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ABSTRACT

Maps are essential tools for providing information about tourism destinations to tourists. With the emergence of digital maps, more and more destination websites use various forms of digital maps to help tourists orient themselves before they even reach the destination. Based on psychology and virtual reality literature, this study constructs a framework to measure how the different types of digital maps affect potential tourists' ability to explore the space represented in the maps. In addition, the study explores how individual characteristics of the tourists such as spatial ability and evaluations of the maps such as perceived interactivity and perceived user control affect virtual experiences of the space presented in the map. An experiment was conducted to test the measures and obtain preliminary findings regarding variations in the constructs based on the type of map used.

Keywords: *digital map, virtual spatial experience, spatial presence, spatial imagery, virtual presence.*

INTRODUCTION

Tourism is an activity that involves movement in space and, thus, requires knowledge of the space that is traversed. Maps have always served as important pieces of information for travelers but have traditionally been limited in terms of what they could display and how. Through advanced digital maps, tourists are now able to learn and experience travel destinations virtually. Holcomb (1999) points out the importance of maps for promoting tourism destinations. Tourism marketers consider the experience of place as the product they sell (Judd, 1999), but they cannot provide a trial experience before consumers purchase the product. Therefore, it can be assumed that the virtual spatial experience of the destination produced by digital maps can affect tourists' perception of the place in important ways and more effectively than static, traditional maps. Many studies have evaluated 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) and also the effectiveness of virtual tours (Cho, Wang & Fesenmaier, 2003). Yet, despite their importance and extensive use, the effectiveness of interactive maps in representing destinations has so far not been systematically evaluated. This paper presents a conceptual model to evaluate interactive maps in terms of their ability to provide compelling virtual spatial experiences and a preliminary evaluation of the measures proposed in the model.

LITERATURE

Virtual spatial experiences

Consumers can have three different types of experiences with products: direct, indirect, and virtual experiences (Gibson, Willming, & Holdnak, 2003; Li, Daugherty, & Biocca, 2001). Virtual experiences are important in providing tourists with quasi pre-trial experiences of tourism products (Klein, 2003). Conceptually, Li, Daugherty & Biocca (2001) believe that "every experience stems from the interaction between an individual and an object or environment" (p. 14). Thus, the characteristics of virtual environments play an important role in determining the experience (Takatalo, Nyman, & Laaksonen, 2008). In conclusion, virtual experiences are defined as psychological and emotional states, which a consumer experiences while interacting with products in virtual environments (Lundh, 1979). They become virtual spatial experiences (VSEs) if the virtual environment has spatial characteristics that are observed by the user as part of the virtual experience. VSEs consist of feelings of spatial presence as well as spatial imagery.

Spatial presence

Spatial presence (SP) is a crucial concept for evaluating virtual environments (VE) and creating compelling VSEs. This study employs the term 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 communication medium (Schubert, Friedmann, & Regenbrecht, 1999; Steuer, 1992; Witmer & Singer, 1998). The concept of spatial presence, "sense of being there," plays a key role in mediating and affecting the degree of a virtual experience established in virtual environments (Biocca 1997). A medium not only delivers information, but also meditates experiences (Li et al., 2001). Thus, in creating the spatial presence of objects, media richness plays a key role (Klein, 2003). Media richness fosters immersion. Immersion is a psychological state "of being part of the action on the screen", that the user experiences. The highest level of immersion is achieved when all senses are engaged (Burdea, 1996; (Grigore & Philippe, p. 2). Witmer & Singer (1998) argue that higher levels of immersion provide higher levels of presence in VEs.

Spatial imagery

Spatial imagery (SI) has been applied in various studies such as education, neuroscience, and virtual reality studies. It can be defined as human visual mental cognition which processes object properties (e.g., shape and color) and spatial properties (e.g., location and spatial relations). Mathewson (1999) states: "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). This study presumes that spatial imagery is an important component of VSEs.

Map interactivity

Zhang (2008) describes that different representations of spatial knowledge grant different levels of abstraction in terms of space. He stresses that spatial knowledge helps people form their internal spatial representation of environments (Tolman, 1948). He also states that "spatial cognition in virtual environments has been found to be similar to that in the real world (Witmer et al., 1996; Ruddle et al., 1997; Wilson et al., 1997), so researchers have drawn on the results of research on navigation in the real world to support wayfinding in virtual environments" (p.245). The realism of VEs is considered as a crucial factor in the design process to stimulate spatial cognition in VEs. Geometric information and GIS data, may provide a higher level of spatial cognition. Digital maps include a wide range of geographic information such as weather/sky/ocean views, satellite maps and terrains, as well as multisensory contents such as 3D maps, tour videos, and sounds. That means that users can obtain different spatial experiences from the different levels of interactivity of the map. From the review of existing studies, this study hypothesizes that perceived interactivity, responsiveness, and user control can be key factors which determine the different level of interactivity presented in digital maps.

Perceived interactivity

The term "interactivity" has been used in different disciplines and is considered as a critical factor in evaluating web-based media. Many scholars from various disciplines have defined and measured interactivity (Aldersey-Williams, 1996; Hoffman, Novak, & Schlosser, 2000; Kiousis, 2002; Rafaeli, 1988; Steuer, 1992; Wu, 1999). According to Wu (1999), "perceived interactivity can be defined as a two-component construct consisting of navigation and responsiveness" (p.6). Steuer (1992) defines interactivity as "the extent to which users can participate in modifying the form and content of a mediated environment in real time" (p.84). In terms of Steuer's definition, Wu (1999) states that "this definition takes into consideration the important role of users in conceptualizing interactivity" (p.3). 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 perceptions rather than the property of the map.

User control

Modern map technologies such as Google Earth provide users with multiple degrees of angles and views which affect perceived control over the interaction with the system. On Google Earth, users are able to navigate the virtual environment and also are able to easily access other sites (Demi, 2007). 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 (Burgoon et al. 2000; Hanssen, Jankowski, and Etienne 1996; Huhtamo 1999; Milheim 1996; Murray 1997; Preece 1993; Tan and Nguyen 1993; Trevino and Webster 1992; Baecker 1980; Biocca 1993; Laurel 1990; Naimark 1990; Nielsen 2000; Schneiderman 1998; Heeter 2000; Nielsen 2000; Belkin, Marchetti, and Cool 1993; Daft, Lengel, and Trevino 1987; Durlak 1987; Hanssen, Jankowski, and Etienne 1996; Looms 1993; Mahood, Kalyanaraman, & Sundar 2000; Steuer 1992; Zeltzer 1992; Milheim 1996; Valacich et al. 1993). From the various studies, it can be derived that user control increases perceptions of interactivity of the technology.

Spatial ability

Individuals differ in their ability to mentally manipulate spatial information. Scholars have examined spatial ability of individual subjects in various contexts such as education, psychology, neuroscience, human-computer interaction, geosciences and virtual reality (Hegarty, Mary & Kozhevnikov, 1999; Hegarty, M & Waller, 2005; Hegarty, M., Montello, Richardson, Ishikawa, & Lovelace, 2006; Kaufmann, Schmalstieg, & Wagner, 2000; Linn & Petersen, 1985; McGee, 1979). It is generally assumed that individuals are not able to make good use of spatial information if they lack the ability to effectively process the information.

Conceptual model

The review of the literature led to the development of a conceptual model (Figure 1). Figure 1 shows that Map Interactivity, determined by Perceived Interactivity as well as Perceived User Control, influences the Virtual Spatial Experience of the user, which consists of the Spatial Imagery and the Spatial Presence experienced. Spatial Ability moderates this relationship. It is assumed that higher Map Interactivity leads to a greater Virtual Spatial Experience if the user possesses the necessary Spatial Ability to process the information provided by the interactive map.

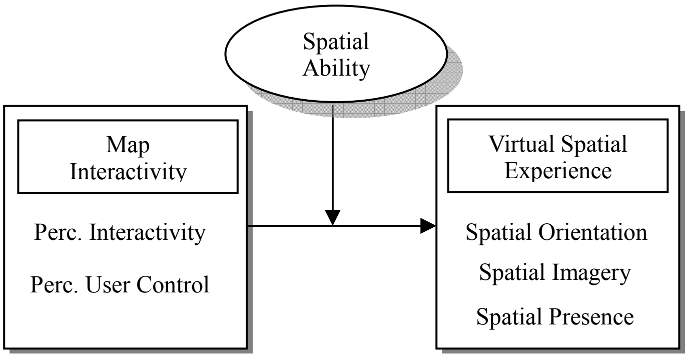

Figure 1. Visual Spatial Experience Framework

METHODOLOGY

Measures

Measurement scales were adapted from psychology and virtual reality studies. For Spatial Presence, this research adopts four items from the "Sense of Being There" presence questionnaire (Witmer & Singer, 1998), five items from Spatial Presence Self-Location (SPSL) questions (Vorderer, Wirth, Gouveia, Biocca, Saari, Jäncke et al., 2004) and six items from Spatial Situation Model (SSM) questions (Vorderer et al., 2004). In terms of Spatial Imagery, seven items from the Visual Spatial Imagery (VSI) questionnaire (Vorderer et al., 2004) and twelve items from Mental Imagery (MI) questionnaire (Blajenkova, Kozhevnikov, & Motes, 2006) are employed. For example, subjects are asked the following questions: "In the map I had a sense of "being there," I felt like I was a part of the environment in the map," and in terms of imagery: "I was able to imagine the arrangement of the spaces presented in the map very well".

To measure Spatial Ability, sixteen items from the Santa Barbara Sense of Direction Scale (Hegarty, M & Waller, 2005) are used. For instance, "I am very good at giving directions" would be one of the items to measure spatial ability. For map interactivity measurements, six items from the Perceived Interactivity (PI) questionnaire (Wu, 1999) and the User Control (UC) questionnaire (Wu, 1999) are adopted. "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 Map Interactivity.

Experiment design and data analysis

In order to test the measures and obtain a preliminary test of the conceptual model, a laboratory experiment with 104 students of either graduate or undergraduate standing was conducted. 96 responses were used for the data analysis. The experiment employed four different types of digital maps. The Heritage Trail in Amishcountry, Northern Indiana, served as the context of the study. The four map types tested were a 1) PDF version of a GIS data map, 2) Flash version of the map, 3) Google map including Kml coding, and 4) Google Earth

Map with Kml coding (see Figure 2).

Figure 2 Experimental Conditions

The PDF and Flash maps available from www.amishcountry.org were used for the first two conditions. The Google map and Google Earth map were developed for this study. They were designed with Kml coding, which displays photos and texts of the individual place on the heritage trail. Photos and text descriptions were kept identical across the conditions.

Data analysis involved a procedure with several steps. First, reliability tests and factor analyses were used to investigate the measurement properties of the scales. Based on the results, additive scales were constructed. Regression analyses were used to test if spatial ability influenced perceptions of interactivity and spatial experiences. Finally, the influence of the experimental conditions on the measures was tested using ANOVAs.

RESULTS

Factor analyses were used to test the dimensionality of the scales and to eliminate items that did not strongly load onto factors. The number of factors was determined according to Eigenvalues and the variables' factor loading scores were deemed acceptable if higher than 0.5. Analyses were conducted separately for the Map Interactivity scales, the VSE scales and the Spatial Ability domain. The VSE results indicated that sense of being there and spatial presence self-location items loaded onto one factor. Eight items out of total nine items were retained (Table 1a). For Spatial Orientation, all six items strongly load onto one factor.

Table 1a
Factor Loadings and Reliability for Virtual Spatial Experience Dimensions

Construct Names & Items	Mean	Factor Loading	Eigen Value	% of Var. [a]	α
Spatial Presence	**4.21**		**5.102**	**63.78**	**.92**
While looking at the map, I had a sense of "being there"		.71			
Somehow I felt that the place surrounded me		.76			
I did not feel present in the map		.68			
I felt like I was a part of the environment in the map		.86			
I felt like I was actually there		.87			
I felt like the objects in the map surrounded me		.85			
It was as though my true location had shifted into the map environment.		.81			
It seemed as though myself was present in the map		.82			
Spatial Orientation	**4.72**		**3.39**	**56.44**	**.84**
I was able to imagine the arrangement of the spaces presented in the map very well		.84			
I had a precise idea of the spatial surroundings presented in the map		.81			
I was able to make a good estimate of the size of the presented space.		.78			
I was able to make a good estimate of how far apart things were from each other.		.77			
Even now, I could still draw a plan of the spatial environment in the map		.64			
Even now, I could still find my way around the spatial environment in the map		.64			

[a] % of Variance Explained, * reversely coded item

The VSI and MI questionnaires mapped onto three factors. Ease of Mental imagery includes seven items. For Quantity of Mental Imagery, three items were included after one item was deleted due to cross-loadings. For Vividness of Mental Imagery, the study includes seven items out of eight items (Table 1b).

Table 1b
Factor Loadings and Reliability for Spatial Imagery

Construct Names & Items	Mean	Factor Loading	Eigen Value	% of Var. [a]	α
Ease of Mental Imagery	**4.71**		**3.10**	**59.04**	**.88**
In my mind's eye, I was able to clearly see the arrangement of the objects presented/described		.83			
I was able to imagine the space easily		.82			
It was easy for me to negotiate the space in my mind without actually being there.		.81			
I had a precisely detailed image of the described surroundings in my mind's eye.		.74			
I could easily imagine the arrangement of the objects described		.74			
I could picture the route as though I were watching a film		.72			
It was very easy for me to imagine the space clearly		.72			
Quantity of Mental Imagery	**4.67**		**2.32**	**77.26**	**.84**
While looking at the map, many images came to my mind		.94			
While looking at the map, a lot of images came to my mind		.93			
While looking at the map, I experienced very few images *		.76			
Vividness of Mental Imagery	**3.33**		**4.39**	**62.66**	**.88**
Even now, I still have a concrete mental image of the spatial environment		.66			
The mental imagery I had while looking at the map was:					
Vivid: Vague		.80			
Clear: Unclear		.85			
Sharp: Dull		.86			
Intense: Weak		.75			
Lifelike: Lifeless		.77			
Fuzzy: Well-defined *		.83			

[a] % of Variance Explained, * reversely coded item

For Interactivity, the perceived interactivity and user control items mapped onto one factor. There was no item eliminated from the original six items (Table 2).

Table 2
Factor Loadings and Reliability for Interactivity

Construct Names & Items	Mean	Factor Loading	Eigen Value	Var. [a]	α
Perceived Interactivity	**5.45**		**3.57**	**59.50**	**.86**
I was in control over the information display format when using this map		.79			
I was in control over the content of this map		.68			
I was in control over the content of this map		.74			
While I read the map, I was always able to go where I wanted to go		.80			
While I read the map I could choose freely what I wanted to see		.79			
While reading the map, I had control over what I could do on the map		.83			

[a] % of Variance Explained, * reversely coded item

For Spatial Ability, ten items are included and six items were eliminated (Table 3). The Cronbach Alpha scores for all scales indicate high reliability.

Table 3
Factor Loadings and Reliability for Spatial Ability

Construct Names & Items	Mean	Factor Loading	Eigen Value	Var. [a]	α
Spatial Ability	**4.84**		**6.29**	**62.95**	**.93**
I am very good at giving directions		.84			
My ''sense of direction'' is very poor *		.85			
I very easily get lost in a new city *		.86			
I enjoy reading maps		.76			
I have trouble understanding directions *		.84			
I am very good at reading maps		.83			
I do not remember routes very well when driving as a passenger in a car *		.73			
I usually let someone else do the navigational planning for long trips*		.76			
I can usually remember a new route after I have traveled it only once		.81			
I do not have a very good ''mental map'' of my environment *		.62			

[a] % of Variance Explained, * reversely coded item

Table 4 summarizes the descriptive properties of the constructed measures. ANOVAs with the experimental conditions (four map types) as the factor and the constructed measurement scales for map interactivity and virtual spatial experience as dependent variables were conducted. Only two of the measurement scales were significantly influenced. First, a significant influence of map type on quantity of mental imagery was found (p=0.047), with the Flash map condition resulting in greatest quantity of mental imagery (mean = 4.93), followed by Google Earth (mean =4.89), Google Map (mean = 4.80) and the PDF map (mean = 4.03). Second, the influence of the map conditions on interactivity was also statistically significant (at p=0.013), with the Google Earth map condition resulting in the highest perceived interactivity (mean = 5.873), followed by the Flash Map (mean = 5.703), the PDF map (mean = 5.159) and the Google Map (mean = 5.073).

Table 4
Descriptive Analysis Results

	N	Range	Mean	Std. Deviation	Variance
Spatial Presence	96	4	4.21	1.134	1.287
Spatial Situation Model	96	5	4.72	1.026	1.054
Ease of Mental imagery	96	5	4.71	1.005	1.010
Quantity of Mental Imagery	96	6	4.67	1.273	1.620
Vividness of Mental Imagery	96	5	3.33	1.058	1.119
Interactivity	96	4	5.45	1.046	1.094
Spatial Ability	96	6	4.84	1.437	2.064

CONCLUSION

This paper presented a conceptual framework for analyzing virtual spatial experiences in the context of digital destination maps. Based on a review of literature from disciplines such as psychology, human computer-interaction, geosciences and virtual reality studies, the conceptual framework proposes a relationship between map interactivity and virtual spatial experiences that is moderated by an individual's spatial ability. Scales were adopted from existing literature in the respective areas. A preliminary study was conducted to evaluate the measures. Since the measures were tested in a new context, exploratory factor analyses were deemed appropriate. A process of consolidation of measures and elimination of items resulted in seven scales measuring distinct constructs. The resulting scales show very good measurement properties.

An exploratory analysis was also conducted with respect to whether the map interactivity and VSE scales varied based on the use of a specific map type. The results indicate that perceived interactivity and quantity of mental imagery were significantly influenced but not other VSE constructs. The Google Earth map and the Flash version of the map achieved the highest interactivity scores and also led to more mental imagery. The next step in the research process will be a study to test the full model based on the tested scales.

The proposed model helps guide research to gauge interactive maps with respect to their ability to stimulate engaging virtual spatial experiences that can help tourists learn about a destination. Such research will help system developers and tourism marketers decide which types of maps to include on a destination Website. Additional map features often represent increased programming and maintenance costs. The proposed framework can help measure whether additional interactivity is actually perceived and translated into greater spatial presence and spatial imagery by the users. Of course, it is also applicable to other contexts in which interactive maps might be used, e.g. for teaching and training purposes. It can also be applied to tourism applications in virtual worlds like Second Life or to destination Websites in general.

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