtual world, they were asked to be teleported to the orientation area (Figure 37). The virtual classroom was designed for students and teachers meeting together (Figure 38). The teacher explained grammar topics of verbs: action verbs and linking verbs, transitive verbs and intransitive verbs, helping verbs and irregular verbs when they go from singular to plural and when they go from present time to past time. The teacher could talk to students via chat (public or private) or using voice.

Students were required to login their Moodle accounts to preview course contents of module two. Virtual classroom learning environments were designed as learners in a face-to-face classroom — a familiar classroom environment might reduce teachers and learners anxiety of using the virtual world. It was in the virtual orientation area that teachers lectured on module two and gave instructions on inworld activities. In all, there were four groups of 20 participants. In what follows, I expand on our detailed planning and considerations for each of these four groups.

Figure 36. Creating virtual world accounts
Figure 37. Orientation area – virtual school building

Figure 38. Orientation area – virtual classroom

2. **Group One (N=20)**

Four learners were grouped in one team and altogether five groups of learners (n=20) were asked to teleport to the HWL 1 region to conduct conversations at a real estate company
(Figure 39), a clothing store (Figure 40), a shoe store (Figure 41) and a supermarket (Figure 42).

A sample of video conversations in each context such as at a real estate company, a clothing store, a shoe store, a supermarket, a hotel and a restaurant was provided in Moodle (Figure 43). These videos provided learners a great opportunity to start thinking their own sentences in the same context. For example, at a hotel, learners would listen to the following conversation in the video:

Hotel Manager: Good morning! May I help you, Sir?

Customer: Good morning! We would like to book a room for three days!

Hotel Manager: Sure sir, Single or Double?

Customer: Double. Double, of course!

Hotel Manager: Just a moment sir! Yes Sir, you could have one on the 2\textsuperscript{nd} floor.

Customer: Ah! She wants to know if we could get a room on the ground floor.

Hotel Manager: Let me see…

Hotel Manager: Yes! We have just one room next to the lift. Will that be ok?

Customer: All right! We will take that one.

Previewing these learning materials – videos and texts were required before learners were teleported to the HWL 1 region. They should either use sentences in the conversation from the video or modify sentences using grammar tips discussed in the text materials.
Figure 39. Conversations in a real estate company

Figure 40. Conversations in a clothing store
Figure 41. Conversations in a shoe store

Figure 42. Conversations in a supermarket
Figure 43. Module Two in Moodle
Learners were then asked to teleport to the HWL 3 region, an old time western town, to conduct conversations in a hotel (Figure 44) and in a restaurant (Figure 45). Similar as in the HWL 1 region, learners were asked to preview learning materials, videos and texts, related to conversations in these two contexts before they conducted their own conversation on HWL 3 region.

*Figure 44. Conversation in a hotel*

*Figure 45. Conversation in a restaurant*
Learners were then asked to be teleported back to the HWL 1 region to report what happened on the HWL 3 region. Past tense was necessary when learners told stories in the old time western town.

The purpose of these conversations was to help learners to understand how to use an appropriate format of verbs. Learners needed to distinguish verb formats and tenses in each context. Through putting verbs and tenses in use, we hoped that we could change the traditional way of reciting verbs and tenses.

3. **Group Two (N=20)**

Group two had similar learning path as Group one. The only difference was that group two had a NPC bot to facilitate learning (Figure 46). The NPC bot provided hints on changing tenses and singular/plural formats of verbs. When learners touched the bot designed in each learning environment, it started talking to learners through text. The inclusion of a bot in conversations provided learners a clue of appropriate verb formats and tenses. For example, when two learners did a role-play in a supermarket, they could get help from the NPC bot, in particular, the little cat on the counter (e.g. John and Kellie’s conversation at a clothing store, p. 179). Due to technological limitations, there was no voice recognition built into the virtual world, so the NPC bot could only communicate with learners through chat messages.
Group Three (N=20)

Group Three had similar learning path as Group One. The only difference was that Group Three had a time machine to facilitate learning (Figure 47). The time machine was designed as a way of teleporting inworld without using a map. It was not just a prop for enhancing fantasy but served as a link to the role-playing area, an old time western town, similar as hyperlinking on a web page. When learners were ready, they could pass through the time machine and were teleported to the HWL 3 region for more activities. There they conducted conversations in hotels and restaurants using present tense. But when they were teleported back to the HWL 1 region and told their stories about the HWL 3 region, they had to consider past tense. Time machine functioned as a hint for learner to think about conversations happened in different time slots.
**Figure 47.** Time machine reused as inworld teleporter

5. **Group Four (N=20)**

Group Four had similar learning path as Group One. The only difference was that Group Four had both the NPC bot and time machine to facilitate learning. Both the NPC bot and time machine were available for this group to get grammar points and time hints.

**Making the Immersive Virtual Learning World Online...**

After checking firewall issues and related protocols, we created online access on the server in order that our remote participants could access the immersive virtual learning world. When we put our server online with all designed inworld artifacts and 20 students logging in each time, the performance of the server had degraded. It appeared that the amount of RAM was seriously limiting performance. When we initially configured the server, we installed three
512Mb sticks of RAM for a total of 1.5 Gb. This was adequate for basic web server performance. However, after increasing the number of “Worlds” for the Diva installation, the MySQL database expanded to a gigabyte or more. A database of this size needs much more RAM than 1.5 Gb. We believed that adding more RAM would improve performance significantly. We decided to find a more powerful server to host our design.

Our original thought were that we could import our robust design of immersive virtual learning environment into BC OpenSim for further testing (Figure 48). Our research team collaborated with BC OpenSim group at UNBC about eight months between 2011 and 2012, in examination of the affordances of immersive virtual learning environments. Our research at UBC was funded by the “How We Learn” SSHRC sponsored project, exploring how children, adolescents, teens and adults learn technology. BC OpenSim\textsuperscript{39}, funded by BCcampus Online Program Development Fund (OPDF)\textsuperscript{40}, provides a free, robust, open platform for BC post-secondary institutions seeking to explore the potential of online simulations for teaching and learning. BC Opensim offers access to a range of tools such as VOIP, integration with Moodle using Sloodle, and integration of video and audio resources. It is a private, but open space for local BC post-secondary institutions through contacting the technology manager at the UNBC Centre for Teaching, Learning, & Technology. BC OpenSim servers supports about 40 users across 3 regions. An Imprudence viewer was selected for this research as in the low fidelity field study (Figure 49).

\textsuperscript{39} http://blogs.unbc.ca/bcopensim/category/about/
\textsuperscript{40} http://www.bccampus.ca/online-program-development-fund-opdf-2/
Figure 48. BC OpenSim

Figure 49. BC OpenSim login using imprudence
However, due to the migration of BC OpenSim server during the time when we started data collection, we had to rethink another available server that we could use. We revisited our lab server and updated a bigger RAM and installed Vivox for voice\textsuperscript{41}.

3.3.7 Phase Seven: Field Study – High Fidelity Prototyping

**Research Design...**

The field study at this phase aimed to evaluate our high fidelity design of the immersive language learning environment. Suggestions of best design practices such as embodied avatar, co-presence and meaningful learning participation became the focus of the field study. Ethnographic and case study methods or techniques were employed.

Conventional ethnographic research has traditions within anthropology and sociology (Bogdan & Biklen, 1992; LeCompte, 1993; Lincoln & Guba, 1985) and typically includes: field work done in natural settings, the study of a large picture to provide a more complete context of activity, an objective perspective with rich descriptions of people, environments and interactions, and a bias toward understanding activities from the informants’ perspective (Blomberg, Giacomi, Mosher, & Sewenton, 1993; Millen, 2000). Meanings of ethnography have been extended and practiced in many disciplines in addition to anthropology and sociology. Many ethnographers now categorize any small-scale study carried out in everyday settings that focuses on field observation methods as ethnography (Savage, 2000). In HCI, the use of ethnographic techniques has been focused on understanding work practices in order to inform the design of information systems.

“Typically, ethnography will take place over a period of several months with at least the same amount of time spent in analysis and interpretations of the observations” (Millen, 2000, \textsuperscript{41}Vivox is giving free voice service to small OpenSim worlds. It has terms and conditions here:  
https://support.vivox.com/opensim/
p. 281). Thus, one of the biggest challenges facing HCI ethnographers is the time-consuming fieldwork activities when “matching the pace of ever-quickening product development cycles” (Millen, 2000, p. 280). This is also the biggest challenge for this DBR research since the results of the field study will either pass on to the next phase – prototyping and trialing – or return to the first phase – grounded models.

Tackling this problem, Millén’s rapid ethnography was adopted to provide a reasonable understanding of our design. Participant observation and participant reconstructive interviews (open-ended) were used as methods to collect data. This ethnographic study involved fairly lengthy contact with all participants through participant observation and through participant reconstructive interviews designed to gain insights of our high fidelity design. I “typically insist(ed) on the importance of coming to understand the perspectives of the people being studied” (Hammersley, 2006, p. 4).

1. Participants

Eight language learners (four females and four males) were selected from high schools in Vancouver based on a snowball selection. These participants were all ESL learners. They came to Vancouver about two years. All of them were preparing LPI test\(^2\) when they participated this study. They were selected entirely by volunteering. Participant consent was gathered before the study.

2. Site of Research

The field study was conducted online using the virtual platform, with a combination of four designed regions hosted in our lab with the ability of twenty participants (maximum) logging in at the same time. Eight participants were divided into four groups (each groups with 2 language learners). They presented inworld once a week from 8:00 am -11:00 am (Vancouver

\(^2\) http://www.lpittest.ca/
They spent four sessions (each session 3 hours) on learning verbs and tenses inworld (Figure 50). The field study lasted one month.

<table>
<thead>
<tr>
<th>Learners’ Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Week One</strong> (8:00am-11:00am)</td>
</tr>
<tr>
<td><strong>Week Two</strong> (8:00am-11:00am)</td>
</tr>
<tr>
<td><strong>Week Three</strong> (8:00am-11:00am)</td>
</tr>
<tr>
<td><strong>Week Four</strong> (8:00am-11:00am)</td>
</tr>
</tbody>
</table>

*Figure 50. Learners’ activities in each week*

3. **Inworld learning facilitator**

Ms. Li (pseudonym) was the inworld learning facilitator for these four sessions. She holds Master’s degrees of Linguistics and Educational Technology. She was an English instructor in one of universities in Beijing China. She was in Vancouver when she participated the study.

4. **Instrument for the Study: BC Opensim Virtual World Platform**

Vivox for HWL virtual world was used in order to support the inworld voice communication. Screen Cast O’ Matic\(^{43}\) was used to capture learners’ interactions inworld and publish mp4 files of video recordings for further open-ended participant reconstructive interviews.

5. **Methods**

A better understanding of our design practices was the focus of the field study. With this perspective, the field study investigated three design practices – embodied avatar, co-presence and meaningful learning artifacts. Participant reconstructive interviews (open-ended) and participant observation were employed during the field study.

5.1 **Participant Reconstructive Interviews**

\(^{43}\) http://www.screencast-o-matic.com/
Participant reconstructive interviews, which depended on interviewing participants and eliciting data from them, were conducted on week three. An interview is “the ethnographer’s most important data gathering technique” (Fetterman, 1998, p. 37), because “it directly taps into the participants’ perceptions and views of reality” (Zhang, 2007). Each participant was interviewed inworld for about 30 minutes on week three. By sharing screen-captured videos with each participant as a stimulus, each of them reconstructed his/her feelings of embodied avatar, co-present in a virtual learning community and meaningful learning artifacts during his/her learning processes of verbs and tenses.

The use of screen-captured videos in the interview optimized the conditions for effective recall of associated learning processes of using BC OpenSim. Such verbal accounts provided legitimate data for this research (Ericsson & Simon, 1980; Nisbett & Wilson, 1977). Within the study, participants’ verbal reconstructions of their interactions and feelings were given significant thought. These verbal reports of interactions and feelings of using BC OpenSim, when prompted by videos of the particular associated scenario, could provide useful insights into these participants’ thoughts. The important key role of the video-stimulated recall resided in the juxtaposition of participants’ account of their appraisal, feelings and actions.

5.2 Participant Observation

The open-ended participant reconstructive interview captured participants’ thoughts that they themselves found memorable or remarkable. However, to see the actual moment-to-moment interaction among participants, virtual learning artifacts and instructors in BC OpenSim immersive virtual learning environment required participant observation. The use of the participant observation reflected the conviction that there were essential details of everyday, situated human activities and interactions that would be missing from interview data (Suchman & Trigg, 1986). The meanings of action were grounded in the context of activity (Hollan et al., 1999b). The method of participant observation, with its virtue of direct experiential and
observational access to the meanings and interactions in everyday life, offered the opportunity for researchers to understand and capture moment-to-moment participants’ actions when using virtual world platform (Jorgensen, 1989). In addition, direct observation also enabled researchers to see things, which were often overlooked, and learn things that participants were unwilling to discuss in the interview (Patton, 2002). To that end, participant observation provided an overview of progress of interaction in the immersive virtual learning world.

### 3.3.8 Phase Eight: Definitive Test

The field study resulted in an in-depth discussion on whether language learners felt the virtual world was operatively real in enabling them to transfer their language skills into real life settings. Hence, the definitive test was conducted to further measure presence in the immersive virtual learning environment.

Data were collected by researchers recruited and course instructors in China. Data were analyzed in consultation with a survey questionnaire specialist in Canada. As indicated, 80 participants were selected randomly and were assigned randomly into each group (details as in experimental participants).

Presence, one of the most elusive and evocative aspects of virtual systems, is used to describe participants’ subjective sense of being in virtual worlds (Dinh, Walker, & Hodges, 1999; Johns et al., 2000; Schubert, Friedmann, & Regenbrecht, 1999; Schuemie, Straaten, Krijn, & Mast, 2001). It goes to the heart of what feels “real” and creates the quality of experience that signals “I am here” (Taylor, 2002, p. 42). Presence “forms the very foundation on which immersion is built” (Taylor, 2002, p. 42). Through the use of a body as material in the dynamic performance of identity and social life, users “come to be made real – that they come to experience immersion” (Taylor, 2002, p. 42).
Literature on presence identified that the line between what is real and what can be computer generated is becoming increasingly blurred with technology (IJsselsteijn, de Kort, & Haans, 2005; Regenbrecht, Franz, McGregor, Dixon, & Hoermann, 2011). The definitive test at this phase contributed to measure presence in order to find out whether language learners learning in the immersive virtual environment feel real. I utilized the *Igroup Presence Questionnaire* (IPQ)\(^4^4\) to measure presence in the immersive virtual learning environment. In addition, I used Witmer and Singer’s *Immersive Tendencies Questionnaire* (ITQ)\(^4^5\) to measure differences in the tendencies of individuals to experience presence.

**Research Design**

Based on prior explorations and tests, the definitive test study examined presence under four learning conditions: virtual learning environment without digital learning artifacts (VE), virtual learning environment with chatbot (VEC); virtual learning environment with time machine (VETM), and virtual learning environment with chatbot and time machine (VECTM). The study was a single-factor, independent-measures design (a separate sample for each treatment condition). Each subject was allowed to experience only one learning condition. The purpose of this study was to determine whether learning conditions affected learners’ presence in virtual learning environments. Independent variables such as the chatbot and time machine were manipulated to create the treatment learning conditions in the experiment.

Four different groups of participants, one for each situation, participated in the study and each group (N=20) (Figure 51) was measured at the end of week four (Figure 52). The structure of the research design is shown in Figure 52.

\(^4^4\) [http://www.igroup.org/pq/ipq/download.php#English](http://www.igroup.org/pq/ipq/download.php#English)
### Table of Learning Conditions

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Group One</strong></td>
<td>Immersive Virtual Environment (VE)</td>
</tr>
<tr>
<td><strong>Group Two</strong></td>
<td>Immersive Virtual Environment with Chatbot (VEC)</td>
</tr>
<tr>
<td><strong>Group Three</strong></td>
<td>Immersive Virtual Environment with Time Machine (VETM)</td>
</tr>
<tr>
<td><strong>Group Four</strong></td>
<td>Immersive Virtual Environment with Chatbot and Time Machine (VECTM)</td>
</tr>
</tbody>
</table>

*Figure 51. Groups in different learning conditions*

<table>
<thead>
<tr>
<th>Conditions</th>
<th>Presence</th>
<th>VE</th>
<th>VEC</th>
<th>VETM</th>
<th>VECTM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group One</td>
<td>Score of group 1</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Group Two</td>
<td>N/A</td>
<td>Score of group 2</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Group Three</td>
<td>N/A</td>
<td>N/A</td>
<td>Score of group 3</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Group Four</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>Score of group 4</td>
<td>N/A</td>
</tr>
</tbody>
</table>

*Figure 52. The structure of the research design*

**Hypothesis**

We predicted that language learners who experienced the virtual learning environment would feel the property of presence. Language learners who experienced the environment where there was only one type of learning artifact included, or those who experienced the virtual environment without any learning artifacts, were expected to feel less present than those who experienced the environment with both learning artifacts.

Two hypotheses were tested in the experiment: the null hypotheses \((H_0)\), which was that learning conditions had no effect on presence, and the alternative hypothesis \((H_1)\), which was that learning conditions did affect presence. In particular,

i. \(H_1 = \text{chatbot learning artifact increased language learners’ presence in the immersive virtual language teaching and learning environment.}\)

ii. \(H_1 = \text{time machine learning artifact increased language learners’ presence in the immersive virtual language teaching and learning environment.}\)

iii. \(H_1 = \text{the combined use of chatbot and time machine increased presence more than either learning artifact alone.}\)
Immersion for Presence

In this study, I defined the sense of presence as the subjective sense of being in a virtual environment, while immersion was the ability of technology to immerse a participant. In order to measure the effect of learning conditions on presence, we first identified the factors that influenced presence. Did sample differences affect how much presence was experienced? What role did immersion play in experiencing presence? Examining existing literature, it appeared that a participant with highly immersive tendencies would feel more present in the virtual environment, and would enjoy the experience more than a participant who does not generally become immersed in activities (Johns et al., 2000; Nunez, 2002; Witmer & Singer, 1998). In order to conclude that it was the designed virtual learning artifacts that elicited a strong feeling of presence in learners, I first needed to know whether there was significant difference in Immersive Tendencies among four groups. Prior to exploring our designed virtual learning environment, we asked our participants to complete the Immersive Tendencies Questionnaire (ITQ) designed by Witmer and Singer (1998, p. 234), which identified a property of each participant and showed how likely a participant was to become immersed in an activity: how much presence individuals would or could experience in a virtual environment.

We measured all participants’ immersive tendencies scores. With a 95% confidence level to suggest no significant difference in Immersive Tendencies among the four groups of participants (details in chapter four), we continued our experiment using these four groups. On completion of this questionnaire, we repeated instructional procedures similar as at the field study at Phase Seven (Figure 53). Following the completion of the four weeks’ interaction, all
participants were required to complete the *Igroup Presence Questionnaire* (IPQ)\(^{46}\) based upon their learning experiences inworld.

**Variables**

Two dependent variables and two independent variables were defined for this experiment. Presence and Immersive Tendencies were the dependent variable to be measured, while chatbot and time gate were independent variables. Presence was the feeling of being there in the immersive virtual learning environment. Immersive tendencies were a property of each participant and showed how likely a participant was to become immersed in an activity. These variables were the most important to the experiment, as they allowed us to investigate the effect of two designed learning artifacts on presence. This investigation provided insight into the participants’ experiences of the immersive virtual learning environment on a local server.

**Equipment**

The experiment took place online using the local server in the university where we conducted the experiment due to the Great Firewall of China. Two online survey questionnaires\(^ {47}\) were available for participants to complete before and after the four sessions.

A chatbot was designed in the immersive virtual learning environment on BCOpensim platform to scaffold participants’ learning. The time machine was designed with the purpose of changing contexts. Passing the time machine meant time travel – participants could be aware of different time changes without guidance.

**Experimental participants**

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\(^{46}\) [http://www.igroup.org/pq/ipq/download.php#English](http://www.igroup.org/pq/ipq/download.php#English)

\(^{47}\) [https://www.surveyfeedback.ca/surveys/wsb.dll/s/1g1abb](https://www.surveyfeedback.ca/surveys/wsb.dll/s/1g1abb)
All of the participants in the experiment were language learners from a Chinese university. Invitation letters were sent to language classes in the university in Beijing in order to recruit subjects. All participants were first year undergraduate students with different majors. English was their core course for obtaining the degree. The design sought to find significant differences across four groups. The first group of participants was told that they would be participating in an immersive virtual language learning environment. A second group was told that they would be participating in an immersive virtual language learning environment, in which they could chat with chatbot. A third group of participants was told that they would be participating in an immersive learning environment, in which they could use the inworld time machine to teleport. The fourth group of participants was told that they would be participating in an immersive learning environment, in which they could have both a chatbot and a time machine to facilitate their learning.

A total of 80 participants participated in the experiments. The participants were all in their twenties and were fairly evenly composed of male and female. All participants were randomly assigned into the four experimental conditions as evenly as possible in order to obtain roughly equal numbers of observations in each condition. Each participant only experienced one of the experimental conditions.

**Questionnaires**

Two questionnaires were used in this experiment: Witmer and Singer’s *Immersive Tendencies Questionnaire (ITQ)*\(^{48}\) and the Igroup consortium’s *Igroup Presence Questionnaire (IPQ)*.\(^{49}\) As introduced earlier, the ITQ is a questionnaire developed by Witmer and Singer to measure individuals’ immersive tendencies. This questionnaire measures immersive tendencies.


\(^{49}\) http://www.igroup.org/pq/ipq/download.php#English
by eliciting information about a participant’s previous experiences with various media. Witmer and Singer’s version of a presence questionnaire was not used in this experiment due to critiques of its failure to measure presence accurately (Johns et al., 2000; Schuemie et al., 2001; Slater, 1999). Hence, based on Schuemie’s report (2001), in which two presence questionnaires, *Igroup Presence Questionnaire (IPQ)* and the *ITC Sense of Presence Inventory (ITC-SOPI)*, were proved valid and reliable, we decided to use the first to measure presence. The *ITC-SOPI* is a questionnaire to measure presence of a variety of media such as virtual reality, television and cinema, while the *IPQ* is targeted at measuring presence in the virtual environment. As a result, the *IPQ* was selected as a questionnaire to measure presence in this experiment.

*IPQ* is a scale for measuring the sense of presence experienced in a virtual environment. It was constructed by combining previous questionnaires and some new questions, using a large pool of items and two survey waves with approximately 500 participants. The current version of the *IPQ* contains three subscales and one additional general item not belonging to a subscale. The three subscales are

1) Spatial Presence – the sense of being physically present in the virtual environment.

2) Involvement – measuring the attention devoted to the virtual environment and the involvement experienced.

3) Experienced Realism – measuring the subjective experience of realism in the virtual environment.

The theoretical stance for creating and validating the *IPQ* is that sense of presence is considered as a subjective sense of being in a virtual environment. Since presence is a variable of a user’s experience, *IPQ* measures the sense of presence from subjective rating scales. Reliability and factor analysis of *IPQ* were tested in two studies.\(^5\) *IPQ* questionnaires were originally

\(^5\) http://www.igroup.org/pq/ipq/fa.php
written in German. An English version of IPQ items\textsuperscript{51} can be downloaded from the Igroup.org website. Due to the translated version of IPQ items, we conducted a validity study to test whether the translation was meaningful in an English speaking environment.

ITQ and IPQ questionnaires were uploaded to UBC Vovici EFM Continuum Survey tool\textsuperscript{52} and made available online for the participants. Participants were asked to answer ITQ questionnaires before using the virtual learning environment and IPQ questionnaires at the end of the week-four session.

3.3.9 Phase Nine: Dissemination and Impact

The last phase, dissemination and impact, involves the intervention’s transportability. Researchers take the results from the seventh phase and the eighth phase and report findings to research, teaching and learning communities.

3.4 Conclusion

This chapter detailed the methods used in the study and framed the methods through design-based research. The description of the DBR framework included a dialogue among the researcher, co-researchers and participants in the design of the virtual learning environment used for data collection. Descriptions of the participants and qualitative and quantitative techniques were also provided. Chapter four addresses the data analysis and findings.

\textsuperscript{51} http://www.igroup.org/pq/ipq/download.php
\textsuperscript{52} https://www.surveyfeedback.ca/surveys/wsb.dll/s/1g1abb
Chapter Four: Findings

Throughout the project, I was interested in exploring potentially effective ways of designing immersive language teaching and learning environments in virtual worlds. The design-based research solution can eventually support up to thousands of second language learners learning a foreign language in a virtual world.

The main task was to pilot and test effective design features of virtual worlds to immerse second language learners. Focusing on designing virtual worlds as a catalyst for change, three studies, feasibility study, low fidelity field study and high fidelity field study as well as definitive experiments were conducted in this research. Mixed methods (DBR, qualitative, quantitative) used to test and evaluate the design provided complementary data for understanding immersive virtual learning environments.

4.1 The Feasibility Study

The feasibility study aimed to answer

- Which open source virtual world platform with current release versions made immersive language learning environments possible?
- What technical risks were there when using different platforms?
- Which platform was the best fit for our needs – complete control, low cost, and privacy?
- Which platform could be connected with learning management systems such as WebCT (Blackboard) or Moodle?

As outlined in Chapter 3, a primary concern of this project was the location of the server. Who would host the virtual world for this research? Due to the USA Patriot Act of October 2004, the Information and Privacy Commissioner of British Columbia issued a report
recommending that the provincial legislature “prohibit personal information in the custody or under the control of a public body from being temporarily or permanently sent outside Canada for management, storage or safekeeping… prohibit personal information in the custody or under the control of a public body from being… accessed outside Canada” (Information and Privacy Commissioner of British Columbia, 2004). This meant that Canadian universities had to switch to computer servers located in Canada (We gave up our first thought of using well-developed Second Life as a potential platform for developing the immersive learning environment due to the server and financial issues). After a preliminary literature review, we identified four potential open source platforms – RealXtend, Open Wonderland, OpenSimulator, and Open Cobalt (Figure 53).

Figure 53. Open source virtual platforms

All four platforms can be hosted locally. In considering which weighted more favorably, I conducted the feasibility study to refine the choice of a platform for further design.
4.1.1 Testing RealXtend

RealXtend’s core development is funded by Finnish Entrepreneur Juha Hulkko and the City of Oulu in Finland. Beginning in 2007, this open source project aimed to extend the features of OpenSimulator to support normal 3d meshes, which were not available in Second Life or OpenSimulator at the time. At the beginning of the project, RealXtend aimed to achieve uniqueness from other platforms by the design of its modularity and extensibility. The most important modularity that RealXtend added to virtual environment platforms was the mesh support. Unlike Second Life or OpenSimulator, which is built with prims because prims are more compact, lower cost to render and easier to map to the physics model, RealXtend is built with meshes that allow users to import content from external tools like Maya, 3dMax and Blender. Meshes behave just like another prim type that can be linked with other primitives, saved into inventory and dragged, scaled and rotated. The difference between a prim and a mesh is that a prim is a solid, defined by an equation, cube, whereas a mesh is a series of triangles in 3d, which conform to the shape of the object. On the RealXtend platform, meshes provide proper 3d model support. Therefore, a lot of existing materials that are created by proper 3d modeling software are easily transferred from games to RealXtend based virtual worlds and vice versa (Figure 54).

Figure 54. RealXtend inworld meshes
Another feature that *RealXtend* provides is avatar customization. *RealXtend* version 0.5 built an avatar generator into its viewer. Users’ current avatar can be automatically imported into the generator and modified. The avatar generator also has a standalone version running outside of the viewer. The model box built in the avatar generator allows users to change to a different 3d avatar. The model box provides several options for users to edit the current avatar such as outfit, skin, animations, appearance and advanced options. The outfit, 3d virtual clothes, is placed over the avatar body. Skin is texture-based clothing that can be painted on the avatar skin. The drop-down animation list allows avatars to have an action and movement speed. Appearance is for basic avatar mass, muscle and posture modifications that can be used to change the body shape. Advanced is for more detailed re-shaping either using morphing, or, editing the bone sizes\(^5\) (Figure 55).

\(^5\) [http://docs.realxtend.org/index.php/Viewer_Customizing_Avatar](http://docs.realxtend.org/index.php/Viewer_Customizing_Avatar)

*Figure 55. Avatar generator in RealXtend*
The *RealXtend* server enables users to host their own virtual worlds. The server comes with a sample world or can be modified to suit users’ special needs. The original *RealXtend* viewer, Tundra, is under the *Second Life* GPL license.\(^5\) There are currently two generations of *RealXtend* technology available: Naali and Taiga. Naali is a built-from-scratch viewer available under the Apache 2 license; Taiga is a continuation and refinement of the original server project under the DSD license. The *RealXtend* server platform consists of three servers: authentication server, which keeps records of users and handles authentication; avatar storage server, which stores and delivers avatar data; and realXtend server, which is built based on *OpenSimulator* with modres plugins and handles world simulation\(^5\) as shown in Figure 56.

![Diagram](http://docs.realxtend.org/index.php/Introduction_to_realXtend_Server_Platform)

**Figure 56. RealXtend server**

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\(^5\) The GPL license released by *Second Life* required companies that create and distribute new software based on *Second Life* code must make it open source. This is one reason why there haven’t been any commercial viewers based on the *Second Life* code base.

*RealXtend* with an Apache 2 license aspires to be the standard for the coming 3D Internet. However, there is a long way forward for *RealXtend* before it actually becomes a standard. With an Apache 2 license, it is separated from *Second Life* and *OpenSimulator*. *RealXtend* developers work in isolation to create its own viewer from scratch. They adopted the Apache 2 license for both the server (Taiga) and the viewer (Naali), which results in a loss of both *Second Life* users and *OpenSimulator* users, leading to a significant reduction in total use of the platform. One of the main reasons for low numbers of usage compared to *OpenSimulator* is the non-transferability of previous *Second Life / OpenSimulator* experiences, such as taking advantage of documentation, video tutorials, free training classes and other resources available from *Second Life / OpenSimulator* communities.

Also, *RealXtend* does not have public grids available for users, which causes it to lag behind in usability and ecosystem. *RealXtend* is currently used for behind-the-scenes infrastructure (developers build games or meeting platforms rather than users). The distribution of *RealXtend* is mainly friendly for developers. Hence, *RealXtend* lacks a community of content creators and both online and inworld stores offering goods and services such as *Second Life / OpenSimulator*. Compared with more than a hundred public *OpenSimulator* grids and hundreds of others running in private mode of *OpenSimulator*, *RealXtend* needs work to make it easier for end users.

### 4.1.2 Testing Open Wonderland

*Open Wonderland* is a 100% Java open source toolkit for creating collaborative 3D virtual worlds. The *Open Wonderland* project was built by Sun Microsystems. The purpose of the project was to figure out how to manage and leverage a remote workforce culture. Aiming at communicating with colleagues with natural voices, Sun Microsystems created a virtual
workplace called MPK20\textsuperscript{56}, a 3D virtual environment that was designed to be fully open source under a GPL license. MPK20 utilizes server and client technology developed by Sun. The server technology is called DarkStar, which is “the game industry’s first open source, enterprise grade, highly scalable, online game server” (Saulnier, 2008). “It is the communication and event processing system on which a game client can be built, and Sun released it entirely as open source. It is platform and game agnostic and is therefore used on a variety of applications from massively multiplayer games to casual games to serious games”\textsuperscript{57} (Saulnier, 2008).

The client technology is called Wonderland, which is “to provide an environment that is robust enough in terms of security, scalability, reliability, and functionality that organizations can rely on it as a place to conduct real business. Organizations should be able to use Wonderland to create a virtual presence to better communicate with customers, partners, and employees. Individuals should be able to do their real work within a virtual world, eliminating the need for a separate collaboration tool when they wish to work together with others. Individuals should also be able to tailor portions of the world to adapt to their work needs and to express their personal style”\textsuperscript{58} (From Wonderland Website) (See Figure 57 for software architecture).

\textsuperscript{56} http://labs.oracle.com/projects/mc/mpk20.html
\textsuperscript{57} http://saulnier.typepad.com/learning_technology/2008/01/immersive-educa.html
\textsuperscript{58} http://openwonderland.org/about
Unlike OpenSimulator or RealXtend, Open Wonderland does not allow its users to build inworld but imports from Maya or Blender. Hence, an avatar, instead of being built inworld, must be created using Evolver Avatar Loader\(^5\). Through the Evolver Avatar Loader, users can drag and drop avatars into the Open Wonderland virtual world.

One distinct character that Open Wonderland has over OpenSimulator and RealXtend is that outside applications can be embedded inside the virtual world. OpenSimulator has the ability to run web-based applications, but not all standalone software packages. Open Wonderland runs a standalone software package inworld, so avatars inworld can gather around and interact with the application in real time. Open Wonderland currently does not have grids, but Wonder School project\(^6\) is worth analysis if interested. One important feature of Wonder School, located in Groningen (Dutch), is its embedded Alice\(^6\) program in the virtual world.


\(^6\) [http://wonderschool.org/](http://wonderschool.org/)

\(^6\) [http://alice.org/](http://alice.org/)
4.1.3 Testing Open Cobalt

*Open Cobalt* is an open source 3D environment for real-time collaboration. The roots of *Open Cobalt*\(^{62}\) can be traced back to the Croquet Project started by Alan Kay and David A. Smith in late 2001 (Figure 58). Croquet is a software developer's kit for creating collaborative 3D applications that was under active development from 2002-2007. It was released as an open source SDK in 2007. Open Cobalt was built using the Croquet SDK and is the only active open source line of development from the original technology\(^{63}\)

![Figure 58. History of Open Cobalt](http://www.opencobalt.org/about/history)

The core infrastructure of *Open Cobalt* was funded by Hewlett-Packard, Viewpoints Research Institute Inc. at the University of Wisconsin, University of Minnesota, Japanese National Institute of Communication Technology, Duke University, and private individuals. Open Cobalt is similar to other 3D virtual environments in that it allows users to enter 3D worlds as avatars and interact with the worlds and other avatars. Different from other 3D virtual environments, *Open Cobalt* uses peer-to-peer (P2P) technology instead of servers. According to the *Open Cobalt* website, P2P technology allows its users to access *Open Cobalt* virtual worlds on local networks, intranets, or even across the Internet without any need to access other servers. Anyone can host an *Open Cobalt* virtual world for free. *Open Cobalt*’s leverages P2P technology

\(^{62}\) [http://www.opencobalt.org/about/history](http://www.opencobalt.org/about/history)

\(^{63}\) [http://www.opencobalt.org/about/faqs](http://www.opencobalt.org/about/faqs)
to support interactions and this is a major difference from commercial multi-user virtual world systems such as *Second Life*, where central servers manage all inworld interactions. Hence, users can set up virtual spaces and interact with others of their choosing with no hosting fees, licensing or virtual land lease costs.

Like *Open Wonderland*, *Open Cobalt* lacks content creation tools inworld. But it does provide the infrastructure for world creation, navigation and collaboration and most important, it supports content created in free or open source authoring applications such as Sketchup or Blender. One big advantage of *Open Cobalt* is the motion simulation. Motion Simulation, written in Smalltalk and using the FreeCAD application, can be easily imported into *Open Cobalt* virtual worlds. This technology is currently under development and will allow users to create and simulate 3D solids.⁶⁴

### 4.1.4 Testing OpenSimulator

*OpenSimulator* is an open source multi-platform, multi-user 3D application server written in C# and is designed to be easily expanded through the use of plugin modules. *OpenSimulator* uses the *Second Life* protocol for client to server communication. It uses a .NET/MONO framework to provide system-level framework and is compliant with a range of virtual world viewers such as Imprudence (see the viewer comparison in Appendix A).

*OpenSimulator* contains communications services known as a user service, grid service, asset service and inventory service. These services account for the bulk of the virtual world architecture (Figure 59).

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**OpenSimulator** adopts a unique approach, inworld scripting, to develop virtual world applications. Scripting is the engine driving activity inside of an *OpenSimulator* virtual world. *OpenSimulator* supports Linden Scripting Language (LSL)\textsuperscript{65}, *OpenSimulator* Scripting Language (OSL) and C# scripts (Figure 60).

The physical places such as mountains, buildings or oceans, where avatars can walk, fly and interact, make up *OpenSimulator*’s regions (Figure 61). There are two modes of regions that can be run in *OpenSimulator*, stand-alone and grid, and many regions may be run simultaneously on the same server.

\textsuperscript{65} http://wiki.secondlife.com/wiki/LSL\_Tutorial
Figure 60. Regions in OpenSimulator

Figure 61. Scripts in OpenSimulator
*OpenSimulator* supports the concepts of Megaregions\(^66\): several regions stitched together without borders (Figure 62). Megaregions can be designed as Hypergrid regions as well as Non-Hypergrid regions.

![Figure 62. Megaregion\(^67\) mapping](http://metaverseink.com/blog/?p=28)

Hypergrid regions allow users to link their own *OpenSimulator* to other *Opensimulators* on the Internet. The function supports seamless agent transfers among *OpenSimulators*. It can be used both in a standalone mode and grid mode.\(^68\) The basic idea for hypergrid is that region/grid administrators can place hyperlinks on their map to hypergridded regions run by others. Once those hyperlinks are established, users interact with those regions in exactly the same way as they interact with local regions. In particular, users can teleport to hypergrid regions. Once the user reaches the hypergridded region, they interact with a different virtual world without logging out their own world (Figure 63).

\(^{66}\) http://metaverseink.com/blog/?p=28

\(^{67}\) http://opensimulator.org/wiki/Setting_Up_Mega-Regions

\(^{68}\) http://opensimulator.org/wiki/Hypergrid
There are 330 key functions in Second Life and at least 300 of them have been fully implemented in OpenSimulator (Korolov, 2009). Direct skills can be transferred from Second Life. Avatar and all related assets are similar, and templates created for Second Life also work for OpenSimulator, which provides OpenSimulator a larger social community than any other virtual world platform.

OpenSimulator is still in an Alpha stage. Frequent updates mean things change often and sometimes radically. When I started my research, OpenSimulator was a 0.6.9 version and upon writing this section had its newest release, the 0.7.3.1 version. Not all features in the old version work well in the newest version of OpenSimulator.

### 4.1.5 Our Choice: OpenSimulator as a Catalyst for Change

Our choice of potential virtual world platforms was based on six parameters: server hosting, connection with learning management systems, transferable Second Life skills and prims, Hypergate Teleport, NPCs and inworld voices. OpenSimulator, RealXtend and Open Wonderland platforms can provide similar functions on server hosting, but Open Cobalt uses a
P2P service. All these four platforms can be hosted locally. All of them can embed inworld voices.

However, *OpenSimulator* platform has four more key elements over other three virtual world platforms: connection with learning management systems, transferable *Second Life* skills and prims, Hypergate Teleport and NPCs.

### 4.1.5.1 SLOODLE

*OpenSimulator* can be connected with the learning management system Moodle through Sloodle, which stands for simulation linked object oriented dynamic learning environment. Sloodle blends *OpenSimulator* and Moodle into a single 3D virtual learning environment. Sloodle uses custom built objects in *OpenSimulator* to communicate with scripts running on a Moodle server.

The core modules are Sloodle controller, Sloodle set and Sloodle registration booth. Sloodle controller, a Moodle module, is used to enable the use of Sloodle in Moodle. Sloodle set contains a set of the various Sloodle virtual world objects. And Sloodle registration booth pairs Moodle users to their virtual world avatars.

A wide range of Sloodle tools are available for teaching and learning. Web-intercom is a chat room that brings the Moodle chat room and virtual world chats together. Discussions inworld are archived in a Moodle database. Quiz chair allows instructors to author quizzes in Moodle, and with Dloodle students can take the quiz inworld. Distributor is a vending machine that can be filled with learning items. The Choice tool allows students to vote and see results inworld and access them in Moodle. Presenter provides quick inworld presentations of slides, videos and/or web pages on Moodle.
4.1.5.2 **Transferable Second Life Skills and Prims**

*OpenSimulator* shares many similarities with *Second Life*. *Second Life* skills can be applied to *OpenSimulator* virtual world platforms. Primsets, scripts, regions, terrains and textures designed in *Second Life* can be imported into *OpenSimulator* virtual world platforms. *OpenSimulator* shares social communities with *Second Life*, which means *OpenSimulator* users can draw on their *Second Life* experiences.

4.1.5.3 **Hypergate Teleport**

*OpenSimulator* makes it possible for hypergrid teleports using hypergates (Figure 64). Hypergates establish a centralized service where people can register their worlds, and others can travel to them using an inworld teleporter, a scripted object. The inworld teleporters such as hypergates make hypergrid traveling more fun than using a map.

![Figure 64. Hypergate](image)

4.1.5.4 **Non Player Characters (NPC)**

*OpenSimulator* has Non Player Characters (NPC) functionality. NPC is an important functionality for role-play scenarios. NPC inworld can help populate the landscape and make the world realistic and interactive.
The main use for NPC is for training scenarios.\textsuperscript{69} NPC in \textit{OpenSimulator} can be created by cloning existing avatars and move around on autopilot, even when original avatars are no longer logged in. LibOMV-controlled NPCs are basically standard avatars, and can do anything that avatars can do, but one must be logged in as their own user accounts. They are “bots” that can populate virtual worlds.

\textbf{4.2 Field Study at Low Fidelity Design Stage}

Many projects addressed the affordances of \textit{OpenSimulator} for learning; however, few have explored how teachers feel about this innovated technology in their classrooms and which competencies they need to develop in order to properly integrate this technology into their teaching activities. Hence, the field study at the low fidelity design stage aimed at listening to preservice teachers.

Participants felt immersive virtual worlds not only have a lot to offer learning in terms of engaging and rich learning environments but also pose a challenge to learners, teachers, ICT services in the schools, and language institutions if they are not properly implemented.

Through analysis of these data, four design principles of \textit{OpenSimulator} that determined successful language teaching and learning outcomes were found. These design principles guided our further design practices of the immersive virtual learning environment with the potential of increasing reliability, interoperability and reduced access issues for language teachers, language trainers and language learners.

\textsuperscript{69} http://www.hypergridbusiness.com/2011/08/npcs-are-coming-to-opensim/
4.2.1 Design Scopes, Which Determine How Much Time and Money is Worth Investing in Developing Learning Resources in 3D Immersive Language Learning Environments, Should Be Considered Beforehand.

A single group (number = 19) in our study indicated that, in general, pre-service teachers (grades k-9) did not have even basic technological competencies of virtual worlds. Most of them found that virtual worlds were daunting and quite time intensive. For example:

Student 1: While it's loading, though: So we come to this virtual world, which is quite time intensive.

Student 2: Well, actually we found the idea of virtual reality daunting.

Student 3: To be able to do this and to create it and to spend the time and whatever, it comes at a cost, right, and there's the financial cost, whatever, and there's also the time cost. So time that I'm putting in or my students are putting in to creating and being in this is time that they're not spending in let's call it the real world.

Hence, when we planned our next step of designing virtual worlds for language acquisition, we took into consideration teachers’ technical knowledge of virtual worlds and anxiety of using new technologies. Integrating virtual worlds into teaching and learning is not as simple as integrating PowerPoint into a lesson or blogging. A design group composed by instructional designers, programmers and graphic designers is almost indispensable. Such a design group needs to work closely with teachers on the integration of virtual worlds into their teaching.

Design scope, which determines how much time and money is worth investing in developing learning resources in 3D immersive language learning environments, should be considered beforehand. The more precise and detailed the design scope is, the better learning outcomes will be. Such integration is not possible with a single teacher’s effort, but a group of people can make it happen. The design scope also provides a common understanding of the project among teachers, learners, instructional designers, programmers and graphic designers and
provides necessary details to perform more detailed planning, estimation and execution of the work.

By defining boundaries at the design scope stage, the things that are applicable to a specific language course will be separated from those that are peripheral. Designing an immersive virtual language learning environment is time-consuming and can involve a heavy cost. Hence, defining what is relevant to a specific language teaching and learning activity and what is not becomes one of critical elements of the successful integration at the end.

4.2.2 Digital Learning Artifacts Should Not Be Dumped Inworld.

Our case study also showed a concern for meaningful artifacts inworld. For example:

Student 1: Other than, you know, kind of space visualization and the little clip that we saw from that Australian school last week, I'm still struggling with the value— the educational value of it. The Australian school, all they did was to make these little things that they could have done outside the virtual world, make shops, make art galleries, you know. Instead of going outside and having a classroom on the lawn, they had a classroom in the virtual world.

Student 2: I’m confused with this virtual land, because aren’t the students using the technology to learn technology or are they using the technology to play? I can’t figure out learning elements in this virtual land. Are they using this virtual space to learn programming and skills on the computer, then that’s great; otherwise, if it’s just for play, it’s different.

4.2.3 Appropriate Pedagogical Approaches Should Be Considered When Teaching in Immersive Virtual Worlds

It is necessary to examine which learning and teaching approaches suit the use of immersive virtual worlds for language acquisition. Our participants clarified that they could imagine how virtual worlds could be used to facilitate teaching and learning. The key point was which learning and teaching approaches were appropriate for them to use virtual spaces in
classrooms. There was a different usage of virtual worlds in classrooms and in online environments:

Student 1: The thing that excites me about this possibility is not necessarily for everyday, regular kids that come into the classroom. The thing that excites me about being able to have a virtual classroom, which is essentially what this is, taking online courses and giving people an actual place where they can go and interact with their course and with their course material, and it doesn’t excite me necessarily for the regular kids, but it excites me for the kinds that don’t have the opportunities, for whatever reason, to make it into a regular school, the kids that live way up north where their schools are one-room schoolhouses, the kids that have such severe anxiety that going out into the actual world stresses them out so much that they can’t do it. This is a steppingstone that they could come to school and to a classroom without having to actually go to a classroom.

Student 2: Right. Students with disabilities would be able to do things in here that, like, they wouldn’t normally be able to do. And in my mind, that is where the value is. I don’t think that it’s right for every class, I don’t. I think that you could teach a lot of the social interactions in the virtual world. I also think that it is a full immersion thing. So if you were to have, like, a French island, you could go and interact with other avatars that are in France to practice your French, and that aspect of it— those two aspects of it really excite me for this. I think that having virtual classrooms could potentially happen down the line.

### 4.2.4 Clear Tutorials of How-to are Necessary

Our participants expressed their concerns of including clear tutorial for students to refer to inworld. It could be overwhelming without a clear line of what students needed to go and to do. Students could get lost inworld and could not make it back on the normal track of the curriculum. Virtual worlds not only typically have no pre-defined game rules and game leveling but also they do not contain strong game fictions, which is what MMORPG’s did well. Students roamed inworld, generating their own fictions, communities and meanings. Without clear tutorials of how-to, students get confused about learning objectives, goals of activities and their learning progress. For instance:

Student 1: I felt lost inworld. There were so many places and I didn’t know where I should go to and where I could find my colleagues.
Student 2: I was concerned about how we could measure our students’ progress using this virtual world? How did we know they should follow a learning procedure, what was coming first, what next and so on.

Student 3: Students could be given some freedom of discovering learning activities and meaningful learning materials but not full freedom. It was difficult for teachers to control the learning progress for the whole class.

4.3  **Field Study at High Fidelity Design Stage**

Meanings derived from field study data relied on inductive reasoning to interpret and structure. The field study at the high fidelity design stage took the position that an interpretive understanding was only one possible by way of uncovering or deconstructing the meanings of a phenomenon. The theoretical lens, learning as embodied, situated and distributed, from which I approached design, the strategies, ethnographic methods, which I used to collect and construct data, and the understandings, embodied avatar, co-present and meaningful learning artifacts, which I had about what might count as relevant data in answering the research question, were all analytic processes that influenced the data.

Analysis of field study data at the high fidelity design stage occurred as an explicit step in conceptually interpreting the data set as a whole, using Computer-Mediated Discourse Analysis (CMDA) to transform the raw data into a new and coherent depiction of the affordances of virtual worlds for language teaching and learning and how we should design immersive language teaching and learning activities in virtual worlds to engage language learners.

CMDA was used to understand the nature of online communication and how it could be optimized in specific contexts of use. Such an understanding was facilitated by the fact that learners engaged in socially meaningful activities online in a way that typically left a textual trace, making the interactions accessible to scrutiny and reflection and enabling researchers to employ empirical, micro-level methods to shed light on macro-level phenomena (Herring, 2004).
The CMDA approach fit best with a study dataset in which learners interact by means of verbal language and their behaviors. The qualitative inductive thematic analysis at this study phase was an iterative multilayered process and was supplemented by interviews and ethnographic observation. The analysis was informed by a linguistic perspective, where I viewed online behavior through a lens of language and grounded its interpretations in observations about language and language use.

Initially, open coding was used to compare and contrast discrete parts of inworld verbal communication, observation field notes and interview Q/As to develop conceptual concepts. Then these conceptual concepts were combined together based on similarities under a category (Strauss & Corbin, 1990). An integrating, relational category from the data was described using themes. Themes were identified as a result of the open coding technique (Figure 65).

In coding inworld verbal communications among participants with interview Q/As as well as observational field notes, I observed that the thematic topic of instructional scaffolding, inworld knowledge and skills transfer and collaborative learning emerged as strong affordances of virtual worlds for language teaching and learning. In the following section, addressing the above three themes, I illustrate how we should design immersive language teaching and learning activities in virtual worlds to engage language learners. In particular, I discuss how embodiment and avatars in a virtual world could support language acquisition, how virtual world platforms could support legitimate peripheral participation and engagement in communities of practice that were relevant to language learners’ needs through co-presence and how virtual worlds could be designed as places where three-dimensional contextual objects and buildings invited meaningful participation using a sculpted prim.
Figure 65. Iterative multilayered data analysis process
4.3.1 Learning Occurred through Instructional Scaffolding by Designing Various Supportive Distributed Learning Artifacts such as Chatbot, Time Machine in Virtual Worlds and Videos in Moodle.

In coding the raw data, I found inworld design of chatbot and time machine supplemented by videos in Moodle optimized learning through instructional scaffolding. Videos initially provided extensive instructional support to learners in building their understanding of new contents. Once learners internalized the learning contents (conversation samples provided by video tutorials), they accessed to virtual worlds to further learn language in use. When they presented inworld, learners interacted with each other, with chatbot and with time machines.

When learners were not capable of continuing the inworld conversation or performing correctly on their own, chatbot, time machine and videos provided them a piece of solution through hints or open questions. Peers, chatbot and time machines assisted a language learner to be able to achieve more than he/she would be able to achieve alone. These designed virtual learning artifacts tailored to learners’ needs with the intention of supporting them to achieve their learning goals (Sawyer, 2006). Secondly, these designed virtual learning artifacts built a shared understanding of what was known and what was knowable. Thirdly, chatbot, time machine and video tutorials supported learners’ autonomy of learning by allowing them to articulate solution paths. In doing so, these artifacts created opportunities for learners to self-correct or evaluate approaches and solutions.

The illustrative cases that I chose were those of the eight observed learners. I believed that learners’ discourse patterns reflected how learning occurred through instructional scaffolding by designing various supportive distributed learning artifacts such as chatbot, time machine in virtual worlds and videos in Moodle.
Three categories under this theme were coded using transcripts of inworld conversations and interviews: building a supportive online learning environment, building a common ground for understanding and building autonomy. Each coded participants’ discourse could range from a single word to the entire speaking turn. The categorization continued until the participant’s turn ended or a different code was used. If a participant’s discourse could not be coded (e.g. conversations irrelevant to language learning during the intercome), then ‘no code’ was used.

**Building a supportive online learning environment**

Chatbot, time machine and video tutorials created a supportive context woven throughout learners’ conducting inworld conversations. One of the major affordances that learners mentioned was that inworld digital learning artifacts built a supportive online learning environment.

John and Kalie’s CMDA revealed that they had the highest rating of learning support from chatbot. Lisa and Lilly’s CMDA revealed that they had the highest rating of learning support from time machine. Lillian and Tony’s CMDA revealed that they had the highest rating of learning support from video tutorials.

At the beginning of module two in June 2012, learners’ understanding of verbs and tenses appeared sketchy. The inworld learning facilitator Ms. Li began the inworld discussion from singular / plural forms of verbs and tenses. She also reminded learners of the advantage of using video tutorials in Moodle and, more over, chatbot and time machine in the virtual world:

**MS LI:** We will have a different learning environment for module two. In learning verbs and tenses, all of you will have a chance to practice in situations. Please log into your course Moodle to preview video tutorials for today’s session. Each group will be teleported to HWL 1 region to conduct conversations in a real estate company, a clothing store, a shoe store and a supermarket. We will start from group one. Others will use camera’s view to observe group one. Each group can seek help from video tutorials, chatbot and time machine whenever you encountered difficulties during the conversation.
One of conversations conducted by John and Kalie revealed that chatbot as a learning support did foster their learning.

**John and Kalie in a clothing store**

KALIE: May I help you?
JOHN: Yes. I would like to buy a T-shirt.
KALIE: What color do you like?
JOHN: Green.
KALIE: Oh, Mu… Here’s the green one. Do you know… Mu… where can we get help with our sentences? [seeking help]

JOHN: Video tutorials, Chatbot and Time machine. [assistance]
KALIE: Where is the chatbot? [confirmation]
JOHN: At the front door.
(Kellie’s avatar and John’s avatar went to the front door together.)
KALIE: Hello, can you help me?
Chatbot: Hi there!
KALIE: I would like to buy a T-shirt.
Chatbot: What color do you like?
KALIE: Pink.
Chatbot: Sure. Please right click the pink T-shirt on the wall and then you can select ‘buy’ button on the bar chart. [an answer that Kellie is looking for]

KALIE: Thank you!
Chatbot: No problem! It’s ok…
(Kellie’s avatar and John’s avatar went inside the clothing store, standing in front of the clothing wall.)
KALIE: What color do you like?
JOHN: Green.
KALIE: Sure. Please right click the pink T-shirt on the wall and then you can select ‘buy’ button on the bar chart. [supported by chatbot]
JOHN: Got it! Thank you!

Kalie appeared to be unsure how to respond to John’s choice of green T-shirt. She switched her turn to the chatbot, hoping that it might provide her a hint. The chatbot showed her one way to respond to John. Kalie learned the expression from the chatbot and applied it when she and John went inside of the clothing store. In fact, there were many other expressions that
Kalie could use to respond to John. For example, Kalie could have said “Here you are’ or “Would you like to try it? In this scenario, the chatbot functioned as instructional scaffolding, providing Kalie and John some language hint so that they could continue their conversation. Both of Kalie and John relied on the perceived information to finish their inworld conversation. This scenario represented a successful design case of using a chatbot to provide instructional scaffolding. Similarly, time machine provided instructional scaffolding and support through relating to a particular learning environment.

**Lisa and Lilly in a shoe store**

LISA: Did I meet you in a restaurant? Indirect start
LILLY: What? Confusion
LISA: Did we see each other in a restaurant? Repetition
LILLY: What? Confusion
LISA: The time machine. Reminding
LILLY: Oh, right. It was a nice restaurant. Understanding
LISA: Oh Yeah! What can I do for you? Turn
LILLY: I want a pair of shoes.
LISA: What size?
LILLY: I do not know.
LILA: Let me see. Can you try this one?
LILLY: Sure.

Lisa enjoyed the moments in the HWL 3 region. It was an old time restaurant. Lisa and Lilly had a great time in that restaurant discussing the menu, ordering food and paying bills. Lisa played a role as a sale woman in the shoe store. She used some sales techniques to start the conversation. However, Lilly did not seem to quite understand the way that Lisa started the conversation. Time machine here in the conversation functioned as a hint reminding Lilly about the restaurant in another region. Once Lisa mentioned Time Machine, Lilly understood what Lisa was talking about. Similarly, video tutorials provided instructional scaffolding and support through giving examples:

**Lillian and Tony in a real estate company**
TONY: Welcome friend! How can I help you?
LILLIAN: I need a flat on rent.
TONY: Do you want it for residential purpose?
LILLIAN: Yeah.
TONY: How many rooms do you want?
LILLIAN: Two bedrooms and one drawing room. Flat should be well furnished.
TONY: At what floor would you like to have this flat?
LILLIAN: I would like this flat either on ground floor or on first floor.
TONY: What do you do?
LILLIAN: I am a software engineer in a company.
TONY: How many family members are you?
LILLIAN: I, my wife, two children.
TONY: Can you tell me about your budget?
LILLIAN: I need a good flat with a good location and a space for parking.
TONY: Ok. I am sure that you will have a good flat according to your requirement. Let’s go.
LILLIAN: I am ready to see.

Tony and Lillian attempted to use exactly the same sentences as in the video tutorial. During the interview, both of them mentioned that they encountered discomfort and uncertainty when they created new sentences in a new environment. They preferred to follow the tutorial and whenever they were fluent in using what they learned from tutorials, they would generate new sentences. Virtual worlds provided them a learning context and allowed them to apply what they learned from tutorials to the real practice.

**Building a common ground for understanding**

The importance of building a supportive online learning environment provided learners a basis for participation and development of self-regulation. Instructional support such as the chatbot, time machine and video tutorials helped build shared understandings. These supportive techniques were necessary to promote learners’ competence. Participants reported feelings of low negative affect even after failing in conducting conversations. These reports indicated that participants approached learning with some confidence.
KALIE: I am happy to learn a sentence from chatbot (Sure. Please write click the pink T-shirt on the wall and then you select ‘buy’ button on the bar chart.) I know there are other expressions. But during the role-play, I believed that this would be the best expression due to the time constraints.

INTERVIEWER: Why?
KALIE: I cannot remember other expressions at once. I appreciate chatbot provides me this option. I do not want to fail the conversation.

INTERVIEWER: If you failed to respond to your team member, how do you feel?
KALIE: A little bit embarrassed. But I can still continue the conversation. I feel more confident in this environment than real classroom. I am very shy whenever I speak English. I dare not to look at others’ eyes. But my avatar does not.

Tony shared the same feeling when asking chatbot for help.

INTERVIEWER: Do you think chatbot help you learn something?
TONY: Oh, Yeah! I learned sample sentences from chatbot.
INTERVIEWER: Could you please tell me one of them?
TONY: Sure. For example, please write click the pink T-shirt on the wall and then you select ‘buy’ button on the bar chart.
INTERVIEWER: How do you feel about it?
TONY: I am happy that chatbot can help me answer my colleague. I want to pass the pink T-shirt to my colleague, but I do not know how to express this action in virtual worlds.

It appeared that the chatbot, like video tutorials, provided learners an opportunity to find an answer to their confusion or uncertainty while replying to their colleagues. Learners shared a common understanding that the chatbot, time machine and video tutorials provided them such as sentence examples. Learners built upon these examples to find more solutions in creating new sentences.

Building autonomy

Autonomy in this study refers to the ability to take charge of one’s own learning (Holec, 1981). Video tutorials and chatbot provided learners a shared common ground in understanding conversations in contexts. They encouraged peer support and cooperation during co-construction of conversations. Learners began their practices by previewing what was given. Video tutorials, the chatbot and time machine supporting scaffolding created room for learners’
development of autonomy. Learning was shifted from the teachers’ responsibility to the learners’ by having inworld opportunities for learners to demonstrate competence. Learners-in-inetraction with these technologies had felt in control of learning, correcting and evaluating.

**Lisa and Lilly in a shoe store**

LISA: Did I meet you in a restaurant? 🔄 *past experiences*
LILLY: What?
LISA: Did we see each other in a restaurant?
LILLY: What? 🔄 *confusion*

LISA: The time machine. 🔄 *reminding*
LILLY: Oh, right. It was a nice restaurant.
LISA: Oh Yeah! What can I do for you?
LILLY: I want a pair of shoes.
LISA: What size?
LILLY: I do not know.
LISA: Let me see. Can you try this one?
LILLY: Sure.

Lisa began her conversation by creating something new. Instead of following the sample video tutorials, Lisa decided to apply some sales techniques in the conversation. By asking whether both of them met before, Lisa hoped that they could talk about the past stories in order to be closer to her customer. However, Lilly did not understand Lisa’s interlocution and questioned “what?”. It appeared that Lilly either felt confused about Lisa’s question or was not sure why Lisa started a conversation like this. Through mentioning ‘time machine’, Lisa reminded Lilly that an encounter transpired before. Virtual learning environments with the chatbot, video tutorials and time machine afforded learners freedom to learn by themselves.
4.3.2 Learners’ Knowledge and Language Skills Acquired Inworld Might Transfer into Real World Practices through Embodied Avatars.

The resemblance of aspects of virtual learning environments to real life led to my early hypothesis that learners’ knowledge and language skills acquired inworld might transfer to real life. I observed that an embodiment of learners in virtual worlds came in the form of avatars. Through avatars, learners were embodied and made their engagement with a virtual world real (Taylor, 2002). Participants stated that avatars provided them a means to live digitally, to fully inhabit the world. They existed not just as ‘mind’, but instead construct identities through avatars (Taylor, 2002). They agreed that learning experiences in virtual worlds transferred into their real lives in the form of avatars in contexts.

The key issue here was which body was the most evocative to the participants. In another words, how much the representation allowed them to immerse themselves in the environment – how much they felt being connected to an avatar. I observed that all eight participants visited the HWL 4 region, a shopping mall, whenever they got time. They spent quite an amount of time on putting together their first avatars. I found that they tried different heads, bodies, skins, clothes, hair and accessories. I was even asked to help them import their favorite style of clothes and hair.

The feeling of resemblance was something that I heard repeatedly in interviews. Their statements about feeling resemblance revealed how an avatar fosters transferability in both places and how learning was interrelated. Tony wrote to me: “I need someone inworld who looks like me. Learning environments are different from games. In games, I prefer a beast-like avatar rather than humans because I believe that beast is much stronger and powerful. In learning environment, I wish that my avatar is me in virtual.”
Tony’s statement about the feeling “my avatar is me in virtual” showed how learners believed the resemblance was important for the transfer of learning, knowledge and information to real life activity. Another participant Lillian expressed a similar feeling of resemblance: “I wish my avatar looks exactly like me. I spent quite a lot of time on customizing my avatar. It is not as easy as making up myself. I believed that if the avatar looks like me, I would immerse in the environment to experience learning in different scenarios. Also, I felt I could socialize with others in the virtual world as the same as in the real life through the avatar who looks like me.”

In both instances, the resemblance of avatars became a central focus of these learners to engage in learning in the virtual world. For Tony, there was a difference between a learning world and a gaming world. Such a difference was evidenced in the form of his avatar. The strong and powerful beast avatar provided Tony courage to fight with others in a gameworld. However, the resemblance of himself in a virtual learning world created a sense of self. Like Tony, Lillian mentioned that resemblance allowed her to immerse in the environment. Lillian also reflected that it was through a self-like avatar that she connected with other learners as if they were in real life.

I also found that the transfer of learning into real life was reflected by learners linking their real world experiences directly back to their avatars’ experiences in the virtual world. I noticed that learners spoke of their avatars in the third person such as my avatar rather than I am in the virtual world. When I queried learners about how they felt about their relationship with their avatars, Lisa said “I visit the virtual world though my avatar. My avatar shares my intelligence and experiences in real world.”

Lisa’s comments on the relationship between herself and her avatar reflected a particular interest in connecting herself with her avatar. A real person brought her/his own real life experiences, culture and knowledge to the virtual world. Vice versa, what an avatar experienced in the virtual world might influence a real human beings’ construction of knowledge
and skills. Tony described: “I experienced the virtual world through my avatar. He is in the restaurant, so I can share with him the restaurant experience. I believe that I have some connections with my avatar. These connections allow me to practice my English through avatar.”

Interestingly, most participants I spoke with made similar connections between their avatars and themselves like Lisa and Tony. This process of working through constructing the connections with avatars reflected the transferability of learning in virtual worlds to real life.

4.3.3 Simulated Role-play Situated Language Learning in Contexts

Promoted Deep Learning through Communities of Practice.

I looked into the traces of learning that learners left in their inworld conversations and interviews and found that learning occurred by participating in collective practices in virtual worlds.

After the first time in the immersive virtual learning environment, eight learners asked me whether they could continue to use this space after my study was done. They decided to host an English learning community inworld so that they could learn English together and practice the language with peers. They noted that they would invite some of their local friends who were interested in Mandarin to join in this community. In that way, they could exchange languages.

During the study, each group worked as a small learning community. Whenever a particular group was familiar with a particular setting, they invited other group members to join in them to share their discovery. Other group members thus became new members of a particular group, and members from a particular group became experts. Lisa and Lilly had a great time in an old time restaurant on HWL 3 region. So they decided to invite all others to join in their conversation.

LISA: I would like to have dinner with other group members. How do you like it?
LILLY: Sounds great! What kind of dinner would you like to have then?
LISA: Western food.
LILLY: We can ask them to bring their favorite food too.
LISA: Good idea. There are plenty of foods in the shopping mall.
LILLY: You are right. We can also share ours. I save some cakes in my inventory.
LISA: I can search more on the internet.

Experts helped new members move from the periphery to venter and develop expertise of a particular setting by encouraging them to join in their conversation.

LISA: Hi John. Would you like to join in our party in the restaurant on HWL 3 region?
JOHN: We haven’t gotten a chance to work on conversations in the restaurant.
LISA: No problem. We can work on it together.
JOHN: Do I need to preview the video tutorials?
LISA: You can if you like.
JOHN: Ok, I will see you later.

It was very interesting to see that two members in a group create a small community where they built up trust and personal relationships, and encouraged others to help and share ideas. We observed that learning as a process took place when a member participated in collective actions through legitimate peripheral participation (LPP). Learning occurred as an integral part and was the product of engagement in social practice.

Secondly, I noticed that designed virtual learning artifacts such as the chatbot, time machine and videos engaged learners who worked collaboratively in tasks that would be too difficult for them to complete on their own.

**John and Kalie in a clothing store**

KALIE: May I help you?
JOHN: Yes. I would like to buy a T-shirt.
KALIE: What color do you like?
JOHN: Green.
KALIE: Oh, Mu... Here’s the green one. Do you know... Mu... where can we get help with our sentences? ── seeking help

JOHN: Video tutorials, Chatbot and Time machine. ── assistance
KALIE: Where is the chatbot? ── confirmation
JOHN: At the front door.
(Kellie’s avatar and John’s avatar went to the front door together.)
KALIE: Hello, can you help me?
Chatbot: Hi there!
KALIE: I would like to buy a T-shirt.
Chatbot: What color do you like?
KALIE: Pink.
Chatbot: Sure. Please write click the pink T-shirt on the wall and then you can select ‘buy’ button on the bar chart. ── an answer that Kalie is looking for

KALIE: Thank you!
Chatbot: You are welcome!
(Kellie’s avatar and John’s avatar went inside the clothing store, standing in front of the clothing wall.)
KALIE: What color do you like?
JOHN: Green.
KALIE: Sure. Please write click the pink T-shirt on the wall and then you can select ‘buy’ button on the bar chart. ── supported by chatbot
JOHN: Got it! Thank you!

John and Kalie were collaborative conducting a conversation in a clothing store. It would be difficult for an individual to practice this dialogue by herself or himself. With her/his partner, s/he encounters difficulties together. As in this example, when Kalie did not remember a sentence to reply to John, John reminded her about asking the chatbot for help. Kalie listened to her colleague and began a conversation with the chatbot. To her surprise, the chatbot replied her using the language she wanted to express. Here, the chatbot not only scaffolded learners but also encouraged them to work collaboratively.

### 4.4 The Definitive Study at High Fidelity Design Stage

One-way analysis of variance (ANOVA) was used to determine whether there were significant differences between the means of four independent groups. ANOVA was used to
compare the means between the four groups and determined whether any of those means were significantly different from each other. Specifically, it tested the null hypothesis: \( H_0: \mu_1 = \mu_2 = \mu_3 = \mu_4 \) (where \( \mu \) = group mean). If, however, the one-way ANOVA returned a significant result, then we accepted the alternative hypothesis \( (H_1) \), which was that there were at least 2 group means that were significantly different from each other. At this point, the ANOVA was an omnibus test statistic and could not indicate which specific groups were significantly different from each other, but only that at least two groups were different. To determine which specific groups differed from each other, I used a post-hoc Tukey test.

When carrying out a one-way ANOVA in order to validate the results, I made and checked the following assumptions:

- Independent variable consisted of four categorical independent groups (Group One, Group Two, Group Three and Group Four).
- Dependent variables (Immersive Tendencies and Presence) were ratio (continuous).
- Dependent variables (Immersive Tendencies and Presence) were approximately normally distributed for each category of the independent variable.
- Variances between the independent groups (homogeneity of variances) were equal.
- Cases were independent.

### 4.4.1 SPSS Output of the One-Way ANOVA – Presence

A four-sample one-way ANOVA was undertaken and analyzed for Presence using the Presence Questionnaire (IPQ). Its subscales, in particular, General Presence subscale (item 13), Spatial Presence (items 4, 5, 6, 7, 8), Involvement Presence (items 9, 10, 11, 12 – items 9 & 10 were reverse coded), and Experienced Realism (items 13, 14, 15, 16) were also analyzed. These
subscales were based on the Igroup IPQ\textsuperscript{70} Presence Questionnaire. For each analysis, a short description of the subscale as defined by Igroup is provided together with the results of a four-sample one-way ANOVA and 95% confidence interval.

Within this analysis, I distinguished between immersion and presence. Immersion was defined as a variable of the technology that could be described objectively, while the sense of presence was a variable of a user’s experience. Therefore, I relied on self-reports for measuring presence. The scale items\textsuperscript{71} of the Presence Questionnaire were validated by Igroup, using structural equation modeling (SEM)\textsuperscript{72} (Figure 66).

\textit{Presence Total} – Presence Total identifies the ability of an individual to obtain a sense of presence within a virtual environment.

\textsuperscript{70} http://www.igroup.org/pq/ipq/download.php#English
\textsuperscript{71} http://www.igroup.org/pq/ipq/construction.php
\textsuperscript{72} http://www.igroup.org/pq/ipq/construction.php
A one-way ANOVA was used to examine whether the treatment had effects on learners’ presence total in virtual worlds. Results from the ANOVA were (Table 1):

Table 1. Presence Total - robust tests of equality of means

<table>
<thead>
<tr>
<th>Presence Total</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Std. Error</th>
<th>95% Confidence Interval for Mean</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Lower Bound</td>
<td>Upper Bound</td>
<td>Lower Bound</td>
<td>Upper Bound</td>
<td>Lower Bound</td>
<td>Upper Bound</td>
</tr>
<tr>
<td>Group One</td>
<td>20</td>
<td>54.10</td>
<td>3.959</td>
<td>.885</td>
<td>52.25</td>
<td>55.95</td>
<td>46</td>
</tr>
<tr>
<td>Group Two</td>
<td>20</td>
<td>64.10</td>
<td>6.888</td>
<td>1.496</td>
<td>60.97</td>
<td>67.23</td>
<td>56</td>
</tr>
<tr>
<td>Group Three</td>
<td>20</td>
<td>66.35</td>
<td>4.716</td>
<td>1.055</td>
<td>64.14</td>
<td>68.56</td>
<td>57</td>
</tr>
<tr>
<td>Group Four</td>
<td>20</td>
<td>70.90</td>
<td>8.905</td>
<td>1.544</td>
<td>67.67</td>
<td>74.13</td>
<td>57</td>
</tr>
<tr>
<td>Total</td>
<td>80</td>
<td>63.86</td>
<td>8.342</td>
<td>.933</td>
<td>62.01</td>
<td>65.72</td>
<td>46</td>
</tr>
</tbody>
</table>

Table 1 displays descriptive statistics including the mean, standard deviation and 95% confidence intervals for the dependent variable (Presence Total) for each separate group (Group One, Group Two, Group Three, and Group Four) as well as with all groups combined (Total). The approximately equal size of each group (N=20) reduced the effects of unequal variances. ANOVA was used to compare the sample estimates to determine if the population means differ. The four groups showed a different mean in this study: \( \mu_1 = 54.1, \mu_2 = 64.1, \mu_3 = 66.35, \) and \( \mu_4 = 70.9. \)

The standard deviation (\( \sigma_1 = 3.959, \sigma_2 = 6.888, \sigma_3 = 4.716, \sigma_4 = 6.905 \)) indicates the amount of variability of the scores in each group. These values should have been similar to each other, for an appropriate ANOVA test. Equality was inspected via the Levene test (Table 2).

The 95% confidence interval for the mean (95% CIs \([52.25, 55.95]\), 95% CIs \([60.97, 67.23]\), 95% CIs \([64.14, 68.56]\), 95% CIs \([67.67, 74.13]\) indicated the upper and lower bounds that contained the true value of the population mean, 95% of the presence total.
Maximum and minimum values (Group One [46, 59], Group Two [55, 75], Group Three [57, 73], Group Four [57, 80] indicated the highest and lowest presence total for each of the learning conditions experienced by the four groups.

Table 2. Presence Total - test of homogeneity of variances

<table>
<thead>
<tr>
<th>Levene Statistic</th>
<th>df1</th>
<th>df2</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.103</td>
<td>3</td>
<td>76</td>
<td>.032</td>
</tr>
</tbody>
</table>

One of the assumptions of the one-way ANOVA was that the variances of the four groups compared were similar. Table 2 shows the result of the Levene Test of Homogeneity of Variance (tested for similar variances). Levene’s $F$ Statistic showed the significant value of .032 was less than 0.05 ($p < .05$), and therefore, the four groups did not have similar variances. The assumption of homogeneity of variance was not met. Since the equal variance assumption was violated, I used the Welch Statistic to determine whether there were significant differences between groups (Table 3).

Table 3. Presence Total - robust tests of equality of means

<table>
<thead>
<tr>
<th>Welch</th>
<th>Statistic</th>
<th>df1</th>
<th>df2</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>42.338</td>
<td>3</td>
<td>41.233</td>
<td>.000</td>
<td></td>
</tr>
</tbody>
</table>
I found that $F(3, 41.233) = 42.338, p < .05$. The significant value of .000 was less than 0.05, and therefore, there were statistically significant differences between groups. We rejected the null hypothesis $H_0$ and concluded that there was at least one mean different from the rest. Presence total of at least one type of the learning conditions differed from the rest.

However, this result did not show which of the specific groups differed. When the equal variances assumption has been violated, it is appropriate to use the Games-Howell post hoc test in the Multiple Comparisons Table to determine which groups differ from each other (Table 4).

**Post Hoc Tests**

*Table 4. Presence Total - post hoc tests*

Table 4 lists the pairwise comparisons of the four group means for all selected post hoc procedures. Mean difference indicates the differences between the four-group means. Sig
indicates the probability that the four group means differ. A 95% confidence interval was constructed for each difference.

The Games-Howell post-hoc test (Table 4) revealed that there were statistically significant differences between Group One and Group Two ($p = .000 < .05$), Group One and Group Three ($p = .000 < .05$), Group One and Group Four ($p = .000 < .05$) as well as Group Two and Group Four ($p = .016 < .05$). There were no significant differences between Group two and Group Three ($p = .613 > .05$) as well as between Group Three and Group Four ($p = .090 > .05$).

To summarize, the chatbot (64.1±6.688), time machine (66.35±4.716) and both the chatbot and time machine combined (70.9±6.905) increased learners’ presence total compared with virtual environment group (54.10±3.959) ($p = .000 < .05$) (Table 5). Learners who experienced both the chatbot and time machine (70.9±6.905) had a higher mean score of presence total than learners who only experienced the chatbot (64.1±6.688) ($p = .016 < .05$) (Table 5). There were no differences in presence total in virtual learning environment between learners who experienced the chatbot and those who experienced the time machine ($p = .613 > .05$) as well as between learners who experienced the time machine and those who experienced both of the two learning artifacts ($p = .090 > .05$).

Table 5. Mean of presence total
**Spatial Presence** - the sense of being physically present in the virtual environment.

A one-way ANOVA was used to examine whether the treatment had effects on learners’ spatial presence in virtual worlds. Results from the ANOVA were (Table 6):

Table 6. Spatial Presence – descriptives

<table>
<thead>
<tr>
<th>Spatial Presence</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Std. Error</th>
<th>95% Confidence Interval for Mean</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group One</td>
<td>20</td>
<td>19.95</td>
<td>2.743</td>
<td>.613</td>
<td>18.67, 21.23</td>
<td>14</td>
<td>25</td>
</tr>
<tr>
<td>Group Two</td>
<td>20</td>
<td>25.05</td>
<td>2.188</td>
<td>.489</td>
<td>24.03, 26.07</td>
<td>20</td>
<td>28</td>
</tr>
<tr>
<td>Group Three</td>
<td>20</td>
<td>24.70</td>
<td>4.092</td>
<td>.915</td>
<td>22.78, 26.62</td>
<td>13</td>
<td>30</td>
</tr>
<tr>
<td>Group Four</td>
<td>20</td>
<td>26.25</td>
<td>2.425</td>
<td>.542</td>
<td>25.11, 27.39</td>
<td>21</td>
<td>30</td>
</tr>
<tr>
<td>Total</td>
<td>80</td>
<td>23.99</td>
<td>3.774</td>
<td>.422</td>
<td>23.15, 24.83</td>
<td>13</td>
<td>30</td>
</tr>
</tbody>
</table>

Table 6 displays descriptive statistics including the mean, standard deviation and 95% confidence intervals for the dependent variable (Spatial Presence) for each separate group (Group One, Group Two, Group Three, and Group Four) as well as when all groups are combined (Total). The approximately equal size of each group (N=20) reduced the effects of unequal variances. One-way ANOVA was used to compare the sample estimates to determine if the population means differ. The four groups showed a different mean in this study: \( \mu_1 = 19.95, \mu_2 = 25.05, \mu_3 = 24.70, \) and \( \mu_4 = 26.25. \)

The standard deviation (\( \sigma_1 = 2.743, \sigma_2 = 2.188, \sigma_3 = 4.092, \sigma_4 = 2.425 \)) indicated the amount of variability of the scores in each group. These values should be similar to each other for the ANOVA to be an appropriate test. Equality was inspected via the Levene test (Table 7).

The 95% confidence interval for the mean (95% CIs\(_1\) [18.67, 21.23], 95% CIs\(_2\) [24.03, 26.07], 95% CIs\(_3\) [22.78, 26.62], 95% CIs\(_4\) [25.11, 27.39] indicated the upper and lower bounds which contained the true value of the population mean 95% of the spatial presence. None of the four groups overlapped with any of the other three groups.
Maximum and minimum values (Group One [14, 25], Group Two [20, 28], Group Three [13, 30], Group Four [21, 30] indicated the highest and lowest spatial presence for each learning conditions that the four groups experienced.

*Table 7. Spatial Presence - test of homogeneity of variances*

<table>
<thead>
<tr>
<th>Spatial presence</th>
<th>Levene Statistic</th>
<th>df1</th>
<th>df2</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.768</td>
<td>3</td>
<td>76</td>
<td>.160</td>
</tr>
</tbody>
</table>

One of the assumptions of the one-way ANOVA was that the variances of the four groups compared were similar. Table 7 showed the result of Levene’s Test of Homogeneity of Variance (tested for similar variances). Levene’s $F$ Statistic showed the significant value of .160 was greater than 0.05 ($p > .05$), and therefore, the four groups had similar variances. The assumption of homogeneity of variance was met. I used results in ANOVA Table 8 to determine whether there were significant differences between groups.

*Table 8. Spatial Presence – ANOVA*

<table>
<thead>
<tr>
<th>Spatial presence</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>461.138</td>
<td>3</td>
<td>153.713</td>
<td>17.598</td>
<td>.000</td>
</tr>
<tr>
<td>Within Groups</td>
<td>663.850</td>
<td>76</td>
<td>8.735</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1124.988</td>
<td>79</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*The mean difference is significant at the 0.05 level.*
I found that $F(3, 76) = 17.598, p < .05$. The significant value of .000 was less than 0.05, and therefore, there were statistically significant differences between groups. We rejected the null hypothesis $H_0$ and concluded that there was at least one mean that differed from the rest. Spatial presence of at least in one type of learning conditions differed from the rest.

However, this result did not show us which of the specific groups differed. When the equal variances assumption has been met, the Tukey HSD post-hoc test is generally the preferred test for conducting post-hoc tests on a one-way ANOVA to determine which groups differ from each other.

Table 9 lists the pairwise comparisons of the four group means for all selected post hoc procedures. Mean difference indicates the differences between the four-group means. Sig indicates the probability that the four group means differ. A 95% confidence interval was constructed for each difference.

**Post Hoc Tests**

The Tukey HSD post-hoc test (Table 9) revealed that there were statistically significant differences between Group One and Group Two ($p = .000 < .05$), Group One and Group Three ($p = .000 < .05$) as well as Group One and Group Four ($p = .000 < .05$). There were no statistically significant differences between Group Two and Group Three ($p = .987 > .05$), between Group Two and Group Four ($p = .368 > .05$) as well as between Group Three and Group Four ($p = .475 > .05$).

To summarize, the chatbot (25.05±2.188), time machine (24.70±4.092) and both the chatbot and time machine (26.25±2.425) increased learners’ spatial presence compared with virtual environment group (19.95±2.743) ($p = .000 < .05$) (Table 10).

There were no differences in spatial presence in the virtual learning environment between learners who experienced chatbot and those who experienced time machine ($p = .987 >$
.05), between learners who experienced the chatbot and those who experienced both of the two learning artifacts \((p = .368 > .05)\) as well as between learners who experienced the time machine and those who experienced both of the two learning artifacts \((p = .475 > .05)\).

**Table 9. Spatial Presence - post hoc tests**

<table>
<thead>
<tr>
<th></th>
<th>Group One</th>
<th>Group Two</th>
<th>Group Three</th>
<th>Group Four</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Difference (L - R)</td>
<td>Lower Bound</td>
<td>Upper Bound</td>
<td>Lower Bound</td>
<td>Upper Bound</td>
</tr>
<tr>
<td>Safety</td>
<td>5.000</td>
<td>0.000</td>
<td>100</td>
<td>0.000</td>
</tr>
<tr>
<td>Attraction</td>
<td>-1.000</td>
<td>0.000</td>
<td>0.000</td>
<td>5.000</td>
</tr>
<tr>
<td>Relevance</td>
<td>-2.000</td>
<td>0.000</td>
<td>0.000</td>
<td>4.000</td>
</tr>
</tbody>
</table>

*The mean difference is significant at the 0.05 level.

**Table 10. Mean of spatial presence**

![Graph of Mean of Spatial Presence](image)

2. Please specify your group.
**Presence Involvement** – measuring the attention devoted to the virtual environment and the involvement experienced. A one-way ANOVA was used to examine whether the treatment had effects on learners’ presence involvement in virtual worlds. Results from the ANOVA were (Table 11):

Table 11. Presence Involvement – descriptives

<table>
<thead>
<tr>
<th>Involvement</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Std. Error</th>
<th>95% Confidence Interval for Mean</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Lower Bound</td>
<td>Upper Bound</td>
<td>Lower Bound</td>
<td>Upper Bound</td>
<td>Lower Bound</td>
<td>Upper Bound</td>
</tr>
<tr>
<td>Group One</td>
<td>20</td>
<td>14.55</td>
<td>2.012</td>
<td>.450</td>
<td>13.61</td>
<td>15.49</td>
<td>11</td>
</tr>
<tr>
<td>Group Two</td>
<td>20</td>
<td>16.30</td>
<td>3.785</td>
<td>.846</td>
<td>14.53</td>
<td>18.07</td>
<td>10</td>
</tr>
<tr>
<td>Group Three</td>
<td>20</td>
<td>18.05</td>
<td>2.417</td>
<td>.540</td>
<td>16.92</td>
<td>19.18</td>
<td>13</td>
</tr>
<tr>
<td>Group Four</td>
<td>20</td>
<td>19.90</td>
<td>3.417</td>
<td>.764</td>
<td>18.30</td>
<td>21.50</td>
<td>15</td>
</tr>
<tr>
<td>Total</td>
<td>80</td>
<td>17.20</td>
<td>3.556</td>
<td>.398</td>
<td>16.41</td>
<td>17.99</td>
<td>10</td>
</tr>
</tbody>
</table>

Table 11 displays descriptive statistics including the mean, standard deviation and 95% confidence intervals for the dependent variable (Presence) for each separate group (Group One, Group Two, Group Three, and Group Four) as well as when all groups are combined (Total). The approximately equal size of each group (N=20) reduced the effects of unequal variances. ANOVA was used to compare the sample estimates to determine if the population means differ. The four groups showed a different mean in this study: \( \mu_1 = 14.55, \mu_2 = 16.30, \mu_3 = 18.05, \) and \( \mu_4 = 19.90. \)

The standard deviation (\( \sigma_1 = 2.012, \sigma_2 = 3.785, \sigma_3 = 2.417, \sigma_4 = 3.417 \)) indicated the amount of variability of the scores in each group. These values should be similar to each other for the ANOVA test to be appropriate. Equality was inspected via the Levene test (Table 12).

The 95% confidence interval for the mean (95% CIs\(_1\) [13.61, 15.49], 95% CIs\(_2\) [14.53, 18.07], 95% CIs\(_3\) [16.92, 19.18], 95% CIs\(_4\) [18.3, 21.5]) indicated the upper and lower bounds which contained the true value of the population mean 95% of the time. None of the four groups
overlapped with any of the other three groups. Maximum and minimum values (Group One [11, 18], Group Two [10, 24], Group Three [13, 23], Group Four [15, 25] indicated the highest and lowest presence for each learning conditions that the four groups experienced.

Table 12. Presence Involvement - test of homogeneity of variances

One of the assumptions of the one-way ANOVA was that the variances of the four groups I was comparing were similar. Table 12 shows the result of Levene’s Test of Homogeneity of Variance (tested for similar variances). Levene’s $F$ Statistic showed the significant value of .006 was less than 0.05 ($p < .05$), and therefore, the four groups did not have similar variances. The assumption of homogeneity of variance was not met. Since the equal variance assumption has been violated, I used the Welch Statistic to determine whether there were significant differences between groups (Table 13).

Table 13. Presence Involvement - robust tests of equality of means
I found that $F(3, 41.099) = 15.089, p < .05$. The significant value of .000 was less than 0.05, and therefore, there were statistically significant differences between groups. We rejected the null hypothesis $H_0$ and concluded that at least one mean differed from the rest. Presence involvement of at least in one type of learning conditions differed from the rest. However, this result did not show us which of the specific groups differed. When the equal variances assumption has been violated, it is appropriate to use the Games-Howell post hoc test in the Multiple Comparisons Table to determine which groups differ from each other.

**Post Hoc Tests**

Table 14 lists the pairwise comparisons of the four group means for all selected post hoc procedures. Mean difference indicates the differences between the four-group means. Sig indicates the probability that the four group means difference. A 95% confidence interval was constructed for each difference.

The Games-Howell post-hoc test (Table 14) revealed that there were statistically significant differences for Group One and Group Three ($p = .000 < .05$), Group One and Group Four ($p = .000 < .05$) as well as Group Two and Group Four ($p = .016 < .05$). There were no significant differences between Group One and Group Two ($p = .282 > .05$), between Group Two and Group Three ($p = .319 > .05$) as well as between Group Three and Group Four ($p = .216 > .05$).

To summarize, the time machine (18.05±2.417) and both of the chatbot and time machine (19.90±3.417) increased learners’ presence involvement (compared with virtual environment group (14.55±2.012) ($p = .000 < .05$)) (Table 15). Learners who experienced both the chatbot and time machine (19.90±3.417) had a higher mean score of presence involvement than learners who only experienced chatbot (16.30±3.785) ($p = .016 < .05$) (Table 15). There
were no differences in presence involvement in the virtual learning environment between learners who experienced just the virtual environment and those who experienced only the chatbot \((p = .282 > .05)\), between learners who experienced the chatbot and those who experienced the time machine \((p = .319 > .05)\) as well as between learners who experienced the time machine and both of the two learning artifacts \((p = .216 > .05)\).

*Table 14. Presence Involvement - post hoc tests*

![Table 14](image)

*The mean difference is significant at the 0.05 level.

*Table 15. Mean of involvement*

![Table 15](image)
**Experienced Realism** – measuring the subjective experience of realism in the virtual environment.

A one-way ANOVA was used to examine whether the treatment had effects on learners’ experienced realism in virtual worlds. Results from the one-way ANOVA were (Table 16):

*Table 16. Experienced Realism - descriptives*

<table>
<thead>
<tr>
<th>Experienced realism</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Std. Error</th>
<th>95% Confidence Interval for Mean</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Lower Bound</td>
<td>Upper Bound</td>
<td>Lower Bound</td>
<td>Upper Bound</td>
<td>Lower Bound</td>
<td>Upper Bound</td>
</tr>
<tr>
<td>Group One</td>
<td>20</td>
<td>15.46</td>
<td>3.034</td>
<td>.979</td>
<td>14.03</td>
<td>16.87</td>
<td>9</td>
</tr>
<tr>
<td>Group Two</td>
<td>20</td>
<td>17.90</td>
<td>1.997</td>
<td>.447</td>
<td>16.97</td>
<td>18.83</td>
<td>15</td>
</tr>
<tr>
<td>Group Three</td>
<td>20</td>
<td>18.70</td>
<td>2.203</td>
<td>.495</td>
<td>17.67</td>
<td>19.73</td>
<td>13</td>
</tr>
<tr>
<td>Group Four</td>
<td>20</td>
<td>19.35</td>
<td>2.159</td>
<td>.483</td>
<td>18.34</td>
<td>20.38</td>
<td>15</td>
</tr>
<tr>
<td>Total</td>
<td>80</td>
<td>17.86</td>
<td>2.770</td>
<td>.310</td>
<td>17.23</td>
<td>18.47</td>
<td>9</td>
</tr>
</tbody>
</table>

Table 16 displays descriptive statistics including the mean, standard deviation and 95% confidence intervals for the dependent variable (Presence) for each separate group (Group One, Group Two, Group Three, and Group Four) as well as when all groups are combined (Total). The approximately equal size of each group (N=20) reduced the effects of unequal variances. ANOVA was used to compare the sample estimates to determine if the population means differ. The four groups showed a different mean in this study: \( \mu_1 = 15.45, \mu_2 = 17.90, \mu_3 = 18.70, \) and \( \mu_4 = 19.35. \)

The standard deviation (\( \sigma_1 = 3.034, \sigma_2 = 1.997, \sigma_3 = 2.203, \sigma_4 = 2.159 \)) indicated the amount of variability of the scores in each group. These values should be similar to each other for ANOVA to be appropriate. Equality was inspected via the Levene test (Table 17).

The 95% confidence interval for the mean (95% CIs\(_1\) [14.03, 16.87], 95% CIs\(_2\) [16.97, 18.83], 95% CIs\(_3\) [17.67, 19.93], 95% CIs\(_4\) [18.34, 20.36]) indicated the upper and lower bounds
which contained the true value of the population mean 95% of the time. None of the four groups
overlapped with any of the other three groups.

Maximum and minimum values (Group One [9, 21], Group Two [15, 21], Group Three
[13, 22], Group Four [15, 23] indicated the highest and lowest presence for each learning
conditions that the four groups experienced.

*Table 17. Experienced Realism - test of homogeneity of variances*

<table>
<thead>
<tr>
<th>Experienced realism</th>
<th>Levene Statistic</th>
<th>df1</th>
<th>df2</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.526</td>
<td>3</td>
<td>76</td>
<td>.215</td>
</tr>
</tbody>
</table>

One of the assumptions of the one-way ANOVA was that the variances of the four
groups I was comparing were similar. Table 17 shows the result of the Levene Test of
Homogeneity of Variance (tested for similar variances). Levene’s $F$ Statistic showed the
significant value of .215 was greater than 0.05 ($p > .05$), and therefore, the four groups had
similar variances. The assumption of homogeneity of variance was met. I used results in
ANOVA Table 18 to determine whether there were significant differences between groups.

*Table 18. Experienced Realism – ANOVA*

<table>
<thead>
<tr>
<th>Experienced realism</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>174.703</td>
<td>3</td>
<td>58.233</td>
<td>10.257</td>
<td>.000</td>
</tr>
<tr>
<td>Within Groups</td>
<td>431.503</td>
<td>76</td>
<td>5.678</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>606.203</td>
<td>79</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*The mean difference is significant at the 0.05 level.

I found that $F (3, 76) = 10.257, p < .05$. The significant value of .000 was less than
0.05, and therefore, there were statistically significant differences between groups. We rejected
the null hypothesis $H_0$ and concluded that there was at least one mean differing from the rest. Experienced realism of at least one type of the learning conditions differed from the rest.

However, this result did not show us which of the specific groups differed. When the equal variances assumption has been met, the Tukey HSD post-hoc test is generally the preferred test for conducting post-hoc tests on a one-way ANOVA to determine which groups differ from each other. Table 19 lists the pairwise comparisons of the four group means for all selected *post hoc* procedures. Mean difference indicates the differences between the four-group means. Sig indicates the probability that the four group means differ. A 95% confidence interval was constructed for each difference.

### Post Hoc Tests

The Tukey HSD *post-hoc* test (Table 19) revealed that there were statistically significant differences between Group One and Group Two ($p = .009 < .05$), Group One and Group Three ($p = .000 < .05$) as well as Group One and Group Four ($p = .000 < .05$). There were no statistically significant differences between Group Two and Group Three ($p = .714 > .05$), between Group Two and Group Four ($p = .227 > .05$) as well as between Group Three and Group Four ($p = .824 > .05$).

To summarize, chatbot (17.90±1.997), increased learners’ experienced realism (compared with virtual environment group (15.45±3.034) ($p = .009 < .05$)) (Table 20). The time machine (18.70±2.203) and both of the chatbot and time machine (19.35±2.159) also increased learners’ experienced realism compared with the virtual environment group (15.45±3.034) ($p = .000 < .05$) (Table 20).
Table 19. Experienced Realism - post hoc test

*The mean difference is significant at the 0.05 level.

There were no differences in experienced realism in the virtual learning environment between learners who experienced the chatbot and those who experienced the time machine ($p = .714 > .05$), between learners who experienced the chatbot and those who experienced both of the two learning artifacts ($p = .227 > .05$) as well as between learners who experienced the time machine and those who experienced both of the two learning artifacts ($p = .824 > .05$).

Table 20. Mean of experienced realism
**General Presence** – the general definition of the sense of presence, sense of being there.

A one-way ANOVA was used to examine whether the treatment had effects on learners’ general presence in virtual worlds. Results from the ANOVA were (Table 21):

**Table 21. General Presence – descriptives**

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>95% Confidence Interval for Mean</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Group One</strong></td>
<td>20</td>
<td>4.15</td>
<td>.933</td>
<td>[3.71, 4.59]</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td><strong>Group Two</strong></td>
<td>20</td>
<td>4.85</td>
<td>.671</td>
<td>[4.54, 5.16]</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td><strong>Group Three</strong></td>
<td>19</td>
<td>5.16</td>
<td>.765</td>
<td>[4.79, 5.53]</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td><strong>Group Four</strong></td>
<td>20</td>
<td>5.40</td>
<td>.598</td>
<td>[5.12, 5.68]</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>79</td>
<td>4.89</td>
<td>.877</td>
<td>[4.69, 5.08]</td>
<td>2</td>
<td>6</td>
</tr>
</tbody>
</table>

Table 21 displays descriptive statistics including the mean, standard deviation and 95% confidence intervals for the dependent variable (Presence) for each separate group (Group One, Group Two, Group Three, and Group Four) as well as when all groups are combined (Total). The approximately equal size of each group (N=20) reduced the effects of unequal variances. The ANOVA was used to compare the sample estimates to determine if the population means differ. The four groups showed a different mean in this study: \( \mu_1 = 4.15, \mu_2 = 4.85, \mu_3 = 5.16, \) and \( \mu_4 = 5.40. \)

The standard deviation \( (\sigma_1 = .933, \sigma_2 = .671, \sigma_3 = .765, \sigma_4 = .598) \) indicated the amount of variability of the scores in each group. These values should be similar to each other for ANOVA to be appropriate. Equality was inspected via the Levene test (Table 22).

The 95% confidence interval for the mean (95% CIs\(_1\) [3.71, 4.59], 95% CIs\(_2\) [4.54, 5.16], 95% CIs\(_3\) [4.70, 5.53], 95% CIs\(_4\) [5.12, 5.68]) indicated the upper and lower bounds which contained the true value of the population mean 95% of the time. None of the four groups overlapped with any of the other three groups. Maximum and minimum values (Group One [2,
[4, 6], Group Two [4, 6], Group Three [4, 6], Group Four [4, 6] indicated the highest and lowest presence for each of the learning conditions the four groups experienced.

*Table 22. General Presence - test of homogeneity of variances*

One of the assumptions of the one-way ANOVA was that the variances of the four groups I was comparing were similar. Table 22 shows the result of Levene’s Test of Homogeneity of Variance (tested for similar variances). Levene’s $F$ Statistic showed the significant value of .857 was greater than 0.05 ($p > .05$), and therefore, the four groups had similar variances. The assumption of homogeneity of variance was met. I used the ANOVA Table 23 to determine whether there were significant differences between groups.

*Table 23. General Presence - ANOVA*

I found that $F (3, 75) = 10.340, p < .05$. The significant value of .000 was less than 0.05, and therefore, there were statistically significant differences between groups. We rejected
the null hypothesis $H_0$ and concluded that there was at least one mean differing from the rest. General presence of at least in one type of learning conditions differed from the rest.

However, this result did not show us which of the specific groups differed. When the equal variances assumption has been met, the Tukey HSD post-hoc test is generally the preferred test for conducting post-hoc tests on a one-way ANOVA to determine which groups differ from each other. Table 24 lists the pairwise comparisons of the four group means for all selected post hoc procedures. Mean difference indicates the differences between the four-group means. Sig indicates the probability that the four group means differ. A 95% confidence interval was constructed for each difference.

**Post Hoc Tests**

The Tukey HSD post-hoc test (Table 24) revealed that there were statistically significant differences between Group One and Group Two ($p = .022 < .05$), Group One and Group Three ($p = .000 < .05$) as well as Group One and Group Four ($p = .000 < .05$). There were no statistically significant differences between Group Two and Group Three ($p = .580 > .05$), between Group Two and Group Four ($p = .104 > .05$) as well as between Group Three and Group Four ($p = .747 > .05$).

To summarize, the chatbot (4.85±0.671), increased learners’ general presence compared with virtual environment group 4.15±0.933) ($p = .022 < .05$) (Table 25). The time machine (5.16±0.765) and both of the chatbot and time machine (5.40±0.598) also increased learners’ general presence compared with virtual environment group (4.15±0.933) ($p = .000 < .05$) (Table 25).
There were no differences in experienced realism in the virtual learning environment between learners who experienced chatbot and those who experienced the time machine ($p = .580 > .05$), between learners who experienced the chatbot and those who experienced both of the two learning artifacts ($p = .104 > .05$) as well as between learners who experienced time machine and those who experienced both of the two learning artifacts ($p = .747 > .05$).

*Table 24. General Presence - post hoc test*

<table>
<thead>
<tr>
<th>Group One</th>
<th>Group Two</th>
<th>Group Three</th>
<th>Group Four</th>
</tr>
</thead>
<tbody>
<tr>
<td>-1.700</td>
<td>238</td>
<td>0.022</td>
<td>1.32</td>
</tr>
<tr>
<td>-1.078</td>
<td>241</td>
<td>0.000</td>
<td>1.64</td>
</tr>
<tr>
<td>-1.250</td>
<td>239</td>
<td>0.000</td>
<td>1.87</td>
</tr>
<tr>
<td>-0.850</td>
<td>236</td>
<td>0.104</td>
<td>1.32</td>
</tr>
<tr>
<td>1.008</td>
<td>241</td>
<td>0.000</td>
<td>1.64</td>
</tr>
<tr>
<td>0.308</td>
<td>241</td>
<td>0.580</td>
<td>-0.23</td>
</tr>
<tr>
<td>-2.422</td>
<td>241</td>
<td>0.747</td>
<td>-0.23</td>
</tr>
<tr>
<td>1.250</td>
<td>238</td>
<td>0.000</td>
<td>1.64</td>
</tr>
<tr>
<td>0.550</td>
<td>238</td>
<td>0.104</td>
<td>1.32</td>
</tr>
<tr>
<td>2.422</td>
<td>241</td>
<td>0.747</td>
<td>-0.23</td>
</tr>
</tbody>
</table>

*The mean difference is significant at the 0.05 level.

*Table 25. Mean of general presence*
From the results we knew that there were significant differences between groups. But we were not sure whether the significant differences were caused by treatment or other factors. When examining existing literature, it appeared that a participant with highly immersive tendencies would feel more present in the virtual environment, and would enjoy the experience more than a participant who does not generally become immersed in activities (Johns et al., 2000; Nunez, 2002; Witmer & Singer, 1998).

In order to conclude that it was the treatment, designed virtual learning artifacts, that elicited a strong feeling of presence in learners, I needed to know whether there was significant differences in Immersive Tendencies between groups. The following data analysis contributed to identify a property of each participant and how likely a participant was to become immersed in an activity.

4.4.2 SPSS Output of the One-Way ANOVA – Immersive Tendency

*Immersive Tendencies Total* – Immersive Tendencies identifies possible differences in the ability of individuals to immerse themselves in different environmental situations.

A one-way ANOVA was used to examine whether there was significant differences in Immersive Tendencies Total between groups. Results from the ANOVA were (Table 26):

*Table 26. Immersive Tendency Total - test of homogeneity of variances*

![Test of Homogeneity of Variances](image)

One of the assumptions of the one-way ANOVA was that the variances of the four groups I was comparing were similar. Table 26 shows the results of the Levene Test of
Homogeneity of Variance (tested for similar variances). Levene’s $F$ Statistic showed the significant value of .080 was greater than 0.05 ($p > .05$), and therefore, the four groups had similar variances. The assumption of homogeneity of variance was met. I used the ANOVA Table 27 to determine whether there were significant differences between groups.

Table 27. Immersive Tendency Total - ANOVA

<table>
<thead>
<tr>
<th>Immersive tendencies total</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>106.137</td>
<td>3</td>
<td>35.379</td>
<td>3.044</td>
<td>.034</td>
</tr>
<tr>
<td>Within Groups</td>
<td>883.250</td>
<td>76</td>
<td>11.622</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>989.387</td>
<td>79</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*The mean difference is significant at the 0.05 level.

I found that $F (3, 76) = 3.044, p < .05$. The significant value of .034 was less than 0.05, and therefore, there were statistically significant differences between groups. We rejected the null hypothesis $H_0$ and concluded that there was at least one mean differed from the rest. The Immersive Tendencies Total of at least in one of groups differed from the rest. However, this result did not show us which of the specific groups differed. When the equal variances assumption has been met, the Tukey HSD post-hoc test is generally the preferred test for conducting post-hoc tests on a one-way ANOVA to determine which groups differ from each other. Table 28 lists the pairwise comparisons of the four group means for all selected post hoc procedures. Mean difference indicates the differences between the four-group means. Sig indicates the probability that the four group means differ. A 95% confidence interval was constructed for each difference.
Post Hoc Tests

The Tukey HSD post-hoc test (Table 28) suggested that no significant difference in Immersive Tendencies Total existed between Group One and Group Two ($p=1.000 > .05$), between Group One and Group Three ($p=.956 > .05$), between Group One and Group Four ($p=.125 > .05$), between Group Two and Group Three ($p=.975 > .05$) as well as between Group Two and Group Four ($p=.103 > .05$). There were statistically significant differences between Group Three and Group Four ($p=.038 < .05$).

**Immersive Tendencies Focus** - Immersive Tendencies Focus identifies how mentally alert a person feels, the extent to which they can concentrate and how they can block out distractions.

A one-way ANOVA was used to examine whether there were significant differences in Immersive Tendencies Focus between groups. Results from the ANOVA were (Table 29):

Table 28. Immersive Tendencies Total - post hoc tests

*The mean difference is significant at the 0.05 level.*
One of the assumptions of the one-way ANOVA was that the variances of the four groups I was comparing were similar. Table 29 shows the result of the Levene Test of Homogeneity of Variance (tested for similar variances). Levene’s $F$ Statistic showed the significant value of .073 was greater than 0.05 ($p > .05$), and therefore, the four groups had similar variances. The assumption of homogeneity of variance was met. I used the ANOVA Table 30 to determine whether there were significant differences between groups.

I found that $F (3, 76) = 7.317, p < .05$. The significant value of .000 was less than 0.05, and therefore, there were statistically significant differences between groups. We rejected the null hypothesis $H_0$ and concluded that at least one mean differed from the rest. Immersive Tendencies Focus of at least in one of groups differed from the rest. However, this result did not
show us which of the specific groups differed. When the equal variances assumption has been met, the Tukey HSD post-hoc test is generally the preferred test for conducting post-hoc tests on a one-way ANOVA to determine which groups differ from each other.

Table 31 lists the pairwise comparisons of the four group means for all selected *post hoc* procedures. Mean difference indicates the differences between the four-group means. Sig indicates the probability that the four group means differ. A 95% confidence interval was constructed for each difference.

**Post Hoc Tests**

The Tukey HSD *post-hoc* test (Table 31) suggested no significant difference in Immersive Tendencies Focus existed between Group One and Group Two ($p = .412 > .05$), between Group One and Group Three ($p = .987 > .05$), as well as Group Two and Group Three ($p = .616 > .05$). There were statistically significant differences between Group One and Group Four ($p = .000 < .05$), between Group Two and Group Four ($p = .046 < .05$) as well as between Group Three and Group Four ($p = .001 < .05$).

*Table 31.* Immersive Tendencies Focus - post hoc tests

*The mean difference is significant at the 0.05 level.*
**Immersive Tendencies Involvement** – Immersive Tendencies Involvement identifies the ability of an individual to passively become involved while witnessing something.

A one-way ANOVA was used to examine whether there were significant differences in Immersive Tendencies Involvement between groups. Results from one-way ANOVA were (Table 32):

**Table 32. Immersive Tendencies Involvement - test of homogeneity of variances**

One of the assumptions of the one-way ANOVA was that the variances of the four groups compared were similar. Table 32 shows the result of the Levene Test of Homogeneity of Variance (tested for similar variances). Levene’s *F* Statistic showed the significant value of .790 was greater than 0.05 (*p* > .05), and therefore, the four groups had similar variances. The assumption of homogeneity of variance was met. I used the ANOVA Table 33 to determine significant differences between groups.

**Table 33. Immersive Tendencies Involvement - ANOVA**

<table>
<thead>
<tr>
<th></th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>21.350</td>
<td>3</td>
<td>7.117</td>
<td>2.608</td>
<td>.058</td>
</tr>
<tr>
<td>Within Groups</td>
<td>207.400</td>
<td>76</td>
<td>2.729</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>228.750</td>
<td>79</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*The mean difference is significant at the 0.05 level.*
I found that $F(3, 76) = 2.608, p > .05$. The significant value of .058 was greater than 0.05, and therefore, there were no statistically significant differences between groups. We accepted the null hypothesis $H_0$ and concluded that there were no mean differences from each other. Immersive Tendencies Involvement of the four groups was the same (Table 33).

**Immersive Tendencies Games** – Immersive Tendencies Games identifies the frequency and their level of involvement during playing video games.

A one-way ANOVA was used to examine whether there were significant differences in Immersive Tendencies Games between groups. Results from one-way ANOVA were (Table 34):

Table 34. Immersive Tendencies Games - test of homogeneity of variances

![Test of Homogeneity of Variances Table]

One of the assumptions of the one-way ANOVA was that the variances of the four groups compared were similar. Table 34 showed the result of the Levene Test of Homogeneity of Variance (tested for similar variances). Levene’s $F$ Statistic showed the significant value of .920 was greater than 0.05 ($p > .05$), and therefore, the four groups had similar variances. The assumption of homogeneity of variance was met. I used the ANOVA Table 35 to determine whether there were significant differences between groups.
Table 35. Immersive Tendencies Games – ANOVA

\begin{center}
\begin{tabular}{|c|c|c|c|c|}
\hline
 & Sum of Squares & df & Mean Square & F & Sig. \\
\hline
Between Groups & 1.637 & 3 & .546 & 1.545 & .210 \\
Within Groups & 26.850 & 76 & .353 & & \\
Total & 28.487 & 79 & & & \\
\hline
\end{tabular}
\end{center}

*The mean difference is significant at the 0.05 level.

I found that $F (3, 76) = 1.545, p > .05$. The significant value of .210 was greater than 0.05, and therefore, there were no statistically significant differences between groups. We accepted the null hypothesis $H_0$ and concluded that there were no mean differences from each other. Immersive Tendencies Games of the four groups was the same.

To conclude, it appears from the data that there is no statistical difference between the first three groups on Immersive Tendencies. There were statistical differences between Group One and Group Four, between Group Two and Group Four as well as between Group Three and Group Four on Immersive Tendencies Total and Immersive Tendencies Focus.

4.5 Conclusion

The chapter reported findings from the design-based research design, including a feasibility study of virtual world platforms, analysis of qualitative data, and results from quantitative tests of hypotheses. An initial contribution to DBR included a nuanced revision of Middleton’s design cycle, wherein I conceptualized and tested low and high fidelity design stages. Following the report of data for the choosing OpenSimulator as the virtual world platform for the research, this chapter focused primarily on the field test of the language teaching and learning environment or virtual world in the high fidelity stage. Each iteration of the DBR cycle
informed the following iterations and stages. For example, data collected at the low fidelity stage shaped a redesign of the virtual world and learning artifacts. The high fidelity stage was used for qualitative feedback and quantitative tests of the effects of these artifacts on immersion and presence within the virtual world setting. One-way ANOVA tests suggested that effects on presence were due to an interaction of the artifacts. Chapter Five provides a summary and analysis of these findings.
Chapter Five: Conclusion

The primary purpose of this dissertation research was to gain insight into effective ways of designing immersive language teaching and teaching and learning environments in virtual worlds. Iterative studies of three design phases provided evidence for the relevance and effect of affordances of virtual worlds as immersive language learning environments.

Through an analysis and evaluation of technical feasibility, the first phase determined the open source OpenSimulator was the best fit for the research. Through a study of nineteen pre-service teachers using the low fidelity prototype of OpenSimulator, a more robust design, including a chatbot and time machine as learning artifacts to scaffold instructions to learners, was developed. The third phase employed a mixed research design to investigate how well these affordances of virtual worlds immerse language learners and their effects on immersion and sense of presence. Results of the high fidelity test phase demonstrated effects of these inworld learning artifacts.

Two critiques of learning in virtual worlds shaped this research: 1) many virtual worlds were designed as places where three-dimensional contextual objects and buildings did not invite meaningful participation and interaction (Zheng & Zhao, 2009); and 2) “activities and approaches (in virtual worlds)— for example, task-based activities, role-play, vocabulary and grammar games— resembled those used in real world second language (L2) classrooms” (Zheng & Newgarden, 2012, p. 14). My research addresses embodied, situated and distributed learning within and through design features of virtual worlds. In this final chapter, I discuss findings from the three studies and research limitations as well as next steps and parting thoughts.
5.1 A Brief Summary of Three Studies

This dissertation was comprised of three phases or studies, offering distinct theoretical perspectives and analytical data techniques for describing and measuring iterative processes for the design of a virtual world. These three studies shared a theoretical framework of learning as embodied, situated and distributed.

5.1.1 Feasibility Study

The feasibility study established an overall picture of available open source virtual world platforms with current released versions. Considering one important concern of this project, the location of the server, I critically reviewed four potential open source platforms – RealXtend, Open Wonderland, OpenSimulator, and Open Cobalt. The findings reflected the choice of OpenSimulator platform, based on six parameters: server hosting, connection with learning management systems, transferable Second Life skills and prims, Hypergate Teleport, NPCs and inworld voices. These parameters showed a potential design preference using OpenSimulator over three other virtual world platforms.

5.1.2 Field Study of Pre-Service Teachers

The field study aimed at listening to teachers’ feedback. It took a fine grain analysis of pre-service teachers’ group discussions on affordances of virtual worlds for learning. When listening to this group of teachers, we heard not only advantages of using virtual worlds and a need to design engaging and rich learning environments but also a challenge to learners, teachers, ICT services and language institutions. By thoroughly examining the data, I found that four design principles of OpenSimulator could determine successful language teaching and
learning in virtual worlds: Design scope, which determined how much time and money was worth investing in developing learning resources in 3D virtual learning environments, should be considered beforehand; digital learning artifacts should not be dumped inworld; appropriate learning and teaching approaches in immersive virtual worlds should be considered; and clear ‘how-to’ tutorials should be designed.

5.1.3 Mixed Studies on Inworld Learning Artifacts – Chatbot and Time Machine

Qualitative and quantitative, or mixed-method, studies were conducted to test the effectiveness of the designed inworld learning artifacts: the chatbot and time machine. This field study indicated that learning occurred through instructional scaffolding by designing various supportive distributed learning artifacts such as the chatbot and time machine. I also found that learners’ knowledge and language skills acquired inworld might transfer into real world practices through embodied avatars. Qualitative data indicated that scenario-based, simulated role-play, or situated language learning in contexts, promoted learning and shaped communities of practice.

It appeared from the quantitative data that no statistical difference between the first three groups existed for Immersive Tendencies. However, a statistically significant difference between the first three groups existed in the level of Presence achieved during the experience. The implications of these results follow.

As described in Chapter Four, the Immersive Tendencies Questionnaire was used to identify and measure possible individual differences in the ability of a person to immerse themselves in different environment situations, not specifically a virtual environment. Group One, Group Two and Group Three recorded similar Immersive Tendencies scores across the three subscales. Group Four had higher Immersive Tendencies scores than other three groups.
Therefore, although Group Four had a higher score in Presence across four subscales, we could not conclude that the combined use of a chatbot and time machine increase Presence more than either learning artifact alone.

As the first three groups had similar Immersive Tendencies scores across three subscales, I further explored their differences in Presence. The significant differences in Presence among Group One, Group Two and Group Three raised my interest. As indicated in Chapter Four, the IPQ measures and identifies the degree to which aspects of a virtual environment engages a sense of Presence. From the results in Chapter Four, statistically significant differences between Group One and Group Two, Group One and Group Three, as well as Group Two and Group Three were identified within the Presence Total, Spatial Presence, Presence Involvement, General Presence and Experienced Realism.

The Presence Total results suggested a difference among learners who experienced only the virtual environment, only the chatbot and only the time machine. These results suggested that the learning artifact, chatbot, increased language learners’ Presence Total in the immersive virtual language teaching and learning environment. As well, the learning artifact, time machine, increased language learners’ Presence Total in the immersive virtual language teaching and learning environment.

The Spatial Presence results suggested a difference among learners who experienced only the virtual environment, only the chatbot and only the time machine. These results suggested that the learning artifact, chatbot, increased language learners’ Spatial Presence in the immersive virtual language teaching and learning environment. As well, the learning artifact, time machine, increased language learners’ Spatial Presence in the immersive virtual language teaching and learning environment. The Presence Involvement results suggested a difference among learners who experienced only the virtual environment and only the time machine.
results suggested that the learning artifact, time machine, increased language learners’ Presence Involvement in the immersive virtual language teaching and learning environment.

The Experienced Realism results suggested a difference among learners who experienced only the virtual environment, only the chatbot and only the time machine. These results suggested that the learning artifact, chatbot, increased language learners’ Experienced Realism in the immersive virtual language teaching and learning environment. As well, the learning artifact, time machine, increased language learners’ Experienced Realism in the immersive virtual language teaching and learning environment.

The General Presence results suggested a difference among learners who experienced only the virtual environment, only chatbot and only time machine. These results suggested that learning the artifact, chatbot, increased language learners’ General Presence in the immersive virtual language teaching and learning environment. As well, the learning artifact, time machine, increased language learners’ General Presence in the immersive virtual language teaching and learning environment.

5.2 Limitations of the Study

Due to a limited amount of time and other practical reasons, there were several limitations associated with this study. The first limitation of this study was a technical limitation. My original design philosophy was to reuse a so-called ‘old’ computer. We installed a Linux server on a computer with 1.5G RAM. When further designing the virtual world with a growing MySQL database, 1.5G RAM was inadequate for effective function. Although we maximized the RAM with 3G (the largest RAM we could have for this computer), the speed was still slow. It did not have the ability to support 20 learners logging in at the same time. So we had to consider collaborating with BC OpenSim.
Another possible limitation was the techniques used to collect data. The university that I conducted the experiment had a Great Firewall: participants could not log into the server overseas. So we had to alter our data collection plans by moving our server locally. This resulted in the researcher’s slow access to the local server in the participants’ country (the researcher was in Canada). Hence, observational data were missing. Experimental data were analyzed by using data collected by questionnaire.

A further limitation of this study was that the interview data were not directly linked to participants’ experiences in the virtual world. Although video as a stimulus was employed during the interview, participants constructed their feelings and experiences based on recall, which sometimes conflicted with what I observed and what was derived from think aloud techniques. But the interviews did assist in understanding the perceptions of the participants concerning their performance in the virtual learning environment.

5.3 Future Research

By applying theories of learning as embodied, situated and distributed, this study generated important findings for designing future immersive virtual language teaching and learning environments. In particular, it pointed to the importance of how theories guide the design of meaningful inworld learning artifacts. Given design of the chatbot and time machine for teaching and learning verbs and tenses, a further investigation into additional designs of these types of artifacts would be extremely helpful. As well, further experimental studies on the effects of combined learning artifacts should be conducted. This research provided an excellent test of models for design-based research and in the process I was challenged to be nuanced and add low and high fidelity stages to Middleton’s helpful model. Future studies will hopefully test and
validate my revision. Consistent with design-based research, I view this research as an iteration and am excited about prospects of redesigning and testing learning artifacts and virtual worlds.
Bibliography


Descartes, R. (1639). *Meditations on First Philosophy in which are demonstrated the existence of God and the distinction between the human soul and the body*.


http://saulnier.typepad.com/learning_technology/2008/01/immersive-educa.html


http://plato.stanford.edu/entries/embodied-cognition/#WhaEmbCog


### Appendix A: Virtual Worlds’ Viewer Comparison

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<td>X</td>
<td>X</td>
<td>√</td>
<td>(v2/3)</td>
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Table from http://opensimulator.org/wiki/Connecting

Notes

- #1 LightShare is a method for altering WindLight settings on a parcel or region by means of a script. See Lightshare.
- #2 The Parcel Windlight referred to here, is a Phoenix/Firestorm feature which lets parcel owners define a windlight setting which is to be applied to a user's viewer if the viewer supports it, and if the visitor has enabled that feature. See the Parcel WL article on the Phoenix wiki for more info.
- #3 RealXtend requires an additional module to be active on OpenSimulator. See ModRex.
- #4 Data based on Kokua-3.0.0-WIP [2], may soon be out of date!
- #5 Only source code is provided. No precompiled binaries!
Appendix B: PRESENCE IN VIRTUAL WORLDS

(Igroup presence questionnaire, 2008)

http://www.igroup.org/pq/ipq/download.php#English

Thank you for your interest in our survey. It will take you about 20-30 minutes to fill in the questionnaire. You can work through the questionnaire offline, but in order to submit the results at the end you’ll have to be online.

Please answer all questions only with reference to one single episode of interaction with a virtual environment.

1) Please specify your gender.
   - Female
   - Male

2) Please specify your group.
   - Group One
   - Group Two
   - Group Three
   - Group Four

3) In the computer generated world I had a sense of being there.
   - Not at all
   - -2
   - -1
   - Occasionally
   - +1
   - +2
   - Very Much

4) Somehow I felt that the virtual world surrounded me.
   - Fully disagree
   - -2
   - -1
   - Occasionally
   - +1
   - +2
   - Fully agree

5) I felt like I was just perceiving pictures.
   - Fully disagree
   - -2
   - -1
   - Occasionally
   - +1
   - +2
6) I did not feel present in the virtual world.
   - Fully agree
   - Did not feel
     - 2
     - 1
     - Occasionally
     - +1
     - +2
     - Felt present

7) I had a sense of acting in the virtual space, rather than operating something from outside.
   - Fully disagree
   - -2
   - -1
   - Occasionally
   - +1
   - +2
   - Fully agree

8) I felt present in the virtual space.
   - Fully disagree
   - -2
   - -1
   - Occasionally
   - +1
   - +2
   - Fully agree

9) How aware were you of the real world surrounding while navigating in the virtual world? (i.e. sounds, room temperature, other people etc.)
   - Not aware at all
   - -2
   - -1
   - Moderately aware
   - +1
   - +2
   - Extremely aware

10) I was not aware of my real environment.
    - Fully disagree
    - -2
    - -1
    - Occasionally
    - +1
    - +2
    - Fully agree
11) I still paid attention to the real environment.
   - Fully disagree
   - -2
   - -1
   - Occasionally
   - +1
   - +2
   - Fully agree

12) I was completely captivated by the virtual world.
   - Fully disagree
   - -2
   - -1
   - Occasionally
   - +1
   - +2
   - Fully agree

13) How real did the virtual world seem to you?
   - Not real at all
   - -2
   - -1
   - Moderately real
   - +1
   - +2
   - Completely real

14) How much did your experience in the virtual environment seem consistent with your real world experience?
   - Not consistent
   - -2
   - -1
   - Moderately consistent
   - +1
   - +2
   - Very consistent

15) How real did the virtual world seem to you?
   - About as real as an imagined world
   - -2
   - -1
   - 0
   - +1
   - +2
   - Indistinguishable from the real world
16) The virtual world seemed more realistic than the real world.

- Fully disagree
- -2
- -1
- Occasionally
- +1
- +2
- Fully agree

Simply score the boxes for each question from left to right beginning with one and increasing in value to the box the subject has marked, and the number of that box becomes the score. The subscale scores are the sum of the scores for each subscale item. There is no weighting of items or subscales. The questionnaire total and subscales are comprised as follows:

PRESENCE QUESTIONNAIRE

Total: Items 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15 & 16.
IPQ-PRES: Items 3.
IPQ-SP: Items 4, 5, 6, 7 & 8.
IPQ-IN: Items 9, 10, 11 & 12.
IPQ-REAL: Items 13, 14, 15 & 16.

New questions have been added to the questionnaire, but should not be added to the total or subscales as they are just beginning to be investigated. The new (unanalyzed) questions are scored the same as the other questions. None of the new questions seem to require reverse scoring.

Thank you for your time and feedback!
Appendix C: Immersive Tendencies Questionnaires

(Witmer & Singer, 1998)


Indicate your preferred answer by marking an "X" in the appropriate box of the seven point scale. Please consider the entire scale when making your responses, as the intermediate levels may apply. For example, if your response is once or twice, the second box from the left should be marked. If your response is many times but not extremely often, then the sixth (or second box from the right) should be marked.

1) Please specify your gender

☐ Female
☐ Male

2) Please specify your group.

☐ Group One
☐ Group Two
☐ Group Three
☐ Group Four

3) Do you ever get extremely involved in projects that are assigned to you by your boss or your instructor, to the exclusion of other tasks?

☐ Never
☐ -2
☐ -1
☐ Occasionally
☐ +1
☐ +2
☐ Often

4) How easily can you switch your attention from the task in which you are currently involved to a new task?

☐ Never
☐ -2
☐ -1
☐ Occasionally
☐ +1
☐ +2
☐ Often

5) How frequently do you get emotionally involved (angry, sad, or happy) in the news stories that you read or hear?
6) How well do you feel today?
   - Never
   - -2
   - -1
   - Moderately
   - +1
   - +2
   - Frequently

7) Do you easily become deeply involved in movies or TV dramas?
   - Never
   - -2
   - -1
   - Occasionally
   - +1
   - +2
   - Often

8) Do you ever become so involved in a television program or book that people have problems getting your attention?
   - Never
   - -2
   - -1
   - Occasionally
   - +1
   - +2
   - Often

9) How mentally alert do you feel at the present time?
   - Not alert
   - -2
   - -1
   - 0
   - 1
   - 2
   - Very alert

10) Do you ever become so involved in a movie that you are not aware of things happening around you?
    - Not involved
11) How frequently do you find yourself closely identifying with the characters in a story line?

-2
-1
Moderately involved
+1
+2
Extremely involved

12) Do you ever become so involved in a video game that it is as if you are inside the game rather than moving a joystick and watching the screen?

-2
-1
0
Occasionally
+1
+2
Often

13) How physically fit do you feel today?

-2
-1
0
+1
+2
Extremely fit

14) How good are you at blocking out external distractions when you are involved in something?

-2
-1
Moderately good
+1
+2
Extremely good

15) When watching sports, do you ever become so involved in the game that you react as if you were one of the players?
16) Do you ever become so involved in a daydream that you are not aware of things happening around you?

- Never
- -2
- -1
- Occasionally
+ 1
+ 2
- Often

17) Do you ever have dreams that are so real that you feel disoriented when you awake?

- Never
- -2
- -1
- Occasionally
+ 1
+ 2
- Often

18) When playing sports, do you become so involved in the game that you lose track of time?

- Never
- -2
- -1
- Occasionally
+ 1
+ 2
- Often

19) Are you easily disturbed when working on a task?

- Not easily
- -2
- -1
- Moderately easily
+ 1
+ 2
- Extremely easily

20) How well do you concentrate on enjoyable activities?
21) How often do you play arcade or video games? (OFTEN should be taken to mean every day or every two days, on average.)

- Not often
- -2
- -1
- Moderately often
+ 1
+ 2
- Extremely often

22) On average, how many books do you read for enjoyment in a month?

23) What kind of books do you read most frequently? (CIRCLE ONE ITEM ONLY)

- SPY NOVELS
- FANTASIES
- SCIENCE FICTION
- ADVENTURE
- ROMANCE NOVELS
- HISTORICAL NOVELS
- WESTERN
- MYSTERIES
- OTHER FICTION
- BIOGRAPHIES
- AUTOBIOGRAPHIES
- OTHER NON-FICTION

Scoring Instructions

Simply score the boxes for each question from left to right beginning with one and increasing in value to the box the subject has marked, and the number of that box becomes the score. The subscale scores are the sum of the scores for each subscale item. There is no weighting of items or subscales. The questionnaire total and subscales are comprised as follows:
IMMERSIVE TENDENCIES QUESTIONNAIRE

TOTAL: Items 3,4,5,6,7,8, 9,10,11,12,13,14,15,16,17,18,19,20,21.
ITQ-FOCUS: Items 7, 9, 13, 14 &18
ITQ-IN Volvement: Items 8, 10, 11, 16 & 17
ITQ-GAMES: Items 21

New questions have been added to the questionnaire, but should not be added to the total or subscales as they are just beginning to be investigated. The new (unanalyzed) questions are scored the same as the other questions. None of the new questions seem to require reverse scoring.
Appendix D: OpenSimulator Server Commands

General

- `alert <message>` - send an inworld alert to everyone
- `alert-user <first> <last> <message>` - send an inworld alert to a specific user
- `backup` - trigger a simulator backup (Persist objects to the database now). The simulator does this automatically at regular intervals and on shutdown.
- `bypass permissions <true / false>` - Bypass inworld permission checks
- `change region <region name>` - subsequent commands apply only to the specified region. If region name is "root" then all regions are selected
- `clear-assets` - forcibly clears asset cache, probably leaving sim unstable. Use with caution.
- `command-script [name of scriptfile]` - Runs a command script containing server commands
- `create region [name] [filename]` - Create a new region
- `debug packet <level>` - Turn on packet debugging, where OpenSimulator prints out summaries of incoming and outgoing packets for viewers, depending on the level set
- `debug permissions` - Turn on permissions debugging
- `debug scene` - Turn on scene debugging
- `delete-region <name>` - Delete a region from disk
- `edit scale [primitivename] [xvalue] [yvalue] [zvalue]` - changes size of the named prim
- `emergency-monitoring` - turn emergency debugging monitoring mode on or off.
- `export-map [<path>]` - Save an image of the world map (default name is exportmap.jpg)
- `force permissions` - Force permissions on or off.
- `force update` - triggers a resend of all prims in a region
- `help [<command>]` - Get general command list or more detailed help on a specific command or set of commands
- `kick user <first> <last> [message]`: - Kick a user off the simulator
- `kill uuid <UUID>` - Kill an object by UUID (helpful with red lines in the console)
- `link-mapping` - Set a local grid co-ordinate to link to a remote hypergrid
- `link-region` - Link a HyperGrid region. Not sure how this differs from link-mapping
- `modules list` - List modules
- `modules load <name>` - Load a module
- `modules unload <name>` - Unload a module
- `monitor report` - Returns a variety of statistics about the current region and/or simulator
- `quit` - equivalent to shutdown.
- `region restart abort [<message>]` - Abort a scheduled region restart, with an optional message
- `region restart bluebox <message> <delta seconds>++` - Schedule a region restart. If one
delta is given then the region is restarted in delta seconds time. A time to restart is
sent to users in the region as a dismissable bluebox notice. If multiple deltas are
given then a notice is sent when we reach each delta.

- region restart notice <message> <delta seconds>+ - Schedule a region restart. Same as
  above except showing a transient notice instead of a dismissable bluebox.
- reload estate - reload estate data
- remove-region - remove a region from the simulator
- restart - Restarts all sims in this instance
- set log level [level] - change the console logging level only. For example, off or debug.
- set region flags <Region name> <flags> - Set database flags for region
- set terrain heights <corner> <min> <max> [<x>] [<y>] - Sets the terrain texture
  heights on corner #<corner> to <min>/<max>, if <x> or <y> are specified, it will
  only set it on regions with a matching coordinate. Specify -1 in <x> or <y> to
  wildcard that coordinate. Corner # SW = 0, NW = 1, SE = 2, NE = 3.
- set terrain texture <number> <uuid> [<x>] [<y>] - Sets the terrain <number> to
  <uuid>, if <x> or <y> are specified, it will only set it on regions with a matching
  coordinate. Specify -1 in <x> or <y> to wildcard that coordinate.
- show caps - show all registered capabilities URLs.
- show circuits - Show agent circuit data
- show connections - show connections data
- show http-handlers - show all registered http handlers
- show hyperlinks - list hg regions
- show info - show server information (version and startup path)
- show modules - show module data
- show neighbours - Shows the local regions' neighbours
- show pending-objects - show number of objects in the pending queues of all viewers
- show pqueues [full] - show priority queue data for each client. Without the 'full' option,
  only root agents are shown. With the 'full' option child agents are also shown.
- show queues - Show queue data for agent connections.
- show ratings - Show rating data
- show regions - Show region data (Region Names, XLocation YLocation coordinates, Region Ports, Estate Names)
- show stats - show useful statistical information for this server.
- show threads - shows the persistent threads registered with the system. Does not
  include threadpool threads.
- show throttles [full] - Show throttle data for each client connection, and the maximum
  allowed for each connection by the server. Without the 'full' option, only root
  agents are shown. With the 'full' option child agents are also shown.
- show uptime - show server startup time and uptime.
- show users [full]- show info about currently connected users to this region. Without the
  'full' option, only users actually on the region are shown. With the 'full' option
  child agents of users in neighbouring regions are also shown.
- show version - show server version.
- shutdown - disconnects all clients and shutdown.
• unlink-region <local name> - unlink a hypergrid region

**Appearance Module Commands**

• appearance show - Show information about avatar appearance. Currently just checks whether the baked texture is "OK" or "corrupt". Still in development. Only exists in development code at the moment.

**Archive Commands**

• load iar <first> <last> <inventory path> <password> [archive path] - Load user inventory archive.
• load oar [filename] - load an OpenSimulator archive. This entirely replaces the current region. Default filename is *region.oar*.
• load xml [-newIDs [<x> <y> <z>]] - Load a region's data from XML format (0.7.*: DEPRECATED and may be REMOVED soon. Use "load xml2" instead)
those xml are the result of the export save or *export save-all
• load xml2 [filename] - optional parameters not supported for XML2 format as at 1-Jul-2008
• save iar <first> <last> <inventory path> <password> [archive path] - Save user inventory archive.
• save oar [filename] - save the current region to an OpenSimulator archive. Default filename is *region.oar*.
• save prims xml2 [<prim name> <file name>] - Save named prim to XML2
• save xml [filename] - save prims to XML
• save xml2 [filename] - save prims to XML (Format 2 - rearrangement of some nodes, to make loading/saving easier)

**Config Commands**

• config get [<section>] [<key>] - Get the current configuration, either for a particular key, a particular section or the whole config.
• config save <path> - Save the current configuration to a file.
• config set <section> <key> - Set a particular configuration value. On the whole, this is useless since neither OpenSimulator nor modules dynamically reload config values.
• config show [<section>] [<key>] - Synonym for 'config get'

**Land Module Commands**

• land show - Shows all parcels on the current region.

**Script Commands**

These currently only exist in git master OpenSimulator development code post the 0.7.2 release.

• scripts resume [<script-item-uuid>] - Resumes all suspended scripts
• scripts show [<script-item-uuid>] - Show script information. <script-item-uuid> option only exists from git master 82f0e19 (2012-01-14) onwards (post OpenSimulator 0.7.2).
• scripts start [<script-item-uuid>] - Starts all stopped scripts
• scripts stop [<script-item-uuid>] - Stops all running scripts
• scripts suspend [<script-item-uuid>] - Suspends all running scripts
Terrain Module Commands
Note that some of these may require a sim restart to show properly.

- terrain load - Loads a terrain from a specified file.
- terrain load-tile - Loads a terrain from a section of a larger file.
- terrain save - Saves the current heightmap to a specified file.
- terrain fill - Fills the current heightmap with a specified value.
- terrain elevate - Raises the current heightmap by the specified amount.
- terrain lower - Lowers the current heightmap by the specified amount.
- terrain multiply - Multiplies the heightmap by the value specified.
- terrain bake - Saves the current terrain into the regions revert map.
- terrain revert - Loads the revert map terrain into the regions heightmap.
- terrain newbrushes - Enables experimental brushes which replace the standard terrain brushes. WARNING: This is a debug setting and may be removed at any time.
- terrain stats - Shows some information about the regions heightmap for debugging purposes.
- terrain effect - Runs a specified plugin effect

Tree Module Commands

- tree active - Change activity state for the trees module
- tree freeze - Freeze/Unfreeze activity for a defined copse
- tree load - Load a copse definition from an xml file
- tree plant - Start the planting on a copse
- tree rate - Reset the tree update rate (mSec)
- tree reload - Reload copse definitions from the in-scene trees
- tree remove - Remove a copse definition and all its in-scene trees
- tree statistics - Log statistics about the trees
Appendix E: Interview Questionnaire

Directions: All responses to the following items will be kept confidential. Please answer freely and honestly.

I. Please read each of the following statements carefully. Then choose an appropriate answer. Please note this is not a test and there is no right or wrong answer, please circle the one that best describe you.

1. I am a girl___ boy___

2. I use English outside of school (Check all that applies)
   ___ at Church
   ___ in Online chat room
   ___ in an Instant Message
   ___ after school English class
   ___ sending and receiving emails
   ___ other places, please specify___

3. Besides homework, I speak English outside of school, e.g. at church, after school English classes, shopping or somewhere else.
   ___ Don’t speak at all
   ___ Less than an hour a week
   ___ 1 – 2 hours a week
   ___ More than 2 hours a week

4. Besides homework, I read in English outside of school.
   ___ Don’t read at all
   ___ Less than an hour a week
   ___ 1 – 2 hours a week
   ___ More than 2 hours a week

5. Besides homework, I write in English outside of school.
   ___ Don’t read at all
   ___ Less than an hour a week
   ___ 1 – 2 hours a week
   ___ More than 2 hours a week

II. Please rate each of the following statements on a scale from 1 to 5. “1” represents something with which you strongly disagree. “5” represents something with
which you strongly agree. Circle the number that best matches your feelings.

1= strongly disagree with the statement
2= disagree with the statement
3= are not certain or undecided about the statement
4= agree with the statement
5= strongly agree with the statement

2. The inworld chatbot builds a supportive online learning environment.
   1. 2. 3. 4. 5.

3. The inworld time machine builds a supportive online learning environment.
   1. 2. 3. 4. 5.

4. Video tutorials build a supportive online learning environment.
   1. 2. 3. 4. 5.

III. In this section, please share with us, as much as you can, your ideas about the following questions. If you do not feel you can fully express yourself in English, please feel free to use Chinese.

5. HOW DO YOU FEEL WHEN YOU FAIL TO RESPOND TO YOUR TEAM MEMBERS?

6. How do you feel your relationship with an avatar?

7. How do you feel your relationship with your peers inworld?
Appendix F: Sample of Raw Data Analysis – Presence

ONEWAY
PreTotal BY group
/STATISTICS DESCRIPTIVES HOMOGENEITY WELCH
/MISSING ANALYSIS
/POSTHOC = TUKEY GH ALPHA(.05).

[DataSet1] C:\Documents and Settings\ZhenLi\Desktop\Yifei\Presence.sav

Oneway

Descriptives

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<th>Std. Error Upper Bound</th>
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Test of Homogeneity of Variances

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Robust Tests of Equality of Means

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#### Post Hoc Tests

**Multiple Comparisons**

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Homogeneous Subsets

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Means Plots
ONEWAY
SP BY group
/STATISTICS DESCRIPTIVES HOMOGENEITY WELCH
/PLOT MEANS
/MISSING ANALYSIS
/POSTHOC = TUKEY GH ALPHA(.05).

Oneway

[DataSet1] C:\Documents and Settings\ZhenLi\Desktop\Yifei\Presence.sav

### Descriptives

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<th>Std. Error</th>
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### Test of Homogeneity of Variances

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### Robust Tests of Equality of Means

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**Post Hoc Tests**

**Multiple Comparisons**

Dependent Variable: Spatial presence

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**Homogeneous Subsets**

**Spatial presence**

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Means Plots
OneWay

INV BY group
/STATISTICS DESCRIPTIVES HOMOGENEITY WELCH
/PLOT MEANS
/MISSING ANALYSIS
/POSTHOC = TUKEY GH ALPHA(.05).

Oneway

[DataSet1] C:\Documents and Settings\ZhenLi\Desktop\Yifei\Presence.sav

Descriptives

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Test of Homogeneity of Variances

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Robust Tests of Equality of Means

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Post Hoc Tests

Multiple Comparisons

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Homogeneous Subsets

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Means Plots
ONEWAY
REAL BY group
/STATISTICS DESCRIPTIVES HOMOGENEITY WELCH
/PLOT MEANS
/MISSING ANALYSIS
/POSTHOC = TUKEY GH ALPHA(.05).

Oneway

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### Descriptives

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### Test of Homogeneity of Variances

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### Robust Tests of Equality of Means

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**Multiple Comparisons**

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### Homogeneous Subsets

**Experienced realism**

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235
Means Plots
## Descriptives

General presence—PRES-In the computer generated world I had a sense of being there.

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<th>Maximum</th>
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## Test of Homogeneity of Variances

General presence—PRES-In the computer generated world I had a sense of being there.

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## ANOVA

General presence—PRES-In the computer generated world I had a sense of being there.

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## Robust Tests of Equality of Means

General presence—PRES-In the computer generated world I had a sense of being there.

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Post Hoc Tests

Multiple Comparisons

Dependent Variable: General presence--PRES-In the computer generated world I had a sense of being there.

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Homogeneous Subsets

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Means Plots
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/COMPRESSED.
ONEWAY
  Total BY Group
/STATISTICS DESCRIPTIVES HOMOGENEITY WELCH
/PLOT MEANS
/MISSING ANALYSIS
/POSTHOC = TUKEY GH ALPHA(.05).

Oneway

[DataSet1] C:\Documents and Settings\ZhenLi\Desktop\Yifei\Immersive_short.sav

Descriptives

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Test of Homogeneity of Variances

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### Robust Tests of Equality of Means

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### Post Hoc Tests

#### Multiple Comparisons

**Dependent Variable: Immersive tendencies total**

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Means Plots

Oneway

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Test of Homogeneity of Variances

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Robust Tests of Equality of Means

FOCUS: 7.9.13.14.18

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Post Hoc Tests

Multiple Comparisons

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FOCUS: 7.9.13.14.18

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Means Plots
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**Descriptives**

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# Post Hoc Tests

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## Homogeneous Subsets

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Test of Homogeneity of Variances

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Robust Tests of Equality of Means

Games-Howell

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<td>.187</td>
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<td>Group Four</td>
<td>Group One</td>
<td>-.400</td>
<td>.202</td>
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**Homogeneous Subsets**

GAMES: GAME-21. How often do you play arcade or video game? (Often should be taken to mean every day or every two days, on average.)

<table>
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<th>Tukey HSD</th>
<th>N</th>
<th>Subset for alpha = .05</th>
</tr>
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</tr>
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</table>

**Means Plot**