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How Spatial Presence in VR Affects Memory Retention and Motivation on Second Language Learning: A Comparison of Desktop and Immersive VR-Based Learning

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ABSTRACT

Virtual Reality (VR) software and hardware are becoming increasingly stable as are the production values for VR content. This progress makes it essential to research the impacts of language learning in VR to provide directions and guidelines for the field of educational technology. This research examines the efficacy of media effects and memory retention in language learning through computer assistance with an increased focus on VR. This paper evaluates the effectiveness of using VR as a method for second language (L2) learning. It is assumed that VR uses latent acquisition when used for learning L2, increasing memory retention by producing spatial presence and a stronger immersion experience. Thus, the VR method has potential to be an effective novel approach that uses subconscious mechanisms of memory coding, 'Method of Loci', to facilitate the acquisition of new words through learning. In order to corroborate it, immersive and desktop learning environments based on VR need to be compared to analyze the media's impact on constructs, such as spatial presence, memory, enjoyment, and motivation. The Korean language learning module and a test were administered to a group of participants, none of whom had prior learning experience with the Korean language. The research implication is a positive correlation between media and medium impacts with findings that provide an important foundation in the fields of language education and media communications. Accordingly, L2 learning through VR offers a novel method to learning new languages by facilitating convenience and effectiveness.

Keywords: *Spatial Presence, Enjoyment, Motivation, VR, Language Learning, Spatial Memory*

How Spatial Presence in VR Affects Memory Retention and Motivation on Second Language Learning: A Comparison of Desktop and Immersive VR-Based Learning

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I. INTRODUCTION

Anecdotal evidence for memory recall was provided by journalist Joshua Foer in 2005 while interviewing the "grand master" of memory, Ed Cooke. After making observations, Foer practiced applied these concepts into practice. A year later, Foer attended the 2006 memory championship to become a memory champion. The mnemonic strategy applied is called 'Memory of Loci,' which uses subconscious capturing of the space in an image to map objects using relations in sequential order (Foer, 2012). Foer's experience suggests that Virtual Reality (VR), by using the 'Method of Loci' strategy, may have potential for enhancing language learning.

Language plays a critical role in communication by providing the opportunity to express emotions and establishing social relationships. Thus, the study of language is a process of communication that is determinative of people's social nature and joint culture building (McDevitt, 2004), while learning a language is essential for living in a society with other people.

Similar to the importance and prevalence of language learning, learning a second language (L2) has recently become increasingly necessary for communication. Various researchers assert that there are major advantages to learning L2. For instance, it is useful for building multitasking skills (Swayne & Messer, 2011). Possessing foreign language knowledge improves brain functionality through challenges of negotiation, communication, and recognition in different systems of languages (Merritt, 2013). However, despite the many benefits with L2, it is typically not easy to learn. Learning L2 can reduce motivation and increase anxiety, which negatively impacts the language learning by increasing avoidance and distress when engaging in difficult areas of the target language (Horwitz, Horwitz, & Cope, 1986). Thus, developing efficient methods for learning of L2 must be addressed to assist future learners.

Implementation of L2 learning has been made easier with rapid technological growth in recent years. Blake (2013) argues that in the 21st century, computer technology will become essential for all tasks in the society. Thus, there is an increasing demand for developing efficient methods for L2 proficiency via technology. Language administrators and teachers must consider incorporating innovative and effective teaching methods by harnessing the advantages offered by technology.

Unsurprisingly, with the proliferation and integration of the Internet, various computer-assisted language learning (CALL) systems have become commonplace in the home and school environments (Iandoli, 1990). For instance, it is now possible to acquire L2 learning through video teaching of L2, online communication with a L2 partner or playing language games via a mobile phone. Warschauer and Healey (1998) support the argument that pedagogical and technological developments have been increasingly integrating computer technology into the process of language learning.

With the presence of computer technology, CALL has been praised by many researchers as a method that offers suitable tools for increasing cultural knowledge, language, and motivation achievement (Dunkel, 1991; C.-L. C. Kulik, Kulik, & Bangert-Drowns, 1990; J. A. Kulik, Kulik, & Cohen, 1980; Waxman & Huang, 1996). The researchers believed that computers are capable of promoting the acquisition of new languages to people with its capability in provisioning several communicative activities, reducing learning stress and anxiety, and providing repeated lessons (Lai & Kritsonis, 2006).

There has been an increase of L2 learners in the use of simulation computer games to assist L2 learning. A study by Miller and Hegelheimer (2006) investigated the structural play of the original version of The Sims in combination with support materials specifically designed for facilitating English L2 learning by retaining the video gaming aspect as well as for enhancing grammar and vocabulary. Statistically, the researchers found a significant increase of vocabulary words among the participants who played The Sims during their study. K.-w. Lee (2000) argued that the application of computer technology in L2 learning is based on its ability to provide experiential learning practice and the application of multiple resources, such as puzzles, online tutors, simulations or games.

Although there are various benefits of computer-based L2 learning (C.-L. C. Kulik et al., 1990), researchers indicate limitations (Lai & Kritsonis, 2006) arise with a lack of immersion. Most researchers of CALL intended to focus on learning based on the desktop computer with the utilization of a monitor to present learning media. E. A. Johnson (2010) gave a definition of learning based on the desktop computer as “non-immersive virtual environments can be viewed on a regular PC with a standard monitor” (p. 49). Also, Kim, Rosenthal, Zielinski, and Brady (2012) defined the desktop as a system with the lowest level of immersion among other mediums compared with a VR Head Mounted Display (VR HMD) or a Cave Automatic Virtual Environment (CAVE). However, the desktop display may also disrupt concentration and negatively influence the motivation to continue the study due to a lack of immersion.

The importance of immersion in education was underscored by many scholars (Bricken, 1991; Dede, Salzman, & Loftin, 1996; Katz & Halpern, 2015). Dede et al. (1996) evaluated the effect of immersion and motivation in MaxwellWorld, which was designed for learning the concept of the electric potential. Most of the students stated that they were able to learn more effectively about electric fields when using computer-generated 3-D representations compared to textbooks. Also, pre- and post-testing showed students developed a more in-depth understanding of the electric field and continued their study. This example suggests the question of how a higher level of immersion could be applied to L2 learners for increasing motivation and learning effectiveness.

Considering this, VR provides an interesting and viable solution. Identifying VR as a full-immersion technology with head-mounted display, data glove, 3-D earphones, and tracking equipment, Chiou (1995) described the potential for VR as a learning medium. VR HMD enables a fully immersive, 360-degree environment (Rose & Billinghurst, 1995). Solak and Erdem (2015) assert that a sense of presence can generate a high-immersive environment in VR, where the concept of presence is defined as “being there” (F. Biocca & Delaney, 1995). This increased immersion is responsible for the simulation of a VR’s authentic environment.

Using this authentic environment, VR systems can apply to nearly every field of education (Bellini et al., 2016), including helping students comprehend nuclear reactions, observe complex surgeries, visit places they have never been, train military personnel, and learn L2. Dede et al. (1996) found the use of VR for exploring Newton’s Laws by presenting zero gravity and zero frictional forces in the virtual environment (VE). Bonde et al. (2014) introduced the VR Labster, which is a virtual chemistry laboratory, with comparisons to lectures and traditional learning. Participants who used the VR laboratory demonstrated a 14% increased performance compared to students who followed a traditional lecture for learning. This effect was realized due to the provision for a sense of a higher presence through VR to create an authentic environment for the content.

VR can also affect memory retention using spatial presence. The vividness with which the interaction is communicated in a VR environment enhances the persuasive power, produces more central arguments with vivid cognitive elaboration, and ensures an increase of the memory of the relevant information according to C. Wu and Shaffer (1987). An experiment conducted by E. A. Johnson (2010) compared various media (non-VR vs. VR) capable of immersion level generation. A shutter glass with tracking sensors was used at the head to create an immersive 3-D environment. A correlation was found between spatial memory and presence due to a higher immersion level offering greater impact on the spatial memory. With this correlation, there was limited use of the immersive experience in the research to show how various presence levels influences memory retention in the learning of languages along with how VR HMD might enhance acquiring L2 through the use of spatial memory.

Another benefit of using VR in language learning is to increase the motivation of the learner. When 3-D and 2-D animation effects were compared in how they increased motivation and interests of students, the study revealed that learning scenarios with a fully immersive 3-D environment maintained motivation levels as well as keeping interest in the learning process (Limniou, Roberts, & Papadopoulos, 2008). Some researchers have insisted that the students' role in language learning through VR is a key advantage along with creating an environment with no stress, offering a total immersion of the language, and motivation generated by VR and empowerment of the student (Duffy & Jonassen, 2013; Rose & Billinghurst, 1995).

Learning based on VR environments offers better chances for L2 learners because of a higher immersion level, higher retention of memory, and enhancement of the motivation for the continuous study by the learners. VR is still in the early adoption stages as a technology, so there exists no research comparing the medium with media effects for L2 learning. Therefore, through a comparison with desktop-learning, this paper verifies VR as a language education media with various potential elements in the learning of language.

Overview of the Paper

The aim of this research is the investigation of the effectiveness of VR as a platform for language learning. The research includes a definition of what is meant by desktop and reality-based learning to allow for a comparison between the features of the learning methods.

The literature review divides previous research into VR as a tool for education technology and VR for retention of memory. The first review offers descriptions of the factors that influence the retention of memory, such as with acquiring L2, through a VR's authentic environment using spatial memory in the simulation. From the literature, an argument emerges for the factors likely to support memory in VR. The second review involves the significance of applying VR in the learning of L2. The previous research investigates spatial enjoyment, presence, and motivation all of which are crucial learning language elements, so it is important to research the existing relations between the effects of these media. Based on the information presented in the literature review, it can be presumed that spatial presence remains a critical factor in the learning of L2. Therefore, with the media effects and memory overall, the research summarizes the spatial presence as a critical factor in the process of language learning through VR (see Figure 1).

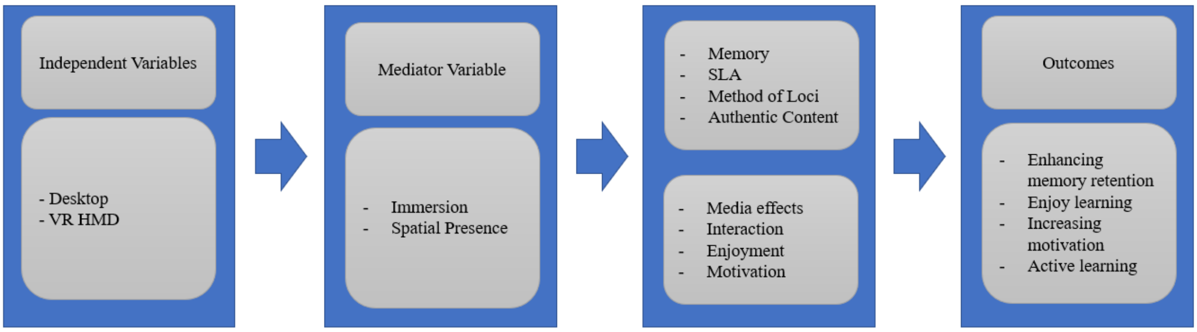


Figure 1. The conceptual framework of the research outcomes and the causal relationships in VR-based learning environments

The methodology explains how the experiment is designed to visualize the effects of media in the various mediums (desktop monitor vs. VR HMD). For the experiment, content for language learning was created in the VR platform and tested against the spatial presence, spatial memory, motivation, and enjoyment. A quantitative analysis is conducted using

AMOS and SPSS to verify the model proposed from the literature review followed by a conclusion on the effectiveness of VR as a tool for educational language applications.

Spatial Presence Theory

Definition and Terminology

The sense of ‘presence' has been trending in the field of research with many researchers studying the subject (F. Biocca, 1997; Lombard & Ditton, 1997; Lombard, Reich, Grabe, Bracken, & Ditton, 2000; Tamborini, 2000). According to Waterworth, Waterworth, Riva, and Mantovani (2015), ‘presence’ is defined as ‘the feeling of being located’ in an external environment. Spatial presence is a form of the ‘presence' dimensions (Shafer, Carbonara, & Popova, 2011). F. Biocca, Harms, and Burgoon (2003, p. 459) stressed, “a spatial presence as the phenomenal sense of ‘being there’ including automatic responses to spatial cues and the mental models of mediated spaces that create the illusion of place.” As also stated by Witmer and Singer (1998) regarding spatial presence, a person feels they are in a particular surrounding, yet they are physically situated in another setting. Spatial presence is an important factor in the area of VR (Steuer, 1992) as ‘presence' is expected to be increased for VR devices compared to other media (Mennecke, Triplett, Hassall, Conde, & Heer, 2011).

One factor affecting ‘presence’ is immersion (Schubert, Friedmann, & Regenbrecht, 1999), and Lombard and Ditton (1997) stated that immersion is a classification of presence resulting in a ‘spatial presence.' Immersion is the overall feeling as a result of the use of various display and interaction platforms (Sanchez-Vives & Slater, 2004), such as Head Mounted Devices immerse a person into the VR (Heeter, 1992) more than a desktop monitor. Due to spatial presence, a person can feel a different sense of immersion for various media.

Sherman and Craig (2002) explained the idea of spatial presence as physical and psychological immersion. Physical immersion involves the sensory organs interacting with devices, such as auditory, visual or haptic devices (as in HMD and headphones). On the other hand, psychological immersion refers to the creation of a feeling a person is inside a particular space. Sherman and Craig (2002) also claimed that a VE is the state of concentration because immersion is conceptualized at a varying magnitude depending on the degree of the physical immersion and an individual's character. Also, according to Sanchez-Vives and Slater (2004), immersion is an explanation of the general fidelity in relation to the physical reality as a result of interaction and display systems. Therefore, to measure spatial presence at different levels, the display format must be transformed by using various devices such as a desktop monitor or HMD.

Spatial Presence & Memory

VE is an essential tool in the study of brain activation in the use of spatial navigation (Sanchez-Vives & Slater, 2004). A relationship between spatial memory and spatial presence exists as investigated by some researchers. Brooks (1999); Carassa, Geminiani, Morganti, and Varotto (2002) suggested that the application of episodic memory is increased through use of VR. They also claimed that the subjects in their experiments who frequently used VE devices completed more memory tasks in contrast to those who passively used VEs. Carassa et al. (2002); Plancher, Nicolas, and Piolino (2008) found that the use of spatial memory increases with increased use of the immersive VR systems.

Lekan (2016) studied the relationship between presence and spatial memory in computer-based and VR media and discovered that 2-D technological devices do not yield a feeling of presence so do not affect spatial memory. On the other hand, VR stimulates the section of the brain related to experience enhanced memorization as these sections are associated with spatial memory. Subsequent research by Kelly and McNamara (2008) looked at the question of if VR could result in essential cues, such as extrinsic structure, fundamental structure, and egocentric experience, to improve spatial memory not provided by 2-D technologies. They found that VR could enable the cues in memory just as in the real environment thus increasing the efficiency of spatial memory.

Spatial Presence & Motivation

Motivation is known to be related to spatial presence. Green and Bavelier (2003); Stoerger (2008) claimed that students could interact better with visual and spatial representations as a result of the immersive experience resulting in an improved performance in learning. Witmer and Singer (1998) compared the magnitude of presence experienced by a user of VR and computer-based learners and found the spaces caused by the user and the computer are separate. They also stated that a user of VR felt immersed in the virtual environment thereby increasing their output.

Using highly immersive devices results in a motivation that helps improves the desire to learn and educate. Limniou, Roberts, and Papadopoulos (2008) experimented by comparing 2-D images and 3-D molecular representations and realized that a full immersive 3-D VR learning environment (VRLE) causes the learners to respond with increased interest and motivation to learn. From past work, it was observed that spatial presence positively influences learning by improving motivation. On the other hand, it remains controversial whether spatial presence can enhance language learning motivation (Plass, Chun, Mayer, & Leutner, 2003).

Category of Features in VR-Based Learning

This study is aimed at gauging the effectiveness of immersive VR-based learning (using VR HMD) in comparison to desktop VR-based learning (using a 2-D monitor) as it applies to enhancing language learning. Javidi (1999) defines VR, "it has been applied more widely to include graphics applications that allow users to walk through a simulated environment and, possibly, to interact with objects in it" (p. 4). Like his description, VR is used to refer to VR environment (3-D environment) delivered through a VR Head Mounted Display (VR HMD) as the technological device. To clarify the terminology, definitions according to Cronin (1997) for VR and other features are generalized and analyzed for this work as outlined in Table 1. Cronin (1997) grouped VR according to the immersion quality. A standard desktop computer is defined as 'desktop VR,' which lacks the feeling of immersion. On the other hand, a semi-immersive VR system offers a sense of being more immersed in a VE. The third form includes electronic devices used to display three-dimensional images involving headphones, HMD, and motion-sensing gloves. An HMD provides a 360-degree virtual environment allowing the users to be mentally separated from the actual world. For studying the differences in the media effects at different levels of immersion, we select fully immersed and desktop VR. VR-based learning implies using desktop VR, and immersive VR-based learning refers to the application of the VR HDM devices during learning.

Cronin (1997) further argued that VR creates high interactivity and high sense of immersion that can enhance students' learning experiences. Burdea and Coiffet (2003) coined the idea of "I3," which is an abbreviation for immersion-interaction-imagination, claiming the three features have a strong relationship. VR's captivating and interactivity power creates immersion as a result of onscreen action (Huang, Rauch, & Liaw, 2010).

Desktop itself can display 2-D environments. For instance, Bliss, Tidwell, and Guest (1997) applied VR to improve firefighters' training with route navigation. In the experiment, desktop itself displayed 2-D environment, and coupled head-tracking on a desktop monitor was utilized to make the 3-D display. Spatial information from 3-D displays was used more effective than those from 2-D displays (such as with blueprints). On the other hand, Virtual

Reality Head Mounted Display (VR HMD) itself can generate 3-D environment without any additional devices.

Table 1.

Analysis of *Features between Desktop and VR*

	Desktop VR-based learning	**Immersive VR-based learning**
Visual displays	Desktop Monitor	VR HMD
Immersion	Low	High
Interactivity	Low	High
Dimension	2-D	3-D

II. LITERATURE REVIEW

Research Area 1. Factors Affecting Memory in VR

Authentic Environments in Simulation

Simulations and advance games made to support learning exotic languages have been invented in the last decade (Li & Topolewski, 2002; Mich, Betta, & Giuliani, 2004; Ranalli, 2008a; Sørensen & Meyer, 2007). Simulations can allow a connection between the student and the culture from which the language originates, thus providing a realistic language learning environment (Schwienhorst, 2002). In other words, the VR environment created represents active situations with which students can identify by providing a realistic learning environment. For example, the latest VR language learning (VRLL) application, “Mondly VR,” allows users to practice real-world situations in a virtual environment, such as in a hotel reception, café or train. The high-quality content and 3-D environment may help learners feel a sense of presence while dealing with the situation in VR. Another example is the “House of language,” which is an application for learning vocabulary by interacting with 3-D objects. In this application, a virtual teacher offers a word quiz and the learner selects the correct object in response to each question. As with these examples of VRLL applications, the learners are placed within real-situation environments, such as the home or movie theater.

Furthermore, many simulations provide an authentic environment so that the student can enjoy and practice without stress or anxiety (Wehner, Gump, & Downey, 2011). There exists research aimed at analyzing the effectiveness of VR learning through simulation in the process of learning new languages. For instance, Ranalli (2008b) noted how the language vocabulary of subjects increased after playing simulation games. In the study, university students studying the English language participated and were made to participate in the simulation game before being tested with a weekly quiz to gauge vocabulary levels. It was found that the combination of the game enhanced learning while additional reading materials improved the ability to memorize the weekly vocabulary. This result was verified when it was observed that a statistical significance existed in the gain of the 30 weekly vocabulary challenges.

The reason behind this phenomenon is that VR can generate an authentic environment, which helps students learn the language while they are repeating what they learn in the virtual world. This approach is also why VR can be widely used beyond language learning to other practical training, such as military (Kozak, Hancock, Arthur, & Chrysler, 1993), firefighter (Bliss, Tidwell, & Guest, 1997), and medical and rehabilitation training (Satava, 1995). In particular, Bliss et al. (1997) introduced VR for training firefighters to acquire and display knowledge about spatial navigation in an unfamiliar place. They compared the blueprint, VR, and no training conditions to investigate which approach is the most effective for firefighter training and hypothesized the VR exploration method would be the best training tool because 3-D displays provide more visual and the top spatial information than 2-D displays. However, opposite to his hypothesis, the blueprint performed best for the task of navigation time as well as for the number of wrong turns. They explained this result because firefighters are more familiar with using a blueprint, and the data was limited due to a low number of test samples with only 10 participants. In this research, they differentiated the implemented tools between paper and a computer monitor. Thus, the immersion level depended on the visual tool and did not affect the result. If they had experimented utilizing VR HMD, the result could have been different due to a higher spatial presence. Thus, this study posits the following hypotheses:

H1. During L2 learning, participants who are assigned to a VR HMD interface will report a higher sense of spatial presence compared to participants who are assigned to desktop monitor.

Second Language Acquisition

L2 learners have two independent systems for developing skills in L2: subconscious language acquisition and conscious language learning (Kasper, 1999). These systems are interrelated. However, according to Kasper (1999), subconscious acquisition appears to be far more important because while conscious language learning is more similar to learning through error correction and becoming familiar with explicit rules (Krashen & Seliger, 1975), subconscious language acquisition does not require awareness of the grammar rules. Second Language Acquisition (SLA) is like the process children use while acquiring first and L2s (Kasper, 1999). Ellis (2015) explained the differences in detail as “acquisition is the incidental process where learners ‘pick up’ a language without making any conscious effort to master it; whereas learning involves an intentional effort to study and learn a language” (p. 25). SLA is defined as subconscious memorizing without learning the grammatical rules or syntax (Krashen, 1981).

Memory of Loci Increases Spatial Memory

Forgetting things is the nature of the human brain (Bower, 1970). By developing schemes or encoding information into patterns, people can overcome this weakness (Moffat, 2009). Humanity is known for searching for methods (Moffat, Zonderman, & Resnick, 2001), tricks or rituals to improve its memory (Atwood, 1969). The 'Method of Loci' is one potentially effective strategy for learning and memorizing (Murthy, 2014). Loci means "places" in Latin, and the method involves the processing of both spatial locations and imaginal associations (Lea, 1975). Bass and Oswald (2014) summarized this approach as three steps. First, memorize a few locations, such as a building with a gate, entrance, garage, lounge, stairs, kitchen, and bedroom, each of which are called cues. Second, form an image of incoming information or relate new information to already present items visualized in the room. Third, generate a sequence of information, which can later be retrieved.

The 'Method of Loci' is related to spatiality. For example, when a geographic map is provided to students as an adjunct to text, students remember more textual information referenced in the map than they would if provided only the text (Abel & Kulhavy, 1986; Kulhavy, Stock, Peterson, Pridemore, & Klein, 1992; Kulhavy, Stock, Verdi, Rittschof, & Savenye, 1993; N. H. Schwartz & Kulhavy, 1981). Another example from a California State University study (Bass & Oswald, 2014). They recruited 94 participants and divided two groups to memorize five lists of five fruits: one group using the 'Method of Loci' and another group using without any other particular method strategy. The results presented that the group used the 'Method of Loci' showed high memory retention than another group that did not use 'Method of Loci'. It is because the 'Method of Loci' supports to recall the serial order of the images based on the location and spatiality. Bass & Oswald (2014) concluded that sequential and visual techniques like the 'Method of Loci' may reduce forgetfulness and aid in retention.

Spatial memory is related to VR since VR presents a visual framework with spatiality (Järvinen, Bernardet, & Verschure, 2011). Pantelidis (2010) asserts that because VR improves spatial memory, VR is a good tool to use in training courses and education. Bailey, Bailenson, Won, Flora, and Armel (2012) experimented with students after experiencing an environment through VR HMD, where they were given a questionnaire to write about details of the environment. Results showed they remembered details of the virtual environment more than details of the actual environment. This suggests VR techniques impacts mediated experiences on cognition, which helps to improve spatial memory (Järvinen et al., 2011).

Another supportive research is measure level of immersion and spatial memory by E. A. Johnson (2010). The research focused on the question, "when navigating a complex virtual 3-D environment, does the user's spatial memory improve with an increased level of immersion?" (p. 1). Depending on the level of immersion, it may affect to the user's short-term spatial memory. The work analyzed two virtual environment contexts (the Muscatatuck Virtual Tour and the 21st Century World Future City) and used shutter glass with a tracking sensor immersive environment in 3-D. The results presented that a higher level of immersion significantly affects to spatial memory. This suggests VR techniques impacts mediated experiences on cognition, which helps to improve spatial memory (Järvinen et al., 2011). Thus, the following hypothesis is also considered:

H2. During L2 learning, participants assigned to immersive VR-based learning will experience increased memory retention *compared to participants who are assigned desktop VR-based learning.*

Correlation Between Spatial Presence and Spatial Memory

People may memorize things by their physical location (Patel & Vij, 2010) or sequential order by location. If a feeling of presence exists, then virtual objects related to the location will encode in the brain (Järvinen, Bernardet, & Verschure, 2011). Thus, VR has the advantage of convincing its user because they feel as if they are in a real physical environment, such as on a road, in a city or hotel, while learning a new language in that environment or situation. Thus, enhancing memory through immersion is shown in research as being important to the success of maintaining learning.

According to Bailey, Bailenson, Won, Flora, and Armel (2012), to measure the immersion level, researchers observe the presence level, and to measure presence, researchers use memory tasks or tests of recall because memory retention in the virtual environment is associated with levels of presence (Bailey et al., 2012). The greater level of presence users' experience, the more they remember the details of the virtual environment, such as virtual objects, spatial layouts, and message content (Lin, Duh, Parker, Abi-Rached, & Furness, 2002; Mania & Chalmers, 2001). For example, researchers at The Computer Museum developed an VR HMD application designed to teach children about the structure and function of cells (Gay & Greschler, 1994). Comparing non-immersive and immersive treatment groups, they found that the group in the immersive environment had better memory retention of information and more interest in the class. Thus, in this research, the following hypothesis posits:

H 3. A positive correlation exists between spatial presence and spatial memory.

Research Area 2. Educational Benefits of Using VR

Fostering and Enjoyable Environment

Enjoyment of the word incorporates meaning of appeal, liking, joy, and pleasure (Tamborini, Bowman, Eden, Grizzard, & Organ, 2010). Particularly in the communication field, enjoyment often carries a meaning of pleasure in response to media (Raney, 2003; Vorderer, Klimmt, & Ritterfeld, 2004; Zillmann, 1994). Because enjoyment includes entertainment elements (Nabi & Krcmar, 2004), it is commonly used to assess video game experiences (Ryan, Rigby, & Przybylski, 2006).

Many scholars argued that a game is an enjoyable and useful means to develop communicative competence (Baltra, 1990; Peterson, 2009; Ryan et al., 2006). Also, Lai and Kritsonis (2006) asserted that the computer provides many fun games and communicative activities in simulation learning. Since the scope of gaming is broad, in this paper, the game refers to a simulation game. There are a few reasons why playing computer games can be enjoyable for players: (1) they allow players autonomy of controlling the game, which may make the players more active (Ho & Crookall, 1995), (2) computer-based learning offers to learn through repetition (Lai & Kritsonis, 2006) and anonymity (Ortega, 1997) with elements of simulation learning that reduces stress and anxiety while enhancing confidence through practicing skills without fear (W. L. Johnson & Wu, 2008; Ortega, 1997), and (3) an authentic environment through a simulation provides a more immersive environment to visualize the virtual world as it the real world (Scoresby & Shelton, 2010).

These advantages of using a simulation game can be expanded to help language learning. SZABÓ (2011, p. 67) stated, “language learning environments and language teaching materials are the facet on retention of language learning”. Since the task of langue learning requires repeated learning, it should be performed through a routine. Thus, incorporating enjoyment into the routing can be a crucial element for successful language learning.

There is a great deal of research to support this recommendation. Deutschmann, Panichi, and Molka-Danielsen (2009) used Second Life for in a Ph.D. oral proficiency course to prepare students to present. The data from this study showed that the group who used

Second Life reported lower anxiety compared to a control group. They concluded the anonymity brings less anxiety to students, so the simulation game should be beneficial to language learning as well. Also, Wehner, Gump, and Downey (2011) conducted a comparison experiment while teaching undergraduate students taking a Spanish course through a traditional curriculum or by utilizing a simulation game in Second Life. They used the Attitude/Motivation Test Battery (Gardner, 1985) to measure anxiety and motivation. They reported 75% showed more positive results in favor of the Second Life scenario group due to having a sense of anonymity in the simulation game makes learners less anxious and more comfortable to interact with each other.

Furthermore, a variety of medium (e.g., computer, mobile, and VR) may influence the level of perceived enjoyment during language learning. Taylor (1997) researched the relationship between a feeling of presence and enjoyment in VR learning. Students were given a session in a virtual environment and taught different topics to measure a sense of presence, enjoyment, navigation, and malaise among the students from elementary through high school. The result showed students from all levels enjoyed this experience and were convinced to use VR in the learning process. Hussein and Nätterdal (2015) performed a comparison study on the use of VR and simple technology in education. They incurred that participants were excited to use VR and said they learned things while enjoying the process. Thus, if entertainment is mixed with a VR environment, then learners will maintain interested and experience more enjoyment while learning (SZABÓ, 2011). To prove the evidence of the benefits of VR in language learning, the following hypothesis will be explored:

H4. During L2 learning, participants who are assigned to immersive VR-based learning will report higher enjoyment compared to participants who are assigned to desktop VR-based learning.

Motivation as Active Learning

The motivation of students is an area of active research by educators (Deci, Koestner, & Ryan, 2001; Pinder, 2014). According to many motivation theorists, intrinsic and extrinsic motivation are two types that exist (C. P. Cerasoli, J. M. Nicklin, & M. T. Ford, 2014; Deci et al., 2001; Teo, Lim, & Lai, 1999). Intrinsic motivation refers to behavior that can be motivated for intrinsic reasons, such as task enjoyment, and extrinsic motivation is something motivated from an external cause, such as incentives, reinforcement or rewards (Christopher P Cerasoli, Jessica M Nicklin, & Michael T Ford, 2014; Pinder, 2014).

For educational purposes, many researchers argued that intrinsic motivation is more important for learning and adjustment in educational settings than extrinsic motivation (Ryan & La Guardia, 1999). To be highly learner-centered (Ang & Zaphiris, 2006), intrinsic motivation is more important than extrinsic motivation. First, intrinsic motivation can make students more actively engaged in learning (Benware & Deci, 1984). Second, when they find a task enjoyable or interesting, students will engage with the task for longer periods (Deci, 1972). With the importance of intrinsic motivation, subsequent references to motivation in this paper will be considering intrinsic motivation.

Furthermore, motivation has an important role in the success of language learning (Klein, 1986) because language learners need to maintain motivation through the repetition of the language until mastery (Brown, 1980). Without motivation, a student will typically only learn vocabulary, grammar, and pronunciation as much as they deem necessary. Thus, it is important to motivate language learners through the educational environment to support a more in-depth understanding and provide minor details of concepts, which will result in long-term memory retention (Atkinson & Shiffrin, 1968; Schwartz, Son, Kornell, & Finn, 2011).

Motivation is enhanced if learners can understand and store the information easily.

The interaction between user and environment can achieve this. In light of these facts, VRLL is designed in a manner that provides interaction between the learner and virtual environment resulting in an increase of the learners' motivation (Kreylos, Bethel, Ligocki, & Hamann, 2003). Due to the 360-degree immersive design of VR, it can help focusing on the learning objectives without any distractions. There are a few VR studies resulting of how students improve concentration when they use immersive VR (Hussein & Nätterdal, 2015). It is because VR provides the opportunity for learning and developing an idea in an environment similar to reality.

Also, the interaction features of VR help students to be more active learners, which also improves the motivation (Pantelidis, 2010). In a VR environment, users play an active role in dictating the occurrence of specific events. For example, Merchant (2012) analyzed the learning of chemistry concepts in a 3-D VR environment through spatial instruction where learners could break apart a molecule or bond atoms to form a molecule enabling them to examine its bond angles virtually. He found that the students with 3-D molecule seemed better understanding of chemistry concepts and became more active learner.

Evidence exists to indicate the advantages of VR include keeping students motivated, playing an active role in the learning process, and providing an experience with learning autonomy and high immersion (Bricken & Byrne, 1993; Loftin, Engleberg, & Benedetti, 1993; Regian, Shebilske, & Monk, 1992). So, VR may be considered an efficient language learning tool, and the following hypothesis will help elicit if this is the case:

H5. During L2 learning, participants assigned to immersive VR-based learning will report higher motivation compared to participants who are assigned to desktop VR-based learning.

Correlation Between Spatial Presence, Enjoyment, and Motivation

With support that there is a correlation between spatial presence, enjoyment, and motivation, only a few studies review the relationship of these three factors. Thus, to further scrutinize the idea, we divide this work into two directions to study based on the approaches from the literature: (1) spatial presence and enjoyment and (2) enjoyment and motivation.

First, there may be a correlation between spatial presence and enjoyment. Skalski and Tamborini (2007) also stated that spatial presence is a component of enjoyment. Shafer, Carbonara, and Popova (2011) also stressed that the feeling of spatial presence is an important factor in enjoyment. They researched to measure spatial presence and enjoyment by comparing the three gaming systems, Wii, Move, and Kinect, with 160 university students randomly assigned to one of the platforms to report their experience. The result revealed a positive impact of spatial presence on enjoyment as the more the respondents felt a sense of presence within the game, the more enjoyment was experienced. The research of Lombard, Reich, Grabe, Bracken, and Ditton (2000) found the different displays (small versus large screen sizes) affect presence and enjoyment. Thus, in this paper, the relation between spatial presence and enjoyment via different displays (desktop monitor versus VR HMD) is analyzed.

Second, spatial presence is associated with motivation. Research by Mikropoulos, Chalkidis, Katsikis, and Emvalotis (1998) on the motivation of students towards VR as a tool in the educational process as well as towards virtual learning environments in specific disciplines, examined students had a positive attitude towards VR in the educational process. In this sense, people prefer VR over other electronic mediums for education (Pantelidis, 2010). Emotions are also important when dealing with virtual teachers in distance and electronic learning contexts. The presence of a realistic character proved to have a positive impact on students' perception of the learning experience (Lester et al., 1997). The finding of

Virvou, Katsionis, and Manos (2005) using an educational VR game named VR-ENGAGE was found to be very motivating. While playing the game to complete a mission in a VR environment, participants were facilitated in such a way as to increase motivation. Indeed, media can make a difference in motivating students to learn.

Third, enjoyment has a strong relationship with motivation. Teo, Lim, and Lai (1999) expressed in their research how perceived enjoyment is a form of intrinsic motivation. They were curious in the purpose of how the Internet was used, so they investigated the reasons through the two lenses of intrinsic and extrinsic motivation. In this research, they suggested intrinsic motivation is tantamount to a perceived enjoyment, and extrinsic motivation refers to perceived usefulness. Other research showed that interest in an activity, inherent satisfaction with an activity, and enjoyment of an activity could increase intrinsic motivations (Ryan & Deci, 2000). They expressed that enjoyment is the primary motivating factor of satisfaction (Frederick & Ryan, 1995), which can be generated when people play a video game or recreational activity through entertainment media (Ryan, Rigby, & Przybylski, 2006) as they fall within the realm of activities that are intrinsically rewarding. Thus, based on the past literature review, enjoyment can be a trigger for increasing motivation.

Prior studies noted the importance of correlations between spatial presence, enjoyment, and motivation. As the goal of this paper is to investigate how different media affect L2 learning along with the advantages of using VR, the following hypothesis must be considered:

H6. Positive correlations exist between spatial presence, enjoyment, and motivation during L2 learning.

Research Model

Based on the conceptual model (Figure 1) and past literature reviews, the research is overviewed on how it will take a look at these relationships in L2 learning and investigate if VR is a good language learning tool. There are likely associations between media, memory, and motivation, such as (1) spatial presence may affect spatial memory, (2) spatial presence may affect motivation. Considering both the above literature studies, research model is proposed as seen figure 2.

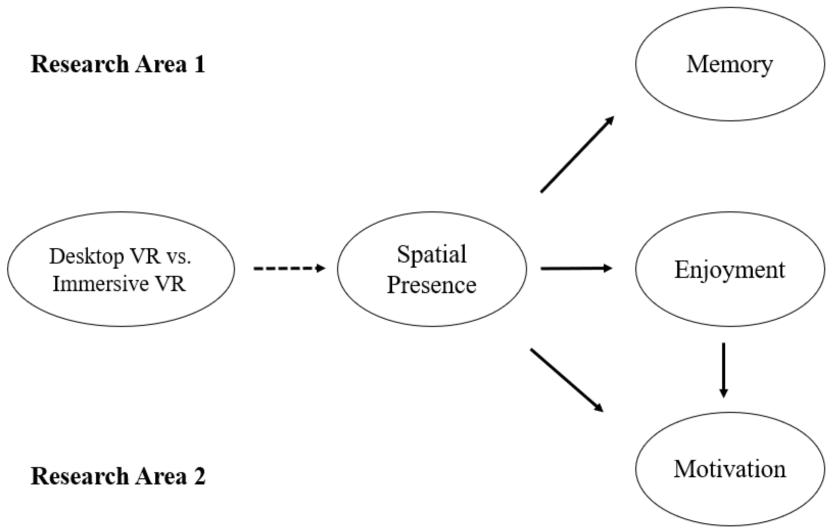


Figure 2. Proposed Research Model

First, presence is apparently an essential feature for L2 learning in VR and is related to spatial reasoning ability (Taylor, 1997). Here, Taylor found the correlation between the presence and spatial memory and a higher level of immersion has a significant effect on the spatial memory. The spatial presence may be a mediator connecting memory, enjoyment, and motivation. According to Hartmann et al. (2015), if spatial presence is understood as a cognitive feeling, then it can be entirely based on unconscious processes even though users consciously experience the sensation. In fact, people can perceive the spatial presence unconsciously and recall it from the subconscious. Thus, as investigated above in Research area 1, since VR has a high spatial presence, it may help increase spatial memory unconsciously and to remember the L2 better.

Second, to claim VR as a latent language learning tool, the media's learning effects must be proved. Many scholars researched the correlations between spatial presence, enjoyment, and motivation as in the relationships explained from Research area 2 of (1) spatial presence affects enjoyment and (2) enjoyment affects motivation.

The unparalleled experience of presence is the most significant motivation for using VR. Research by Mikropoulos, Chalkidis, Katsikis, and Emvalotis (1998) on the motivation of students towards VR as a tool in the educational process, and towards virtual learning environments on specific disciplines, incurred students had a positive attitude towards VR in the educational process. In that sense, people prefer VR over another electronic medium of education (Pantelidis, 2010).

As aforementioned the media effects, it is important to examine the correlation of the variables (i.e., media, spatial presence, spatial memory, enjoyment, and motivation) by comparing the medium (i.e., desktop and VR HMD). Thus, to prove whether VR is a good language learning tool or not, based on results of the two studies, the following research question should be answered:

RQ 1. Does the VR have a latent L2 acquisition feature?

III. METHODOLOGY

Description of Research Design

This study investigates how the use of either a desktop monitor or a VR HMD can affect the effectiveness of L2 learning. Thus, the experiment was developed with a "pretestposttest" single group design using a standard desktop monitor and a VR HMD along with the 20 Korean vocabularies and a computer language learning program. For the participants, the experiment was a randomized block design by gender and conditions (i.e., the desktop monitor was the group and VR HMD ground). The participants were randomly assigned into one of the groups and conducted two memory tests (i.e., pre-memory and post-memory tests) and one questionnaire to measure media effects, such as spatial presence, enjoyment, and motivation. The collected quantitative data were analyzed with the SPSS software.

Rationale for Selecting Korean Words

Miller and Hegelheimer (2006) used the simulation game, The Sims, to teach language learning including vocabulary, grammar, and cultural activities adopted by the model from Melby (2002). The participants in this study claimed the vocabulary actives were the most helpful, so for this experiment, we determined to focus on using Korean vocabulary to teach the Korean language. To select the Korean vocabularies, words were collected from Chapter 1 of *Sogang Korean for the Beginner* or advice was followed from Korean teachers, one of whom teaches a Korean class at Syracuse University and the other Korean literature in Korea. After discussing the research, these resources offered the following guidelines.

First, most foreigners tend to recognize Korean characters as pictures since they contain many lines and circles, which is very different compared to the English alphabet. When foreigners see Korean characters for the first time, they suggest no meaning to them unless they already know how to read the characters. Thus, it is evident that learning Korean characters without any essential pronunciation practice is difficult. With this mind, the Korean teachers advised it is better to include English phonetic pronunciations for each Korean word so at least the foreigners can develop a sense of how to read the Korean words and memorize the objects as images by matching them to the English phonetic alphabet.

Second, learning should be a repeated process. Even though the purpose of the research was to measure memory retention skills of L2 learners, a one-time stimulus is not sufficient to measure the educational effect. Karpicke and Roediger (2008) experimented with repeated study-test trials of foreign language vocabulary words and found that repeated testing produced a large positive effect. As a result, the learners should demonstrate progress while repeating the process of learning.

Third, if the research is intended to measure memory retention from a desktop or VR apparatus, then the syllables of the words should be consistent for all 20 classroom objects. For example, if a syllable is two words, then all objects in the classroom should be two-syllable words. Otherwise, the participants may memorize the word based on the number of syllables.

In summary, the advice from the Korean teachers included (1) incorporating an English phonetic alphabet, (2) use repeated learning, and (3) use two-syllable words.

Pilot Test

To compare whether the level of Korean words offered suitable memorizing and recalling time for a language beginner, a pilot test was conducted in the KOR 101 course with 15 students who had studied the Korean language for an average of 1.29 years. The experiment comprised of a basic memory test and a spatial memory test. The basic memory test was conducted to show the 20 classroom items the researcher selected based on a literature review and advice from two Korean teachers. After three minutes, the students were asked to write down the words they memorized. Due to limited class time, simulation video was used for the spatial memory test during which the player walks through a virtual classroom twice and touches 20 classroom objects to see the Korean cue cards: 칠판

(Blackboard), 분필 (Chalk), 꽃병 (vase), 연필 (Pencil), 시계 (Clock), 지도 (Map), 책상 (Desk), 의자 (Chair), 책장 (Shelf), 공책 (Notebook), 가방 (Bag), 창문 (Window), 그림 (Picture), 거울 (Mirror), 바닥 (Floor), 천장 (Ceiling), 전등 (Light), 볼펜 (Pen), 필통 (Pencil case), and 모자 (Hat).

From the first memory test, the Korean class students performed with an average of 10.25 answers correct out of 20 questions. In the spatial memory test, they had an average of 10 answers correct out of 20 questions. Thus, the pilot tests showed the level of Korean words is an average for the experiment. Moreover, 9 out of 15 students answered in the review survey that the three minutes was sufficient time to memorize the Korean words. Also, with the “easy” words of hat, chair, bag, and floor and the “difficult” words of ceiling, mirror, heater, and vase, the students were asked to rate the difficulty of the test on a scale from one to five. The respondents rated 2.57 on average, so based on the pilot test, a mix of difficult and easy Korean words was included in the research. The review survey is included in Appendix A.

Stimulus and apparatus

Based on the pilot test, the twenty classroom objects in Korean were finalized as hat (모자-Mo Ja), chair (의자-Ui Ja), bookshelf (책장-Chaek Jang), drawer (서랍-Seo Rab), map (지도-Ji Do), calendar (달력-Dal Yeok), lecture desk (교탁-Gyo Tak), blackboard (칠판 - Chil Pan), clock (시계-Si Gye), light (전등-Jeon Dung), heater (난로-Nan Leo), earth (지구-Ji Gu), desk (책상-Chaek Sang), Shoes (신발- Sin Bal), notebook (공책-Gong Chaek), follow Jar (꽃병-Kkot Byeong), 공책, bag (가방-Ga Bang), picture (그림-Gum Rim), pencil (연필-Yeon Pil), and window (창문-Chang Mun).

A virtual classroom with 20 classroom objects and Korean cue cards was developed in the Unity 3-D (version 5.5.1f1) software, and several virtual objects were designed using Maya 3-D. Unity 3-D is a game engine commonly used to make computer games or VR/augmented reality games. Among the game engine tools available today, Unity 3-D is well-established in the gaming industry. The researcher purchased the classroom background from the Unity store and modified it for this research. Objects not included in the purchased classroom kit were created using Autodesk Maya 2017. As shown in Figure 3, objects were designed and rendered in the mesh. After finalizing the object, it was embedded into the Unity file as an OBJ or FBX file. Also, the 20 classroom objects and Korean cue cards were designed in Photoshop, and red arrows were included in the environment to provide guidelines for participants to identify the walking direction. The researcher coded the scripts to toggle the visibility of the Korean cue cards in C# (Figure 3).

The only written language was included on the Korean cue cards since, in a simulation game, text is the representative communication (Ranalli, 2008). Wehner, Gump, and Downey (2011) compared text message bubble interactions in Second Life where one group utilized text chatting, and another did not. The results showed the group using the Second Life text bubble box expressed less anxiety compared to the non-Second Life content users.

The twenty Korean cue cards containing the objects were distributed in the virtual classroom. The card appears on top of the object with the Korean phonetic spelling if the participant in the virtual world approaches a target object. The cue card disappears when the participant steps away from the object.

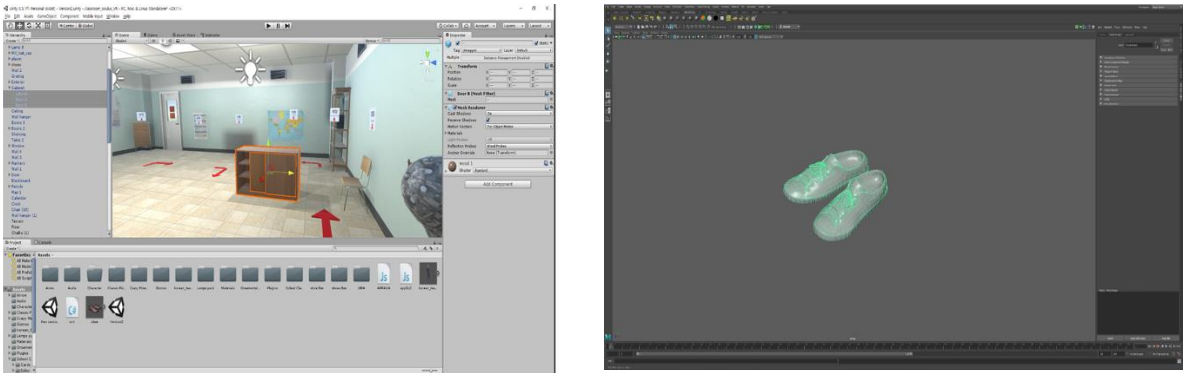


Figure 3. Software Tools Used to Develop the Experimental Environment (Left: Unity 3-D with C#, Right: Maya 3-D Design Tool)

Participants experienced the virtual environment using either a (1) VR HMD or a (2) desktop PC screen. In the VR scenario, the participants played with the HMD in an Oculus Rift device using an Xbox controller. In the desktop scenario, the participants watched the content through a 17-inch PC monitor and interacted through a keyboard and mouse (Figure 4).

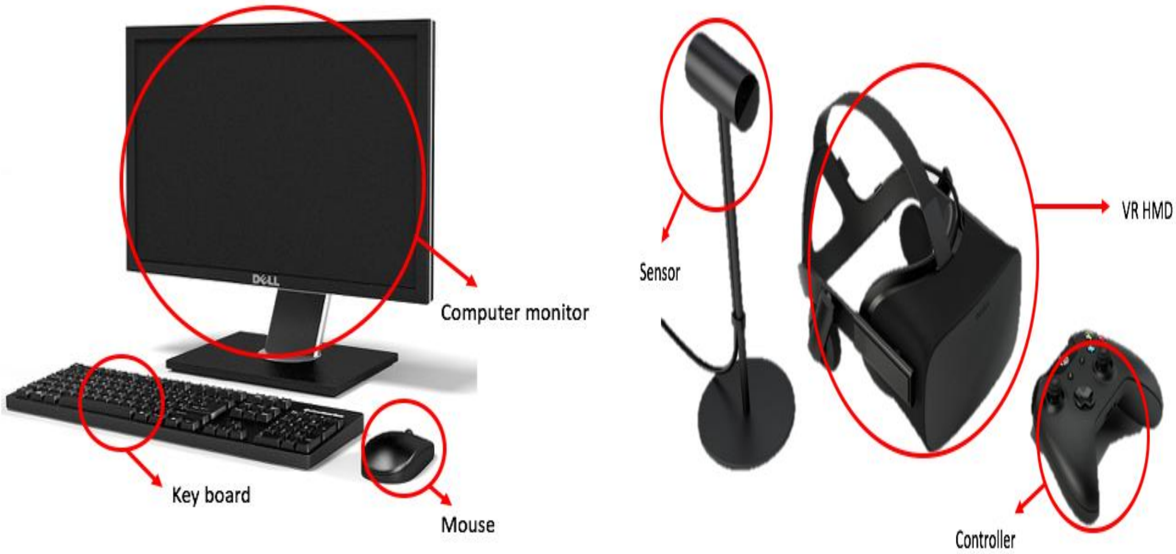


Figure 4. Media Used to Present the Virtual Environment (Left: Desktop Computer Equipment, Right: VR Apparatus)

Participants

A total of 64 (Desktop =32, VR=32) participants were recruited for the study, and those with impairments in visual or aural perceptions were excluded. The genders of the participants were balanced across the scenarios to prevent gender effects. In the experiment, a two-group comparison was used to examine memory retention and the effects of L2 learning. When the participants were recruited, the experiment was introduced as a usability test for the educational content to prevent the participants from preparing beforehand to memorize Korean terms. This process prevented them from intentionally memorizing the objects while interacting with the Korean word cards in the virtual environment. Finally, participants were randomly assigned to one of the two setups in the experiment. The participants were compensated five dollars for their involvement.

Most of the participants were students at Syracuse University with one being a doctor and another an English teacher. The participants were aged between 18 and 65 years with an average age of 27.28 (*SD*=8.02). The key requirement for the recruitment of the participants was that they should not know any Korean language because the research aims to examine how people can learn new languages effectively by using technology. Thus, the participants started from an equal initial condition of no prior experience of learning Korean. It did not matter whether they had experience learning another L2. Among the participants, there were more multilingual (*N*=47) compared to unilingual (*N*=17) who spoke primarily English. Moreover, because the participants were randomly selected, their races differed. Most participants were Asian (59.4%) with the remaining White (25%), Black (14.1%), and Native American (1.6%). Among the Asian participants, most were Chinese or Indian (Table 2).

Table 2.

Descriptive Analysis of Participants

	(N)	Computer	VR	Total
Gender	Male	16	16	32
	Female	16	16	32
Language	Unilingual	10	7	17
ability	Multilingual	22	25	47
Races	White	6	10	16
	Black	7	2	9
	Asian	18	20	38

Procedures

The experiment included a (1) pre-memory test, the (2) experimental treatment, a (3) post-memory test, and a (4) questionnaire. First, all participants completed a paper-based pre-memory test during which they memorize the 20 items and match the images and Korean words. Second, the participants are randomly assigned to either the desktop monitor or VR HMD experimental setup. Third, after experiencing the language learning content, they complete a spatial memory test. Finally, all participants complete a questionnaire to measure perceived interactivity, spatial presence, enjoyment, and motivation (Figure 5).

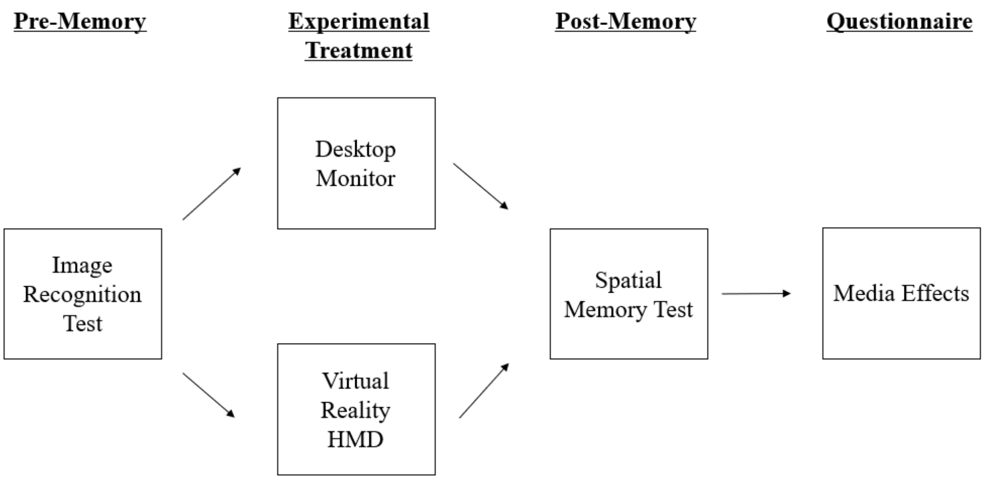


Figure 5. The Experimental Procedure

Pre-memory Test

The pre-memory test provided an initial stage to check how many Korean words the participants knew. They were provided information on 20 items they could find in a classroom (see Appendix B), and the participants were asked to memorize the items for three minutes, which is a period identified based on the pilot test. The memorization was evaluated for image recognition through matching the images and words by drawing lines (see Appendix C), which was adopted from the Griffin and Robinson (2000) experiment comparing images listed in a row and images in a location map.

Experimental Treatment

After the pre-memory test, the participants were randomly assigned to a desktop monitor or VR HMD. They worked in a tutorial module to practice how to use the controller before beginning the experiment because the presence of "novelty effect" may affect learning outcome (Clark, 1983). Thus, the purposes of the tutorial were to prevent the "novelty effect" and make participants comfortable. The tutorial module presented experience with an interactive box. If the participants in the virtual world moved near to the box, then the word test appears, as in the Figure 6. They were allotted as much time as needed to become comfortable with the devices and virtual environment.

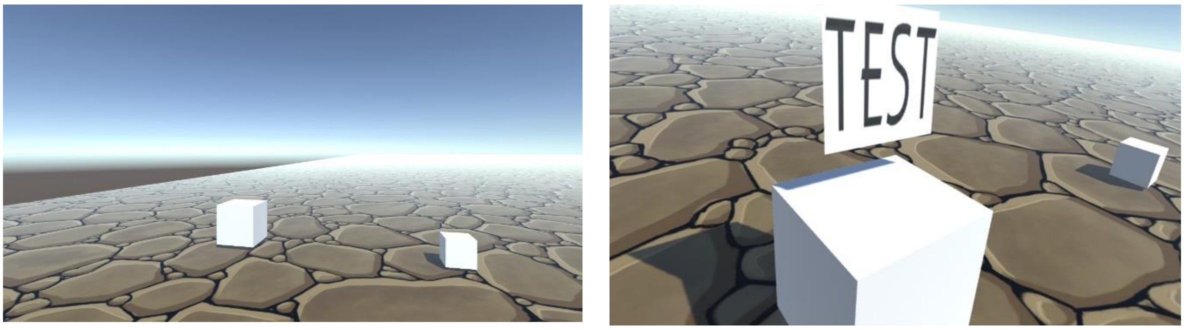


Figure 6. The Tutorial Module

After practicing with the tutorial, if the participant was randomly selected for the desktop condition, then they used the mouse and keyboard to watch and interact with the virtual module through a computer monitor. The participants assigned to the VR condition wore the HMD goggle to watch and interact with the module and used a controller to move around in the environment. Because VR can cause motion sickness (F. Biocca, 1992), all participants (including participants interacting with the desktop) were asked to stand while playing the module (Figure 7).

Figure 7. Experimental Setup with Participants Interacting with the Virtual Environment (Left: Desktop Condition, Right: VR Condition)

For the learning module, participants had no time limit to interact with each environment, and the same mission was presented to every participant to reduce preference bias. The participants were required to interact with twenty objects located in the virtual classroom, and a red arrow located on the floor provided movement guidance. The participants touched the items individually while following the arrow line. They moved around the environment twice before returning to the starting point. The experiment was task-based rather than timed to ensure everyone had enough time to experience all items. While moving around the virtual classroom, if the participant approached an object, Korean cue cards popped up above the object. For example, if the object was a hat, then the Korean cue card appeared that read “Mo Ja (모자).” If they moved beyond the boundary of an invisible virtual collider, then the Korean cue card disappeared (Figure 8).

Figure 8. Appearance of Stimuli

Post-memory Test

After the experiment, the participants were given five minutes to perform a spatial memory test to identify how many items they could memorize based on location. The testing tool was a classroom map sheet on which the participants were provided with the same classroom map previously experienced during the experiment. Also, numbers were included on each item, and the participants were asked to write the corresponding number for where the item was located in the virtual classroom (see Appendix D).

Questionnaire

After completing the experiment and tests, the participant completed a survey based on their feelings or perceptions while experiencing the virtual environment. This survey was paper-based to prevent technology preference and consisted of five parts, including demographics. It was used to measurement spatial presence, perceived interactivity, enjoyment, and motivation (see Appendix E). The participant had enough time to complete the survey.

Measurements

Manipulation check

Many researchers argue that interactivity is associated with the immersion (i.e., the concept of vividness or media richness) (Fortin & Dholakia, 2005; Hoffman & Novak, 1996) and that immersion and interactivity can lead to a sense of presence in an environment (Steuer, 1992).

For a manipulation check, we designed the questionnaire to measure an immersion level for how participants perceived in the medium. Interactivity is defined as “the user responsiveness to the system and vividness.” This has long been associated with the concept of vividness, or media richness (Fortin & Dholakia, 2005; Hoffman & Novak, 1996), which is defined as the intensity at which a mediated environment presents information to the senses (Steuer, 1992). As a result, immersive environments create a strong sense of presence (Huang, Rauch, & Liaw, 2010). Thus, we selected the perceived interactivity as a manipulation check to determine the level at which participants perceived the different media.

Perceived interactivity (α = .80, M = 5.11, SD = .89) was measured by ten questions adapted from Wu (2005) and supplemented from Skalski and Tamborini (2007) and Huang, Rauch, and Liaw (2010), including “I felt like pop-up cards were interacting with me,” “I felt like a teacher had taught me,” “I felt like teacher avatar used voice to communicate with me.” The responses were determined through the 7-point Likert scale (1=Strongly disagree; 7= Strongly agree).

Measured dependent variables

Image Recognition was measured from an image recognition test (M = 5.90, SD = 2.87) used to match the images and Korean words (Appendix C), and the participants drew lines to match 20 classroom items.

Spatial Memory was measured from a spatial memory test (M = 12.09, SD = 5.76) that consisted of a map of the classroom and a list of 20 numbered objects’ image (Appendix D), and the participants were required to match the correct location to the number (each object had a uniquely assigned number) based only on memory recall.

Memory was calculated from the post-test (i.e., the spatial memory test) less the pre-test (i.e., the image recognition test) values from which we determine the memory retention.

Spatial presence (α=.75, M = 5.17, SD = .92) was measured using seven questions related to spatial cognition allowing for physical aspects to be considered (F. Biocca, 1997). For example, questions were introduced as “The classroom seems to be more like,” “The module that I participated seems to be spatially immersive,” “I can feel the space,” and required participants to respond on a 7-point Likert scale (1=Strongly disagree; 7= Strongly agree).

Enjoyment (α=.91, M= 5.58, SD =.93) consisted of six adjectives representing enjoyment: “entertaining,” “interesting,” “enjoyable,” “fun,” “exciting,” and “satisfying.”

These options were based on the enjoyment subscale (Tamborini, Bowman, Eden, Grizzard, & Organ, 2010) and modified for a language learning context. Participants were asked to indicate how much they enjoyed the module based on their experience by rating their statements on a 7-point Likert scale (1=Not at all; 7= Extremely).

Motivation (α=.85, *M*= 4.83, *SD* = 1.16) consisted of intrinsic and extrinsic motivation and was measured through six questions. To look at which motivations influence learning, it is critical to see both types of motivation (Teo, Lim, & Lai, 1999). Intrinsic-related statements consisted of "After interacting with the program, I want to learn Korean more," "After interacting with the program, I am confident in learning Korean vocabulary," and "I prefer to learn Korean with the program than attending school," while the extrinsic motivation statements included "Using the module increased my language learning skills," "I think the module enhanced my efficiency of learning a language (e.g., vocabulary)," and "I found the module useful for my future language learning." Participants responded using a 7-point Likert scale (1=Strongly disagree; 7= Strongly agree).

Data Collection

As mentioned previously, the test and survey were conducted by the paper to eliminate technology preference. For the protection of the human subjects, no private data other than demographic information was included in the survey. Also, during the experiment, if a participant expressed dizziness or motion sickness, then they were offered break or allowed to stop the experiment. If they chose not to return to the experiment, then their data was excluded.

Data Analysis Procedures

For analysis of the quantitative data, SPSS (version 21) and AMOS (version 21) were used. A total of 64 people participated in the experiment, and among these participants, six responded with a minimum of 4 for the question, "How much do you know Korean?" These participants were excluded from the data analysis leaving only 58 participants for data analysis, N = 30 of which were deployed to the desktop condition and N = 28 to the VR condition. Since names have been removed and deleted, the data comprised of numeric codes, which were randomly selected to generate the order.

For the analysis, media effects were analyzed first by using ANOVA, and ANCOVA was used to analyze the difference between the pre-test and post-test memory scores. Finally, the relationships of all dependent variables were analyzed through Structural Equation Modeling (SEM) using AMOS 21.

Ethical Considerations

With CITI training, this paper was approved by the Syracuse University Institutional Review Board (IRB) for the Protection of Human Subjects (# 17-130, approved on May 4, 2017). Since the research is using a VR apparatus, it is expected to pose minimal risk. However, through the process, the researcher worked to reduce risks further as much as possible.

First, potential participants under 18 years old, who have visual perception impairments, who have been experienced dizziness during the playing VR, and who have participated in a similar experiment were excluded from the study. Through the informed consent form, the participants were reviewed and validated.

Second, participants' confidentiality was maintained at all times. During the experiment, at least 15 minutes of buffer time existing between the appointments so participants would not meet each other. For the data, the privacy was maintained with confidential records as numbers replaced names.

Third, wearing the VR gear may be uncomfortable for some participants, which can cause initial disorientation, giddiness, and some uneasiness. Thus, all participants were provided with enough time to play the tutorial module until they become comfortable with the device. During the experiment, the participants were repeatedly asked about their comfort, and if any reported distress or discomforts, such as dizziness or motion sickness, the experiment would be stopped for the participants' safety and the data would be withdrawn.

Fourth, the study was identified to the participants as a usability test for educational content to prevent bias through practicing or memorizing the Korean vocabularies used in the experiment. During a debriefing section following each session, the participants might be confused or feel uncomfortable about the misdirection. So, researcher apologized and explained the need for the deception with a debriefing form. If the participants did not want to use their data, it would be eliminated from the results.

IV. RESULTS

Manipulation Check

After excluding the participants who responded they knew the Korean language well, the remaining sample size was 58 (Desktop = 30, VR= 28). As aforementioned about the relationship between immersion and interaction, in this research, Perceived Interactivity (PI) was selected as manipulation check. Thus, to see the differences between two medium, a one-way ANOVA was used in PI level. The result showed a significant difference in the perceived interactivity level between each medium ($F (1,56) = 7.11$, $p <.01$, $\eta_p^2 = .11$). The mean value of the desktop-based module was 4.83 ($SD = .73$), and the mean value of VR HMD-based module was 5.42 ($SD = .96$).

Statement of Hypothesis and Research Question

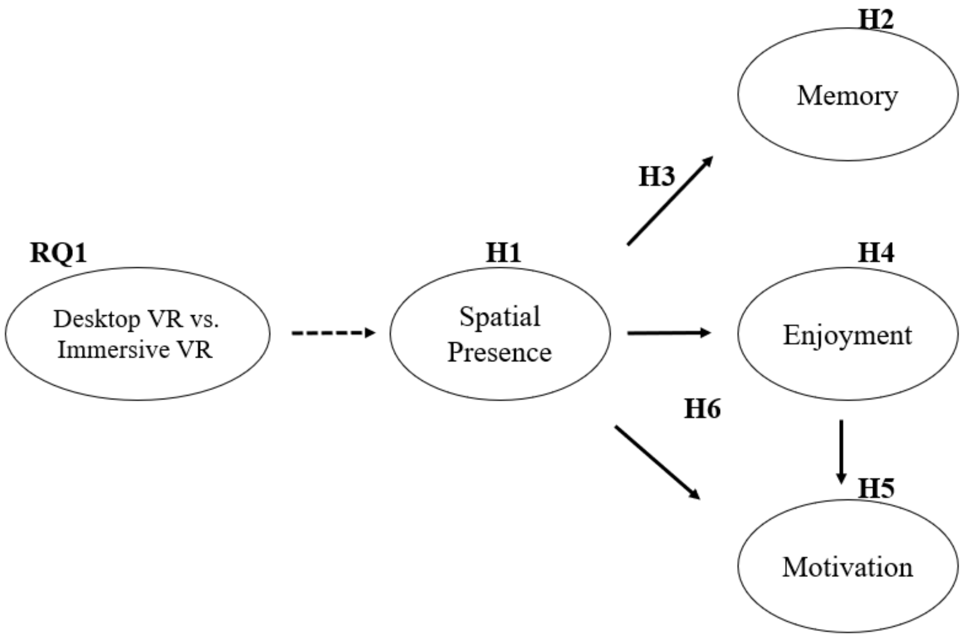


Figure 9. Hypothesized Relations Between the Constructs

H1. During L2 learning, participants who are assigned to a VR HMD interface will report a higher sense of spatial presence compared to participants who are assigned to desktop monitor.

H2. During L2 learning, participants assigned to immersive VR-based learning will experience increased memory retention *compared to participants who are assigned desktop VR-based learning.*

H 3. A positive correlation exists between spatial presence and spatial memory.

H4. During L2 learning, participants who are assigned to immersive VR-based learning will report higher enjoyment compared to participants who are assigned to desktop VR-based learning.

H5. During L2 learning, participants assigned to immersive VR-based learning will report higher motivation compared to participants who are assigned to desktop VR-based *learning.*

H6. Positive correlations exist between spatial presence, enjoyment, and motivation during L2 learning.

RQ 1. Does the VR have a latent L2 acquisition feature?

Results of Hypotheses

H1 tested the effects of the media on spatial presence through a one-way ANOVA to compare the desktop VR and immersive VR. H1 predicted that the participants assigned to the immersive VR-based learning condition would have a higher sense of spatial presence than the participants assigned to the desktop VR-based learning condition. The results showed that there are significant differences in the spatial presence F (1, 56) = 5.65 ($p < .05$, $\eta_p^2 = .09$) between the participants who used the desktop monitor and those who used the VR HMD (see Table 5). Therefore, H1 is supported.

H2 measured how memory is changed from pre-test to post-test scores on the media through an analysis of covariance (ANCOVA) with the pre-test scores as covariates. Effect sizes were computed by using Cohen's *d* by dividing the post-test mean differences between the two groups by the pooled standard deviation in the between-subject design. Effect sizes of 0.20 reflected a small or minimal effect, 0.50 as a medium or moderate effect, and 0.80 or higher as a large or meaningful effect (Olejnik & Algina, 2000). In this memory test, the effect size of medium is small (0.10). This value is explained dependent variable by independent variable (10%).

First, the means of the pre-test and post-test scores for the desktop VR and immersive VR are presented in Table 3 and show there is an increase in both conditions (Figure 10). The dependent variable, memory, was calculated as the mean values from the formula of pre-test minus post-test scores. The assumption of homogeneity of regression slopes was checked before ANCOVA by confirming the non-significance of the main effect of pre-test on post-test, F (1, 54) = 2.84, p = .10. To assess the equality of the group variance, Levene's test and normality checks were performed. The results of Levene's test indicated the group variances are equal, F (1,56) = .04, P = .84. Hence, the assumption of homogeneity of variance is met.

Table 4 outlines the results of ANCOVA. When the covariate pre-test was controlled, the effect of media on the post-test was significant, F (1, 56) = 4.57, p < .05. Therefore, H2 is supported.

Table 3.

Memory Test Scores.

	Desktop VR		Immersive VR		
DVs	M	SD	M	SD	P
Pre-test	5.67	3.48	6.14	2.10	.53
Post-test	10.50	6.04	13.78	5.02	.03
Memory	4.83	5.09	7.64	5.42	.05

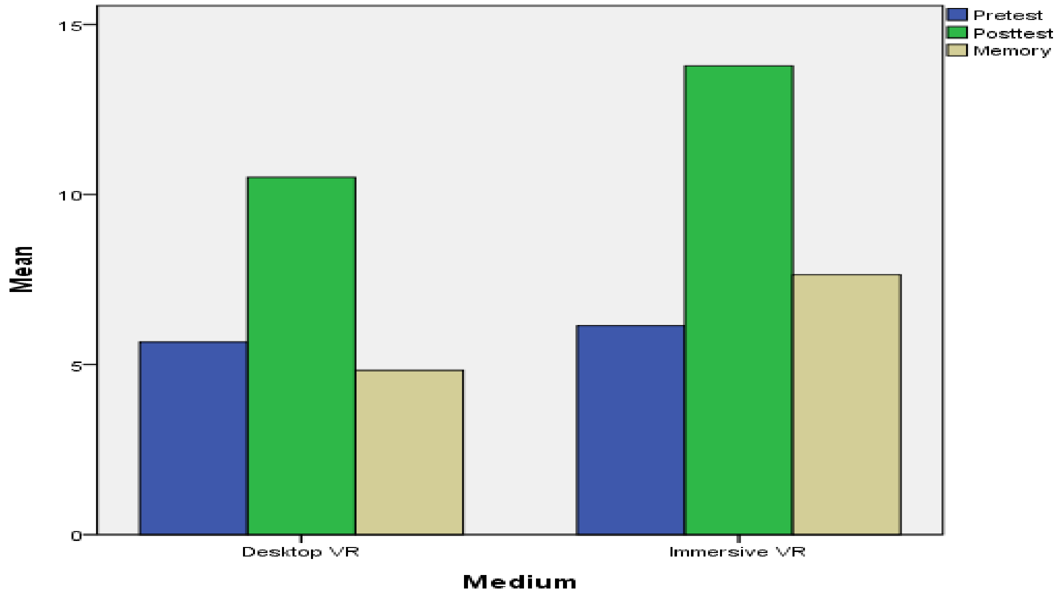


Figure 10. A comparison of the means of memory for the two independent variables

Table 4.

ANCOVA Results of the Post-test with Controlled the Pre-test

Source	*SS*	*df*	*F*	η^2	*p*
Pretest	235.27	1	8.60**	.14	.01
Media condition	125.00	1	4.57*	.08	.04
Error	1504.94	55			
Total	10369.00	58			
Corrected total	1896.57	57			

Note2. $*p < 0.05$, $**p < 0.01$, $*** p < 0.001$, $R^2 = 0.18$

H3 was a test between the spatial presence and memory by calculating a simple linear regression to predict the memory based on spatial presence. Spatial presence significantly predicted memory, $B = .26$, $t\ (2, 56) = -.43$, $p = .67$ as well as explained a significant proportion of the variance in memory, R^2= .07, F (1, 56) = 4.07, p < .05. Thus, H3 is supported.

H4 was a test of the effects of the media on enjoyment through a one-way ANOVA to compare the enjoyment of the desktop VR and immersive VR. H4 predicted that the participants assigned to the immersive VR-based learning condition would perceive a higher enjoyment than the participants assigned to the desktop VR-based learning condition. The results showed significant differences in enjoyment F (1, 56) = 6.85 (p <*.05,* η_p^2 = .11) between the participants who used the desktop monitor and those who used the VR HMD (Table 5). Therefore, H4 is supported.

H5 was a test of the effects of media on motivation through a one-way ANOVA to compare the motivation expressed from the desktop VR and immersive VR. H5 predicted that the participants assigned to the immersive VR-based learning condition would feel a higher motivation than the participants assigned to the desktop VR-based learning condition. The results showed significant differences in motivation F (1, 56) = 4.48 (p <*.05,* η_p^2 = .07) between the participants who used the desktop monitor and those who used the VR HMD (Table 5). Therefore, H5 is supported.

Table 5.

ANOVA of Dependent Variables: Test of H1, H4, H5

	Desktop VR		Immersive VR				
DVs	M	SD	M	SD	F (1, 56)	η_p^2	*P*
Spatial Presence	4.90	1.00	5.45	.73	5.65*	.09	.02
Enjoyment	5.29	.92	5.90	.85	6.85*	.11	.01

Motivation	4.54	1.18	5.14	.96	4.48*	.07	.04

Note2. *$p < 0.05$, **$p < 0.01$, *** $p < 0.001$ two-tailed.

H6 predicted that spatial presence, enjoyment, and motivation are positively correlated depending on the media. Among these correlations, the relations of spatial presence and enjoyment (Skalski & Tamborini, 2007) and enjoyment and motivation (Ryan & Deci, 2000) must be explained in detail, which is presented in the graphs showing the relationships in Figure 11. The means, standard deviations, and correlations were calculated for the spatial presence, enjoyment, and motivation (Table 6), and Pearson correlation was used for this analysis of H6. As Evans (1939) suggested for the absolute value of *r*, there was a strong positive relationship between spatial presence and enjoyment, $r\ (56) = 0.51$, $p < 0.01$. In addition, the Pearson correlation identified the correlation between enjoyment and motivation and showed a strong positive correlation, $r\ (56) = 0.58$, $p < 0.01$. Last, Pearson's *r* data analysis revealed a strong positive correlation between spatial presence and motivation, $r\ (56) = 0.57$, $p < 0.01$. Therefore, strong correlations between spatial presence, enjoyment and motivation are corroborated.

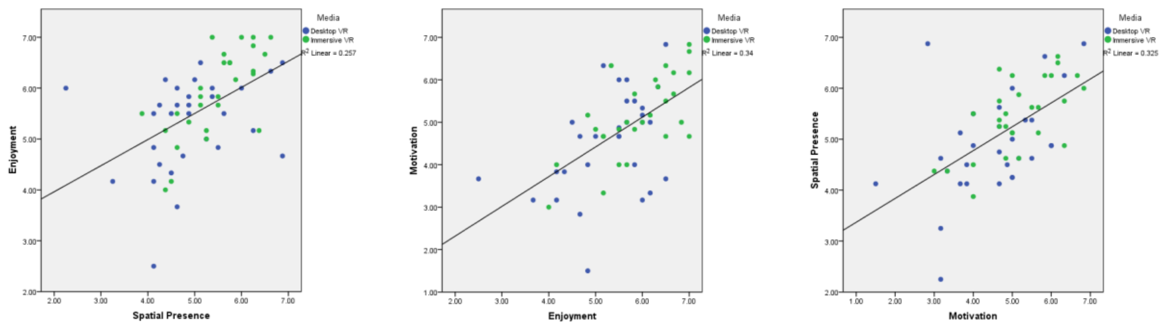


Figure 11. Correlations Between Each Variable

Table 6.

Correlations Among Recognition Test and Measured Variables: Test of H6

	M	SD	1	2	3
1. Spatial Presence	5.17	.92	1		
2. Enjoyment	5.59	.93	.51**	1	
3. Motivation	4.83	1.12	.57**	.58**	1

Note1. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$, two-tailed.

Result of the Research Question

To corroborate RQ1, a structural equation model (SEM) was conducted using the AMOS 21 software. Before starting the path analysis, each path needs to verify validity by regression, and the results revealed they are significantly different as seen in Table 7.

Table 7.

Unstandardized and Standardized Regression Coefficients by the Medium

Path	b	S.E.	B
Spatial presence → Memory	1.53	.76	.26*
Spatial presence → Enjoyment	.51	.12	.51***
Spatial presence → Motivation	.69	.13	.57***
Enjoyment → Motivation	.70	.13	.58***

Note2. *$p < 0.05$, **$p < 0.01$, *** $p < 0.001$

In the next step, a model-fit was assessed using the most common goodness-of-fit (GOF) indices (Hair, Black, Babin, Anderson, & Tatham, 1998). The most frequently reported indexes include CFI > 0.90 (Bentler, 1990), GFI > 0.90 (Joreskog and Sorbom, 1984), RMSEA < 0.08 (Browne and Cudeck, 1993), and Chi-square/df < 3.0 (Marsh and Hocevar, 1985). According to this level of acceptance, the model fit statistics applied to this research indicated an acceptable fit of the model (Normed χ^2 = 1.219, CFI= .982, GFI= .961, RMSEA = 0.63, Chisq/df =1.219, TLI= .946) (Table 8). Although the model fit is not fully satisfied (e.g., AGFI > 0.90), it remains an acceptable fit of the model.

Table 8.

Goodness-of-fit indices for this research

Name of category	Name of index	Measured model fit	Threshold
1. Absolute fit	Chi-Square	.300	P-value > 0.05
	RMSEA	.063	**RMSEA < 0.08**
	GFI	.961	**GFI > 0.90**
2. Incremental fit	AGFI	.805	AGFI > 0.90
	CFI	.982	**CFI > 0.90**
	TLI	.946	TLL > 0.90
	NFI	.919	NFI > 0.90
3. Parsimonious fit	Chisq/df	1.219	**Chi-square/df < 3.0**

***The indexes in bold are recommended since they are frequently reported in the literature

The two groups, desktop VR (N=30) and immersive VR (N=28), were next analyzed in the multigroup SEM. At the structural level, the test yields the standardized path coefficients, which indicate the positive and negative relationships between the constructs as well as their statistical significance. 5000 bootstrap samples at 95% bias-corrected confidence intervals were used to analyze the path model. As seen in Table 9, the test of the path coefficients for the two samples was compared to identify possible interaction effects between the medium and the constructs.

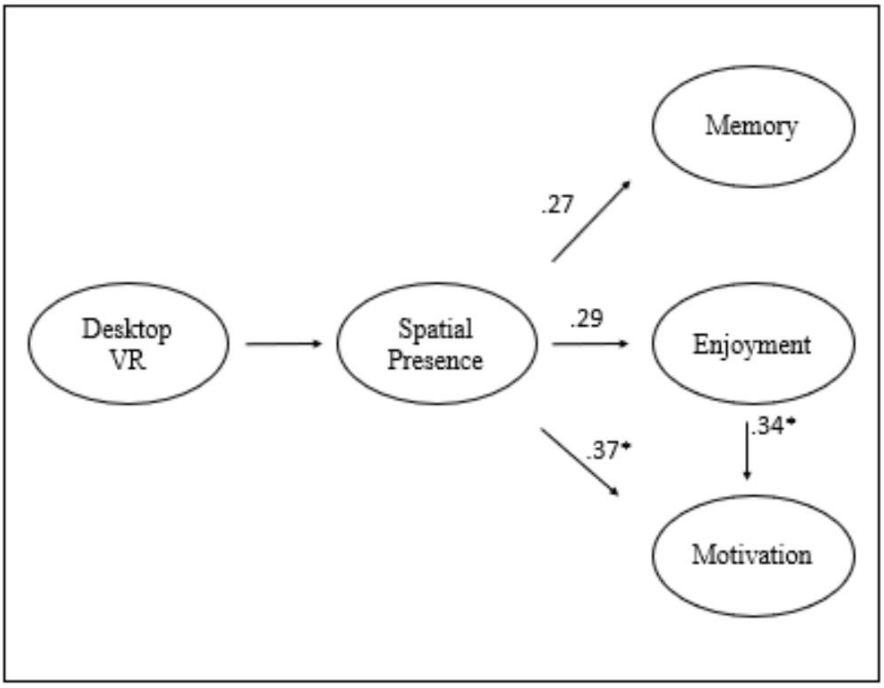
Table 9.

Standardized coefficient and z-score in both environment interfaces

Path	Desktop VR		Immersive VR		z-score
	Standardized coefficient	C.R.	Standardized coefficient	C.R.	
Spatial presence → Memory	1.376	2.34	.755	.532	-0.368
Spatial presence → Motivation	**.440***	2.34	.420	1.66	-0.061
Spatial presence → Enjoyment	.268	1.65	**.829*****	5.34	**2.491***
Enjoyment → Motivation	**.438***	2.14	**.515***	2.35	0.256

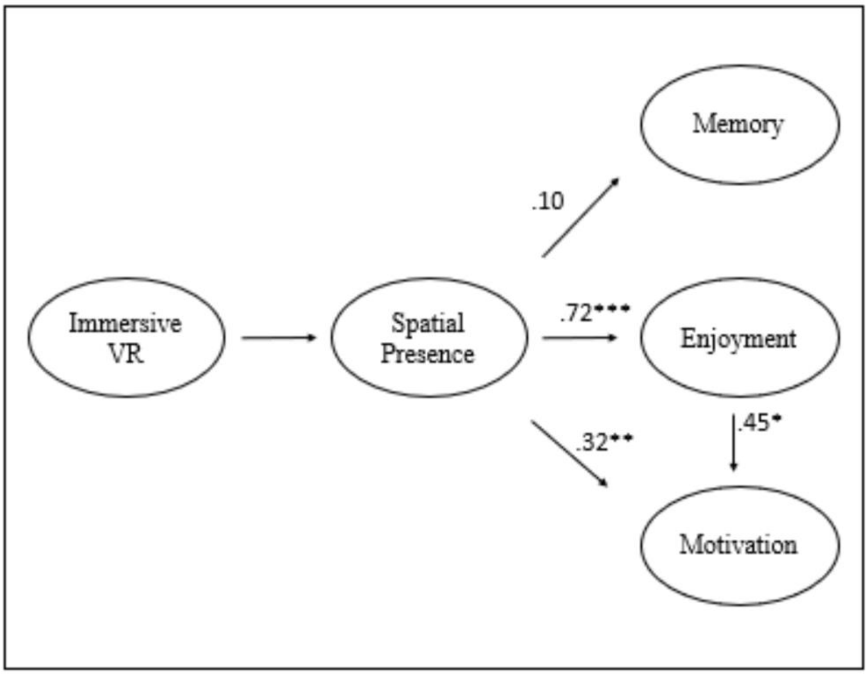
Note2. *$p < 0.05$, **$p < 0.01$, *** $p < 0.001$

There are several paths for which the critical ratio of differences showed significant variation. In the desktop VR, two significantly different paths existed in Spatial presence →Motivation (C. R.= 2.34) and Enjoyment → Motivation (C. R.= 2.14). In terms of the immersive VR, two paths also proved to be significantly different in Spatial presence → Enjoyment (C.R.= 5.34) and Enjoyment → Motivation (C.R.= 2.35). Figures 12 and 13 contain the schematic representation of the final model with the standardized estimates for each sample studied.



Note. *$p < 0.05$, **$p < 0.01$, *** $p < 0.001$

Figure 12. The final model for the desktop VR with standardized estimates.



Note. *$p < 0.05$, **$p < 0.01$, *** $p < 0.001$

Figure 13. The final model for the immersive VR with standardized estimates.

As the next step, Figure 12 and 13 presents the comparison of the multigroup analysis in the structural model to find if there are significant differences between the structural models for the two investigated samples. The z-score was calculated for each path using the regression weights in two samples and the critical ratios matrix. If both samples are together, then the only path of spatial presence → enjoyment is significantly different (Table 9). Therefore, RQ 1 is partially supported.

Other Results

As previously reported for the participants' demographics, the experiment included a gender distribution (Male = 30, Female = 28) and different levels of language ability (unilingual = 30, multilingual= 28) in the participant group. Regarding how the memory retention changed between the two independent variables (desktop VR and immersive VR), the data of these groups were also analyzed. First, there is no significant difference between gender, F (1, 56) = .11, p = .75. However, comparing the mean values between the two conditions in gender groups, females showed a slightly higher memory score than males in both conditions (Table 10). Furthermore, language ability indicates how many languages a participant knows. In this research, participants who know less than two languages are referred as unilingual. In language skills, there are also no significant differences between the two levels, F (1,56) = .24, P = .63. As seen in Table 10, unilingual presents slightly higher memory scores compared to that of multilingual.

Table 10.

Mean values of memory scores in the different demographic groups of the participants.

	N	Mean	SD

Desktop VR	Male	15	4.60	3.80
	Female	15	5.07	6.25
Immersive VR	Male	15	7.33	5.86
	Female	13	8.00	5.08
Desktop VR	Unilingual	23	5.08	5.07
	Multilingual	7	4.00	5.45
Immersive VR	Unilingual	21	7.81	5.53
	Multilingual	7	7.14	5.49

V. DISCUSSION

This study investigated how VR affects memory retention as well as spatial presence, enjoyment, and motivation in language learning. The first assumption was that VR offers high spatial presence, which may affect memory retention based on the 'Method of Loci,' a form of mnemonic strategy. This strategy unconsciously recalls objects by using location-based awareness. We hypothesized that if it is possible to operate within a VR environment, then it can support a more efficient learning language process because learning languages required a great deal of memorization. Therefore, to take advantage of the potential benefits offered by VR in language learning, this research compared the two mediums of the desktop VR (i.e., a desktop monitor) and immersive VR (i.e., VR HMD), which offer different immersion levels and spatial presence. Therefore, at the center of spatial presence theory, the two major implications for the finding of the current study are explained in the following.

Primary Findings

VR increases memory

The literature of Research area 1 investigated correlations between media and memory. Results of H1 indicated that immersive VR offers higher spatial presence than desktop VR. Considering the spatial presence theory, this was an expected result as a large amount of research has supported that spatial presence is high if the immersion level is high (Bricken, 1991; Dede, Salzman, & Loftin, 1996; E. A. Johnson, 2010; Katz & Halpern, 2015). Out of the several factors that increased immersion levels, the delivery device was found to be most significant. VR HMD provides a 360-degree environment, which generates high immersion levels.

Kim, Rosenthal, Zielinski, and Brady (2012) facilitated a fully immersive environment with the following factors. First, the simulation must be interactive. The participants interact with Korean cue cards with corresponding 3-D objects, such as a hat, pencil, desk or shoes. Second, the simulation must have familiarity (Mania & Chalmers, 2001). The background stimulus environment is the classroom, which is familiar context for most participants. Third, the first-person perspective must be used to increase immersion levels.

H3 assumed that an increase of spatial presence affects memory retention. The result of a linear regression test between the spatial presence and memory in the medium of the desktop VR and immersive VR conditions together verified a positive correlation and significant difference. However, when the path analysis was conducted for the immersive VR condition, there were no differences. It is argued that spatial presence affects memory retention, but in unpredictable ways in the use of VR (Groom, Bailenson, & Nass, 2009). Unsurprisingly, the study by Mania and Chalmers (2001) revealed a significant negative association between physical presence and memory, concluding that memorization is associated with individual differences, including the participants' ability to remember certain types of information, limited cognitive capacity, and mediated arousal. Thus, presence is not always associated with memory retention. The following section will explain how spatial presence with arousal affects memory retention.

The question remains if VR affects memory retention. H2 examined the memory test in desktop VR and immersive VR. The results indicate that memory score in immersive VR is 7.64 greater than desktop VR from pre-test to post-test. These findings suggest that VR has potential for enhancing memory retention though spatial presence does not directly affect memory retention in immersive VR.

The goal of this study is to identify how the mechanism of the 'Method of Loci' can be applied in VR and positively affect language learning outcomes. However, the remembering and memorizing process are different. The "remember" awareness state is linked with episodic memory (Tulving, 1985). "Remembering" is defined as a state in which "images" relating to a past event or space come to mind during the process of recall. Alternatively, "memorization" is intentionally attempting to remember a cognitive process. The 'Method of Loci' is a process of memorization rather than remembering. In this experiment, the differences between these two processes were not explained to participants. Thus, we suspect that participants may have recalled objects in such a way that resembles the remembering process. Thus, the remembering process was most likely used in this experiment.

Results found by Mania and Chalmers (2001) agreed with our findings. Comparing real environment, desktop, VR HMD, and audio-only conditions, VR HMD resulted in the highest recall in remembering. This research supports that HMD is effective for remembering objects. Thus, the VR HMD method may not apply to 'Method of Loci' due to the difference between the process of memorizing and remembering. In sum, VR HMD is an effective tool for increasing memory retention, but additional research is required to study the relationship between spatial presence and memory.

VR increases motivation

An advantage to using VR in education is that it increases motivation for learners (Bricken & Byrne, 1993; Kreylos, Bethel, Ligocki, & Hamann, 2003; Loftin, Engleberg, & Benedetti, 1993; Merchant, 2012; Regian, Shebilske, & Monk, 1992). H1, H4, and H5 were conducted to verify the media effects of spatial presence, enjoyment, and motivation by comparing desktop VR and immersive VR. These three factors in immersive VR were revealed to be higher than those in desktop VR. K. M. Lee (2004) asserted that the more spatial cues the medium offers, the more attentive and motivated users would be. As suggested by the strong positive correlation between spatial presence and motivation found in H6, spatial presence may affect motivation.

Enjoyment has been found to be essential for learning due to its strong association with motivation in the learning process (E. A.-L. Lee, Wong, & Fung, 2010). Enjoyment reduces stress or fear when practicing a language. Motivation is increased when people enjoy a task (Deci, 1972). Among the correlations between dependent variables, correlation between enjoyment and motivation was the highest ($r = .58$). Even in the multigroup SEM model, the path spatial presence to enjoyment and enjoyment to motivation were significantly different. This suggests that enjoyment is moderating the spatial presence to the motivation path. Enjoyment can help reduce stress or anxiety to study (Johnson & Wu, 2008), which is why many game-based learning systems use this strategy to enhance confidence and motivation without a negative response. Therefore, since immersive VR showed a significant difference in the path analysis of spatial presence to motivation, enjoyment factors should be considered for increasing motivation.

Furthermore, H6 and RQ1 showed a strong correlation between spatial presence and motivation. The spatial presence is high in immersive VR as verified in H1, and with this increased spatial presence, immersive VR facilitates motivation. For example, a participant commented that VR was fun because of the freedom they felt when controlling their virtual arm in the environment. With a high immersive environment, autonomy for learners can increase motivation (Ho & Crookall, 1995), which was similar to results found by Merchant (2012), who reported VR enhances learning of molecular 3-D structures or atomic bonds giving more agency to students as active learners, promoting self-study. Therefore, from the path analysis and result, immersive VR-based learning can increase learner motivation.

Overall Implication and Contribution

VR is a good language learning tool

Immersive VR is a useful language learning tool as it has a latent language acquisition based on the results. From H1 to H6, immersive VR demonstrated superior results compared to desktop VR, including higher memory scores, spatial presence, enjoyment, and motivation. The participants who used immersive VR showed a higher satisfaction as seen in the survey question, "Do you think this language learning program was effective for learning a language?" receiving 5.79 for immersive VR and 4.97 for desktop VR out of 7 on the Likert scale. Most of the participants expressed satisfaction with the immersive VR language learning tool.

However, immersive VR could not adequately explain what makes the 'Method of Loci' possible because spatial presence failed to show an impact on memory retention. Although the memory retention in immersive VR was higher than that in desktop VR, and media effects such as spatial presence, enjoyment, and motivation were also higher in immersive VR, the exact mechanism for increasing memory retention could not be concluded. Thus, additional research is needed for identifying factors affecting memory retention.

The current study contributes to the current literature on VR-based learning as there has been very little work in this area. Comparisons between two different interfaces and measured media effects have been rare in the literature. Additionally, this study deepens the current research literature on creating new language content. VR-based learning is currently in its nascent stages. Thus, there has been a need for further verification using novel VR methods for learning. In terms of language content, this paper offers a guide on how to leverage the advantages of VR HMD in language learning.

Limitations and Future Research

The current study aimed to measure the media and language learning effects as a communication lens. As a language learning purpose, however, it requires more work for implications from a language learning perspective. Learning words cannot be referred to as a full language learning activity as learning a language requires many processes, such as memorization, learning grammar, speaking practice, and situationally relevant drills. According to by Richards (2002) covering the theories of methodology in language teaching, he emphasized that language learning is a process to memorize, and learning occurs through dialogs and drills. As such, while memorizing words is a core feature, speaking and listening to language is also important. Thus, learning words alone is not enough to thoroughly verify language learning effects. For further research, there must be a broader variety of learning content to compare. For example, language represented in sentences or having a conversation can be potential targets for further research considerations.

Secondly, the memory test conducted in the experiment was measuring short-term memory exclusively. Retention or memory plays an essential role in the learning process as in Bloom’s Taxonomy of learning (Bloom, 1956), memorization/remembering is the first step toward learning. Memory has been found to be encoded into three structural components: sensory register, short-term store, and long-term store. We consistently receive information and process it through the sensory register. Through selective attention, our mind decides which information to store and which to discard. Information in the sensory register stays for a short period, decaying shortly thereafter. The short-term store is a form of working memory that receives selected input from the sensory register and long-term store. Information stored in short-term memory decays completely and is lost in approximately 30 seconds. Long-term memory is a permanent repository. The brain localizes the information in long-term or short-term memory (Atkinson & Shiffrin, 1968). There was a long-term memory section initially included in the research survey. However due to difficulties recalling participants back to the lab, the long-term memory test was conducted through an online survey. Half of the participants responded to the survey, rendering the data unusable for the study. For future work into verifying external validity, both short-term and long-term memory should be measured to support the argument that language learning in VR is effective.

A third limitation is that since VR is a digital device, differential proficiencies and preferences may impact participant experience. While questions were added to the survey assessing participant proficiency, such as “Have you ever experienced VR?” and “How comfortable are you with using a personal computer?” the subjective nature of these questions may not be sufficient for gauging requirements. More relevant requirements for assessing technology proficiency skills or preferences should be included.

Finally, experiencing VR can cause cyber-sickness resulting from interactions with or immersion in virtual environments. Too much physical immersion can be problematic when it leads to disorientation, motion sickness, dizziness, and other problems (Azar, 1996; F. Biocca, 1992; F. A. Biocca & Rolland, 1998; Lee, 2004). For example, 78% of users experience some form of oculomotor problems, 70% become nauseated, and 67% are disoriented following the VR interaction (Stanney, Kingdon, Graeber, & Kennedy, 2002). Even Taxén and Naeve (2002) mentioned that due to these drawbacks, immersive HMD could not be used in large classroom settings. In this experiment, the setup was designed to avoid these physical symptoms. Thus, if the participants had these symptoms or discomfort of using VR, they were provided the necessary rest before resuming the experiment. These pauses may have also increased the enjoyment of VR. Thus, as an element for future study of VR, it will be interesting to categorize the advantages and disadvantages for using VR in language learning classroom.

Conclusion

This study tested media and educational effects in VR for language learning. From the perspective of 'Memory of Loci', VR impacts language learning using spatial memory, which facilitates memory retainment and acquisition of vocabulary as the process is related to L2 acquisition via unconscious mechanisms.

From the perspective of communication, this research contributed to the literature on how to find the right medium for the right content. Biocca and Delaney (1995) implied, "the computer is a protean technology; VR is a protean medium" (p. 118), which may be interpreted that VR could be widely used as a messenger in a variety of fields. In this case, VR is used as a medium to learn a language. Thus, this study provides an approach to verify the media effects of VR in language learning. If learners use VR in language learning, they can have a high sense of spatial presence which may potentially lead to positive learning outcomes.

From the technology perspective, the effectiveness of using VR learning environments should be further explored. It is essential to measure the user's performance when engaging in such an innovative technology. Although much research has been done on VR, investigations for practical application purposes is still limited (Tinianow, 1997). Thus, this study aids in finding ways to improve VR design for practical purposes, such as language learning. Also, the results showed that people are inclined to use VR rather than a computer. It can be argued that if VR technology is used appropriately, media effects such as enjoyment will be increased. In that point of view, this research provides positive influences for VR educators considering VR technology in their classrooms. Therefore, this study contributes insight into evaluating the most suitable candidates for learning through VR use.

From the language learning perspective, the study focused on the effectiveness of VR technology as well as language learning. Through the study, it was concluded that VR increases memorization via simulation, and this innovative approach can be beneficial for L2 learners. Due to a sense of presence, if learners replicate language study in VR simulation, it can help them remember words more efficiently. Thus, VR can be a valuable language tool for simulating real-world situations and increase language learning.

Immersive VR-based learning has potential as an effective form of pedagogy for teaching L2 based on the three perspectives outlined above. This study offers meaningful implications as a first feasibility test regarding spatial memory and language learning. Thus, this study bridges the utilization of VR and L2 learning. In the future, VR content creators can consider the following factors as a guide for designing VR language learning content in the future. (1) Using a high spatial presence through VR will increase memory retention, and by following the strategy of the ‘Method of Loci’, a memory game in VR could support enhanced language memory. (2) Spatial presence is the most important factor for increasing enjoyment and motivation via VR. Thus, when creating VR content, presence factors, such as high resolution, spatiality, and interaction should be considered in the design of the VR language learning content. Finally, despite the research finding some interesting results on how spatial presence mediate media effects to increase language learning in VR, more empirical studies of VR must be conducted to create better VR language learning programs.

APPENDICES

A. Pilot Test

Survey

Test 1 (Memory test of Korean words)

1. After viewing the picture initially for 3 minutes, do you think it is enough time to remember the objects?

   If not, how many more minutes would have been sufficient?

2. You had 3 minutes to write down the Korean words. Do you think it is enough time to write down the Korean words?

   If not, how many more minutes would have been sufficient?

3. What was the easiest words/objects to memorize? (you can explain in English)

4. What was the most difficult words/objects to memorize? (you can explain in English

5. Any comments for future study?

Test 2 (Spatial test based on Korean words)

1. What was the most confusing aspect of this test?

2. Was it easy or difficult? Tell me the reason why you think so.

Easy 1 2 3 4 5 Difficult

3. Any comments for future study?

Thank you ☺

B. Baseline Memory Test

Twenty items with images paired with the Korean language word and pronunciation using the English alphabet.

C. Image Recognition Test

Please, match the object with correct Korean character.















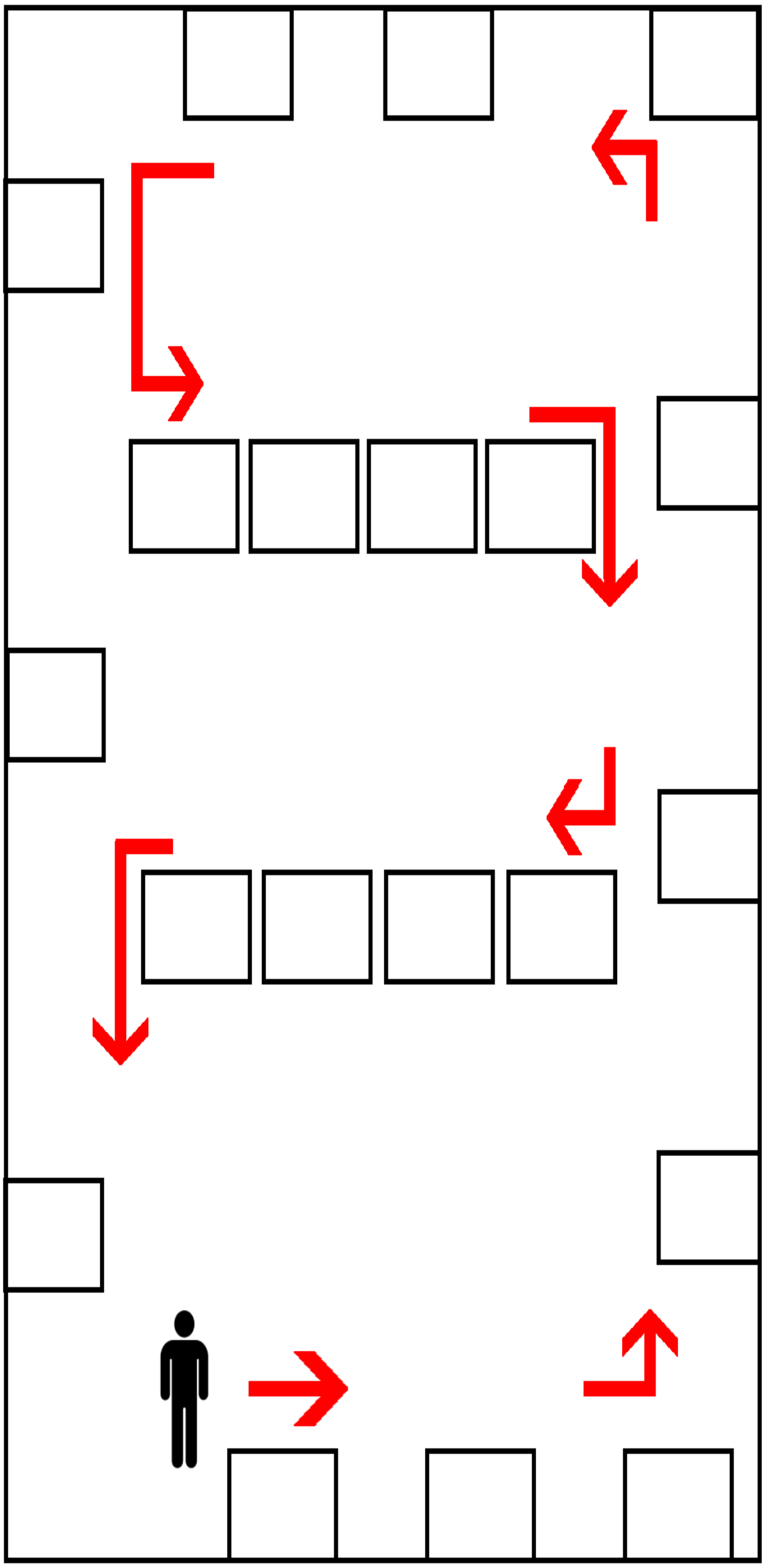




- 지도 [Ji Do]
- 달력 [Dal Yeok]
- 전등 [Jeon Dung]
- 연필 [Yeon Pil]
- 책장 [Chaek Jang]
- 칠판 [Chil Pan]
- 모자 [Mo Ja]
- 시계 [Si Gae]
- 서랍 [Seo Rab]
- 난로 [Nan Leo]
- 지구 [Ji Gu]
- 꽃병 [Kkot Byeong]
- 신발 [Sin Bal]
- 그림 [Geu Rim]
- 의자 [Ui Ja]
- 교탁 [Gyo Tak]
- 창문 [Chang Mun]
- 공책 [Gong Chaek]
- 가방 [Ga Bang]
- 책상 [Chaek Sang]

D. Spatial Memory Test

Please, fill out empty box with a number that you think the object was there.



E. Questionnaire

<u>Media Prototype Usability Test</u>

<u>General Instructions:</u>

Please read all instructions and questions carefully and **CIRCLE** the most appropriate answer.

Section A (Interactivity)

Please <u>circle</u> the option that best describes your **response about the interaction.**

1. I felt like pop-up cards were interacting with me.

Strongly Disagree 1 2 3 4 5 6 7 Strongly Agree

2. I felt like the cue cards were easy to remember?

Strongly Disagree 1 2 3 4 5 6 7 Strongly Agree

3. I felt like it was like learning a game?

Strongly Disagree 1 2 3 4 5 6 7 Strongly Agree

4. I felt like a teacher had taught me.

Strongly Disagree 1 2 3 4 5 6 7 Strongly Agree

5. I felt like teacher avatar was interacting with me.

Strongly Disagree 1 2 3 4 5 6 7 Strongly Agree

6. I felt like teacher avatar used his voice to communicate with me.

Strongly Disagree 1 2 3 4 5 6 7 Strongly Agree

7. I felt like I was learning the language with the teacher together.

Strongly Disagree 1 2 3 4 5 6 7 Strongly Agree

8. I felt like I was engaged in the learning module program.

Strongly Disagree 1 2 3 4 5 6 7 Strongly Agree

9. I felt like the learning program led me to learn Korean?

Strongly Disagree 1 2 3 4 5 6 7 Strongly Agree

10. I felt like it was easy to interact with the program?

Strongly Disagree	1	2	3	4	5	6	7	Strongly Agree

Section B (Spatial Presence)

Please circle the option that best describes your **overall experience on the space**.

1. I had a sense of “being there” in the classroom

Not at all	1	2	3	4	5	6	7	Very much

2. I felt like I was in a real classroom.

Not at all	1	2	3	4	5	6	7	Very much

3. I can feel the space.

Not at all	1	2	3	4	5	6	7	Very much

4. The classroom seems to be more like:

2D	1	2	3	4	5	6	7	3D

5. Overall, I feel physically comfort.

Very uncomfortable	1	2	3	4	5	6	7	Very comfortable

6. Overall, I feel like I am lost.

All the time	1	2	3	4	5	6	7	Never

7. I still remember where the objects are located throughout the classroom.

Not at all	1	2	3	4	5	6	7	Very much

8. The content that I participated seems to be spatially immersive.

Not at all	1	2	3	4	5	6	7	Very much

Section C (Enjoyment)

Please circle the option that best describes your **overall feeling of the experience.**

	Not at all						Extremely
1. Enjoyable	1	2	3	4	5	6	7
2. Entertaining	1	2	3	4	5	6	7
3. Exciting	1	2	3	4	5	6	7
4. Fun	1	2	3	4	5	6	7
5. Interesting	1	2	3	4	5	6	7
6. Satisfying	1	2	3	4	5	6	7

Section D (Motivation)

Please circle the option that best describes **how you perceived the experience**.

1. After interacting with the program, I want to learn Korean more.

Strongly disagree 1 2 3 4 5 6 7 Strongly agree

2. After interacting with the program, I am confident in learning Korean vocabulary.

Strongly disagree 1 2 3 4 5 6 7 Strongly agree

3. I prefer to learn Korean with the program than attending school.

Strongly disagree 1 2 3 4 5 6 7 Strongly agree

4. Using the module increased my language learning skills.

Strongly disagree 1 2 3 4 5 6 7 Strongly agree

5. I found the module useful for my future language learning.

Strongly disagree 1 2 3 4 5 6 7 Strongly agree

6. I think the module enhanced my efficiency of learning a language (e.g., vocabulary).

Strongly disagree 1 2 3 4 5 6 7 Strongly agree

Section E (Others)

1. I think this language learning program was effective to learn a language

Strongly disagree	1	2	3	4	5	6	7	Strongly agree

2. How much do you know Korean?

Not at all	1	2	3	4	5	6	7	Very much

3. Have you ever experienced VR?

First time	1	2	3	4	5	6	7	Very experienced

4. How comfortable are you with using a personal computer?

Totally uncomfortable	1	2	3	4	5	6	7	Totally comfortable

Section F (Demographics)

1. Age: (   )

2. Gender: *circle one* – Male / Female

3. Major : (   )

4. How many languages can you speak? (   )

   Which languages? (   )

5. Race/Ethnicity check all that apply

   White_____

   Black/African American____

   Asian_____

   Native American/Alaska Native_____

   Other (please specify) _______

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Top Paper Award - International Communication Association (ICA), Instructional Communication Division, 2018

Michael A. Chaprnka Scholarship recipient - Michigan State University, 2011

PROFESSIONAL EXPERIENCE

VR Content Creator, 'IMAJION' Mixed Reality (Start-up company), Syracuse, USA, 2016 – 2017

President of Korean Student Association at Syracuse University, Syracuse, USA, 2016 – 2017

M.I.N.D (Media, Interface, Network & Design) Lab Researcher, Syracuse, USA, 2015 – 2017

Human Resource Manager, SK (IT & telecommunication company), Bundanggu, South Korea, 2012 – 2014