SENSE OF PLACE EVOKED BY INTERACTIVE MAPS

A Dissertation

by

HANYOUNG GO

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

May 2012

Major Subject: Recreation, Park, and Tourism Sciences

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Approved by:

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| Co-Chairs of Committee, | Gerard Kyle |
| | Ulrike Gretzel |
| Committee Members, | William A. McIntosh |
| | Frank Shipman |
| Head of Department, | Gary Ellis |

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# ABSTRACT

Sense of Place Evoked by Interactive Maps.

(May 2012)

Hanyoung Go,

B.B.A., Sejong University, Korea; M.U.P., University of Oregon

Co-Chairs of Advisory Committee: Dr. Ulrike Gretzel
Dr. Gerard Kyle

Maps are essential tools for providing tourism information. Hence, it is imperative for tourism marketers to understand how tourists perceive spatial information and sense physical places virtually presented in digital maps. Based on sense of place, spatial cognition, and virtual reality literature, this study constructed a conceptual framework to measure how different interactivity levels of a digital map interface affect potential tourists' experience when exploring maps. In addition, the study explored how individual characteristics such as place attachment and spatial ability affect virtual-spatial experiences. An experiment was conducted to test the developed Virtual Spatial Experience model. Google Earth maps were manipulated using two experimental conditions: low level (satellite view map only) vs. high level (three dimensional (3D) dynamic objects). The questionnaire included self-report items regarding perceived map interactivity, spatial ability, affective place attachment, spatial orientation, spatial imagery, and spatial presence. Responses from 211 students were analyzed using structural equation modeling (SEM).

The study results showed that map interfaces influence human perceptions of map interactivity. Perceived map interactivity positively affected virtual spatial experiences: spatial orientation, spatial imagery and spatial presence. Spatial ability positively influenced spatial orientation which in turn led to greater spatial imagery and ultimately greater spatial presence. The results further demonstrated that affective place attachment positively influenced spatial presence.

The findings provided evidence that sense of place in the real world, such as affective place attachment to the experimental setting (Walt Disney World, Florida), influences spatial experiences of an environment virtually presented in the map. Therefore, by applying place attachment to virtual environment studies, this study expanded the scope of theories used in exploring human spatial experience. Moreover, evaluating the influence of map interactivity, this study provided practical implications for designing destination maps. By applying 3D dynamic objects as a design feature in an interactive map, tourism marketers can produce enhanced virtual spatial experiences. As this study used Walt Disney World's Magic Kingdom Park presented on Google Earth as the experimental setting, the collected data also informs the understanding of virtual experiences and perceptions of the park.

# DEDICATION

This dissertation is dedicated to my loving father and mother, Gun Seup Go and Young Ja Kim, who will be missed, and never forgotten.

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Most of all I would like to thank my Father in heaven, a loving God and Savoir, Jesus Christ, who has provided me all the strength and ability to accomplish this project. To Him I give all the honor and glory for He is worthy of my praise.

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# CHAPTER I

# INTRODUCTION

## Study Background

Tourism is an activity that involves movement in space and as such requires knowledge of the space traversed. Maps provide such geographical information to travelers. Through the use of maps, tourists obtain spatial knowledge regarding their travel destination, even before they visit it.

In the tourism industry, maps are also essential tools to promote a tourism destination. Walmsley and Jenkins (1992) stated that "any enhancement of tourists' environmental knowledge is likely to increase the commercial viability of enterprises geared to the generating market by familiarizing tourists with facility locations and offerings" (p. 269). Holcomb (1999) also indicated how tourism marketers use media and maps to promote tourism destinations. While the promoters of tourism, especially destination marketers, have considered the experience of place as the product they sell (Judd & Fainstein, 1999), they have attempted to develop applications or media tools, such as guidebooks, brochures, websites, and virtual tour videos, to represent tourism destinations and provide pre-spatial experiences before tourists reach the destination.

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This dissertation follows the style of *Tourism Management*.

In addition, the tourism destination marketers are likely to add a map to brochures or websites. The map includes geographical information of the destination and gives tourists a sense of the place being promoted. Ward (1995, 1998) emphasized the role of maps in promoting tourism both in the U.S. and in Britain. Given this central role of maps for destination marketing, it is important for tourism marketers to understand the use of cartography in the representation of places (Warnaby, 2008).

*The Evolution of Interactive Maps*

Traditionally, hard copy maps have been used to provide geographical information of places. However, hard copy maps have limitations in terms of how they can display a place and how they can respond to information requests from map users. For example, Oviatt (1997) stated that hard copy maps have several drawbacks and one of the disadvantages is “the visual search time required to find objects and locations of interest” (p. 97). The reduction of visual search time has been one of the major goals of “making maps (hard copy) easy to read” (Phillips, 1979).

Tourists cannot run a search query (e.g., show me where Texas A&M University or College Station is) on a hard copy map. When tourists want to find an object or a location on a hard copy map, they have to scan the entire map or understand how to read the legend symbols or codes used for mapping techniques. Even for people who have good map-reading skills, interactions with hard copy maps are potentially restricted by the map scale and size. The “interactivity” of hard copy maps is very limited.

To overcome these limitations, researchers and IT developers have suggested various interactive map technologies that employ computer-mediated displays (Edsall, 2009). A variety of map features has been considered to overcome the limitations. The latest online maps possess interactive features that permit scrolling, zooming, and searching (Bederson & Hollan, 1994; Kreitzberg, 1991), allowing for active display control and dramatically reduced search times. Design elements such transparency and blur filter content (Colby & Scholl, 1991; Lokuge & Ishizaki, 1995) while retaining information density (Oviatt, 1997).

Interactive maps today feature various virtual representation technologies and open information resources, such as satellite data, GIS systems, API (Application Programming Interface), and three-dimensional graphics (Boulos, 2005; Sheppard & Cizeka, 2009). Advanced map technologies provide various visual cues (e.g., 3D graphics and layered information display) which can help users acquire spatial knowledge and a sense of place. In order to give people a greater sense of place in remote locales, emerging virtual reality (VR) technology has boosted the development of virtual representations of places in virtual environments.

The characteristics of virtual environments play an important role in creating a strong sense of "presence (sense of being there)" (Held, 1992). Through using the combination of VR technology and geographical data from the real world, it is assumed that interactive maps create virtual environments that can provide a powerful sense of presence (sense of being there). However, past VR studies have largely used virtual environments which do not represent a physical place in the real world. To assess the effect on the spatial perceptions of tourists who are exposed to a virtually represented real place through interactive maps, it is essential to understand spatial perceptions of both a real place and a virtual environment, and to integrate sense-of-place studies regarding physical environments into virtual environment studies. Therefore, this study hypothesizes that the virtual spatial experience of destinations that digital maps provide can affect tourists' perceptions of those destinations in important ways and that they are more effective than traditional maps. In addition, it is hypothesized that the sense of place in the real world can influence sense of place in a virtual environment.

## Problem Statement and Study Purpose

Interactive maps and virtual environments have been employed in tourism marketing websites and other online travel promotion media. Tourism agencies include maps in media such as e-brochures and websites for helping tourists to acquire geographical knowledge required for a trip. In addition, they offer virtual tour programs to give consumers a sense of the place they are planning to visit before their trip. It is essential to assess how interactive maps presenting virtual representations of tourism destinations shape tourists' spatial perceptions while interacting with such maps.

Yet, despite their importance and extensive use, the effectiveness of interactive maps and three-dimensional virtual environments in representing destinations has so far not been systematically evaluated. Existing studies have mostly paid attention to evaluating the effectiveness of tourism websites (e.g., Chen & Yung, 2004; Choi, Lehto, & Morrison, 2007; Gehrke, 1999; Hashim & Murphy, 2007; Lee, Cai, & O'Leary, 2006;

Wang & Fesenmaier, 2005), as well as the effectiveness of virtual tours (e.g., Cho, Wang, & Fesenmaier, 2002).

More specifically, studies have not examined how digital map interactivity features, such as digital earth information-based 3D models and multiple degrees of freedom in user control, contribute to the creation of tourists' spatial perceptions in VEs. Five research questions are derived from this need to investigate the effectiveness of different types of interactive map interfaces:

1) What are the spatial experiences that tourists obtain from exploring a physical place represented on an interactive map?
2) Does sense-of-place, especially affective aspects of place attachment regarding a place experienced in the real world, affect spatial perceptions of a map's virtual representation?
3) Does spatial ability influence spatial perceptions of a map's virtual representation?
4) Do different map features lead to different perceptions of map interactivity? and
5) Does map interactivity influence spatial experiences of the virtually represented place?

To answer the research questions, this dissertation presents a theoretical model for evaluating the ability of interactive digital maps to provide tourists with compelling virtual spatial experiences.

# CHAPTER II

# LITERATURE REVIEW

Humans obtain spatial knowledge either from direct experiences or indirect experiences such as exposure to media and viewing a map (Darken & Peterson, 2001; Richardson, Montello, & Hegarty, 1999). Providing spatial knowledge of travel destinations is essential to the tourism industry. Traditionally, hard copy maps have been used to offer a wide range of maps such as destination maps, road maps, city maps and trail maps for supporting tourist activities and vacation planning. Also, tourist marketers consider places or destinations as products to sell (Judd & Fainstein, 1999), but they cannot provide direct experiences or a trial trip like a sample for consumers. To sell the destination, by providing indirect experiences of the place, the destination has been represented on maps or in other forms of virtual environments such as 3D virtual worlds and virtual tour videos.

With regard to map development, various forms of maps are available online. Online maps are popular and seem to meet growing demands for fast access to geographical information, transferring and sharing spatial information. Many studies have paid attention to creating interactive online maps with relatively powerful interface capabilities (e.g., Anderson & Shapiro, 1979; Eikvil, Aas, & Koren, 1995; Gahegan, Wachowicz, Harrower, & Rhyne, 2001; Gross & Brown, 2008; Zaslavsky, 2000). The capabilities allow users to experience sophisticated graphics and advanced functional maps through new visual display and database access systems (Oviatt, 1997). As Oviatt (1997) wrote:

> Dynamic interactive maps with powerful interface capabilities are beginning to emerge for a variety of geographical information systems, including ones situated on portables for *travelers*, students, business and service people, and others working in field settings. In part through the design of more expressive and flexible input capabilities, these map systems can provide new capabilities not supported by conventional interfaces of the past. (p. 93, italics added)

Zhang (2008) argued that different representations of spatial knowledge involve different levels of abstraction in terms of space. He maintained that spatial knowledge helps people shape internal spatial representations of environments. The realism of virtual environments is considered to be a crucial factor in the design process to stimulate spatial cognition in virtual environments. Geographic information and GIS data may provide a higher level of spatial cognition of the virtual representation of real places. Digital maps include a wide range of geographic information, such as weather/sky/ocean views, satellite maps and texturally graphed terrains, as well as multisensory content, such as 3D maps, tour videos, and sounds. That means tourists can obtain different spatial experiences from using different interactivity levels of the map. Therefore, in tourism, virtual environments can play a key role in creating tourist experiences of the destination products.

Interactive digital maps and 3D virtual environments have been studied as tools of contemporary tourism marketing (Dickmann, 2005; Schilling, Coors, & Laakso, 2005). Dickmann (2005) researched effectiveness and efficiency of tourism maps (online 3D map vs. printed map). His study results showed that the portions of correct answers regarding way-finding questions on map-based online systems is about 15% greater than on printed maps. Schilling, Coors, and Laakso (2005) found that digital maps have many advantages when compared to paper maps. But, digital map users are used to 2D maps and said that they may not need to use a 3D map for navigating. The authors noted that some of the participants mentioned that there might be a change in attitudes with the next generation. Regardless of the effectiveness and preferences of using online tourism maps, since the latest generation of consumers has been exposed to computer-mediated representations of places by increased usage of digital devices, it is imperative to evaluate how they perceive virtual representations of real places provided through interactive maps (Go & Gretzel, 2009).

To evaluate spatial perception in the virtual environment, virtual reality studies have used the sense-of-presence concept to measure human spatial cognition and the sense of place perceived in virtual environments (Witmer & Singer, 1998). However, tourism destinations do not exist only virtually; they also exist as physical places in the real world. Thus, to consider both studies of virtual environments and environmental psychology is to take an integrative approach to understanding tourists' spatial perceptions of virtually represented real places. This part of the study reviews human spatial cognition studies that deal with sense of place based on both virtual environment and physical environment literatures.

**Sense-of-Place Studies in the Real World**

Every human being exists in geographic space. However, not every space becomes a meaningful place to every human being. To understand the relation of human beings and place, sense-of-place studies have long been approached by various disciplines. For example, Low and Lawrence-Zúňiga (2003) addressed the role of the human body in defining and creating space, as well as developing spatial experience and consciousness. They argued that "embodied space is presented as a model for understanding the creation of *place* through the body's special orientation and movement, and its action in language" (p. 49). Tuan (1974) described a place as a center of meaning constructed by human experiences. Altman and Low (1992) argued that a space becomes a *place* when the human beings have "given meaning through personal, group, or cultural processes" (p. 5). These studies emphasized the fact that humans can make a space meaningful through their experiences.

However, other scholars have argued that a physical environment, all by itself, can influence the interaction between humans and places; it may have certain features that are intrinsically appealing to humans. As Sack (1997) noted, "some places are richer in natural elements than others" (p. 673). He investigated the role of physical environments in creating place attachment. His framework included emotional elements, such as satisfaction and meaning of places to respondents, as well as physical characteristics such as structures per mile, public access, lake size and so on.

These studies show that there are a variety of perspectives on the way the sense-of-place is conceptualized. Most importantly, studying how humans and places are related requires understanding human cognitions, behaviors, and experiences. Conversely, place–human relation studies are essential to understanding human behaviors, cognition, and experiences of the world.

**Presence Studies in Virtual Worlds**

Unlike sense of place studies in a physical world, the concept of presence has been used to explain human spatial cognition in virtual environments. Sense of presence is defined as the "perceptual illusion of nonmediation" (Lombard & Ditton, 1997, p. 10). Lombard and Ditton (1997) stated that "the term 'perceptual' indicates that this phenomenon involves continuous (real time) responses of *the human sensory, cognitive, and affective processing systems* to objects and entities in a person's environment" (p. 10, italics added).

As a prime cause of presence, interaction is considered a central factor in virtual environments (Takatalo, Nyman, & Laaksonen, 2008). According to Takatalo et al. (2008), interaction is recognized as "one of the prime causes of presence in virtual environments by many authors (e.g., Draper, Kaber, & Usher, 1998; Lombard & Ditton, 1997; Steuer, 1992)" (p. 2). The authors claimed that virtual environments have special features capable of influencing human experience. For example, virtual environments can produce a sense of physical presence, which is defined as the user's feeling of ''being there'' in a mediated environment (IJsselsteijn, Ridder, Freeman, Avons, & Bouwhuis, 2001).

**The Need for Integrating Sense of Place and Spatial Presence Research**

To understand tourists' spatial perceptions of virtually represented real places, a comprehensive approach is required, which integrates concepts for exploring the sense of place as experienced in both physical and virtual environments. This study borrows place attachment studies, which is a key concept of sense-of-place studies, from environmental psychology studies, and the presence concepts from virtual reality studies. This integrative approach has been derived from the fact that both theories have limitations of study settings, which are either only physical settings or virtual settings (experimental/non-existing environments).

As challenges to place attachment, scholars point out that there are limitations to understanding all aspects of human psychological responses, to selecting, and manipulating environmental settings for research, and to applying the implications of these studies to practical management. For instance, with regard to selecting the study range of environmental settings, Hidalgo and Hernández (2001) stated that there are limitations in place attachment studies, since most place attachment studies have focused their range of analysis to neighborhood or community environments. Another limitation in place attachment studies is their failure to trace the psychological implications of human perception of the place in virtual environments (Hidalgo & Hernández, 2001; Milligan, 1998). For instance, Zhang (2008) stated that "spatial cognition in virtual environments has been found to be similar to that in the real world" (p. 245). In cyber-places research, existing studies have used virtual spatial scales to test the way people perceive spatial information in a virtual environment as well as how virtual environments influence navigation or route training of a real place. During these tests, researchers found that virtual environments influence human spatial knowledge acquisition of a real place (Ruddle, Payne, & Jones, 1997; Wilson, Foreman, & Tlauka, 1997; B.G. Witmer, Bailey, Knerr, & Parsons, 1996; Zhang, 2008).

Although scholars have used various scales to deepen the understanding of how humans are related to virtual places, scholars in the virtual reality field have not employed the concept of place attachment as a key indicator in measuring sense of place in their research. Most 3D virtual environment studies have been conducted in the field of computer science. Even though this stream of research attempted to find out the gap between physical and virtual place perception, few studies have used human psychology indicators based on physical places to test spatial experiences in virtual environments (Wagner et al., 2009).

Virtual environment studies and sense-of-place studies are controversial. Some scholars argued that as the number of virtual, homogenized, or anonymous interactions between real worlds and virtual environments is growing, the world becomes increasingly placeless, so that a concept of attachment to the built environment might be less relevant (Kunstler, 1993; Relph, 1976). Milligan (1998) disagreed with this perspective, because attachment is based on the relationship between events in spaces and the passage of time. As long as time is perceived as linear, then space will be used to categorize the events that occur within it, as interactions always occur in spaces that are given meaning by the interactional process, even if that interaction is not face-to-face and if the space is cyber in nature.

In spite of the arguments, studying the interactions between real and virtual places can help to understand how people process maps. Therefore, this study adopts an approach that integrates the concept of place attachment and spatial presence. This approach is expected to provide insights regarding how people perceive spatial information, as well as how they sense the place in a virtually represented real place. The lives of modern people have expanded into an electronic world, where we live between physical and virtual worlds, and conduct our affairs as much through telepresence as through our physical presence. New "architectural forms" have evolved from the electronic interpretations of "traditional architectural types." These new virtual environments parallel, complement, and compete with our existing physical environments (Mitchell, 1995). Through exposures to both physical and virtual worlds, it is inevitable that people are likely to have mixed spatial experiences of any environment.

In short, at the intersection of the physical and virtual worlds, studying the relationship between place attachment and the sense of presence in a virtual environment can contribute to extending the range of applicability of sense-of-place studies. In this sense, applying both place attachment and sense-of-presence concepts to a virtual (or cyber) environment study can help to develop a better measure of how humans perceive places in a virtual world. It is also assumed that the integration of place attachment with spatial presence is beneficial for both virtual reality studies and place attachment studies in the field of environmental psychology.

## Place Attachment

Sense of place has been identified with various psychological indicators that refer to human beings' feelings about place (Shamai, 1991). For example, place identity, place motivation, and place attachment have been used as key indicators to measure the relationship between a place and the human perceptions and experiences of it (Brandenburg & Carroll, 1995; Knopf, 1987; Mitchell, Force, Carroll, & McLaughlin, 1993). Place attachment has been applied to various sense-of-place studies. Williams et al. (1992) stressed that when using place attachment to characterize a recreational setting, it should be grounded in "Important people and places available in recreational research, including use history and substitutability, concern for how the setting is used or managed, and other use (trip) and user characteristics" (p. 32).

Place attachment has been employed in a variety of studies to explain the bonding of humans with places (e.g., Altman & Low, 1992; Eisenhauer, Krannich, & Blahna, 2000; Knopf, 1987; Kyle, Absher, & Graefe, 2003; Kyle, Mowen, & Tarrant, 2004; Stedman, 2003b; Twigger-Ross & Uzzell, 1996; Williams & Stewart, 1998). To investigate the human–place bond, these studies have investigated the nature of humans' attachment to place in a physical environment. Williams, et al. (1992) emphasized that "the significance of place approach is that it captures the connection between people and geographic areas directly rather than establishing such connections indirectly in the form of use and user characteristics" (p. 43). Specifically, tourism destination marketing studies have tried to investigate how visitors sense or feel about geographical places (e.g., Baloglu & Brinberg, 1997; Baloglu & McCleary, 1999; Chon, 1991). Regarding tourism resource management, Walsh et al. (2001) stated the importance of sense of place studies, saying “a sense of place is important to the tourists and tourism developers because it represents what is unique about a place and what is worth preserving” (p. 197). According to Gross and Brown (2008), place attachment has been shown to be applicable in a tourism context. They suggested that “it can be used to help understand how tourists respond in different settings and how they evaluate different dimensions of their destination experience” (p. 1148). In this sense, promoters of tourism destinations can benefit from place attachment studies to understand their consumers.

In sum, place attachment studies have attempted to provide an integrative analysis grounded in various fields, such as anthropology, social ecology, sociology, urban planning, environmental psychology, psychology, and landscape architecture. According to Altman and Low (1992), the concept of place attachment can be summarized as an “integrating concept that involves patterns of attachments (affect, cognition, and practice), places that vary in scale, specificity, and tangibility, different actors (individuals, groups, and cultures), different social relationships (individuals, groups, and cultures), and temporal aspects (linear, cyclical)” (p. 8). The leading theories of place attachment are briefly described below.

### *Place Identity and Place Dependence*

Place dependence and place identity can be considered as primary factors that help us understand the multidimensional concept of place attachment. In this sense, sense-of-place studies use both place dependence and place identity to assess place attachment. For example, Williams et al. (1992) employed place dependence and place identity to investigate how visitors are attached to four different wilderness parks. Bricker & Kerstetter (2000) used place identity, place dependence and level of specialization to measure place attachment toward whitewater rivers.

*Affective Attachment*

Tuan (1974) coined the term *topophilia* to characterize affective ties to place. Mesch and Manor (1998) stressed that "p*lace attachment is a positive emotional bond* that develops between individuals or groups and their environment" (p. 504, italics added). Hunter (1978) argued that place attachment can refer to the "emotional linkage" of an individual to a particular environmental setting. Mesch and Manor (1998) claimed that "the study of place attachment is the study of emotional investment in place (Hummon, 1992)" (p. 505). These studies investigated positive feelings or affective bonds to places. Manzo (2003), on the other hand, investigated the negative bond between people and places. She maintained that the people-place relationship is not static, but dynamic and ever-changing. Hence, the author argued that investigating negative feelings toward a place is also important to understand the people-place bond.

In sum, the concept of place attachment can be identified as an integrative idea that attempts to explain how certain human mental states, such as affects, cognitions, and feelings, cause an attachment to places. Williams and Stewart (1998) epitomized "the sense of place concept as the collection of meanings, beliefs, symbols, values, and feelings that individuals or groups associate with a particular locality" (p. 19). They pointed out that it is important to recognize the meaning of “local,” which should not be limited to the sense of place for residents. They emphasized that tourists and regular visitors can have strong attachments to places. However, in terms of place identity, Giuliani (1991) argued that nomads or tourists have relatively low place identity with specific places.

A main theme in place attachment studies is the importance of understanding the emotional bond of an individual to a particular environmental setting. Therefore, this study defines place attachment as the emotional bonds of a human with an environment perceived from indirect or direct exposure to virtual, physical or mixed space regardless of prior visitation.

**Spatial Relations and Structures**

Most human activities require a process of understanding spatial relations of environments and objects. Spatial relations are stored and retrieved in the human brain for use. The process of creating spatial relations and particularly its structure have been studied in various fields including psychology and virtual environment studies. For example, McNamara (1986) found that spatial relations are encoded in part hierarchically between locations in different regions of an environment. Stevens and Coupe (1978) also described spatial information as being stored hierarchically in the human brain.

Thorndyke and Goldin (1983) suggested that spatial knowledge representation can be formed through such a development process as the Landmark, Procedural, and Survey knowledge process (configurationally developed knowledge). When people process configurational spatial knowledge, they can generate a path of unseen environments using the ability to estimate relative distances between two locations (Darken & Peterson, 2001).

In addition, spatial cognition studies have examined users' spatial perceptions of a virtual environment when using maps or virtual environments. For example, Thorndyke and Hayes-Roth (1982) argued that map users combine mental simulation of travel through the environment presented in the map and informal algebra to compute spatial judgments. In order to captivate and comprehend the complexity of the spatial knowledge process, virtual studies adopted various segments of spatial cognition as sub-dimensional concepts for their research, such as spatial presence, spatial orientation, and spatial imagery.

**Spatial Presence**

Spatial presence (SP) is a crucial concept for evaluating virtual environments and creating virtual-spatial experiences (VSEs). Virtual reality studies have used the concept of "telepresence," "the sense of presence," or "presence" to measure a human's spatial sense in a virtual place. The definitions of the terms are similar to each other (Wirth et al., 2007). Therefore, this study employs the term *spatial presence* (SP) as an inclusive concept of both presence and telepresence.

Spatial presence is the sense of existence and subjective experience constructed in a virtual environment through a medium of communication (Schubert, Friedmann, & Regenbrecht, 1999; Steuer, 1992; Witmer & Singer, 1998). The concept of spatial presence, the "sense of being there," plays a key role in mediating and affecting the degree of a virtual experience established in virtual environments (Biocca, 1997).

According to Biocca (1997), "when we experience our everyday sense of presence in the physical world, we automatically generate a mental model of an external space from patterns of energy on the sensory organs" (p. 129). The author hypothesized that the experience of the virtual place or virtual environment involves patterns of energy stimulating structures similar to those experienced in physical environments. The author argued that the patterns of energy can be used to "activate the same automatic perceptual processes that generate our stable perception of the physical world" (p.129). Hence, it is assumed that with regard to the mental process of spatial perception, virtual experiences in VEs may have the same structure as real experiences in physical environments.

Media such as television shows and telecommunication systems provide indirect experiences of objects to consumers (Klein, 2003). Li et al. (2001) argued that the human multisensory and behavioral simulations in 3D digital environments can generate presence, which can enhance richer virtual experiences regarding objects. As such, a medium not only delivers information, but also mediates experiences (Li et al., 2001).

## Spatial Experience of Mixed Environments

In his synthesis of the major philosophical and theoretical propositions relevant to the question of how people relate nature, Knopf (1987) pointed out that humans have both an innate and a learned response to nature. Knopf (1987) emphasized that “the way people perceive an environment depends upon the way they have *experienced* it” (p. 786, italics added). To understand how people perceive a real place presented on a map, it is necessary to identify virtual-spatial experiences obtained from virtual environments.

The notion of “virtual” integrates with technological systems or environments that can create or exceed a subject’s realistic *experiences* of non-realistic objects. Thus, understanding types of user experiences and the concept of virtual experiences can help to identify the nature of the spatial experiences tourists have in interacting with virtual environments.

### *Types of Experiences and Identifications of Virtual Experiences*

Experience can be defined as having several different dimensions. In philosophy, experience is “the product of an ongoing transaction that gains in quality, intensity, meaning, and value, integrating both psychological and emotional conditions” (Li et al., 2001, p. 14). According to Lundh (1979), an experience is a process which occurs spontaneously or voluntarily and involves the internal awareness of something taking place in everyday life. Psychological studies have broken down human experiences into three common states: “mental imagery (cognitive), emotional responses (affective), and derived intentions (conation)" (Li et al., p. 14). It is assumed that mental imagery and affective responses of places have to be considered as important aspects of spatial experiences.

Furthermore, Takatalo, Nyman, and Laaksonen (2008) characterized human experience as follows: (1) experience has two meanings: it can be something one has gone through and gained knowledge of or it can be the content of direct observation or participation in an event, (2) experience may have both mental and bodily states, and (3) it is closely related to feelings and emotional sensations. In addition, Li, Daugherty, and Biocca (2001) argued that "every experience stems from the interaction between an individual and an object or environment" (p. 14). Based on these arguments, interaction between spatial environments and tourists' experiences may be categorized as one of three different types of experiences: direct, indirect, and virtual experience (Gibson, Willming, & Holdnak, 2003; Li et al., 2001).

Direct experiences are created from the direct interaction of tourists and spatial environments. Direct experiences are based on an unmediated interaction through the full capacity of human senses which includes visual, auditory, smell, taste, haptic, and orienting (Gibson et al., 2003). The experiences through multisensory interactions provide several benefits to tourists such as gaining self-generated and trustworthy information, controlling the inspection process and focus, and more direct responses than indirect experiences (Li et al., 2001; Milar & Millar, 1996).

Virtual experiences are defined as psychological and emotional states that a consumer experiences while interacting with objects in virtual environments (Lundh, 1979). Li, Daugherty, and Biocca (2001) distinguished between virtual experiences and indirect experiences. They claimed that virtual experiences resemble direct experiences in providing consumers with virtual affordances of a 3D object or environment. Therefore, virtual tour experiences can be developed if the virtual environment produces (1) a higher presence of the place, (2) a similar environment to real world experiences and (3) virtual affordances.

To sum up, virtual experiences are defined as psychological and emotional states that a tourist experiences while interacting with a virtual representation in virtual environments. They become virtual-spatial experiences (VSEs) if the virtual environment has rich spatial characteristics that are observed by the user as a part of the virtual experience. VSEs consist of spatial cognitions, such as spatial orientation, spatial imagery and spatial presence.

## Integration of Measurements for Virtual-Spatial Experience (VSE)

In various disciplines, cognitive maps have long been studied as a way to understand spatial relations and human perceptions of represented places, whether mediated or not (Maguire, Burgess, & O'Keefe, 1999; McNamara, Ratcliff, & McKoon, 1984). Indeed, there are various discussions regarding definitions and terms of cognitive maps. Cognitive mapping is usually defined as “a process composed of a series of psychological transformations by which an individual acquires, stores, recalls, and decodes information about the relative locations and attributes of the phenomena in his everyday spatial environment” (Downs & Stea, 1973, p. 7).

Instead of the term *cognitive maps*, some studies speak of mental maps or mental representations, but define them in similar ways. For instance, Pocock (1976) stated that “the term *mental maps* is used as one of several synonyms which refer to the cognitive or mental image of an environment held by an individual or group” (p. 493). The author argues that mental maps can be formed by either direct or indirect means.

Despite the confusion regarding the terminology, the concept of cognitive mapping has been adapted to a variety of studies in sense-of-place research and spatial cognition research. Tversky (1993) emphasized the role of cognitive mapping in sense-of-place research. Kitchin (1994) held that “cognitive mapping has a role to play in spatial behavior, spatial decision making, learning and acquisition studies making and in real world applications, such as planning, teaching, map making and computer interfaces and databases” (p.14). Walmsley and Jenkins (1992) stated that “the touristic mental map of an area has an important bearing on which facilities tourists use and which recreational opportunities they undertake” (p. 269).

Therefore, this study outlines a theoretical framework of the virtual spatial experiences that form cognitive maps of places represented in interactive digital maps. Further, the study develops virtual-spatial experience measurements that can help to understand tourists’ spatial perception of virtually represented physical places in interactive digital maps.

*Spatial Imagery*

Spatial imagery can be defined as human mental cognition that processes object properties (e.g., shape and color) in an environment and spatial properties (e.g., location and spatial relations). Mathewson (1999) stated:

> Visual-spatial thinking includes vision—the process of using the eyes to identify, locate, and think about objects, and orient ourselves in the world, and *imagery*—the formation, inspection, transformation, and maintenance of *images in the 'mind's eye'* in the absence of a visual stimulus (p. 34, italics added).

The experience of extensive mental imagery affects feelings of virtual presence (Lee, Gretzel, & Law, 2010). Wirth et al. (2007) emphasized that spatial visual imagery can support the formation of spatial presence, as it enhances "the cognitive salience of spatial structures and makes it easier to 'understand' the spatial quality of the mediated environment" (p.18). Moreover, they argued that individuals with higher spatial visual imagery can find it easier to fill in missing space information from their memory. However, even if people are good at spatial memory, people may need visual experiences for certain spatial processing mechanisms, including spatial imagery, to operate correctly (Thinus-Blanc & Gaunet, 1997). This implies that visual-spatial information can affect spatial imagery processing.

With a system-based view of visual-spatial information, O'Sullivan et al. (2003) maintained that geo-spatial imagery systems, which contain improved technologies of image capturing and storing, and remote sensing and scanning on digital maps, extend available image data in the geosciences and spatial information engineering. Thus, the authors argued that the geo-spatial imagery systems are important to manage problems of imagery information overload, and support tasks which rely on retrieval and analysis of geo-spatial images. Moreover, they indicated that "as geo-spatial information systems are employed to address specific tasks...[A]…the most relevant work product lies not only in the relevant images, but in descriptions of how and why the visual data was selected and the ends to which it has been employed" (p.78). Therefore, it is assumed that projecting the visual-spatial information technology of digital maps produces visual-spatial cues which stimulate visual experiences of places. Visual-spatial experiences stimulated by visual information may influence spatial imagery processing.

### *Spatial Orientation*

Spatial orientation has been examined in empirical studies of subjects' ability to navigate both physical and virtual space (Howard & Templeton, 1966). Based on previous studies, spatial orientation is defined as a subject's ability to orient and navigate within a virtual environment. In spatial presence studies, one of the core dimensions of spatial presence is "the sensation of *being physically situated* within the spatial environment portrayed by the medium ('self-location')" (Wirth et al., 2007, p. 497, italics added). Therefore, individuals' self-location perception has been identified with the concept of spatial orientation. This provides an understanding that spatial orientation can be considered a key component of spatial presence.

With regard to the effect of virtual environments on spatial orientation, some studies have reported the results of experiments on spatial disorientation. Kozlowskia & Bryan (1977) wrote that "intense emotional upset can accompany disorientation" (p.

598). In addition, some virtual reality studies also reported different results with regard to spatial orientation in a virtual environment. While some studies have shown enhanced performance in a navigation task by providing learning experiences in a virtual environment(Waller, Hunt, & Knapp, 1998), others address the disorientation some people experience in a 3D virtual environment (Kozlowskia & Bryan (1977). Despite these dichotomous arguments, the spatial orientation studies have consensus in that virtual environments influence spatial orientation in either positive or negative ways.

*Spatial Ability*

Individuals differ in their ability to manipulate spatial information mentally. Scholars have examined the spatial abilities of subjects in various contexts, such as education, psychology, neuroscience, human-computer interaction, the geosciences, and virtual reality (e.g., Hegarty & Kozhevnikov, 1999; Hegarty, Montello, Richardson, Ishikawa, & Lovelace, 2006; Hegarty & Waller, 2005; Kaufmann, Schmalstieg, & Wagner, 2000; Linn & Petersen, 1985; McGee, 1979). Oman et al. (2000) noted that "human orientation and spatial cognition partly depends on our ability to remember sets of visual landmarks and imagine their relationship to us from a different viewpoint" (p. 355). That is, humans tend to keep track of their orientation and location through an effortless and reliable process of sensory integration, but they need to reorient themselves when they face a familiar environment from an unfamiliar direction.

Based on the spatial ability studies, it is assumed that individuals cannot make good use of spatial information if they lack the ability to effectively process that information. Wagner et al. (2009) stated that presence in MR [mixed reality] is influenced by user preferences and prior experiences. Jacobs et al. (1997) reported that "humans learn and remember the location of invisible targets hidden in virtual space on the basis of relations among distal cues" (p. 536). Hence, spatial ability is considered an important characteristic of individuals who are interacting with virtual representations.

In short, two different fields, physical and virtual environment studies, have inspected human spatial relations. However, through the advent of the Internet and virtual reality technology, human spatial experiences are becoming increasingly mixed. To explore mixed spatial experiences obtained from physical and virtual environments, a different approach is needed, which is based on spatial perception studies explaining both physical and virtual environment fields.

## Technology Characteristics

### *Map Interactivity*

The term *interactivity* has been used in different disciplines and is considered critical in evaluating web-based media. Many scholars from various disciplines have defined and measured interactivity (e.g., Aldersey-Williams, 1996; Hoffman, 1996; Kiousis, 2002; Rafaeli, 1988; Steuer, 1992; Wu, 1999). For example, Steuer (1992) defined interactivity as "the extent to which users can participate in modifying the form and content of a mediated environment in real time" (p. 84). Wu (1999) agreed that Steuer's definition "takes into consideration the important role of users in conceptualizing interactivity" (p. 3). Edsall et al. (2008) argued:

> User interaction can alter the themes and base map information that are displayed, the scale and aggregation of the data, the level of detail, the type of map, the classification, the color scheme, the viewing angle, the highlighted elements—interactive maps afford a user an infinite number of representation possibilities, each with the potential to alter mental models and to construct knowledge in a unique way. (p. 1)

In addition, Edsall et al. (2008) claimed that interaction allows "the environment to *compensate for the indispensable deficiencies* arising from representing information on a computer display… [and] helps to *discover unobvious patterns* in data" (p. 3**,** italics in original). The information represented on a digital map contains not only visual-spatial information, but also sound effects (e.g., click sound and audio tours). Based on the various definitions, map interactivity can be defined as the extent to which map viewers can participate in modifying and controlling the form and content of multimedia-spatial information presented on a map. An interactive map interface may display a variety of spatial information combined with different levels of customizability.

Linn (1997) tested the usefulness of interactive maps in students' learning of geography. She conducted both quantitative and qualitative experiments and reported that, while her quantitative studies showed no preference for one learning technique over another, the results of her qualitative studies suggested that students prefer to use computer techniques over more traditional methods in gathering and presenting geographic information to their class. Students feel that they learn more by using an interactive map on their computers.

Collins et al. (1978) evaluated the tutoring effectiveness of an interactive map display called "Map-SCHOLAR." Their experiment showed that students learn geographic content much more easily with the interactive map display than with either a static labeled or unlabeled map. From their review of previous studies, Collins et al. (1978) hypothesize that perceived interactivity and user control can be key factors that determine the different levels of interactivity presented in digital maps.

*Perceived Interactivity*

According to Wu (1999), “perceived interactivity can be defined as a two-component construct consisting of navigation and responsiveness” (p. 6). Using the condition of virtual environments formed by digital maps, and examining user perception of spatial experiences, this study generally adopts Steuer’s and Wu’s definition of interactivity, and measures it in terms of perceived interactivity rather than objective level of interactivity of the map system.

Today’s interactive maps have more visual information layers than ever before which are activated by and customized by user control. In considering the visual aspect of virtual environments, Steuer (1992) measured telepresence in terms of *vividness* and argued that vividness affects telepresence. Wanger et al. (1992) stated that “visual information determines our perception of spatial relationships” (p. 44). In this sense, it is assumed that the perceived interactivity of maps can affect users’ virtual spatial perceptions.

*Perceived User Control*

Measuring presence in virtual reality also adopts user control as a determinant for establishing presence (Witmer & Singer, 1998). For example, “Multi-Degree of Freedom

Control (DOF)" in rotational viewpoints, or control of viewpoints, affects the degree of presence in virtual reality (Demi, 2007). Technologies of modern maps such as Google Earth provide users with multiple degrees of angles and views which affect perceived control over the interaction with the system. For example, navigating environments of 3D buildings on Google Earth can provide higher presence by stimulating spatial cognition of the VE. In addition, users are able to navigate the virtual environment and easily access other sites which are adjunct to the targeted location through the real-time response technologies of the map.

Much of the literature that focuses on human-to-computer interaction (HCI) examines the ways humans control computers and other new media, such as DVDs and video games (e.g., Baecker, Nastos, Posner, & Mawby, 1993; Belkin, Marchetti, & Cool, 1993; Biocca, 1997; Burgoon et al., 2000; Daft, Lengel, & Trevino, 1987; Durlak, 1987; Hanssen, Jankowski, & Etienne, 1996; Heeter, 1989; Huhtamo, 1999; Laurel, 1990; Looms, 1993; Milheim, 1996; Murray, 1997; Naimark, 1990; Nielsen, 2000; Preece, 1993; Schneiderman, 1998; Tan & Nguyen, 1993; Trevino & Webster, 1992; Valacich, Paranka, George, & Nunamaker Jr., 1993; Zeltzer, 1992). From the various studies, it can be understood that user control generally increases perceptions of interactivity for a particular technology.

*Virtual Reality Technology and Spatial Presence*

In 1962, Morton Heilig invented the first virtual reality video arcade, called the "Sensorama Simulator" (Burdea & Coiffet, 2003a, p. 3). It consisted of three-dimensional (3D) video feedback, motion, color, aromas, wind effects, sound, and vibrating seats. Since then, many researchers have studied virtual reality (VR) and its applications in following the evolution of VR technology (e.g., Burdea & Coiffet, 2003b; Fisher, McGreevy, Humphries, & Robinett, 1987; Wagner et al., 2009; Witmer & Singer, 1998).

According to Burdea & Coiffet (2003b), "virtual reality is a high-end user-computer interface that involves real-time simulation and interactions through multiple sensorial channels" (p. 3). The concept of VR has been used in various studies such as computer science, human behavior, presence, psychology, and marketing. There have been many scientific studies of virtual environments, mostly about the construct of presence, or the sense of being there (e.g., Burdea & Coiffet, 2003b; Demi, 2007).

VR applications have been adopted in various scientific fields, such as NASA's pilot training simulations, the Federal Aviation Administration 's aircraft inspection and maintenance systems, and medical surgery procedures (Fisher, 1991; Oman et al., 2000; Reznek, Harter, & Krummel, 2002; Vora et al., 2002). In addition, consumer marketing studies have investigated the effect of VR applications on consumer perceptions of products (e.g., Chiou, Wan, & Lee, 2008; Klein, 2003; Pan, Zhang, & Chen, 2004; Reynolds, 1997).

There are some limitations of virtual representations through VR technology, such as a smaller field of view, reduced detail resolution, and the reliance on mostly visual information in the absence of other sensory input. Additionally, users must learn new navigation mechanics to control movement. Despite these limitations, however, cognitive maps formed through interactions in virtual environments are as good as those formed in physical environments (Maguire et al., 1999).

*3D Virtual Environments, Dynamic Objects and Image Interactivity*

In the field of virtual reality technology, three dimensional graphics are essential system features for virtual environments. Moreover, the term *virtual* tends to be used in studies and applications relevant to 3D virtual environments as a broader conceptual term. For example, tourism websites provide *virtual* tours based on video records, flash photos, and 3D graphic effects.

However, VR technology had not significantly influenced "everyday life" (Bracken & Skalski, 2009, p. 3) in the earlier digital era. The average consumer had not yet been familiarized with virtual reality products. In recent years, however, various 3D films have been released and proved profitable, as noted by Hatch (2010):

> 3D films accounted for 11% of the $10.6 billion worth of ticket sales in the U.S. last year. More than 20 3D movies were released in 2009—including the blockbuster hit *Avatar*—and this propelled a boost to $1.14 billion of 3D ticket sales in 2009, from just $240 million in 2008, the *New York Times*' Media Decoder reports.

In 2010, Amazon.com launched a special webpage promoting 3D televisions which include Internet services. Internet TV services and products have also been released in the digital product and e-commerce markets. This reflects the fact that 3D visual applications of virtual reality technologies such as 3D movies, 3D TV and 3D virtual worlds are fast becoming a part of media consumption in everyday life.

The use of 3D effects in digital worlds is growing rapidly. Some websites and virtual communities integrate 3D visual effects, as well as clickable or movable functions, and other dynamic objects of virtual affordance into their virtual environments. Digital maps have provided 3D features in their map environments, and recently introduced dynamic functions of 3D objects into their map system. The dynamic 3D object features allow users to click and hide the objects in the map environment and view different angels of various objects (e.g., back, front or inside of building views), unlike satellite photo bases (only showing the tops of buildings) and panoramic photos (limited to front or back side views of buildings).

Further, the dynamic 3D features in virtual environments provide interactivity from visual (non-verbal) cues to tourists. As one aspect of interactivity, Fiore and Jin (2003) have defined image interactivity “which provides the ability to create and manipulate images of a product or environment on a Web site” (p.38). For example, image interactivity on an interactive map can allow tourists to alter a presented destination’s viewing angle or distance, and to simulate their navigation through an environment. In addition, recent studies of virtual environments imply that combining 3D graphics and real photos can create a more compelling sense of presence (e.g., Snavely et al., 2006; Stamos & Allen, 2000). For tourism destination marketing strategies, it is crucial to research the effects of interactive maps including 3D dynamic features on tourists’ spatial perception. This study investigates how map interfaces with 3D dynamic objects influence tourists’ spatial experiences when interacting with the map.

# CHAPTER III

# THEORETICAL FRAMEWORK AND HYPOTHESES

Emerging technologies have the potential to increase the interactivity of maps and thereby affect perceptions of spatial experiences. The study proposes that perceived interactivity of maps is a key determinant in influencing spatial experiences created through virtually presented environments.

## Development of Virtual Spatial Experience (VSE) Process

The review of the literature led to the development of a spatial experience process facilitated by an interactive digital map system (Figure 1).

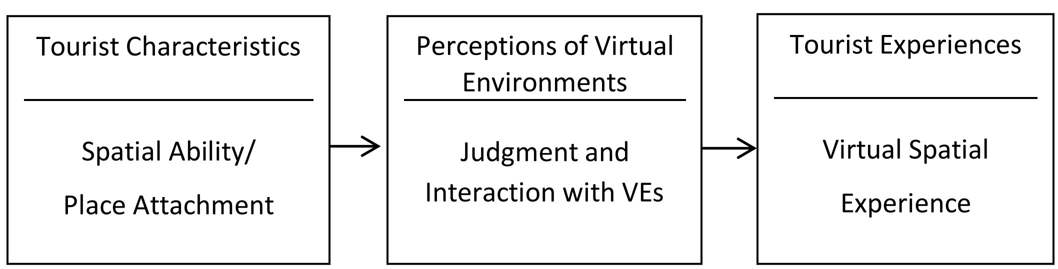


**Figure 1.** Virtual Spatial Experience Process

As shown in the Figure 1, this study conceptualizes how tourists process a place which is virtually represented in an interactive digital map. In the spatial experience process, the individual characteristics of tourists are prior determinants to the interaction with the map. As identified tourist characteristics, this study employs spatial ability and place attachment to the destination presented in the map. It is assumed the tourist characteristics can affect the judgment of the map interface (or design) and virtual environment, thereby influencing users' spatial information perceptions when interacting with the map. These perceptions influence the VSE.

## Development of Hypothesized Model

Based on the conceptual framework shown in Figure 1 and revisited literature, this study developed a hypothesized model (Figure 2).

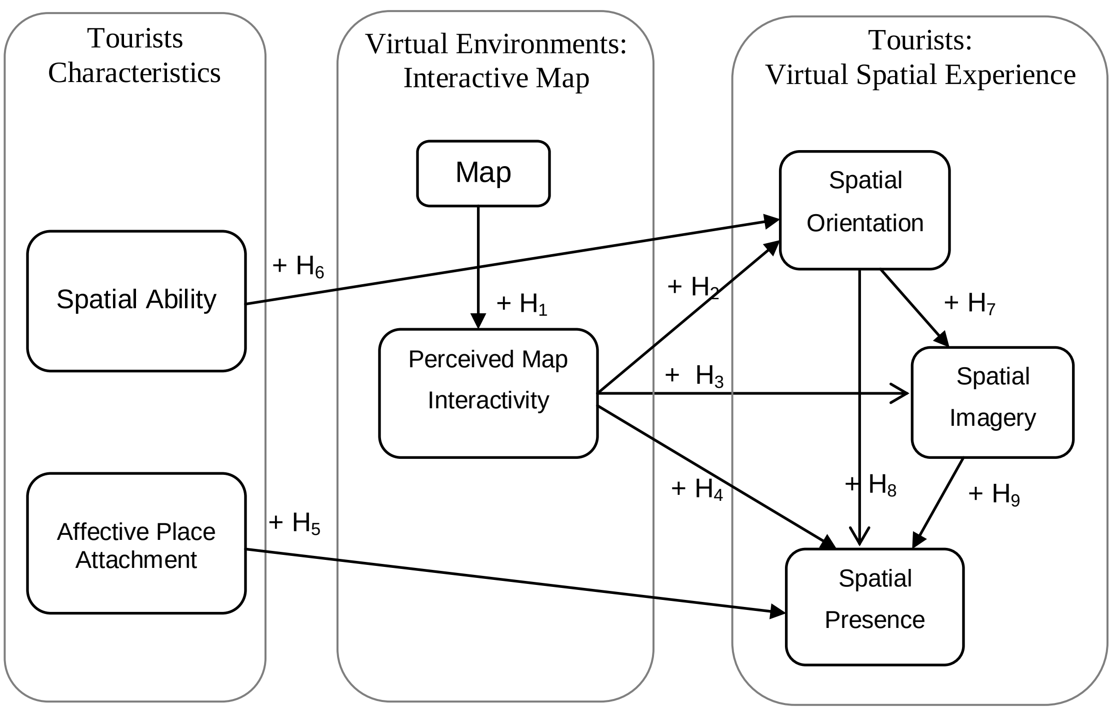


**Figure 2.** Hypothesized Model of Virtual Spatial Experience Formed from an Interactive Map

Figure 2 shows that characteristics of the virtual environment and individuals' characteristics influence the Virtual Spatial Experience (VSE) of the user, which consists of Spatial Imagery, Spatial Orientation and the Spatial Presence experienced. A question arises: could different map interfaces lead to different effects on perceived interactivity and ultimately to an enhanced VSE? To compare the relative effect of the type of interactive map interface on VSE through perceived map interactivity, this study uses two levels of a common map interface: low interactive potential (Google Earth-satellite view map only), and high level of map interactivity (Google Earth x 3D dynamic objects). Perceived Map Interactivity is conceptualized to include Perceived Interactivity and User Control. Individuals' characteristics are identified by Affective Place Attachment and Spatial Ability. This model suggests seven hypotheses, described below.

*Map Interface*

Since most maps present spatial information by various visual resources primarily depending on visual cues, such as pictures, photos, illustrations and figures, customizable visual cues or interacting visual overlays can influence map interactivity. In addition, according to Edsall (2009) map interactivity can be designated from interaction with map systems (e.g., the movement of a mouse impacting the display and the transparency overlay of Google Earth). 3D dynamic objects in the map provide additional visual information and image interactivity to map viewers. Image interactivity is one aspect of interactivity and it offers the ability to create and manipulate images of an environment (Snavely et al., 2006). For example, the Disney World 3D map on Google Earth allows the viewers to manipulate 3D features by clicking, navigating through, and hiding objects. This study suggests, therefore, the 3D dynamic objects increase image interactivity and people perceive relatively higher interactivity from the higher level interactive map which includes 3D dynamic objects/images. Also, this study proposes that people's perception about the system interactivity rather than map types or types of virtual environments is a more direct determinant to investigate their spatial experiences through virtual environments.

***$H_1$:*** Type of Interactive Map Interface will positively influence Perceived Map Interactivity.

***$H_2$:*** Perceived Map Interactivity will positively influence Spatial Orientation.

***$H_3$:*** Perceived Map Interactivity will positively influence Spatial Presence.

***$H_4$:*** Perceived Map Interactivity will positively influence Spatial Imagery.

*Affective Place Attachment*

Place attachment explains the bonding of humans with places (Altman & Low, 1992; Kyle, Absher, & Graefe, 2003). An emotional bond develops between humans and environments in either positive or negative ways. Many place attachment studies concentrated on positive bonds (e.g., Mesch and Manor, 1998). However, some scholars have paid attention to negative feelings and bonds to a place (e.g., Manzo, 2003). To understand the human-place bond, previous studies have investigated the nature of humans' attachment to place in a physical environment. The prior studies have not examined the attachment to virtual environments or the real human-place bond stimulated by a virtual representation.

To understand the influence of place attachment on VSE, this study defines place attachment as the emotional bonds of a human with an environment perceived from indirect or direct exposure to virtual, physical or mixed space. That is, because this study focuses on a physical place presented on a map, a place existing in the real world, it is assumed that some viewers may have prior feelings about the presented place. Regardless of whether people have visited or not, they may have prior feelings about a place. Such feelings may not have a direct impact on a person's ability to perceive or process spatial information such as spatial orientation and spatial imagery, but they could influence a person's sense of place when experiencing a virtual representation by increasing the desire to be virtually at a place through immersion in the virtual environment presented.

Thus, the present study considers attachment to a physical place as a factor attracting a map user’s attention when perceiving the virtual representation of the place. According to Wirth et al. (2007)’s study, factors attracting users' attention influence the construction of spatial situation models, thereby influencing spatial presence. The users' attention can be triggered by the medium (or virtual environment) or the users themselves may devote their attention to the medium because they want to.

Therefore, this study hypothesizes that both positive and negative emotional bonds to a place influence the sensation of the virtual representation, which is the spatial presence of the place). In other words, affective place attachment can influence spatial presence—sense of being there.

***$H_5$:*** Affective Place Attachment to a real place will lead to greater Spatial Presence.

*Spatial Ability and Spatial Orientation*

Spatial orientation has been examined in empirical studies on geographical spatial orientation ability and in navigation tests in virtual environments. The studies have dealt with spatial ability tasks or navigation tasks and found that individuals differ in spatial orientation ability. For example, the studies have paid attention to the differences that occurred from individual characteristics, such as gender, age, and self-assessed spatial ability. Self-location has been identified with the concept of spatial orientation. Hence, this research defines spatial orientation as an individual's ability to orient and navigate within a virtual environment.

In addition, spatial knowledge must be organized in some way for its use during navigation tasks (Darken & Peterson, 2001; McNamara, 1986). Spatial orientation (rough knowledge) is important to develop configurational spatial knowledge (survey knowledge) (Thorndyke & Goldin, 1983). Darken and Peterson (2001) state that although people have not traversed every path of a virtual environment, they can create a path “on-the-fly” because they have “the ability to estimate relative distances and directions between any two points” (p.5). Therefore, regarding the development process of spatial knowledge, it is assumed that spatial imagery can be formed after people have some sense of spatial orientation in an environment. From the studies, two hypotheses are derived.

***$H_6$:*** Spatial Ability will positively influence Spatial Orientation.

***$H_7$:*** Spatial Orientation will lead to greater Spatial Imagery.

***$H_8$:*** Spatial Orientation will lead to greater Spatial Presence.

*Spatial Imagery*

Imagery studies in adverting have shown that visual imagery processing is stimulated by various external sources used in advertising, such as pictures, concrete words, sound effects, and instructions to imagine (Babin & Burns, 1997; Bone & Ellen, 1992). Highly detailed images and combined graphic techniques are more effective than a single technique (El-Hakim, Beraldin, & Picard, 2003). Wirth et al. (2007) suggested that spatial imagery may support the formation of spatial presence while it enhances the cognitive salience of spatial structures and makes it easier to process the spatial quality of virtual environments. Hence, it is assumed that Spatial Imagery influences Spatial Presence, and it can be stimulated by increased map interactivity.

***$H_9$:*** Spatial Imagery will lead to greater Spatial Presence.

# CHAPTER IV

# METHODOLOGY

## Experimental Design

A Web-based experiment was conducted to examine the influence of different map interfaces on perceived map interactivity which in turn was assumed to influence individual virtual spatial experiences. This study employed a between-subject design with two different map interfaces as the treatment. The first level of the map design condition used only satellite photos based on Google Earth maps (see Figure 3). In this first level map view, when users change their view angle to a horizontal view of the area, they only see a sky background and skewed satellite photos of the area (see Appendix A).

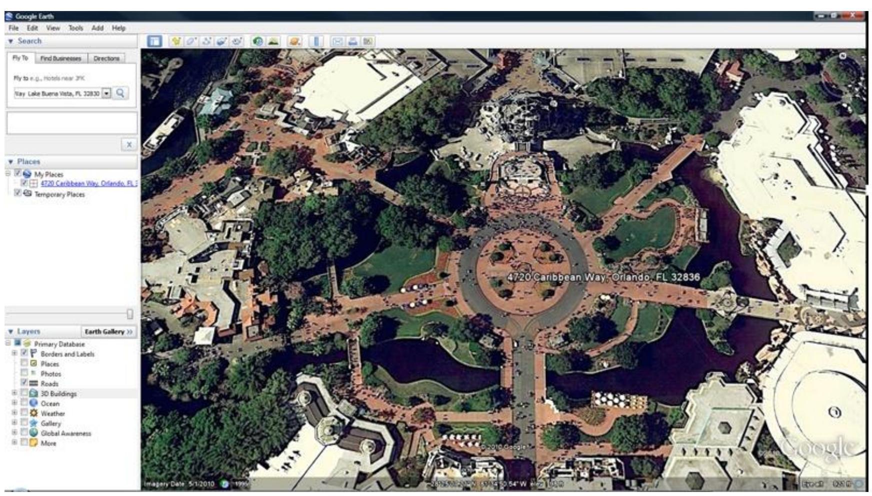


**Figure 3.** The First Level of Interactive Map Interface: Walt Disney World (Magic Kingdom) Map on Google Earth

The second level design contained 3D dynamic objects (3D objects or no 3D objects) (see Figure 4). The 3D objects included hidden overlays which are activated by viewers' clicking actions and allow the viewers to hide 3D objects one by one.

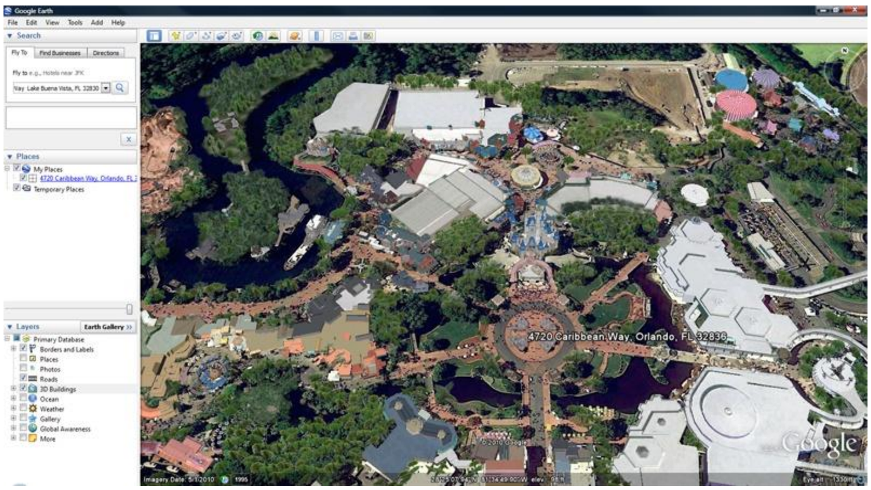


**Figure 4.**The Second Level of Interactive Map Interface: Walt Disney World Map (Magic Kingdom) on Google Earth with 3D Dynamic Objects

Also, the hidden layer of 3D dynamic objects showed additional visual-spatial information when the layer was activated by users' control actions (see Figure 5).

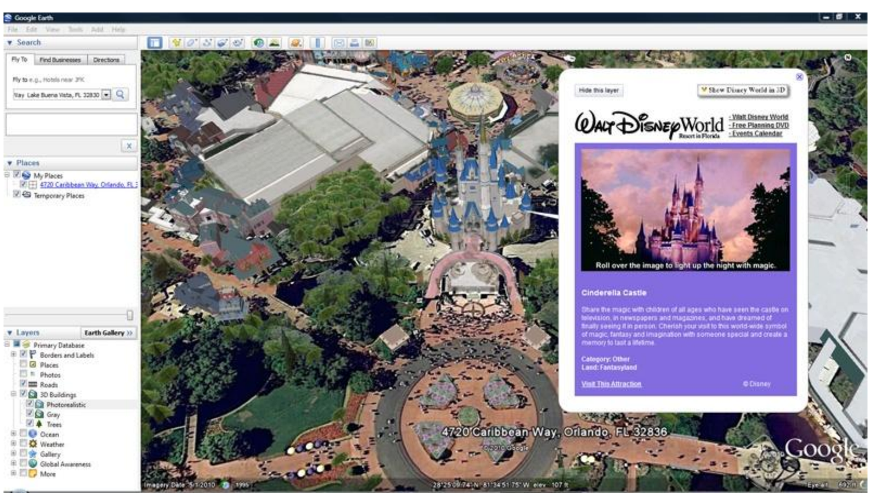


**Figure 5.** Activated (Clicked) 3D Dynamic Object

Figure 6 shows ground level view of the presented area on Google Earth. With the second experimental condition, Google Earth with 3D dynamic objects, people can see buildings and objects on horizontal satellite photos of the presented area.

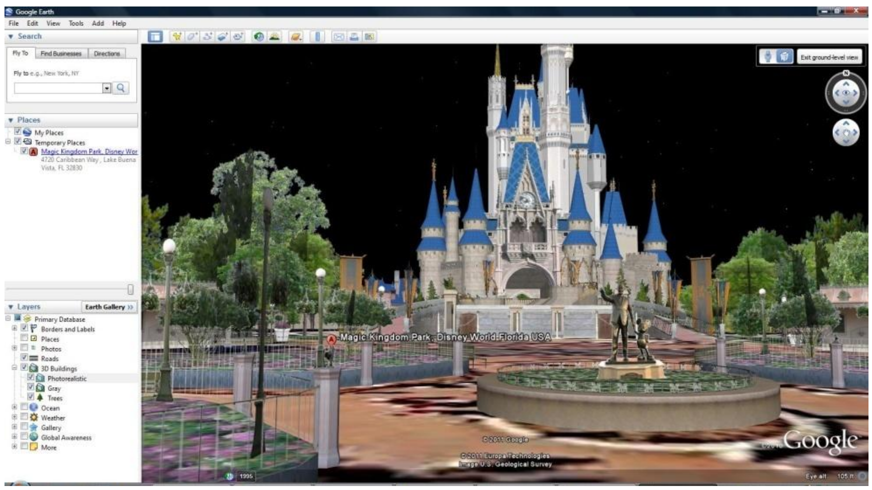


**Figure 6.** The Ground Level View of the Second Level Interactive Map Interface

The study subjects were randomly assigned to one of the two Google Earth map feature treatments (see Appendix A).

## Rationale for Experimental Setting

This study selected Walt Disney World's Magic Kingdom Park area presented on Google Earth as the experimental setting. The selection was made based on the following considerations: first, Walt Disney World is promoted through various media. As a result, it is possible for people to have affective place attachment even if they have never visited the place before. Hence, this study can investigate the effect of people’s affective attachment to a virtually presented place regardless of whether they have visited or not. Second, Walt Disney World created 3D dynamic objects available on Google Earth. To measure the effect of the Type of Interactive Map Interface, this study needs to use accurately represented virtual environments. The 3D dynamic objects provided by Walt Disney World met this demand.

**Measures**

Measurement scales were adapted from psychology and virtual reality studies. Except for the Place Attachment scale, items were tested in a previous study (Go & Gretzel, 2010) as well as extracted and modified from initial study items based on factor analysis results. All the items were measured by 7-point Likert scales and ranged from 1(strongly disagree) to 7(strongly agree).

*Affective Place Attachment*

Since this study employed the definition of place attachment derived from two studies (Kyle et al., 2004; Stedman, 2003a), the instruments from the two studies were adopted to operationalize the Place Attachment construct. In detail, six items were used: Two items from Stedman (2003a) and three items from Kyle et al. (2004) were initially selected and modified to fit the study context. Especially, since the relationship between spatial presence and emotional aspects of sense of place studies has been questioned, the focus of the measure was placed on the Affective Attachment dimension of the existing sense of place scales. For example, “I feel that I can really be myself there” (Stedman, 2003a), and “I feel a strong sense of belonging to…” (Kyle et al., 2004). In addition to the positive affective aspects of place attachment, Manzo (2003) investigated how negative feelings toward a place are important in understanding the people-place bond. Therefore, one question measuring negative feelings toward a place was developed and added in order to better examine the nature of affective attachments toward a place (see Appendix B).

*Spatial Ability*

To measure Spatial Ability, nine highly internally consistent items (based on Go and Gretzel’s (2010) study results) among sixteen items from the Santa Barbara Sense of Direction Scale (Hegarty & Waller, 2005) were selected (see Appendix B). For instance, “I am very good at giving directions” is one of the items used to measure spatial ability.

*Virtual Spatial Experiences*

For Spatial Presence, this research adopted eight items: four items from the “Sense of Being There” presence questionnaire (Witmer & Singer, 1998), and four items from the Spatial Presence Self-Location (SPSL) scale (Vorderer et al., 2004). To assess Spatial Orientation, six items from the Spatial Situation Model (SSM) questions were used (Vorderer et al., 2004). In terms of Spatial Imagery, five items among seven items from the Visual Spatial Imagery (VSI) questionnaire (Vorderer et al., 2004) and three items among twelve items from the Mental Imagery (MI) questionnaire (Blajenkova, Kozhevnikov, & Motes, 2006) were employed and modified. For example, subjects were asked the following questions: “I was able to imagine the arrangement of the spaces presented in the map very well” (see Appendix B).

*Perceived Map Interactivity*

For map interactivity measurements, perceived interactivity and user control are considered key factors that determine the different levels of interactivity presented in digital maps (Collins et al., 1978). Five items from the Perceived Interactivity (PI) questionnaire (Wu, 1999) and the User Control (UC) questionnaire (Wu, 1999) and two items from the Control Factor (CF) questionnaire (Witmer & Singer, 1998) were adopted. For example, “While I read the map, I was always aware where I was” and “I was in control over the information display format when using this map” are examples of items included to measure Perceived Map Interactivity (see Appendix B).

**Procedure**

Participants in all conditions were asked to answer two online surveys during an experiment. Survey 1 contained questions regarding Spatial Ability and Place Attachment. Survey 2 consisted of questions measuring Perceived Map Interactivity and Virtual Spatial Experiences (Spatial Orientation, Spatial Imagery, and Spatial Presence).

The experiment was conducted in the following steps. In the first step, participants were greeted and seated in front of a computer. The computer showed an introductory screen explaining the goal of the study and the steps involved in completing the experiment. To measure independently the effect of tourist characteristics on tourist virtual spatial experiences in the absence of the effect of map interactivity, Spatial Ability and Place Attachment questions were asked before the subjects were exposed to the experimental treatments. Thus, in the second step, participants were asked to take survey 1, which included questions regarding two constructs: Spatial Ability and Place Attachment. They also received instructions regarding how to use navigation keys (or menus). In the third step, participants were randomly assigned to one of the experimental conditions and were asked to freely navigate the map environment. After exploring the map, participants were asked to complete survey 2, which consisted of questionnaires pertaining to Perceived Map Interactivity and Virtual Spatial Experiences. After answering all the questions, all subjects were thanked, and debriefed.

With regards to exposure time, some studies have shown that time spent affects telepresence (Klein, 2003) and level of exposure to a stimulus influences object evaluation (Zajonc, 2001). However, in the real world, individual users navigate freely around the map in their own time frame. Therefore, this study did not limit the time of treatment exposure, but ensured that each subject really navigated the study environment in the map.

**Pre-test**

Pre-tests were conducted to test the overall experimental design as well as the measurement scales. Participants totaled fifteen, consisting of twelve graduate students and one professor from the Department of Recreation, Park and Tourism Science and two graduate students from the Department of Electronic Engineering at Texas A&M

University. They were asked to explore one of the conditions and complete the online surveys.

Pre-tests checked the effectiveness of the type of interactive map interface manipulations for the two experimental conditions (Google Earth map with satellite photo only vs. Google Earth map with 3D dynamic objects). The survey items were evaluated in terms of face and construct validity. All items were kept and two additional questions regarding participants' previous 3D experiences were added. In specific, the question "have you ever experienced a 3D virtual world or environment…" was modified to "have you ever experienced a 3D game or virtual world before…" and one question, "have you ever experienced a 3D movie before…" was created based on the feedback received.

The results of the pre-tests showed that there was no significant difference of Perceived Interactivity between the two map interfaces. However, after the pre-test experiment, pre-test participants had a chance to see the other map and indicate whether they felt the level of the map interactivity differed from the map they initially saw. The pre-test participants indicated then that treatment 2 (Google Earth with 3D) provided a higher level of interactivity. Therefore, this study determined to keep the original treatment with no further change.

**Participants**

For participants, this study recruited a total of 222 undergraduate or graduate students at Texas A&M University. Among the participants, 182 students were randomly approached on campus and 40 students were recruited from an undergraduate level class offered at the Department of Recreation, Parks and Tourism Science.

11 respondents were not included in the final data analysis. Two respondents were exposed to both conditions during the experiment. These two violated the instruction “do not make any change on the menu bar of Google Earth”, turned on the menu slide and clicked the button for viewing 3D buildings. Also, 9 respondents were of Asian descent. The reasons for deleting these 9 respondents were determined based on an argument that there is a difference in geographical thinking between Asians and Westerners (Nisbett, 2003). As a result, a total of 211 were included in the data analysis.

The 3D Google Earth map condition received 108 responses and Google Earth map with satellite condition received 103 responses. For investigating the profile of the study participants, additional questions were included in the survey (see Appendix B). Based on the information from the additional questions, more female participants (61.6%) took part in the study. The majority of the respondents were ages 18 through 24, and people who have been to Walt Disney World were 53.1% of the total respondents (see Table 1). 52.7% of the people who had visited went to Disney World in Florida within 6 years prior to participating in the study.

Only 2.8% of the participants responded that they do not like Disney World (a place attachment item (AP07) was used for this interpretation). However, a t-test reported that there was no significant difference for people disliking Disney world on any of the study constructs except Place Attachment ($t_{209} = -5.517$, $p=0.000$).

**Table 1.**

Profile of Respondents

| **Profile of Respondents** | *%* |
|---|---|
| **Gender** | |
| Female | 61.6 |
| Male | 38.4 |
| **Age** | |
| 18-24 | 92.4 |
| 25-34 | 6.2 |
| 35-44 | 0.9 |
| 45-49 | 0.5 |
| 50 older | 0 |
| **Google Earth Use** | |
| Haveused Google Earth | 87.2 |
| **3D Movie** | |
| Have watched 3D movie | 94.3 |
| **3D Virtual Environment** | |
| Have experienced 3D virtual environments | 55.5 |
| **Visitation** | |
| Have visited Disney World, Fl | 53.1 |
| Visitation year | |
| 2011-2005 | 52.7 |
| 2004-2000 | 26.8 |
| 1999-1995 | 16.0 |
| 1994-1990 | 4.5 |

*Effect of Gender, Pre-visit, and 3D Movie Experience*

With regard to the effects of other factors in the participant profile on virtual spatial experience, this study used a group t-test to check whether there was a significant difference among the groups or not. The t-test showed that there is a significant difference for gender in spatial ability, spatial presence and place attachment (see Table 2). Mean values for females were lower than males in spatial ability (mean: Female=4.22, SD=1.39 vs. Male=4.80, SD=1.11, Cohen's $d$= -0.46, $r$= -0.23) and higher in spatial presence (mean: Female=4.24, SD=1.35 vs. Male=3.80, SD=1.34, Cohen's *d*=0.32, *r*=0.16) and place attachment (mean: Female=4.72, SD=1.17 vs. Male=4.12, SD=1.08, Cohen's *d*=0.77, *r*=0.36).

**Table 2.**
T-test Results for Gender Effect

| Independent Variable | Dependent Variables | T | P-Value |
|---|---|---|---|
| Gender | **Spatial Ability** | **-3.202** | **.002** |
| | **Affective Place Attachment*** | **3.748** | **.000** |
| | Perceived Map Interactivity | 1.329 | .185 |
| | Spatial Orientation | -0.604 | .546 |
| | Spatial Imagery | 1.279 | .203 |
| | **Spatial Presence** | **2.269** | **.025** |

In terms of place attachment, the t-test indicated that there is a significant difference in Place Attachment between people who had watched 3D movies before and people who had not (see Table 3). The mean difference between the group was 1 (mean: Watched 3D movies=4.54, SD=1.15 vs. No 3D movies=3.54, SD=1.23, Cohen's *d*=0.84, *r*=0.39). This is not surprising as Disney also produces 3D movies.

**Table 3.**
T-test Results for 3D Movie Effect

| Independent Variable | Dependent Variables | T | P-Value |
|---|---|---|---|
| 3D Movies | Spatial Ability | 0.275 | 0.783 |
| | **Affective Place Attachment*** | **2.738** | **0.018** |
| | Perceived Map Interactivity | 0.057 | 0.955 |
| | Spatial Orientation | 0.304 | 0.734 |
| | Spatial Imagery | -0.229 | 0.819 |
| | Spatial Presence | -0.391 | 0.696 |

In addition, with regard to place attachment, the t-test showed that there is a significant difference between people who had visited Walt Disney World in Florida and people who had not (see Table 4). The mean difference between the group was 0.46 (mean: visit= 4.70, SD=1.16 vs. No-visit= 4.24, SD=1.15, Cohen's *d*=0.39, *r*=0.19).

**Table 4.**
T-test Results for Pre-visitation Effect

| Independent Variable | Dependent Variables | T | P-Value |
|---|---|---|---|
| Pre-visitation | Spatial Ability | 0.275 | .783 |
| | **Affective Place Attachment*** | **2.849** | **.005** |
| | Perceived Map Interactivity | 0.057 | .955 |
| | Spatial Orientation | 0.304 | .734 |
| | Spatial Imagery | -0.229 | .819 |
| | Spatial Presence | -0.391 | .696 |

## Manipulation Check

The results showed that there was a difference in the perceived map interactivity between Google Earth satellite photo only and Google Earth with 3D dynamic objects. Among survey participants, 48.8% of the participants saw Google Earth with satellite photo only, and 51.2% of the participants explored Google Earth with 3D dynamic objects. According to the t-test result, the 3D map interface was perceived as significantly more interactive (Table 5). As shown in Table 6, the two treatments were significantly different (t-value=6.504, p <0.001, effect-size* *r= 0.41, Cohen's d** =0.90, * values were computed based on Wilson, Becker and Tinker's (1995) formula).

**Table 5.**

Mean Difference for Perceived Map Interactivity and Type of Interactive Map Interface

| | Map | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| **PI** | 3D | 108 | 5.7646 | .87199 | .08391 |
| | No3D | 103 | 4.7878 | 1.26404 | .12455 |

**Table 6.**

T-test Results for Perceived Map Interactivity and Type of Interactive Map Interface

| | Levene's Test | | t-test for Equality of Means | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | 95% Confidence Interval | |
| | F | Sig. | T | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference | Lower | Upper |
| **PI** | 15.378 | .000 | 6.504 | 180.211 | .000 | .97676 | .15018 | .68043 | 1.27309 |

## Data Analysis

*Structural Equation Modeling (SEM)*

To test the hypothesized research model, LISREL 8.70 was used to construct a structural equation model (Jöreskog & Sörbom, 2002). Structural equation modeling (SEM) examines various types of models to depict relationships among observed and latent variables (Schumacker & Lomax, 2004). Importantly, SEM examines the measurement error in the indicators and simultaneously estimates a structural equation model (Bollen, 1989).

SEM has commonly been employed for non-experimental survey studies rather than experimental design studies (Bagozzi & Yi, 1988). However, SEM for experimental data analysis has been supported by scholars (Alwin & Tessler, 1974; Bagozzi & Yi, 1988; Mackenzie, 2001). Measurement error in the covariance that is related to the experimental effect can be assessed by SEM analysis; therefore, using SEM increases the possibility that valid experimental effects will be detected. Accordingly, the SEM procedure for experimental research does not contain the restrictive assumption of homogeneity in variances and covariance of the dependent variables across groups (Bagozzi & Yi, 1988).

*Model Specification*

The procedure of specifying a model involved two different models: the measurement model and the structural model (Anderson & Gerbing, 1988). The measurement model presents the relationships between observed variables and their corresponding latent variables. For using LISREL, a full measurement equation model was generated as follows (1), (2).

$$X = \Lambda_x \xi + \delta \quad (1)$$

$$Y = \Lambda_{y\eta} + \varepsilon \quad (2)$$

Equation (1) is for exogenous variables and equation (2) is for endogenous variables. In the formulation, where $X$ is the $q * 1$ vector of observed variables; $Y$ is the $p * 1$ vector of observed responses; $\Lambda_x$ is the $q * n$ matrix of regression coefficients of x on $\xi$; $\Lambda_y$ is the $p * m$ matrix of coefficients of the regression $y$ on $\eta$; $\xi$ is an $n * 1$ random vector of an independent exogenous variable; $\eta$ is an $m * 1$ random vector of latent dependent or exogenous variables; and $\delta$ and $\varepsilon$ and $q * 1$ and $p * 1$ vectors of measurement errors in $x$ and $y$, respectively (Bollen, 1989).

The research model included one exogenous variable representing the two experimental conditions: satellite photo map ($\xi_1$) and 3D objects interactive map ($\xi_2$); and two other exogenous variables measuring Spatial Ability ($\xi_3$) and Affective Place Attachment ($\xi_4$). Also, the research model contained four endogenous variables: Perceived Interactivity ($\eta_1$), Spatial Orientation ($\eta_2$), Spatial Imagery ($\eta_3$), and Spatial Presence ($\eta_4$).

The mathematical formulation of the causal structural portion of the model is as follows (3):

$$\eta = B\eta + \Gamma\xi + \zeta \quad (3)$$

Where $B$ represents an $m$ x $m$ regression matrix that relates the $m$ endogenous factors ($\eta s$) to one another; $\Gamma$ is the $m$ x $n$ matrix depicting the regression of $n$ exogenous constructs ($\xi s$) on m endogenous variable ($\eta s$) (Bollen, 1989). In this study, the structural model tested the hypothesized relationship between one exogenous categorical (experimental condition) variable, two exogenous constructs and four endogenous constructs (see Figure 7).

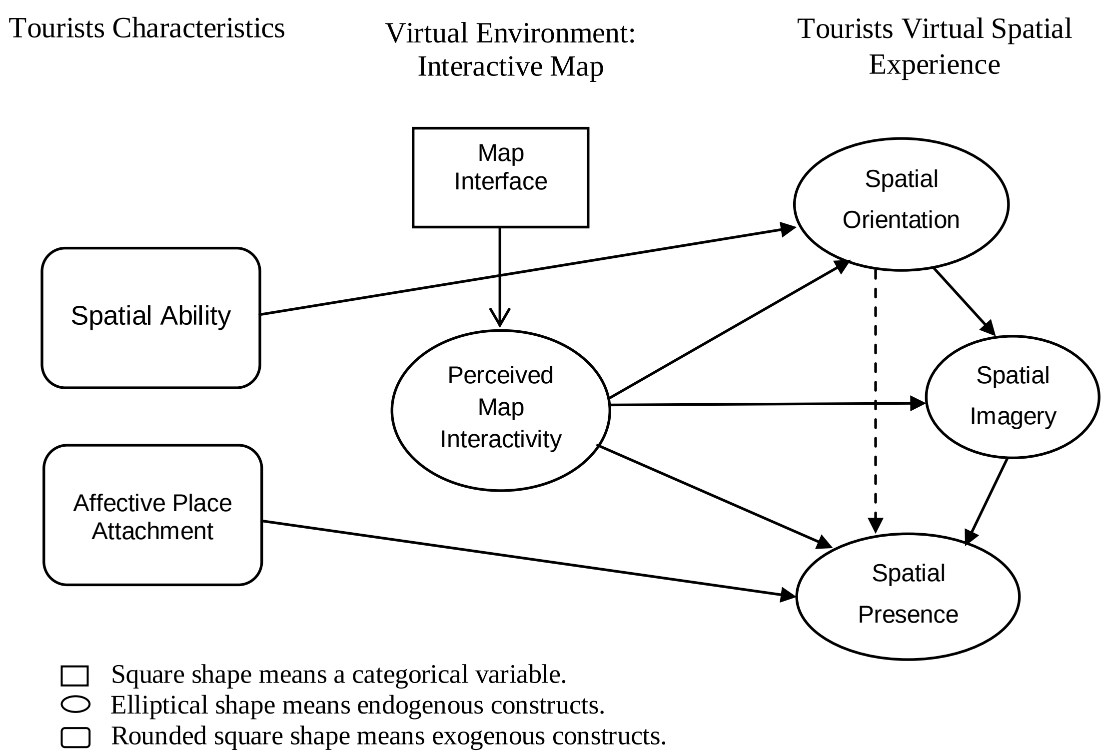


**Figure 7.** Relationships among the Research Constructs

*Selection of an Indicator Structure*

The selection of an indicator structure involves special considerations in terms of research purposes and conceptualizations of the latent constructs (Byrne, 1998). Latent constructs using a single indicator can have issues such as making identification difficult (Bollen, 1989) and being associated with a higher likelihood of an improper solution on SEM fit indices (Ding, Velicer, & Harlow, 1995). Therefore, valid latent constructs require three or four items per latent construct in order to reduce the chance of rendering an improper solution and making identification difficult. This study used a sufficient number of indicators per latent construct: Affective Place Attachment (seven items), Spatial Ability (ten items), Perceived Interactivity (seven items), Spatial Orientation (six items), Spatial Imagery (eight items), and Spatial Presence (eight items).

*Testing for Construct Validity*

A two-step approach has been adopted based on Anderson and Gerbing (1988)'s suggestion. First, the fit of the measurement model was examined. Second, the structural model with the accepted measurement model was assessed. A confirmatory factor analysis (CFA) was conducted using a series of procedures. On the grounds of the CFA results, a measurement model was established and used for assessing the structural equation model.

As CFA results, loading values, composite reliability, discriminant validity and convergent validity were estimated to confirm adequate internal consistency and unidimensionality (Anderson & Gerbing, 1988). A factor loading value less than positive and negative 0.30 (±0.3) was considered as a minimal level; a loading value greater than positive and negative 0.5 (±0.5) was considered as practically significant (Hair, Anderson, Tatham, & Black, 1998).

A composite reliability score over 0.70 was considered to be an adequate indicator for validating the internal consistency of factors. To confirm construct validity, convergent and discriminant validity were assessed. Convergent validity of the model was identified by analyzing the magnitude, factor loading values and squared multiple correlations. Discriminant validity between the constructs was tested by investigating inter-factor correlations between the constructs (Phi coefficient in LISREL). In addition, the average variance-extracted estimates (AVE) measured the amount of variance captured by the factors. The desirable level of variance captured is 50% or greater. Using AVE, discriminant validity was confirmed when AVE was greater than the squared correlation of the constructs (Fornell & Larcker, 1981).

The unidimensionality of the measurement model was evaluated by overall model fit indices. Chi-square statistic with one degree of freedom has been commonly used as evidence for assessing the overall goodness of fit (Byrne, 1998; Fornell & Larcker, 1981). In practice, the chi-square test, however, is not robust under violations of underlying assumptions (in particular, normality assumptions) and may be heavily influenced by sample size (Anderson & Gerbing, 1988; Jöreskog & Sörbom, 1996). Hence, the chi-square index was used more generally as a measure of fit than as a strict test statistic (Jöreskog & Sörbom, 1996).

Accordingly, this study used different indices such as root mean square error of approximation (RMSEA), normed fit index (NFI), and comparative fit index (CFI) to assess model fit (Bagozzi & Yi, 1988; Byrne, 1998). NFI and CFI values close to 1.00 indicate a good fit and values greater than 0.90 are acceptable. RMSEA with less than 0.05 indicates a good fit. RMSEA over 0.08 indicates that there are reasonable errors of approximation in the population.

*Sample Size*

For analyzing the data, the study sample size (*N=211*) was regarded as adequate to provide sufficient statistical power. Using SEM analysis, the sample size is important to assess if the study data is sufficient to estimate parameters and determine model fit given the specific theoretical relationships among latent variables (Schumacker & Lomax, 2004). Schreiber et al. (2001) mentioned that the adequate sample size is 10 respondents for every indicator. Boomsma (1982) suggested that any number above 200 is sufficient to estimate model fit. Anderson and Gerbing (1988) suggested that a sample size of 150 or more is typically required to provide parameter estimates with standard errors which are small enough to be of practical use when the normality assumption was fully met. Also, Ding et al. (1995) claimed that 100 to 150 subjects is the minimum satisfactory sample size.

*Data Screening and Diagnosing Assumptions*

For preliminary analyses, this study used the PRELIS program combined with LISREL 8.7 software and SPSS 16 for data screening. The data was investigated for any coding errors in the following steps: First, raw data was inserted into an SPSS file while the nine negative items were recorded reversely. The data was screened to check that all entries were correctly coded without errors through conducting a frequency analysis. Except for the items regarding participants' major and visitation years (for non-previsitors), there was no missing value in the data set because all questions were forced response questions.

*Input Matrix*

For the data analysis, this study used a variance-covariance matrix as an input matrix. The variance-covariance matrix was comprised of variance terms on the diagonal and covariance terms on the off-diagonal. The variance-covariance matrix shows that the research hypothesized model includes three different matrices, the covariance matrix of the observed indicators of the latent endogenous variables, the covariance matrix of the indicators of the latent exogenous variables and the covariance matrix of the indicators between latent endogenous and latent exogenous variables (Cziráky, Sambt, Rovan, & Puljiz, 2006).

In addition, SEM is based on normality assumptions for the latent endogenous variables. If the endogenous latent constructs are dichotomous or ordinal, the study has to use a polychoric correlation matrix as an input matrix. However, if the exogenous variables are dichotomous, the analysis does not need to use a polychoric correlation matrix (Muthén & Christoffersson, 1981). This study used a single dichotomous exogenous variable (two map interfaces) for the input matrix, but the TE (Theta-epsilon) matrix (variances/covariances of the measurement error variables) was specially modified for the single exogenous variable.

# CHAPTER V

# RESULTS

## Measurement Model

The study measured 46 indicators of a model that was comprised of one single exogenous variable (Type of Interactive Map Interface) and six latent constructs (Spatial Ability, Affective Place Attachment, Perceived Map Interactivity, Spatial Orientation, Spatial Imagery and Spatial Presence).The CFA results of the measurement model showed that the overall fit of the confirmatory factor model was adequate. The indicators of the CFA model fits were $\chi^2_{(df=969)}$ =1563.858 at p=0.00, RMSEA =0.053, NFI =0.93, NNFI=0.97, CFI = 0.97, ECVI=8.379. The measurement model depicted adequate internal consistency and unidimensionality supported by loading values and composite reliability values, convergent and discriminate validity test results (see Table 7). Composite reliability and AVE of each construct were computed to assess the internal consistency of the latent construct in the proposed measurement model (Fornell & Larcker, 1981). As shown in Table 7, all values of the composite reliability ranged from 0.86 to 0.93 and AVE of all the constructs exceeded 0.7. As a result, it is established that the proposed measurement model maintains internal consistency.

Convergent validity was evaluated by investigating the squared multiple correlations (SMC) and analyzing the significance and magnitude of the indicator's estimate coefficient on its specified underlying construct (Anderson & Gerbing, 1988).

The SMC ranged from 0.180 to 0.782; factor loading values ranged from 0.598 to 0.88 and t-values exhibited convergent validity of the measurement model (see Table 8).

Discriminant validity was assessed by testing AVE and squared correlations between constructs. Discriminant validity is accomplished when AVE is greater than the squared correlation between the constructs (Fornell & Larcker, 1981). The smallest AVE of the construct was 0.76 (Spatial Orientation), but the largest squared correlation between the construct (Spatial Orientation and Spatial Imagery) was 0.73 (see Table 7 and 8). Therefore, discriminant validity of constructs was achieved. Furthermore, CFA results identified the measurement adequacy of all six latent constructs displayed in the structural model.

**Table 7.**

The Results of the Measurement Model

| *Construct/Item* | *Factor Loadings* | *t-value* | *Mean* | *$R^2$* | *Composite Reliability* | *AVE* |
|---|---|---|---|---|---|---|
| **Affective Place Attachment** | | | | | 0.89 | 0.82 |
| AP01 | 0.85 | [b] - | 3.83 | | | |
| AP02 | 0.78 | 13.06 | 3.57 | | | |
| AP03 | 0.80 | 13.57 | 3.63 | | | |
| AP04 | 0.71 | 11.34 | 4.05 | | | |
| AP05 | 0.67 | 10.59 | 4.88 | | | |
| AP06 | 0.71 | 11.41 | 5.55 | | | |
| AP07 | 0.65 | 10.14 | 5.90 | | | |
| **Spatial Ability** | | | | | 0.91 | 0.85 |
| SA01 | 0.67 | [b] - | 4.43 | | | |
| SA02 | 0.88 | 11.19 | 4.86 | | | |
| SA03 | 0.72 | 9.45 | 3.75 | | | |
| SA04 | 0.69 | 9.05 | 4.74 | | | |
| SA05 | 0.87 | 11.04 | 4.89 | | | |

**Table 7.**
Continued.

| *Construct/Item* | *Factor Loadings* | *t-value* | *Mean* | $R^2$ | *Composite Reliability* | *AVE* |
|---|---|---|---|---|---|---|
| SA06 | 0.70 | 9.18 | 4.83 | | | |
| SA07 | 0.66 | 8.75 | 3.85 | | | |
| SA08 | 0.72 | 9.42 | 4.05 | | | |
| SA09 | 0.69 | 9.09 | 4.60 | | | |
| **Perceived Map Interactivity** | | | | 0.18 | 0.91 | 0.86 |
| PI01 | 0.74 | [b] - | 5.06 | | | |
| PI02 | 0.76 | 11.05 | 5.24 | | | |
| PI03 | 0.78 | 11.29 | 5.46 | | | |
| PI04 | 0.87 | 12.74 | 5.55 | | | |
| PI05 | 0.84 | 12.16 | 5.54 | | | |
| PI06 | 0.77 | 11.09 | 5.45 | | | |
| PI07 | 0.65 | 9.24 | 4.71 | | | |
| **Spatial Orientation** | | | | 0.29 | 0.86 | 0.76 |
| SO01 | 0.78 | [b] - | 4.94 | | | |
| SO02 | 0.74 | 11.20 | 4.57 | | | |
| SO03 | 0.65 | 9.59 | 4.85 | | | |
| SO04 | 0.68 | 10.08 | 4.95 | | | |
| SO05 | 0.64 | 9.35 | 3.88 | | | |
| SO06 | 0.77 | 11.69 | 4.44 | | | |
| **Spatial Imagery** | | | | 0.78 | 0.93 | 0.90 |
| SI01 | 0.85 | [b] - | 4.9 | | | |
| SI02 | 0.87 | 16.88 | 4.91 | | | |
| SI03 | 0.81 | 14.89 | 4.8 | | | |
| SI04 | 0.81 | 14.88 | 4.59 | | | |
| SI05 | 0.84 | 15.67 | 5.05 | | | |
| SI06 | 0.69 | 11.55 | 4.55 | | | |
| SI07 | 0.86 | 16.57 | 4.83 | | | |
| SI08 | 0.60 | 9.57 | 4.73 | | | |

**Table 7.**
Continued.

| *Construct/Item* | *Factor Loadings* | *t-value* | *Mean* | *$R^2$* | *Composite Reliability* | *AVE* |
|---|---|---|---|---|---|---|
| **Spatial Presence** | | | | 0.46 | 0.94 | 0.91 |
| SP01 | 0.83 | [b] - | 4.33 | | | |
| SP02 | 0.82 | 14.64 | 4.03 | | | |
| SP03 | 0.81 | 14.22 | 4.22 | | | |
| SP04 | 0.73 | 12.30 | 4.03 | | | |
| SP05 | 0.85 | 15.49 | 3.8 | | | |
| SP06 | 0.81 | 14.11 | 4.09 | | | |
| SP07 | 0.78 | 13.49 | 3.98 | | | |
| SP08 | 0.87 | 15.88 | 4.09 | | | |

Note: [a] if t>3,291, significant at p<0.001. [b] Reference Indicators. CFA loading=Completely standardized estimate. Model fit indices: $\chi^2_{(df=1014)}$ =1639.243 at p=0.0, RMSEA =0.055, NFI =0.93, CFI = 0.97. All items were scored from 1 "strongly disagree" to 7 "strongly agree" (n=211). Composite reliability and Ave is computed based on Fornell and Larker's (1981) formula

**Table 8.**

Correlation Matrix of Constructs

| | MAP | APA | SA | PI | SO | SI |
|---|---|---|---|---|---|---|
| MAP | 1.00 | | | | | |
| APA | -0.03<br>(-0.407) | 1.00 | | | | |
| SA | 0.01<br>(0.126) | -0.01<br>(-0.115) | 1.00 | | | |
| PI | 0.41<br>(5.042)* | 0.14<br>(1.871) | 0.04<br>(0.427) | 1.00 | | |
| SO | 0.27<br>(3.463) | 0.13<br>(1.619) | 0.28<br>(3.486) | 0.46<br>(5.058) | 1.00 | |
| SI | 0.32<br>(4.281) | 0.16<br>(2.086) | 0.24<br>(2.990) | 0.59<br>(6.218) | 0.86<br>(7.678) | 1.00 |
| SP | 0.40<br>(5.106) | 0.31<br>(3.859) | 0.04<br>(0.495) | 0.57<br>(5.993) | 0.52<br>(5.700) | 0.60<br>(6.594) |

**t-value: if t>3.291, significant at p<0.001*

**Overall Fit of the Hypothesized Structural Model**

*Model Fit*

The overall fit of the structural research model was $\chi^2_{(df=981)}$ =1585.858 at p=0.00, $\chi^2_{/df=}$1.62, RMSEA =0.054, NFI =0.93, NNFI=0.97, CFI = 0.97, with the overall fit indices representing a relatively good model fit. The ratio of $\chi^2$ to degree of freedom (normalized $\chi^2$) was 1.62, which is considered an adequate model fit (Gefen, Straub, & Boudreau, 2000).

The squared multiple correlations (SMC) were used to assess the extent to which the model explains the variance in the data set. The model explained Spatial Imagery (SMC=0.78) and Spatial Presence (0.45) fairly well, explained Spatial Orientation (SMC=0.29) reasonably well, and moderately explained Perceived Interactivity (SMC=0.18).

*Parameter Estimates*

The overall model fit indices provide a summary of the parameter estimates with the statistic significance. The result shows path coefficients of the research (see Figure 8). The path coefficient is a standardized regression coefficient (beta) which depicts the direct effect of an independent variable on a dependent variable. First, Type of Interactive Map Interface positively influenced Perceived Map Interactivity (path coefficient = 0.43, at t=6.01, $p<0.05$). This result supported $H_1$ and implied that the second type of Interactive Map Interface (3D dynamic objects with Google Earth) leads to greater Perceived Map Interactivity.

Second, the path coefficient exhibited that Perceived Map Interactivity had positive effects on Spatial Orientation (path coefficient= 0.46, at t=5.95, $p<0.05$ ). This result proved $H_2$ and suggested that Perceived Map Interactivity leads to greater Spatial Orientation. In addition, Perceived Map Interactivity positively influenced Spatial Imagery (path coefficient= 0.25, at t=4.68 $p<0.05$). This result, which supported $H_3$, implied that perceiving higher map interactivity also increases spatial imagery of the place presented in the map. Furthermore, Perceived Map Interactivity influenced Spatial Presence (path coefficient=0.33, at t=4.18 $p<0.05$). This result verified $H_4$ and implied that higher perceived map interactivity results in greater perceptions of spatial presence.

Third, as shown in the path model (see Figure 8), Affective Place Attachment affected Spatial Presence (path coefficient=0.21, at t= 3.58, $p<0.05$). This result supported $H_5$ and indicated that tourists' positive feelings toward a place generate a higher "sense of being there" when experiencing the map.

Fourth, the path coefficient showed that Spatial Ability positively influenced Spatial Orientation (path coefficient= 0.28, at t=3.86, $p<0.05$). This result proved $H_6$ and suggested that having higher spatial ability leads to greater spatial orientation.

Fifth, the analysis showed that Spatial Orientation had significant influences on Spatial Imagery (path coefficient=0.74, at t=10.25, $p<0.05$). As a result, $H_7$ was supported. This result indicated that greater spatial orientation yields greater spatial imagery.

Sixth, however, the results also showed that the impact of Spatial Orientation on Spatial Presence was not significant (path coefficient=0.07, at t=0.47, $p<0.05$). Hence,

$H_8$ was not supported. This result implied that spatial orientation has no significant direct influence on spatial presence.

Finally, as shown in the path model, Spatial Imagery positively influenced Spatial Presence (path coefficient= 0.33, at t= 2.16, p<0.05). This result proved $H_9$ and indicated that greater spatial imagery leads to greater spatial presence.

The verification of both $H_7$ and $H_9$ and the insignificant result with regards to $H_{8,}$ implied that there was no direct effect between Spatial Orientation and Spatial Presence. Rather, the impact of Spatial Orientation on Spatial Presence was fully mediated by Spatial ImageryWith regard to the indirect effect of Spatial Orientation on Spatial Presence, the path through Spatial Imagery (Sobel=4.599, $p$<.001) was statistically significant.

In brief, all the hypothesized relationships among the constructs were significant except for the effect of Spatial Orientation on Spatial Presence (see Table 9).

**Table 9.**

Parameter Estimated for the Research Model

| Structural Path | Hypothesis | Standardized Path Coefficients | t-value (p-value) |
|---|---|---|---|
| **Type of Interactive Map Interface □Perceived Map Interactivity** | **$H_1$** | **0.43** | **6.01** |
| **Perceived Map Interactivity□ Spatial Orientation** | **$H_2$** | **0.46** | **5.95** |
| **Perceived Map Interactivity□Spatial Imagery** | **$H_3$** | **0.25** | **4.68** |
| **Perceived Map Interactivity□ Spatial Presence** | **$H_4$** | **0.33** | **4.18** |
| **Affective Place Attachment□ Spatial Presence** | **$H_5$** | **0.21** | **3.58** |
| **Spatial Ability□Spatial Orientation** | **$H_6$** | **0.28** | **3.86** |
| **Spatial Orientation□ Spatial Imagery** | **$H_7$** | **0.74** | **10.25** |
| Spatial Orientation□Spatial Presence | $H_8$ | 0.07 | n.s.* |
| **Spatial Imagery□ Spatial Presence** | **$H_9$** | **0.33** | **2.16** |

**n.s.: no significance*

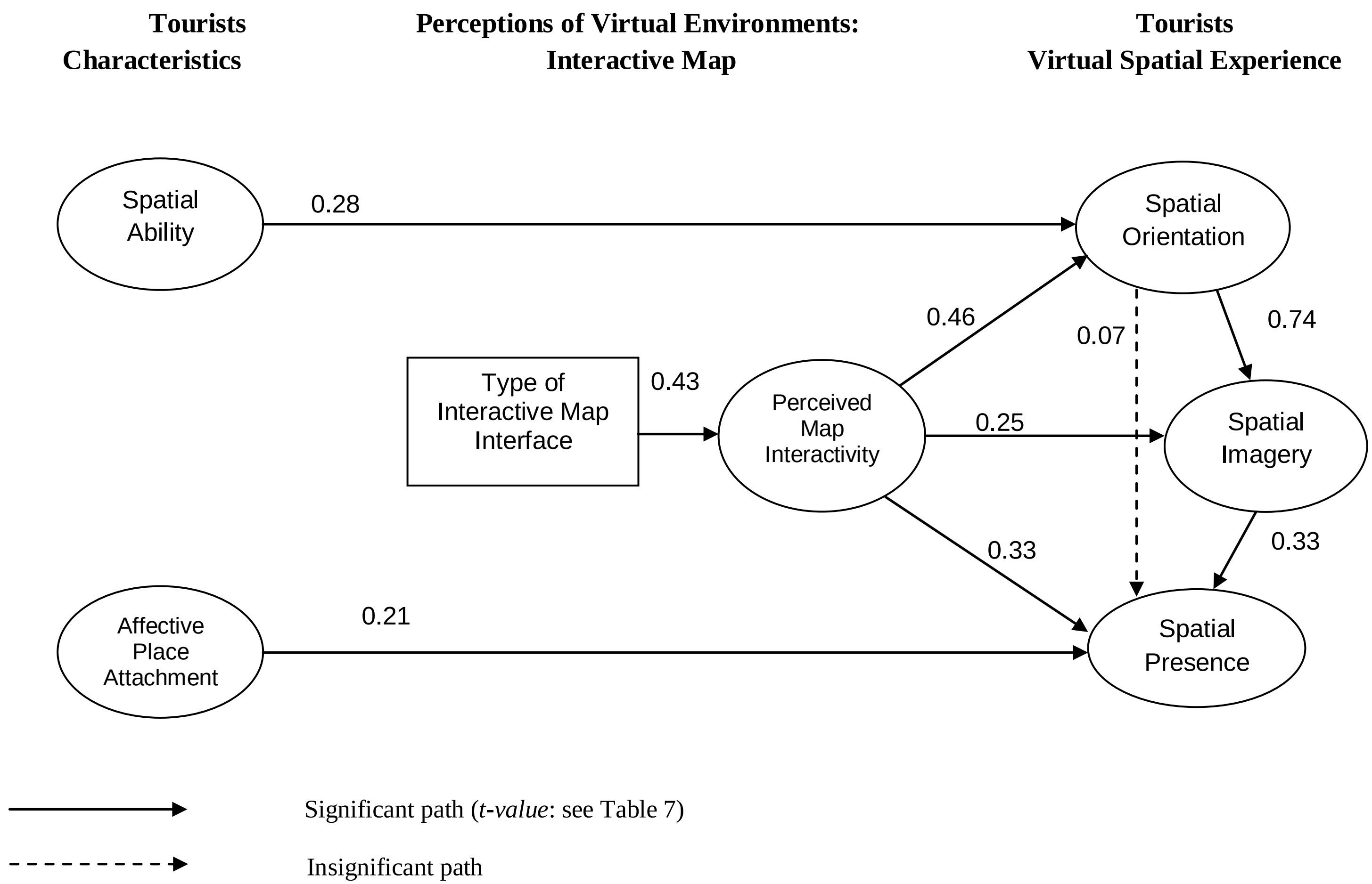


**Figure 8.** Path Coefficient of Research Model

# CHAPTER VI

# DISCUSSION AND CONCLUSION

The purpose of this study was to provide insights regarding the nature of interactive maps and how they create virtual spatial experiences that result in a virtual sense of place. An experiment was conducted to examine the relationship among tourist characteristics such as spatial ability and place attachment, perceptions of map interactivity and the virtual spatial experiences. Based on the results of the experiment, this study provides six findings with further discussions as follows.

First, *the Type of Interactive Map Interface influences Perceived Map Interactivity.* The Google Earth map condition with 3D dynamic objects produced higher perceived map interactivity than the Google Earth map condition with only satellite photo view. Therefore, this result implied that virtual environments with higher levels of map interactivity (3D dynamic objects with Google Earth) are more likely to lead to greater perceived map interactivity. Hence, the finding confirmed that 3D dynamic objects among various user interface features are important in constructing interactive environments. It also confirmed that image interactivity is one aspect of interactivity (Snavely et al., 2006) and map interactivity can be enhanced by providing higher customizability (Edsall, 2009). Therefore, boosting customizability through 3D dynamic objects should be taken into consideration when designing an interactive map.

Second, *Perceived Map Interactivity affects Virtual Spatial Experiences*. The findings indicated that tourists who perceived map interactivity as higher felt that they do better at orientating themselves and estimating objects' scale, arrangement and distance in the environment presented in the map. Also, tourists who perceived higher map interactivity were able to better imagine the place presented in the map. Moreover, tourists with greater perceived map interactivity felt a greater "sense of being there" while they interacted with the map.

Third, *Spatial Imagery has a positive impact on Spatial Presence.* The findings showed that tourists who experienced greater spatial imagery had a greater "sense of being there" while exploring a virtual environment presented in an interactive map. Therefore, the findings confirmed that spatial presence is stimulated by the spatial imagery process, suggesting that spatial imagery is important for the formation of spatial presence (Wirth, et al., 2007). From this finding it can be concluded that an interactive map displaying spatial imagery cues, including design features such as landmarks, vegetation and statues, helps tourists feel greater spatial presence.

Fourth, *Spatial Orientation increases Spatial Imagery, but has no significant direct impact on Spatial Presence*. The findings indicated that tourists who had greater spatial orientation experienced greater spatial imagery of the place while navigating the maps. The findings implied that spatial imagery fully mediates the influence of spatial orientation on spatial presence, which suggests that hierarchical relations among spatial perceptions as indicated in the literature may exist (McNamara, 1986).

Fifth, *greater Spatial Ability leads to greater Spatial Orientation.* This finding showed that tourists with higher spatial ability in the real world reported that they were able to orient themselves well in the virtual environment. The result confirmed that individuals differ in spatial ability (Oman et al, 2000) and that such spatial ability significantly influences virtual spatial experiences.

Sixth, *Affective Place Attachment influences Spatial Presence*. This result supported the idea that tourists who have emotional attachments toward a real/physical place are more likely to have a higher "sense of being there" while they explore a virtual representation of that place. The findings therefore indicated that real world place attachment transfers to virtual experiences of places. When factors attract users' attention to a medium, the users may then devote their attention to the medium because they want to (Wirth et al., 2007). If place attachment can be considered a factor increasing users' attention to the medium, the findings support Wirth et al. (2007)'s spatial presence model: factors attracting users' attention influence spatial presence, through mediated spatial situation models. However, further examinations of the relationships are necessary to provide better understanding of place attachment and spatial perceptions from mixed—physical and virtual—place experiences.

## Theoretical Implications

### *Place Attachment Studies*

Studies regarding sense-of-place, cognitive maps and virtual environments have not examined the effects of physical place experiences on spatial experiences in a virtually presented place. Rather, they largely have investigated sense-of-place in an environment by using one-sided research approaches such as either spatial presence or place attachment studies. Moreover, few studies have tested mixed settings of virtual and physical environments (e.g., Wagner et al, 2009). To understand the nature of mixed spatial experiences and sense of a place, this study was aimed to provide an integrative framework for spatial experiences of a real world destination's virtual representation. The integrative approach provided an initial theoretical framework for future place attachment studies. Consequently, this study expanded the range of place attachment studies from physical places to virtual environments. The findings deepened our understanding of the influences of individuals' prior spatial cognition and of features of interactive digital maps on virtual-spatial experience.

*Spatial Presence Studies and Virtual Environment Studies*

In contrast to other studies regarding virtual environments, this study conceptualized human spatial perceptions as encompassing multiple, hierarchically related components. By applying place attachment studies to spatial presence studies this study expanded the scope of existing theories used in studying virtual environments as well real places. In addition, the findings of this study implied that spatial ability and perceptions acknowledged by a real world experience can have impacts on spatial perceptions generated by a virtual environment. Regardless of direct place experiences, spatial perceptions can be influenced by judgments and perceptions of the map interactivity. Therefore, a virtual representation can play a crucial role in creating vivid virtual spatial experiences.

## Practical Implications

Investigating the influence of map interactivity, this study provides practical implications for travel destination map design and for online destination marketing.

### *The Effect of 3D Dynamic Objects for Map Interface Design*

Since the design features of maps determine perceptions of map interactivity, cartographers, computer engineers and even tourism promoters should pay careful attention to what is included and in what way. The study results implied that 3D dynamic objects combined with satellite photos on a digital map can help tourists/map users perceive higher levels of interactivity. Hence, tourism marketers may produce enhanced virtual spatial experiences by applying 3D dynamic objects as a design feature in an interactive map.

### *Augmented Virtual Spatial Experiences*

The study findings revealed that tourist characteristics such as spatial ability and affective place attachment influenced virtual spatial experiences such as spatial orientation and spatial presence. The study findings indicated that a relationship exists between tourist characteristics regarding spatial knowledge obtained from real world experiences and spatial perceptions generated through virtual environments. Therefore, regardless of pre-visitation experiences, tourism marketers can provide trial (or sample) tourism experiences through an enhanced “sense of being there” and spatial information in interactive maps.

*Virtual Tourism evoked by Interactive Digital Maps*

Providing a virtual tour to tourists using various web applications and computer interfaces has been a project for tourism marketers since the advent of Internet technology. Since tourism experiences cannot become tangible products which can produce a trial trip or sample travel experience, tourism marketers should attempt to give tourists virtual trial experiences and a virtual sense of place for a destination. As found in this study, tourism marketers can use high level interactive maps for destination marketing in order to make potential tourists feel greater spatial presence or a "sense of being there" before visiting the destination. The importance of evoking virtual tour experiences/trial experiences of a destination has been an issue and tourism marketers should try to take advantage of the positive effects a virtual sense of place can create.

*Walt Disney World at Orlando, Florida*

Since Walt Disney World's Magic Kingdom Park presented on Google Earth was the experimental setting, the collected data used in this study is relevant to experiences and perceptions of the park. Therefore, the study findings provide insights regarding perceptions of the Google Earth map of the park area. For example, the finding of this study showed that people who watched 3D movies reported higher mean values in place attachment, implying that Disney World's efforts in 3D movie making may facilitate marketing Disney World. In addition, the study findings indicated that more female participants than male like Disney World, implying that a gender perspective might be useful in promoting the park.

## Limitations of the Present Study

This study contains some limitations. First, the participants were college students and 92.4% of them were age 18 to 24. Hence, the sample might limit the generalizability of the current study to other populations. However, for tourism marketers who want to investigate the new consumer generation (Go & Gretzel, 2009)—Generation Z means people who were born from the mid 1990s or early 2000s through to the present—the participants' age group could be representative of the targeted population. Second, even though most participants, except 40 students who were recruited from a class, were randomly approached, self-selection biases might still exist as there were people who did not agree to participate in this study.

Third, this study did not examine the effect of social presence (e.g., feeling the presence of others in virtual worlds) and the effects of group virtual tours using avatars because the current digital maps do not provide interface design features which allow users to have interactions with others in the map environment. Finally, since the study paid attention to virtual spatial perceptions evoked by interactive maps, this study did not assess the effect of interactions with maps on place experiences in a real world.

## Suggestions for Future Research

Investigations regarding the effect of other factors pertaining to personal characteristics such as gender, prior visitation experiences, and watching 3D movies, should be expanded in future research. Future research could also explore the impacts of spatial presence on motivations to visit the real place which was presented on a map or virtual environment. In contrast to this study model, future studies could explore whether spatial presence can create affective attachment to the place.

In addition, this research model can be applied to examinations of various contexts such as other map formats, (e.g., Ovi Maps, Ski.com 3D maps, etc.), virtual environments (e.g., Second Life virtual tours), and other tourism destinations (e.g., New York and Paris, etc.) instead of Disney World, FL. Further, future studies could test this study model with places which are completely unknown to general tourists. In this case, the future studies could confirm if the effects of perceived interactivity on spatial cognition are even higher as more support for processing the information is needed.

As aforementioned in the context of study limitations, future studies could investigate the effects of social presence or the influence of group tours experiences on virtual spatial experiences and should also take into account cultural differences in processing virtual spatial experiences. Also, other design features (e.g., motion features and 4D, etc.) could be added to distinguish the type of map interface. Future research could compare the effects of each interface features. For example, the effect of 3D graphics could be examined by isolating the 3D feature from other map features (e.g., additional layers, photos, and video, etc.). The influence of motion features on spatial orientation could be explored through comparing a "flying over" view of the map with self-exploration of the map environment.

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APPENDIX A

The first level of the map design condition used only satellite photos based on Google Earth maps (see Figure 9).

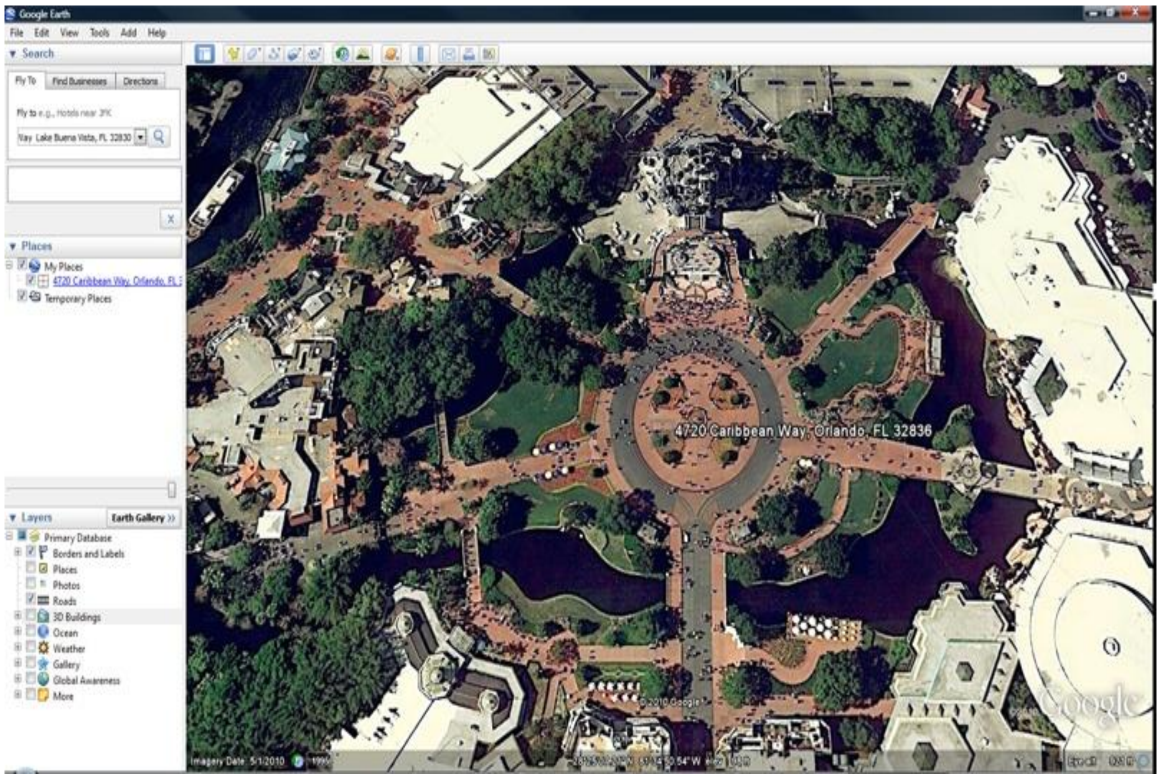


**Figure 9.** Treatment 1: Walt Disney World (Magic Kingdom) Map on Google Earth

Figure 10 shows the second level design containing 3D dynamic objects.

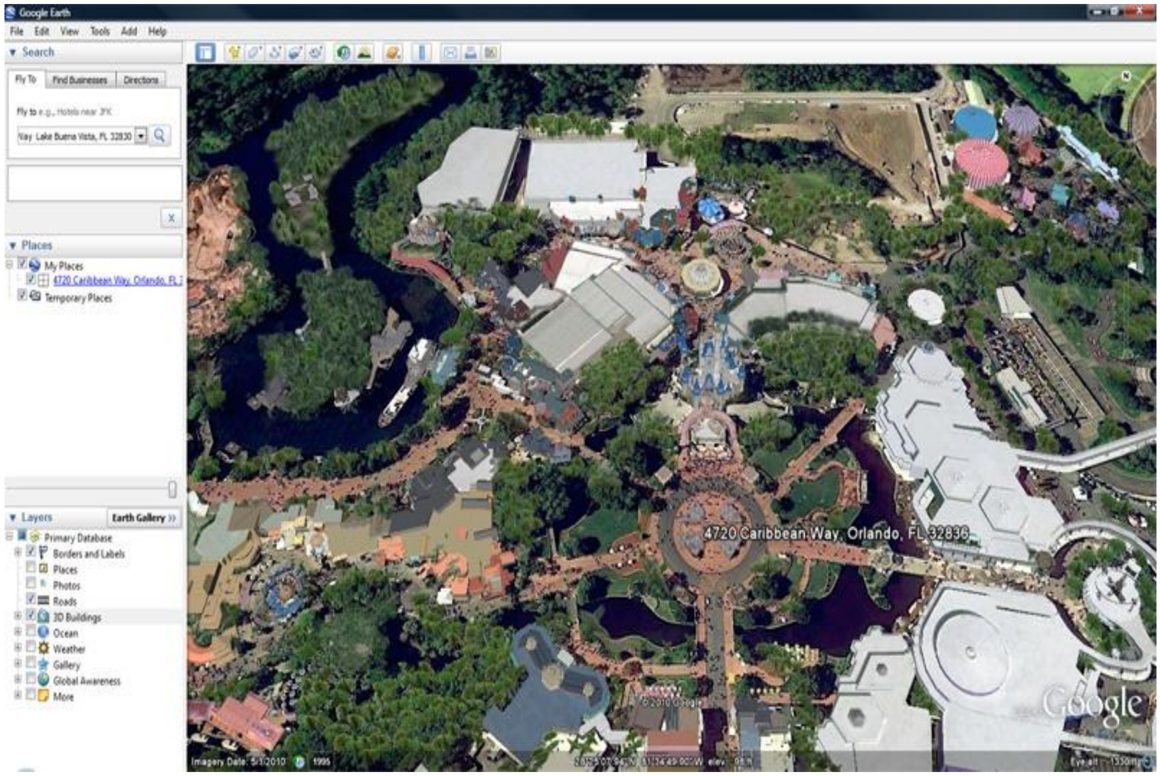


**Figure 10.** Treatment 2: Walt Disney World Map (Magic Kingdom) on Google Earth with 3D Dynamic Objects

Also, the hidden layer of 3D dynamic objects showed additional visual-spatial information when the layer was activated by users' control actions (see Figure 11). Figures 12 and 13 show the ground level view of the area presented by the two treatments. Finally, Figure 14 displays the map with 3D dynamic objects at the ground level view.

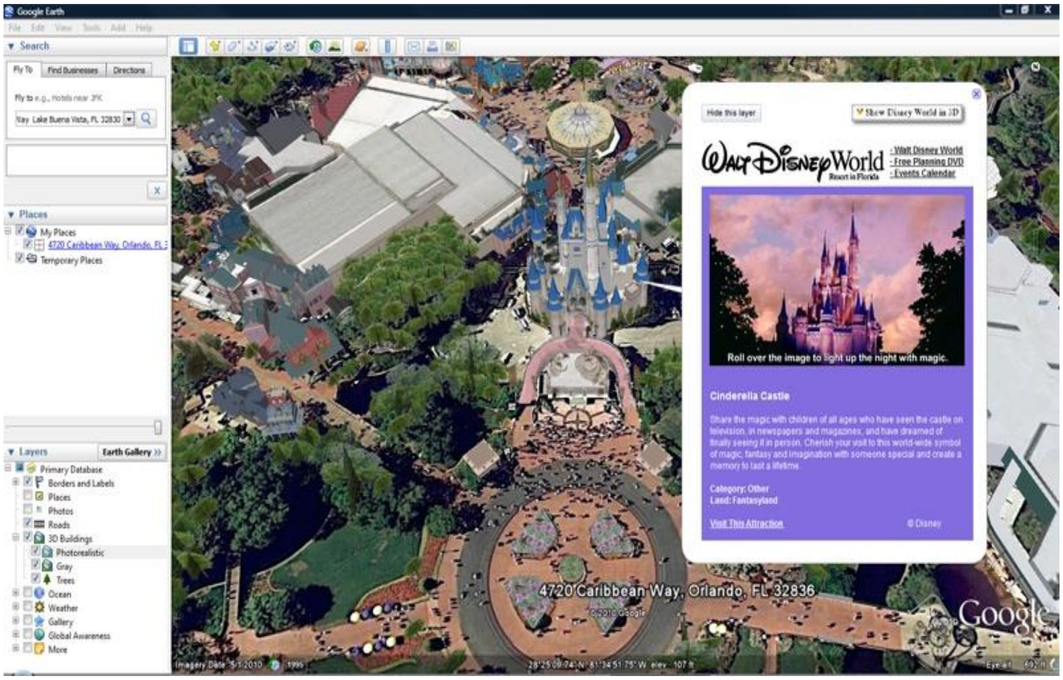


**Figure 11.** Treatment 2 with Activated (Clicked) 3D Dynamic Object

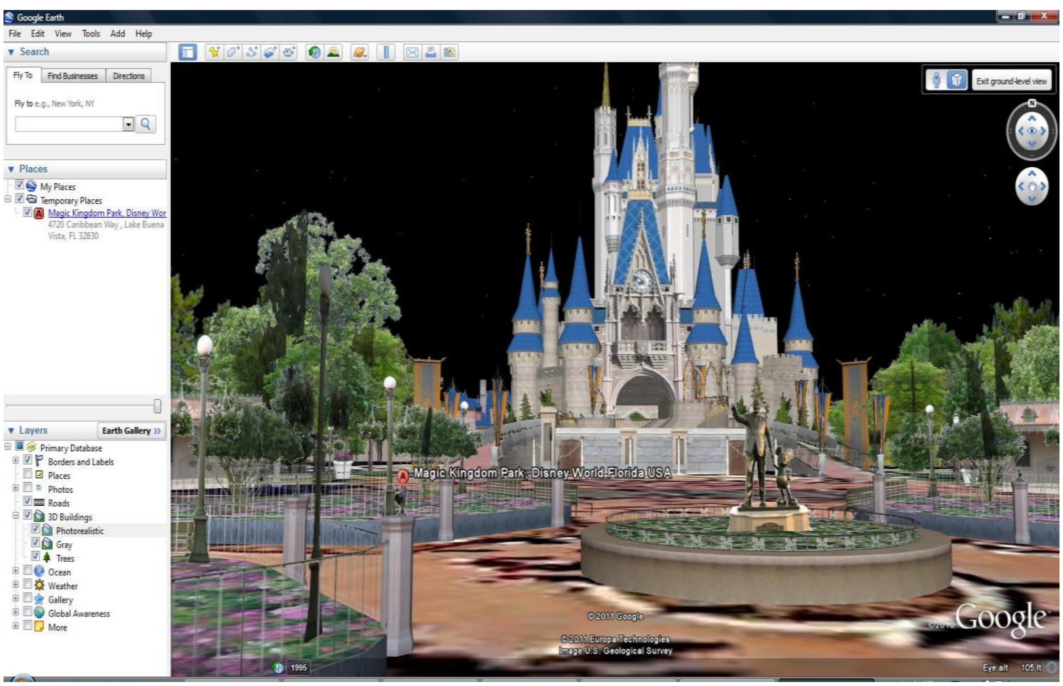


**Figure 12.** The Ground Level View of Google Earth with 3D Dynamic Objects

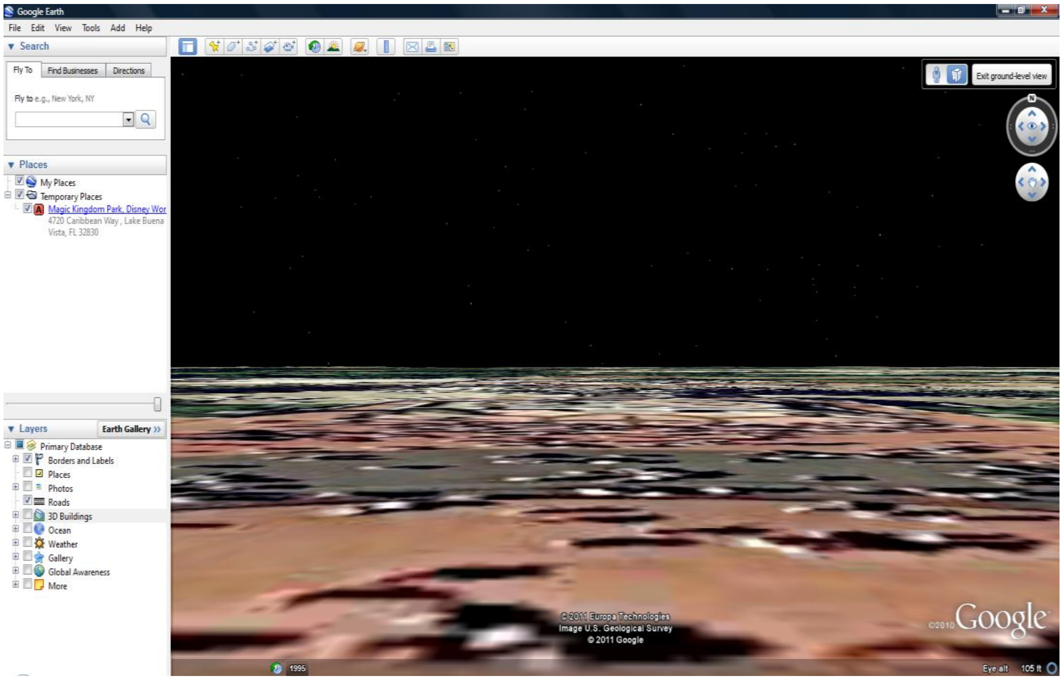


**Figure 13.** The Ground Level View of Google Earth with Satellite Photo View Only

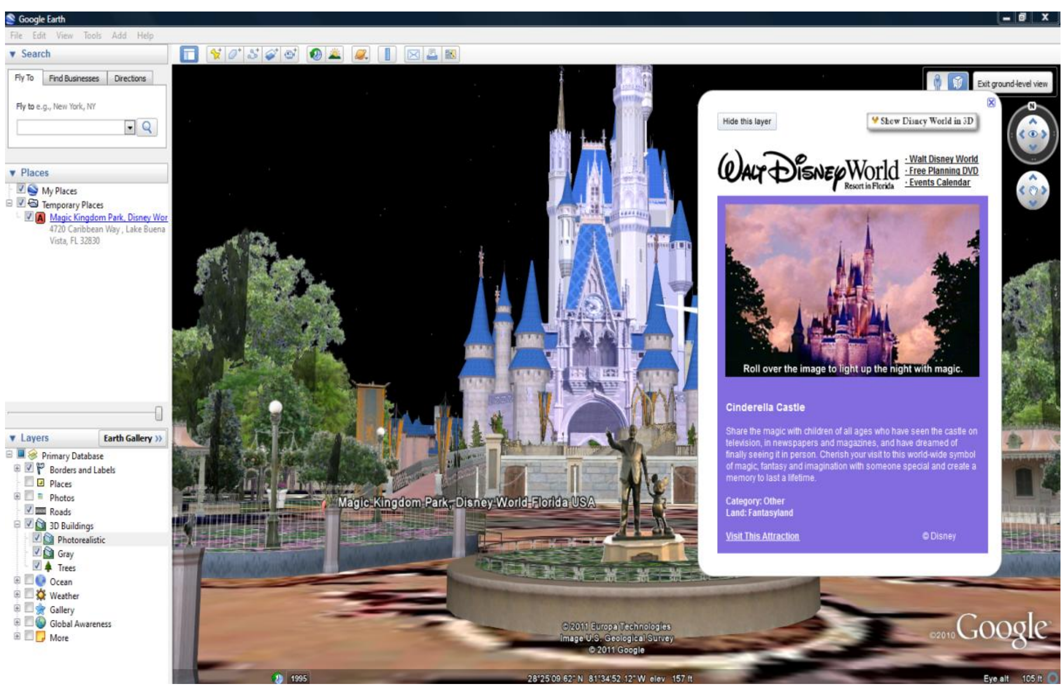


**Figure 14.** Google Earth Map with 3D Dynamic Objects at the Ground Level View

# APPENDIX B

To measure map viewers' spatial perception of a tourism destination presented on an interactive map, this study employs forty five items (See Table 10). Each was measured on a 7-point scale from strongly disagree to strongly agree. Additional items were included to understand participants' profile.

**Table 10.**

Constructs and Items of Virtual Spatial Experience (VSE)

| ***Latent Variable*** | ***Items*** |
|---|---|
| **Perceived Map Interactivity** | |
| PI01 | I was in control over the information display format when using this map. |
| PI02 | I was in control over the content of this map. |
| PI03 | While exploring the map, I was always aware where I was. |
| PI04 | While exploring the map, I could choose freely what I wanted to see. |
| PI05 | While exploring the map, I had control over what I could do on the map. |
| PI06 | While exploring the map, I could examine objects from multiple viewpoints. |
| PI07 | While exploring the map, I could move or manipulate objects in the virtual environment. |
| **Affective Place Attachment** | |
| AP01 | Disney World means a lot to me. |
| AP02 | I feel very attached to Disney World. |
| AP03 | I feel a strong sense of belonging to Disney World. |
| AP04 | I imagine that I would be happiest at Disney World. |
| AP05 | I feel that I can really be myself in Disney World. |
| AP06 | I do not care for Disney World. |
| AP07 | I do not like Disney World. |
| **Spatial Ability** | |
| SA01 | I am very good at giving directions. |
| SA02 | My ‘‘sense of direction’’ is very poor. |
| SA03 | I get easily get lost in a new city. |
| SA04 | I do not have a very good ‘‘mental map’’ of my environment. |
| SA05 | I have trouble understanding directions. |

**Table 10.**

Continued.

| *Latent Variable* | *Items* |
|---|---|
| SA06 | I am very good at reading maps. |
| SA07 | I do not remember routes very well when driving as a passenger in a car. |
| SA08 | I usually let someone else do the navigational planning for long trips. |
| SA09 | I can usually remember a new route after I have traveled it only once. |
| **Spatial Imagery** | |
| SI01 | In my mind's eye, I was able to clearly see the arrangement of the objects presented/described. |
| SI02 | I was able to imagine the space easily. |
| SI03 | It was easy for me to negotiate the space in my mind without actually being there. |
| SI04 | I had a precisely detailed image of the described surroundings in my mind's eye. |
| SI05 | I could easily imagine the arrangement of the objects described. |
| SI06 | I could picture the route as though I were watching a film. |
| SI07 | It was very easy for me to imagine the space clearly. |
| SI08 | Even now, I still have a concrete mental image of the spatial environment. |
| **Spatial Orientation** | |
| SO01 | I was able to imagine the arrangement of the spaces presented in the map very well. |
| SO02 | I had a precise idea of the spatial surroundings presented in the map. |
| SO03 | I was able to make a good estimate of the size of the presented space. |
| SO04 | I was able to make a good estimate of how far apart things were from each other. |
| SO05 | Even now, I could still draw a plan of the spatial environment in the map. |
| SO06 | Even now, I could still find my way around the spatial environment in the map. |
| **Spatial Presence** | |
| SP01 | While looking at the map, I had a sense of "being there." |
| SP02 | Somehow I felt that the place surrounded me. |
| SP03 | I did not feel present in the map. |
| SP04 | My experiences in the virtual environment seemed consistent with real-world experiences. |

**Table 10.**

Continued.

| *Latent Variable* | *Items* |
|---|---|
| SP05 | I felt like I was actually there. |
| SP06 | I felt like the objects in the map surrounded me. |
| SP07 | It was as though my true location had shifted into the map environment. |
| SP08 | It seemed as though myself was present in the map. |

Have you ever experienced Google Earth before participating in this survey?

❍ No (1)

❍ Yes (2)

Have you ever experienced a 3D movie before participating in this survey?

❍ No (1)

❍ Yes (2)

Have you ever experienced a 3D game or virtual world before participating in this survey?

❍ No (1)

❍ Yes (2)

Have you ever visited Walt Disney World, FL?

❍ No (1)

❍ Yes (2)

What is your gender?

❍ Male (1)

❍ Female (2)

What year were you born?

What is your major?

# VITA

Name: Hanyoung Go

Address: Laboratory for Intelligent Systems in Tourism
Department of Recreation, Park & Tourism Sciences
2261, TAMU
College Station, TX 77843-2261

Email Address: aromiangel@gmail.com

Education: B.B.A., Hospitality and Tourism Management; Public Administration, Sejong University, Seoul, Korea, 2003
M.U.P., Community and Regional Planning, University of Oregon, Eugene, OR, 2006
Doctor of Philosophy in Recreation, Park and Tourism Sciences, Texas A&M University, College Station, TX, 2012

Experience: Visiting Scholar, Graduate Research Assistant, Project Coordinator, Member of Laboratory for Intelligent Systems in Tourism, Department of Recreation, Park and Tourism Sciences

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Go, H. and U. Gretzel (2009). Tourism Marketing Opportunities in Virtual Worlds: The Case of Second Life. Proceedings of the 14th Annual Graduate Student Research Conference in Hospitality and Tourism. Las Vegas, January 4-6, 2009.

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