The Impact of Navigability on Flow-like Experiences and User Enjoyment of Online Art Exhibitions
Abstract

With the development of new modes of web interface and 3D virtual environment, the concept of navigability is considered an important element to understand users’ experience with the interface. Particularly in the context of virtual art galleries, navigability can influence users’ level of immersive and enjoyable experience of artworks. Responding to the conflicting evidence showing both positive and negative effects of higher navigability on the evaluation of online art exhibitions, this study examines the impact of navigability on flow-like experiences (i.e., skill-challenge match, immersion) and user enjoyment and behavioral intention. Thirty-five undergraduate students participated in a between-subjects experimental study with two conditions (2D interface for low navigability vs. 3D interface for high navigability). Participants in the low navigability condition reported lower levels of skill-challenge match and higher levels of immersion and enjoyment than those in the high navigability condition. Also, we found that immersion, not a skill-challenge match, mediated the effect of navigability on enjoyment which led to behavioral intention. Based on the findings, theoretical and practical implications are discussed.

Keywords: navigability, flow, immersion, challenge, enjoyment, behavioral intention, online, art museum
Introduction

In recent years, as both computing power and the ability to share media over the Internet have increased, there has been a booming interest in new modes of media consumption and interaction. In particular, there has been a rise in interest in the possibilities of 3D environments. While often studied with positive results (Stieglitz, Lattemann, & Fohr, 2010), there remain open questions regarding the effects of such new media environments on users, and how the means of interaction with a system influences its effectiveness (Balakrishnan & Sundar, 2011). Given that such virtual environments are frequently seen as having possible use in educational settings (Jones, Morales, & Knezek, 2005; Stieglitz et al., 2010), particularly as they may provide an immersive and engaging experience, more investigation into the ways user experiences are impacted by such novel means of media interaction seems warranted.

One area that has seen a lot of interest in the use of new modes of user interactivity has been the development of virtual art galleries (Smith, 2011). In these, would-be museum visitors are given the chance to explore virtual 3D museum spaces populated with artworks. Offering a means for the public to increase their engagement with classical artworks (Mendes, Drees, Silva, & Bellon, 2010), such projects rely on the idea that by offering users an immersive experience of works, they will have a more enriching experience (Lepouras, Katifori, Vassilakis, & Charitos, 2004). Whether within a traditional museum (Lepouras et al., 2004), or branching out into online spaces (Sharples, Lonsdale, Meek, Rudman, & Vavoula, 2007), the use of virtual environments is seen as an effective way of generating and maintaining interest in the arts. In this, there is a sense that virtual museums offer those who would be unable to visit the great museums of the world a chance to engage with their artworks in an immersive way.

Given that the aim of many such projects is to develop an interest in and appreciation of
the arts, there is a constant emphasis on providing users with an experience that is enjoyable and easy to use. When dealing with such virtual environments, it has been demonstrated that the navigability, or an interface’s capability of affording user navigation, of any system is a key element in the success of the experience of a system (Sundar, 2008). As is true with any information system, in order for users to have a satisfying experience it is imperative that users are able to move through the virtual environment in way in which they are able to both engage with the content at hand, as well as discover new content.

In the area of online media use, studies have frequently conceptualized users’ interaction with media in terms of optimal experience, broadly categorized as an experience of “flow” (Procci & Bowers, 2011; Rettie, 2001; Sherry, 2004). Such flow-like experiences are seen as being comprised of aspects of immersion, satisfaction, and control (Ghani & Deshpande, 1994) in which users are seen as fully engaged with the task at hand. In a flow-like state, users hover between opposite poles of anxiety and boredom, facing an experience of a system that is neither too difficult to use nor too simple as not to present some sense of challenge and satisfaction to the user.

Considerations of whether a system is able to develop and sustain a user's experience of optimal flow are important as designers, developers, art professionals, and educators—anyone with a stake in developing virtual environments—fund, build, and deploy such systems. Given their still novel status, the use of 3D interfaces and virtual environments present many challenges to both designers and users.

As such, the current research examines navigability’s impacts on user experience of such virtual interfaces. Specifically, are current assumptions about the viability of 3D environments warranted? Further, what impacts does the navigability of an interface have on a user’s
experience of an online art exhibition? Does the navigability of a system impact the sense of immersion and flow that users have while using the system? In order to address these questions, this article offers insight into the theoretical and practical implications of navigability.

**Literature Review**

**Navigability Explicated**

While traditionally the concept of navigation finds its meaning in the way one goes about finding the correct path to a destination in the physical world (as one would with a map and compass), the advent of cyberspace and virtual environments has added a new complexity to the idea of what it means to navigate. Instead of having to follow a step-by-step linear path to reach a destination as in the real world, virtual spaces offer the possibility of multiple paths and shortcuts to a destination, such as various hyperlinks pointing to one destination. In virtual environments, concerns for navigation, traditionally based on an individual’s movements, become centered on the affordances given by the interface.

From a traditional perspective, navigation in a mediated environment is usually viewed as a user behavior (Herndon, van Dam, & Gleicher, 1994; Jul, 2004). A distinction can be made among defining navigation as purely cognitive (Jul, 2004), that wayfinding in the virtual world is accomplished by the brain only; a physical behavior (J. L. Chen & Stanney, 1999), that navigation is only the execution step of the whole wayfinding process; or as a whole process including both the cognitive decision-making part and the kinesthetic decision-execution part (Herndon et al., 1994).

On the other hand, navigability, the affordance of navigation, is an attribute of the interface that resides in technology, which is defined as the degree to which the interface can “suggest or aid user movement through the media space” (Sundar, 2009, p. 554). Balakrishnan
and Sundar (2011) broke down navigability to two sub-constructs: traversibility and guidance. Traversibility is “the affordance to travel large distances in a virtual environment” (p. 168), while guidance is “the extent of scaffolding support provided by the interface to help reduce the cognitive effort needed for wayfinding” (p. 169). Tan, Robertson and Czerwinski (Tan, Robertson, & Czerwinski, 2001) presented a task-based taxonomy of navigation techniques in 3D virtual environment that improved the function of navigability.

The goal of studying navigability in electronic media environment is to study users’ spatial experience and to improve their wayfinding performance with proper aids supported by the interface. In this, navigability may be operationalized either by measuring the features of the interface (e.g., number of aiding tools) or by manipulating the degree of freedom for user motion afforded by the interface. From this it becomes possible to examine the mechanism (e.g., through flow-like experiences) by which navigability impacts user experience (e.g., level of enjoyment). Thus, following Balakrishnan and Sundar’s (2011) “traversibility” approach but with some adjustments, we define navigability as an attribute of the interface, more specifically, as the degree of freedom for user motion offered by the interface.

Although research examining the effectiveness of navigability in virtual environments, such as 3D settings is relatively new, most of the recent studies indicate that such effects are positive. In an experimental user study, Mendes, Drees, and Silva (2010) developed a virtual museum and found that the realistic visualization of 3D models—with high navigability by our definition—contributes significantly to users’ experience. These findings pointed to the possible application of 3D environments in the areas of education, entertainment, and culture. Eckmann, Yu, Boult, and Kessler (2001) found that participants who were given the task to navigate through a virtual building (high navigability) for training purposes had greater level of
enjoyment and immersion than those who only read the building’s blueprint (low navigability) for the task. Stieglitz, Lattemann, and Fohr (2010) also found that high navigability (i.e., 3D technology) led to positive attitudes and satisfaction of user’s experience in the area of education. However, other studies indicated that high navigability in a virtual museum could also lead to negative outcomes, because too much freedom may increase users' sense of getting lost, therefore harmed users’ experience (Lepouras et al., 2004). Given these conflicting findings, it is important to properly understand the mechanism by which navigability impacts user’s experience.

**Flow-like Experiences in a Navigable Virtual Environment**

First developed by Csikszentmihalyi (1977), the psychological concept of flow is used to describe a state or propensity toward a feeling of total involvement with an activity. When in flow, a person engaged with an activity is seen as maintaining a state of optimal performance positioned mid-way between the poles of boredom and anxiety. Such activities are able to provide a rewarding and engrossing challenge for the participant, resulting in enduring engagement. Often grouped with other, related theoretical constructs such as cognitive absorption and immersion (Agarwal & Karahanna, 2000), flow-like experiences have been seen to play an important role in online interactions and other computer use scenarios (Novak, Hoffman, & Yung, 1998; Rettie, 2001). Previous studies have found significant flow-like experiences when surveying users regarding their use of online shopping sites (Novak, Hoffman, & Yung, 2000), web surfing (H. Chen & Wigand, 2000; Novak et al., 1998), and even simply general workplace computer use (Ghani & Deshpande, 1994).

In studies of human-computer interaction, especially in a virtual environment, flow is characterized by several facets. As antecedent to a flow-like experience, there is a sense of match
between the challenge that an activity presents and the skill that is required for a user to complete it (Ghani, Supnick, & Rooney, 1991), as well as a sense of increased attention and telepresence (Chen & Wigand, 2000; Novak et al., 1998) which is characterized as a form of immersion in which a user is fully engaged in the task at hand and becomes more present in the activity than they are in their immediate surroundings.

Interestingly, studies of video game players have shown that traditional measures for flow and immersion point to a distinction between the concepts (Procci & Bowers, 2011), even as flow-like experiences were found to be dependent, in part, on a sense of immersion (Novak et al., 2000). One possible differentiation here may be that measures of immersion on its own (Witmer & Singer, 1998) seek a stronger display of focused attention than the type of focused attention that is used in most studies of flow-like experiences.

Given the interconnected roles of a challenge/skill match and immersion in a flow-like experience, how is it possible to understand the effect that each has on a user's experience of a virtual environment? Given the findings of Novak et al. (2000) and Procci and Bowers (2011) which point to a differentiation of the main components of flow (defined as skill-challenge and intrinsic motivation by Webster et al. (1993) and Ghani and Deshpande (1994)) and a sense of immersion, how should the characteristics of flow be separated?

**Challenge and skill.** Central to the description of a flow-like experience is the sense of a matching of the challenge of the activity and the skill of the person engaged in the activity. In this, the challenge presented by the task is balanced with a person's ability to successfully complete the task (Csikszentmihalyi & Csikszentmihalyi, 1988). For studies of flow in HCI, this matching of challenge and skill is often related to the sense of control that a user believes that they have over a piece of software (Trevino & Webster, 1992; Webster et al., 1993). In this, there
is an emphasis on a seamless interaction (Hoffman & Novak, 1996) which the user is able to manipulate without difficulty. Specifically, navigability in an interface has been shown to be able to provide users this sense of balance (Sundar, Go, Kim, & Zhang, 2012). Thus, we propose the following hypothesis:

H1: The greater the level of navigability, the greater the degree of skill-challenge match.

**Immersion.** Key to the definition of a flow-like experience are several characteristics related to the concept of immersion when it is considered as a sense of being enveloped in a continuous stream of experiences and stimuli (Witmer & Singer, 1998). In a flow-like experience, this sense of immersion comes out as a loss of self-consciousness (Hoffman & Novak, 1996; Nakamura & Csikszentmihalyi, 2002), an intense and focused concentration (Ghani, 1995; Nakamura & Csikszentmihalyi, 2002), and a distortion of temporal experience (Nakamura & Csikszentmihalyi, 2002). Studies of various types of online interactions have indicated that focused concentration predicts an experience of telepresence (Novak et al., 2000). Curiously, this type of experience of telepresence, or presence, is thought to be in part constituted by a sense of immersion, particularly when studied in relation to virtual interactions (Witmer & Singer, 1998). Therefore, we propose the following hypothesis:

H2: The greater the level of navigability, the greater the degree of immersion.

**Other User Outcomes of Navigability**

**Enjoyment.** In media effect studies, enjoyment has been regarded as a central concept to explain media use for leisure/entertainment and educational purposes (Green, Brock, & Kaufman, 2004; Tamborini, Bowman, Eden, Grizzard, & Organ, 2010). Considering that the experience of media consumption in online environment is fundamentally different from traditional media use (Hoffman & Novak, 1996), it is important to identify distinctive
characteristics of new media technologies which elicit an enjoyable experience. As a positive appraisal of consuming media, enjoyment has been theoretically defined as “a pleasurable affective response to a stimulus” (Green et al., 2004, p. 311). Conceptualizing enjoyment as an emotional outcome evoking a sense of pleasure after exposure to media contents, Raney and Bryant (2002) measured a user’s level of enjoyment by capturing various aspects of certain media content (e.g., how exciting, suspenseful, enjoyable, and etc.). Similarly, in their tripartite conceptualization of enjoyment (engagement, positive affect, and fulfillment), Lin, Gregor, and Ewing (2008) considered that the measurement of positive feelings of pleasure, happiness, content, and satisfaction is crucial to understanding the enjoyment of web media experiences. Due to the general positive outcomes found in previous studies on navigability discussed above, it is plausible that navigability provokes user enjoyment. Thus we hypothesize that:

H3: The greater the level of navigability, the greater the degree of enjoyment.

In previous literature, researchers have suggested that enjoyment can be derived from flow-like experiences. In the discussion of the relationship between flow and media enjoyment, Sherry (2004) argued that the media users experience the flow state when there is a balance between the challenge of media massage and an individual’s cognitive ability to interpret that message; as a desirable consequence of media consumption, the flow state provides a theoretical explanation for media enjoyment. Also, in terms of immersion, Green et al. (2004) proposed that media enjoyment is a consequence of the feeling of being immersed in a media world. Thus, the flow state in total or simply immersion can both be central factors increasing enjoyment. So we further hypothesize that:
H4a: The greater the degree of skill-challenge match, the greater the degree of enjoyment.

H4b: The greater the degree of immersion, the greater the degree of enjoyment.

**Behavioral Intention.** Known as the strongest predictor of actual behavior (Fishbein & Ajzen, 1975), behavioral intention refers to an individual’s intention to carry out a certain action. As an outcome of experiencing services or products, behavioral intention is largely influenced by a customer’s evaluation about various quality attributes (Zeithaml, Berry, & Parasuraman, 1996). In the literature on psychology and consumer behavior, two types of behavior, repeated usage and positive word-of-mouth, have been examined as an indicator of customer loyalty. In the context of media consumption, enjoyment is recognized as a main factor leading to a constant media use. For example, Sherry (2004) discussed that enjoyment derived from flow experience increases the frequency of playing video games. In a similar fashion, it is possible to assume that an enjoyable experience with a navigable web interface can play an important role in human-computer interaction to involve enduring engagement behavior with a certain media contents. Thus, our next set of hypotheses are:

**H5:** The greater the level of navigability, the greater the degree of behavioral intention.

**H6:** The greater the degree of enjoyment, the greater the degree of behavioral intention.

These antecedent characteristics of a matched level of skill and challenge and a sense of immersion lead to both positive affect and a behavioral tendency to explore the system (Novak et al., 1998). In this, such exploration is frequently cited as a propensity toward curiosity and an increase in intrinsic motivation to use the system (Ghani & Deshpande, 1994). Later revisions of the flow model found behavioral outcomes to be related only by the antecedent sense of telepresence, not by a measure of flow in total (Novak et al., 2000). Studying users of a
spreadsheet program, Webster, Trevino, and Ryan (1993) found that when examining flow in relation to computer use, intrinsic motivation and curiosity correlated into one item, leaving a single combined facet of exploratory behavior as resulting from the antecedent factors of immersion and skill-challenge match.

Further, when examined in the context of an online domain, specifically in a virtual environment, this match of skill and challenge is linked to continued use, where a lack of challenge leads users to log off or shift their attention elsewhere (Novak et al., 2000). Given the measured difference between immersion and flow-like experiences (Procci & Bowers, 2011), there remain open questions regarding the relationship between the concept of immersion and the seemingly larger concepts of flow. On the one hand, immersion, as an aspect of presence, is understood as being part of the process of flow, while on the other hand, immersion is measurably distinct from a flow-like experience. In either case, both flow-like experiences (Novak et al., 1998, 2000) and immersion (Witmer & Singer, 1998) have been seen as being positively linked to both positive affect and modifications in behavioral intent. Therefore, our final set of hypotheses are:

H7a: The greater the degree of skill-challenge match, the greater the degree of behavioral intention.

H7b: The greater the degree of immersion, the greater the degree of behavioral intention.

Method

A controlled experiment using a 2-condition (high/low – navigability) between-subjects design was used to test the hypotheses. The research was carried out in a computer laboratory at a large public university.

Participants
Participants \((N = 35)\), aged between 18 and 25 \((M = 20.29, \text{SD} = 1.93)\), were recruited from an undergraduate introductory class in exchange for extra course credit. Twenty of the participants were male (57.14%), twenty-seven were recreation, parks and tourism management majors (77.14%), thirty-four were Caucasian (97.14%), and all of them were native speakers. All participants signed an informed consent form prior to their participation in the experiment.

**Stimulus**

An online, virtual-exploration website of one exhibition room in the Museum of Modern Art (MoMA) in New York, NY, was used as the stimulus material for the study. The virtual museum was created by the Google Art Project (http://www.googleartproject.com/), which allows users to explore museums from around the world and view hundreds of artworks. The stimulus exhibition room we used contained 17 paintings in total. In the laboratory, we offered participants the stimulus material via identical desktop computers (with Microsoft Windows operating system) each with a 17-inch display. The Google Chrome Web browser and a Chrome plug-in application called Stylebot were installed on the computers in order to allow for the manipulation of the stimulus website’s appearance prior to the study. Stylebot allows for the hiding or editing any elements on a webpage through changing CSS code.

Because we wanted the participants to only focus on painting exploration and ignore the various other interface tools on the website, we used Stylebot to hide certain buttons and hyperlinks. Specifically, in low navigability (i.e., 2D interface) condition, we hid the “Art Project powered by Google” logo, the MoMA button (for switching to the 3D condition), the “Visitor Guide” button, the painting information “i” button, the “Sign In” button, and the “Create an Artwork Collection” button (see Figure 1). So we only kept the button with the current painting’s name and the back and forward arrows for participants to go through the gallery without
accidentally going to the 3D version. In high navigability (i.e., 3D interface) condition, we hid the “Art Project powered by Google” logo, the current painting’s name button, the “Visitor Guide” button, the painting information “i” button, the “Sign In” button, and the “Create an Artwork Collection” button (see Figure 2). We kept the MoMA button for participants to go back to the room view after zooming in to see a specific painting. Prior to the start of the study, we conducted pretests on 4 people to make sure the stimulus for both conditions work properly.

**Independent Variable**

Navigability was operationalized as the degree of freedom for user movement in the virtual interface, implemented as either the 2D interface with the paintings in the exhibition room (low navigability), or the 3D virtual environment interface of the exhibition room (high navigability). The independent variable was nominal, and manipulated by assigning either condition to a participant. In the low navigability (i.e., 2D) condition, the participant only had two options of meaningful movement (click to view the previous painting and click to view the next painting). In the high navigability (i.e., 3D) condition, the participant had a greater degree of movement freedom (e.g., move forward, backward, leftward, rightward, upward, or downward in the exhibition room to explore the paintings; control the distance from a painting; zoom in to view details of a painting; view any painting at anytime). Because the values of the independent variable were implemented by manipulation, manipulation check was not necessary.

**Dependent Variables**

*Flow-like experiences as mediating variables.* The flow-like experience was broken down to a) skill-challenge match: operationalized as the extent to which one’s sense of skill can match the degree of challenge posed by the interface; b) immersion: operationalized as the perceived level of total engagement with the activity. Based on the operationalizations, items
were selected from established scales to measure both skill-challenge match and immersion. To measure how participants felt their skill matched the level of challenge posed by the virtual museum’s interface, 2 items (i.e., “My skills allowed me to meet the challenge of exploring the exhibition”) on a 7-point Likert-type scale, ranging from (1) strongly disagree to (4) neutral to (7) strongly agree, were selected from Jackson and Eklund’s (2004) Flow Scales Manual ($r = .84$). Immersion was measured by asking participants how much they were engaged with the virtual museum website, using 2 items on a 7-point Likert-type scale, adapted from Ghani (1995) and Choi & Kim (2004) (i.e., “While I was visiting the online art exhibition, I was entirely absorbed in visiting the online art exhibition”) ($r = .60$). The level of measurement for both immersion and skill-challenge match was interval/ratio.

**Enjoyment and behavioral intention.** As overall outcomes of participants’ experience with the virtual museum, this study measured the level of their enjoyment while visiting the website and their behavioral intention toward the virtual art exhibition after the exploration. For enjoyment, operationalized as positive affect, 3 items on a 7-point Likert-type scale (Lin et al., 2008) were employed (i.e., “While I was visiting the online art exhibition, I felt pleased.”) ($\alpha = .95$). Behavioral intention were assessed on a 7-point Likert-type scale with 5 items (i.e., “I will encourage friends and relatives to visit this online art exhibition”) ($\alpha = .87$) from Zeithaml et al. (1996). The level of measurement for both enjoyment and behavioral intention was interval/ratio.

**Control Variables**

The study measured several control variables, such as age, gender, major, previous experience with Google Street View (which has a similar interface with the 3D virtual museum and may moderate the effect of navigability), general art interest, and number of hours spent online per week.
Procedure

Each participant was welcomed and assigned to one of the desktop computers in a computer lab upon arrival. They were then asked to read and fill out a consent form with paper and a pen. Upon their agreement to participate, they were briefed about the overall experimental procedures, the instruction on exploring the virtual museum interface, the use of mouse controls, and their tasks. They were also informed that they could decide to stop participating at any time during the experiment. All the participants received the instructions from the same experimenter. Since the instructions for two conditions (low/high navigability) were different in terms of the use of mouse control for exploration, the experimental sessions (not the participants) were randomly assigned to one of the two experimental conditions, and the participants joined one of the sessions by signing up a session according to their availability.

To have the participants explore the whole exhibition and focus on the paintings, they were given two tasks. The first one was to pick their favorite painting and explain reasons after the exploration; the second one was to count the number of paintings containing representations of people. After the instruction, the participants were asked to turn on their monitor and briefly practice in order to get familiar with the assigned interface, thus reducing the impact of unfamiliar controls. After the practice time (20 seconds for low navigability condition, 1 minute for high navigability condition, decided by pretest results) was up, the experimenter closed their practice webpage on their computer and showed them the experiment webpage (identical with the practice page, just to make sure every participant would start from the same viewing angle for exploration). The participants then explored the stimulus website to complete the tasks. The experimenter recorded the time spent by each participant exploring the virtual exhibition. After participants finished browsing the website and the tasks, their were asked to fill out an online
questionnaire containing both the responses for the tasks and the aforementioned dependent and control variables. After all the experimental sessions were completed, all the participants were debriefed in their class.

**Data Analysis**

We used JMP 9.0, SPSS 19.0, and AMOS 19.0 to analyze the data. First, the frequency and distribution of the data were tested. Second, we used exploratory factor analysis to identify the factor structure of the measures. Third, in order to compare the mean scores between high and low navigability conditions, a series of t-tests were conducted for immersion, challenge, enjoyment, and behavioral intention. Forth, variables such as age, gender, Internet use, previous experience with interface, and general art interest were statistically controlled in stepwise multiple regression models predicting for each dependent variable. Fifth, path analysis models were used to examine the mediating role of immersion, challenge, and enjoyment.

**Results**

To assure our measurement items represent each concept (i.e., skill-challenge match, immersion, enjoyment, and behavioral intention), we conducted an exploratory factor analysis using the principle component method with Oblimin rotation (see Table 1). Among 13 items, we identified 4 factors based on Eigenvalues (1.03-5.58). Cumulative percentage of explained variance by four factors was 98.21%. Although two items (i.e., IM1 and BI5) were cross loaded above .4, these items were included factors based on a high factor loading when creating factor indexes.

On average, participants in the low navigability condition spent 95 seconds to explore the exhibition and participants in the high navigability spent 241 seconds. Although the difference of time spent in the exhibition was statistically significant ($\Delta M = 146$ s, $t = 4.89$, $df = 33$, two-tailed
p < .05), it was not significantly related to skill-challenge match, immersion, enjoyment, and behavioral intention. Also, there was no interaction effect of navigability and time spent on these four factors. In the same fashion, general art interest was not related to the four factors and there was no interaction effect of navigability and general art interest on these four factors.

To test hypotheses, we examined how the level of navigability influenced participants’ responses on skill-challenge match, immersion, enjoyment, and behavioral intention (see Table 2 and Figure 3-6). As expected, participants in the high navigability condition (M = 6.18, SD = .25) had a higher mean score on skill-challenge match than participants in the low navigability condition (M = 5.47, SD = .24). Also, the difference was statistically significant (ΔM = .71, t = 2.02, df = 33, one-tailed p < .05). By showing a higher level of navigability involves a higher level of skill-challenge match, H1 was supported. On the other hand, opposed to our expectation, participants reported a significantly higher degree of immersion (ΔM = .82, one-tailed t = 2.05, df = 33, one-tailed p < .05) in the low navigability condition (M = 5.03, SD = .28) than in the high navigability condition (M = 4.21, SD = .29). Thus, H2 was not supported. Similarly, participants in the low navigability condition (M = 5.53, SD = .24) more positively responded that exploring the online art exhibition was enjoyable than those in the high navigability condition (M = 4.93, SD = .25). Although the difference was significant (ΔM = .60, t = 1.74, df = 33, one-tailed p < .05), H3 was not supported. In terms of behavioral intention, there was no statistically significant difference between two groups (ΔM = .06, t = .13, df = 33, one-tailed p = .55). Thus, H5 was not supported in our study.

To statistically control the effects of age, gender, Internet use, previous experience with the interface, and general art interest, we included control variables in the stepwise multiple regression models separately predicting for skill-challenge match, immersion, enjoyment, and
behavioral intention (see Table 3). After accounting for the effects of all control variables at the first step, we did not find any significant effects of control variables. Then, we included the level of navigability and other main variables according to the order as shown in Table 3. First, predicting for skill-challenge match ($R^2 = .30$), only condition (low vs. high navigability) was significant ($\beta = .38, p < .05$), immersion was not statistically significant. Second, for immersion ($R^2 = .21$), only the effect of condition was marginally significant ($\beta = -.38, p < .10$), skill-challenge match showed no statistically significant effect. Third, in terms of enjoyment ($R^2 = .47$), condition had no significant effect, immersion ($\beta = .46, p < .05$) had a significant effect (H4b was supported), and the effect of skill-challenge match ($\beta = .30, p < .10$) was marginally significant (H4a was not supported). On the other hand, for behavioral intention ($R^2 = .42$), both skill-challenge match and immersion had no significant effect (H7a and H7b were not supported). However, enjoyment ($\beta = .45, p < .05$) had a significant effect on behavioral intention (H6 was supported) and the effect of condition was marginally significant ($\beta = .35, p < .10$). In sum, there was a significant effect of condition on skill-challenge match and immersion, and then these two variables influenced enjoyment which led to behavioral intention. Based on the findings in multiple regression models, it seemed reasonable to propose a mediation model in order to examine indirect effects.

In order to test the mediation model using a path analysis, the data were screened for missing values. Because less than 5% of the data were missing, an expectation-maximization procedure was performed to account for missing values (Tabachnick & Fidell, 2007). The mediation model included five variables (navigability, skill-challenge match, immersion, enjoyment, and behavioral intention) and was examined by using a path analysis (see Figure 7). First, the overall model fit was assessed. Because chi-square is largely influenced by sample size,
it is necessary to consider other practical fit indices such as RMSEA, CFI, and SRMR. Although a chi-square test was supportive ($\chi^2 = 7.535, df = 5, p = .184$) and other two goodness-of-fit indices (CFI = .909; SRMR = .084) were in the range of an acceptable fit, the model fit of proposed path model was violated in terms of RMSEA (.122, 90% CI = .000-.288) based on the cutoff criteria (Hu & Bentler, 1999). Second, we tested the significance of path coefficients. In line with the results of multiple regression models, a higher navigability was positively related to skill-challenge match ($\beta = .33, t = 2.05$) and negatively influenced immersion ($\beta = -.34, t = -2.08$). While immersion had a significant effect on enjoyment ($\beta = .52, t = 3.62$), the path from skill-challenge match to enjoyment was not significant ($\beta = .25, t = 1.73$). Also, there was a significant effect of enjoyment on behavioral intention ($\beta = .46, t = 3.01$). Third, the mediating roles of skill-challenge match, immersion, and enjoyment were examined by using bootstrapping procedures with 5,000 bootstrap samples and bias-corrected confidence intervals. In the relation between navigability and enjoyment, immersion had a significant indirect effect ($\beta = -.18, p < .05$) while the indirect effect of skill-challenge ($\beta = .08, p > .05$) was not significant. Also, enjoyment had a significant indirect effect between immersion and behavioral intention ($\beta = .24, p < .05$) but the indirect effect from skill-challenge match to behavioral intention ($\beta = .12, p > .05$) was not significant. Because of a) a poor model fit, b) an insignificant effect on enjoyment, and c) an insignificant indirect effect, the mediating role of skill-challenge match was not supported. Thus, we decided to exclude skill-challenge match in the mediation model.

We modified our mediation model by excluding skill-challenge match (see Figure 8). First, the overall model fit was improved by assuring a good model fit ($\chi^2 = 3.184, df = 3, p = .364; CFI = .991; SRMR = .059; RMSEA = .043, 90% CI = .000-.296$). Second, all path coefficients in the model were statistically significant. A higher navigability negatively
influenced immersion ($\beta = -.34, t = -2.08$). There is a positive effect of immersion on enjoyment ($\beta = .53, t = 3.63$) which led to behavioral intention ($\beta = .47, t = 3.09$). Third, both mediators (immersion and enjoyment) showed a significant indirect effect. Bootstrapping procedures using 5,000 bootstrap samples and bias-corrected confidence intervals were conducted to test the indirect effects. The indirect effect of immersion between navigability and enjoyment ($\beta = -.18, p < .05$) was statistically significant. Also, there was a significant indirect effect of enjoyment between immersion and behavioral intention ($\beta = .25, p < .05$).

In summary, we confirmed that skill-challenge match, immersion, enjoyment, and behavioral intention are distinctive factors. Using a series of t-tests, we found that a higher level of navigability had a positive impact on skill-challenge match, and negatively influenced immersion and enjoyment. Also, when controlling for age, gender, Internet use, previous experience with the interface, and general art interest, the findings of multiple regression models showed that both skill-challenge match and immersion were influenced by navigability. Also, both had a significant effect on enjoyment which influenced behavioral intention. By using a path analysis to examine the mediating roles of skill-challenge match, immersion, and enjoyment, we found that there is no significant indirect effect of skill-challenge match. Thus, we finally proposed a modified mediation model of navigability-immersion-enjoyment-behavioral intention.

**Discussion**

Somewhat surprisingly, those participants assigned to the low navigability condition reported higher levels of enjoyment than those in the high navigability condition. The effect of navigability on enjoyment was found to be mediated by immersion in the online exhibition. While a connection between navigability and a sense of skill-challenge match was found to be
significant, there was no significant correlation between reported skill-challenge match and the degree of enjoyment. As such, it appears that in the case of an interactive online experience, the effects of navigability on user enjoyment is mediated by immersion, but not by the larger construct of a flow-like experience such as would be constituted in part by a feeling of a skill-challenge match. From these findings, both theoretical and practical implications can be found.

**Theoretical Implications**

Contrary to earlier studies on the effects of navigability which found there to be positive relationships between both navigability and enjoyment, and navigability and immersion (Eckmann et al., 2001), the present study found higher navigability to a detriment to both a sense of immersion and enjoyment. Further, finding that low navigability conditions predicted higher degrees of enjoyment and intention for future use contradicts earlier studies linking high navigability and user satisfaction (Mendes et al., 2010; Stieglitz et al., 2010). Such contradictory findings suggest that the effects of navigability of a system are more complex than simply offering users a wholly beneficial increase in freedom of movement, and that such freedom may in fact have other, hidden costs.

Discrepancies between the real world and the virtual, and attempts, such as certain strategies for high navigability in virtual 3D environments, at bridging the two, when improperly matched, may make it more difficult for users to orient themselves in the virtual world. If users of virtual environments are too frequently unable to achieve their goals in virtual worlds as smoothly or easily as they would be able to in the real world, any sense of enjoyment in utilizing virtual worlds may be lost.

Finding that immersion, and not a skill-challenge match, mediates the effects of navigability on enjoyment lends support to models of flow-like experiences in which the
experience of flow and effects on behavior are seen as each resulting from a number of factors—
skill-challenge match and immersion being two such antecedents to flow-like experiences—and
not simply a singular concocted experience of flow. The results of the present study moves the
former model even further, suggesting that such immersive aspects of a flow-like experience not
only affect behavior, but also enjoyment.

These previous theoretical models of flow-like experiences, however, do not explain why
our study found low degrees of navigability to be predictive of immersion and enjoyment, while
high degrees of navigability had a lesser effect. Given the inconsistent results reported from
previous studies of navigability, there are clearly other factors affecting the way in which users
respond to differing degrees of navigability. First, given a particular task (such as those given to
participants in the study), it appears that there may be an upper limit at which point greater
navigability is no longer beneficial. That is, it may be possible that for certain types of simpler
tasks there is an ideal degree of navigability, and that once such a degree becomes exceeded the
extra navigability becomes an excess that needs to be managed by the user. Following from this,
there is the possibility that the extra informational complexity that a highly navigable virtual
environment offers may introduce too great a cognitive load, particularly in the setting of a
virtual art museum in which users' attention is meant to be focused on the artworks. In this,
displaying the structure of the museum's rooms adds supplementary information which distracts
from the real object of use: the artworks themselves. Similarly, in a highly navigable
environment, if users are not given any form of guidance or way-finding mechanism to guide
their exploration, they may become lost or disoriented, with this sense of disorientation
preventing users from becoming immersed or enjoying their use of the system. Perhaps most
bluntly, and setting cognitive concerns to the side, the lower degree of immersion and enjoyment
found in highly navigable environments may simply result from the need for such environments to employ more complex control mechanisms which, for a variety of reasons, may prevent users from engaging with the system in the same way as they would with less-navigable systems.

**Practical Implications**

Importantly, this study offers several practical implications for those involved with the design, development, funding, and use of virtual environments. With previous studies offering mixed advice for designers who may be thinking of implementing virtual museum environments (Lepouras et al., 2004; Mendes et al., 2010; Sharples et al., 2007), our findings that high degrees of virtual navigability do not necessarily lead to greater enjoyment or to greater desire for continued use should give designers further pause when considering how to develop such projects. The same advice could be given to educators planning such projects, or even to those considering funding projects aimed to expand access to museums.

More broadly, this study brings into question the viability of 3D virtual environments in general, seeing them not necessarily as the next logical development in media technologies which have seen a progression from text to static images to sound and video, but perhaps something that should be approached with caution, especially given their complexity and cost. As with anything, the development of highly navigable systems should be approached judiciously and with consideration for the goals of such a project. In the present context of online art experience, perhaps greater 3D navigability is unnecessary given the mostly 2-dimensional nature of most of the artworks being displayed.

**Limitations and Future Research**

Although several notable implications were derived from the study, the limitations of the study should also be considered. In this study, the difference between the two conditions—high
navigability and low navigability—posed some threats for internal validity by introducing a few confounding variables. In particular, in order to operationalize navigability, we used different stimuli (2D interface for low navigability vs. 3D interface for high navigability) for the two conditions. Although the two interfaces contained exactly the same set of paintings (17 in total) and had almost identical page designs, the information density presented was slightly different. In low navigability condition, the user could only view paintings themselves, while in high navigability condition, the user could also see the layout of the exhibition room and get a sense of the museum setting. Also, in the low navigability condition, only one type of user control was allowed—clicking on an arrow to view previous or next painting—while in the high navigability condition, single-clicking, double-clicking, and dragging were all afforded by the interface, so modality of user motion could be a confounding variable.

Another limitation of this study arises when considering the ability of our stimulus to properly discriminate between high and low navigability. According to our definition of navigability, we operationalized low navigability with 2D interface and high navigability with 3D interface, and used an online art exhibition as the stimulus material. But navigability also applies to other similar architectural interface designs such as virtual hospitals, virtual offices, and in video games. Although we controlled for participants’ general art interest, the particular goal of the online art gallery distinguishes it from other possibly less leisurely activities. As such, the results may not be immediately generalizable to other interfaces that are concerned with navigability issues. So future research could consider using other stimuli that both contain a more sophisticated range of navigability (e.g., conditions of low, medium, and high degrees of navigability) and is able to elicit proper skill-challenge match.
References


Choi, D., & Kim, J. (2004). Why people continue to play online games: In search of online contents, 7(1), 11-25.


Jones, J. G., Morales, C., & Knezek, G. a. (2005). 3-Dimensional online learning environments: examining attitudes toward information technology between students in Internet-based


Appendix

Table 1
Results of Exploratory Factor Analysis

<table>
<thead>
<tr>
<th>Item</th>
<th>SC</th>
<th>IM</th>
<th>EN</th>
<th>BI</th>
</tr>
</thead>
<tbody>
<tr>
<td>SC1. My skills allowed me to meet the challenge of exploring the exhibition.</td>
<td></td>
<td></td>
<td>.91</td>
<td></td>
</tr>
<tr>
<td>SC2. My abilities matched the challenge of exploring the exhibition.</td>
<td></td>
<td>.90</td>
<td>.49</td>
<td></td>
</tr>
<tr>
<td>IM1. While I was visiting the online art exhibition, I was entirely absorbed in visiting the online art exhibition.</td>
<td></td>
<td></td>
<td>.56</td>
<td></td>
</tr>
<tr>
<td>IM2. While I was visiting the online art exhibition, I did not have to make an effort to keep my mind on the activity.</td>
<td></td>
<td></td>
<td>.95</td>
<td></td>
</tr>
<tr>
<td>EN1. While I was visiting the online art exhibition, I felt satisfied.</td>
<td></td>
<td></td>
<td></td>
<td>.91</td>
</tr>
<tr>
<td>EN2. While I was visiting the online art exhibition, I felt pleased.</td>
<td></td>
<td></td>
<td>.91</td>
<td></td>
</tr>
<tr>
<td>EN3. While I was visiting the online art exhibition, I felt happy.</td>
<td></td>
<td></td>
<td>.60</td>
<td></td>
</tr>
<tr>
<td>EN4. While I was visiting the online art exhibition, I felt contented.</td>
<td></td>
<td></td>
<td>.95</td>
<td></td>
</tr>
<tr>
<td>BI1. I will encourage friends and relatives to visit this online art exhibition.</td>
<td></td>
<td></td>
<td></td>
<td>.87</td>
</tr>
<tr>
<td>BI2. I will say positive thing about this online art exhibition to other people.</td>
<td></td>
<td></td>
<td></td>
<td>.76</td>
</tr>
<tr>
<td>BI3. I will visit this online art exhibition more in the near future.</td>
<td></td>
<td></td>
<td>.92</td>
<td></td>
</tr>
<tr>
<td>BI4. I will recommend this online art exhibition to someone who seeks your advice.</td>
<td></td>
<td></td>
<td>.82</td>
<td></td>
</tr>
<tr>
<td>BI5. I will consider this online art exhibition my first choice to see art works online.</td>
<td></td>
<td>.51</td>
<td></td>
<td>.60</td>
</tr>
</tbody>
</table>

Note. SC=skill-challenge match, IM=immersion, EN=enjoyment, BI=behavioral intention

Table 2
Reliability, Mean, and Standard Deviation

<table>
<thead>
<tr>
<th></th>
<th>Low Navigability (N=18)</th>
<th>High Navigability (N=17)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Skill-Challenge Match</td>
<td>5.47</td>
<td>.24</td>
</tr>
<tr>
<td>Immersion</td>
<td>5.03</td>
<td>.28</td>
</tr>
<tr>
<td>Enjoyment</td>
<td>5.53</td>
<td>.24</td>
</tr>
<tr>
<td>Behavioral Intention</td>
<td>4.17</td>
<td>.31</td>
</tr>
</tbody>
</table>
Table 3

*Results of Multiple Regression Models*

<table>
<thead>
<tr>
<th></th>
<th>Skill-Challenge Match</th>
<th>Immersion</th>
<th>Enjoyment</th>
<th>Behavioral Intention</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Independent Variables</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Condition</td>
<td>.38**</td>
<td>-.38*</td>
<td>-.25</td>
<td>.35*</td>
</tr>
<tr>
<td>Skill-Challenge Match</td>
<td>-</td>
<td>.15</td>
<td>.30*</td>
<td>-.24</td>
</tr>
<tr>
<td>Immersion</td>
<td>.13</td>
<td>-</td>
<td>.46**</td>
<td>.19</td>
</tr>
<tr>
<td>Enjoyment</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>.45**</td>
</tr>
<tr>
<td><strong>Control Variables</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>-.20</td>
<td>-.06</td>
<td>-.03</td>
<td>-.13</td>
</tr>
<tr>
<td>Gender</td>
<td>-.24</td>
<td>-.20</td>
<td>.10</td>
<td>-.24</td>
</tr>
<tr>
<td>Internet Use</td>
<td>.16</td>
<td>-.03</td>
<td>.21</td>
<td>-.03</td>
</tr>
<tr>
<td>Previous Experience with the Interface</td>
<td>.07</td>
<td>.02</td>
<td>.00</td>
<td>-.09</td>
</tr>
<tr>
<td>General Art Interest</td>
<td>.12</td>
<td>-.10</td>
<td>.20</td>
<td>.30</td>
</tr>
</tbody>
</table>

*Note.* Numbers are standardized path coefficients; *p<.10, **p<.05
Figure 1. Example of stimuli for the low navigability condition. The top image shows the unmodified stimuli, with the lower image showing the stimuli with extraneous information (highlighted in the original image) hidden.
Figure 2. Example of stimuli for the high navigability condition. The top image shows the unmodified stimuli, with the lower image showing the stimuli with extraneous information (highlighted in the original image) hidden.
Figure 3. T-test result of skill-challenge match by navigability

Figure 4. T-test result of immersion by navigability
Figure 5. T-test result of enjoyment by navigability

Figure 6. T-test result of behavioral intention by navigability
Figure 7. Estimates of the proposed mediation model. $\beta =$ standardized path coefficients; $t$ = t-value; **$p<.05$, ***$p<.01$

Figure 8. Estimates of the final model. $\beta =$ standardized path coefficients; $t$ = t-value; **$p<.05$, ***$p<.01$