2020

Validating and Developing the User Engagement Scale in Web-based Visual Information Searching

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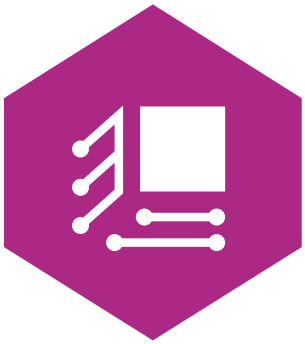

VOLUME 16 ISSUE 3

The International Journal of

Technology, Knowledge, and Society

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THE INTERNATIONAL JOURNAL OF TECHNOLOGY, KNOWLEDGE, AND SOCIETY
https://techandsoc.com
ISSN: 1832-3669 (Print)

https://doi.org/10.18848/1832-3669/CGP (Journal)

First published by Common Ground Research Networks in 2020
University of Illinois Research Park
2001 South First Street, Suite 202
Champaign, IL 61820 USA
Ph: +1-217-328-0405
https://cgnetworks.org

The International Journal of Technology, Knowledge, and Society is a peer-reviewed, scholarly journal.

Common Ground Research Networks, a member of Crossref

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Validating and Developing the User Engagement Scale in Web-based Visual Information Searching

Qiong Xu,[1] Queens College of the City University of New York, USA

Abstract: Guided by the theoretical frameworks of interactive information searching and user engagement (UE), this study proposed sense discovery (SD) as a UE attribute and suggested a refined four-factor user engagement scale (UES) model for the measurement of users' psychological involvement in web-based visual information searching. Using a mixed-methods approach based on a survey, this study confirmed the inter-item reliability of the original six-factor UES in three visual contexts—a general visual context, image searching on Google (ISG), and video searching on YouTube (VSY). Principal component analyses (PCA) partially confirmed the internal consistency of the original six UE subscales and suggested conceptual overlaps among four of six original subscales. Through thematic and sentiment analyses of the participants' visual information needs, the study further explored their positive experience and categorized a total of eight items related to SD. Based on the findings, a refined four-factor UES model, which can be flexibly administered, is proposed to measure users' psychological involvement in web-based visual information searching.

Keywords: User Engagement, User Engagement Scale, Visual Information Searching, Sense Discovery, Psychological Involvement

Introduction

The past decade has seen a growing interest in extending the interactive information retrieval (IIR) research from a simply system-centered approach to explore user-centered user-system interaction (Bent et al. 2017; Du and Spink 2011; Järvelin 2011; Kleiman et al. 2015; O'Brien and Toms 2010b, 2013; Sundar et al. 2016; Xie and Joo 2010; Yuan and Belkin 2014). User satisfaction is commonly used to evaluate the success of information systems in IIR, while user engagement (UE), a multi-faceted construct, is proposed to delineate user experience with interactive products or information searching systems (O'Brien 2010; O'Brien and Cairns 2015; O'Brien, Cairns, and Hall 2018; O'Brien and McKay 2018; O'Brien and Toms 2008, 2010a, 2010b, 2013).

As a multidimensional concept, UE not only contains users' perceptions of the pragmatic qualities of systems but also comprises their emotional and hedonic experience like stimulation, fun, attractiveness, etc. The user engagement scale (UES) is therefore developed to measure such psychological experience (O'Brien and Toms 2010a). Validated in an e-shopping context (O'Brien and Toms 2010a), the UES is further tested and refined in different applications such as social networking (Banhawi, Ali, and Judi 2012), exploratory search environments (O'Brien and Toms 2013), and online news and social book search (O'Brien and Cairns 2015; O'Brien, Cairns, and Hall 2018). The applicability of the UES in IIR is also tested and calls for further validations (O'Brien and Toms 2010b, 2013; Xu 2015).

Visual information searching systems provide knowledge and entertainment support in daily life, and this makes available the interactive communication between users and systems (Conniss, Ashford, and Graham 2000; Yoon 2011). The increasing use of images and videos makes it significant to examine UE and the relationships between UE and task-related factors in visual information searching. The more the field of information science knows about user experience in information searching, the better it will be able to meet users' information needs.

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The International Journal of Technology, Knowledge, and Society
Volume 16, Issue 3, 2020, https://techandsoc.com

ISSN: 1832-3669 (Print)
https://doi.org/10.18848/1832-3669/CGP/v16i03/21-45 (Article)

The past two decades have seen many visual information searching studies examining users' physical participation. Employing statistical methods, these studies investigate important participation factors (i.e., search task completion time, amount of interaction, number of keyword query and modification, search action patterns, etc.) during information searching (Albertson 2015b; Chen 2001; Choi 2010, 2013; Jörgensen and Jörgensen 2005; Kelly 2009; Kleiman et al. 2015; McDonald and Tait 2003; Westman, Lustila, and Oittinen 2008; Wildemuth, Oh, and Marchionni 2010). The descriptive statistics presented in these studies, however, are limited to examine users' search actions, rarely concerning users' psychological involvement or experience.

The current study mainly focuses on web-based visual information searching. Based on prior studies in IIR and UE, this study proposes that user engagement is a multidimensional concept that integrates both search behavioral and psychological attributes. It is argued that the original UES can be used to measure users' psychological involvement during visual information searching. Discussing the assumption, on which the UES is developed, that engagement may not be directed by specific goals (O'Brien 2010; O'Brien and Toms 2008, 2010a), this study proposes that sense discovery (SD), a perceived cognitive or cognitive-affective experience related to search goals, is one of UE attributes.

Using a mixed-methods approach based on a survey, this study confirms the inter-item reliability of the original six-factor UES in three visual contexts—a general visual context, image searching on Google (ISG), and video searching on YouTube (VSY). Principal component analyses (PCA) partially confirm the internal consistency of the original six UE subscales and suggest conceptual overlaps among four of six subscales. Through thematic and sentiment analyses of the participants' visual information needs, the study further explores users' positive experience related to SD. Based on the findings, a refined four-factor UES model, which can be flexibly administered, is proposed to measure users' psychological involvement in web-based visual information searching.

The findings of this study will advance our understanding of user experience in web-based visual information searching and contribute to the exploration of the concept UE and the validation of the UES in context. Due to the limitations of the current study, the propositions of SD as a UE attribute and the refined four-factor UES model call for further examinations and validations in different visual contexts among different user groups.

The rest of this article is organized into five parts. Literature Review summarizes the present literature and lists research questions to be addressed. Methodology outlines the research methods and statistical and qualitative analyses conducted in this study. The fourth part presents the findings. Subsequently, some of the important findings and implications are discussed. The final part concludes the study with limitations and implications.

Literature Review

User-system Interaction and Sense Making

The Information searching is an active process of meaning construction (Dervin 1998; Du 2014; Kuhlthau 2005; Marchionini 2006; Savolainen 2006). During this process, users not only make efforts to find the information objects, but also experience rich feelings and emotions through different stages of the search process, such as uncertainty at task initiation; confusion at topic selection; confusion, doubt, or uncertainty at pre-focus exploration; optimism at focus formulation; confidence or increased interest at information collection; and satisfaction or disappointment at presentation stage (Kuhlthau 2005; Savolainen 2015).

In IIR context, information is organized and stored in electronic information systems. Users can search visual information objects by querying semantic annotations and browsing visual content features such as key frames, duration, motion, shape, and color (Albertson 2015a;

Gornale, Babaleshwar, and Yannawar 2019; Hu et al. 2011; Patel and Meshram 2012; Zhang et al. 1997). A keyword, a control vocabulary, or a content element used for searching information is a surrogate of meaning that represents the knowledge of either the searcher or the information organizer, or both. Moreover, usually meaning creation occurs when user-information and user-system interactions happen (Otto et al. 2019; Smeulders et al. 2000).

As such, the user-system interaction is a dynamic process. For users, the information stored in a system is an entity conveying rich knowledge of the world, including both the physical and social world, or both the internal and external world. During the interaction, users not only find information objects but also discover the meaning represented by the objects and even make sense with the current situation. Discovering meaning (i.e., understanding, evaluating, and judging information objects using previous knowledge) is therefore an indispensable element of user engagement in a searching process.

Visual Information Searching

Visual information searching is a process in which users search visual information objects or entities (i.e., images and/or videos) in information collections, databases, or resources to meet their information needs (Albertson 2015b; Gupta and Jain 1997; Marques 2016). In addition to gaining knowledge, users search visual information out of curiosity, entertainment, and problem solving (Yoon 2011). Visual information has characteristics "ranging from conceptual to semantic to low-level content-based visual qualities" (Albertson 2015b, 1103). The multidimensionality of visual information may hence result in the challenge of visual information searching.

In visual information searching, specific or known item requests may include specific semantic content such as people, places, and object (Chen 2001); and perceivable visual features such as file formats, size, resolutions, and the reliability and restrictions due to copyrights (Choi 2013). Searching for specific or known items, users usually can quickly decide on search results via an assessment of relevance. Searching for uncertain or vague information, however, users may have to continuously define and modify their searches as they may not have a clear criterion to decide on the results (Conniss, Ashford, and Graham 2000).

In general, there are a set of relevant results or items returned with different levels of user satisfaction, and hence the concept of ideal, which refers to the satisfaction above a threshold, is argued as a more applicable assessment criterion of search results than does the concept of relevance (Piwowarski and Dupret 2006). The assessment of ideal items can further evolve as searches prolong, needing more knowledge to make the abstract or vague queries become more specific or clearer (Choi 2013; Christel 2007; Conniss, Ashford, and Graham 2000). As such, user-system and user-information interactions in visual context are inevitably accompanied by rich cognitions and emotions (Bhandari, Chang, and Neben 2019; Poretski, Lanir, and Arazy 2019).

Conceptualization of User Engagement in Prior Research

In past decades, information science research uses user engagement (UE) as a general construct referring to both participation and involvement (Claussen, Kretschmer, and Mayrhofer 2013; Hwang and Thorn 1999; Kappleman and McLean 1991; Lehmann et al. 2012). It is argued that UE is "the total set of user relationships toward information systems and their development" and thus "includes both user participation (the behavior) and user involvement (the attitude)" (Kappleman and McLean 1991, 340). Moreover, it is demonstrated that UE can be measured using three approaches: "self-reported engagement, cognitive engagement, and online behavior metrics" (Lehmann et al. 2012, 165). These studies address the multidimensional characteristic of UE yet fall short of explaining inner connections between psychological and physical UE elements.

Emerging human-computer interaction studies examine UE in task-related context (O'Brien 2010a; O'Brien and Toms 2008, 2010b). Stressing the multidimensional characteristic of UE, the studies reveal that UE is a quality of user experience occurring in the human-computer interaction and further propose six UE attributes—focused attention (FA), felt involvement (FI), aesthetic appeal (AE), novelty (NO), perceived usability (PUs), and endurability (EN)—to delineate self-reported user experience during the human-computer interaction. For example:

- AE: perception of the visual appearance of an application interface;
- EN: holistic experience of success and whether users would use such application and recommend it to others;
- FI: the sense of involvement with feelings of having fun;
- FA: mental activity such as concentration, absorption, and temporal dissociation;
- NO: curiosity, novelty and interest evoked by interactive task;
- PUs: affective and cognitive perception of functionality resulted from the control of interaction.

The proposition of six UE attributes is grounded in theories including flow (Csikszentmihalyi 1990), aesthetics (Jennings 2000), play (Stephenson 1967), and information interaction (Toms 2002), and they comprise distinct user experiences resulting from positive human-computer interactions. However, the proposition does not emphasize user experience with content and the meaningfulness of user experience which is addressed by the theories. It argues that user engagement may not form or may not be directed by specific goals for the interaction; users may have engaging experience via interacting with the system without any desirable outcome or specific purpose, and that an engaging experience may have no more meaning than a lasting impression which is enjoyable or challenging.

Establishment, Generalization, and Refining of the User Engagement Scale (UES)

In the conceptualized model of user engagement, a six-factor user engagement scale (UES) is established and tested in a variety of applications (i.e., online shopping, social networking, IIR, and exploratory search environments). Examining the generalizability of the original six-factor UES, a four-factor UES model is proposed based on new findings (O'Brien and Cairns 2015; O'Brien, Cairns, and Hall 2018).

The original UES is a 31-item questionnaire that examines six attributes of perceived user experience in human-computer interactions. It includes 7-item FA, 8-item PUs, 5-item AE, 5-item EN, 3-item NO, and 3-item FI subscales. The prior studies have demonstrated that the AE and FA subscales have strong reliability and internal consistency; the internal consistency of the PUs subscale is not always stable and some evidence has suggested that its cognitive and affective items may be distinct dimensions in some contexts (Landa-Avila and Cruz 2017; O'Brien and Toms 2010b).

The prior studies also find that NO items do not always load on one factor and suggest that they may combine with EN and FI items to constitute one factor. It is argued that a conceptual perplexing or conceptual overlap among EN, FI and NO may exist due to the internal inconsistency in these subscales. Re-analyzing the original data and grouping original three factors FI, NO and EN into a new defined factor reward (RW), recent studies propose and verify a four-factor (i.e., RW, PUs, AE and FA) UES model in an online news domain. It is argued that the four-factor UES can be effectively applied in use and analysis as it is a briefer documentation and the new group of RW reduces the conceptual perplexing in NO, FI and EN subscales which is found by previous studies (O'Brien and Cairns 2015; O'Brien, Cairns, and Hall 2018).

Current Study

It is noticed that some gaps exist and need further discussions between the conceptual and operational definitions of UE established by previous studies. For instance, the UES is developed based on the conceptualization of UE in task-oriented contexts (O'Brien and Toms 2008, 2010b, 2013), however, it does not stress the characteristics of meaningfulness and goal-directed action of UE when mapping the UE attributes with flow.

Based on the nature of user-system interaction which is an evolving process driven by user-information interaction and users' sense making of information encountered (Bates 1989), the current study proposes that sense discovery (SD), a cognitive or cognitive-affective experience, should be one of UE attributes in the context of information searching. SD refers to sense making or meaning construction which occurs when ideal information is assessed and selected.

Briefly, this study proposes that UE occurs during user-system and user-information interactions. The user-system and user-information interactions interweave users' behavioral search actions (i.e., search time, search pattern, and search strategy) and psychological (i.e., affective and cognitive) experience during an information searching process. Wherefore, UE is a multidimensional concept characterized by psychological involvement and behavioral action between which correlations may exist. Moreover, users' psychological involvement can be measured by a viable UE scale.

Research Questions

This study aims to validate and develop the user engagement scale (UES) in web-based visual information searching. Web-based visual information searching refers to an interactive information searching process involving users' physical search action and psychological involvement or interaction with information system and visual information (i.e., images and/or videos). The original six-factor UES and its refined four-factor model suggested by previous work are applied to measure users' psychological involvement in visual information searching. The above literature review suggests that the existing UES needs to be validated and developed in the context of web-based visual information searching. As a result, the first research question guiding this study is:

RQ1: Is the existing UES developed by previous work applicable to the context of visual information searching?

The six UE attributes identified by prior research mainly focus on users' subjective feeling and perception of system appearance and usability, interest in user-system interaction, and holistic evaluation of experience using systems. The six attributes stress users' emotion, paying little attention to users' cognitive efforts in sense discovery or meaning construction.

The current study proposes that sense discovery (SD), a cognitive or cognitive-affective attribute, can be defined as a new subscale measuring user experience related to information needs. SD refers to users' discovery of the meaning contained in information and the interest evoked by the information content in the searching process. Exploring users' information needs and positive experience in selecting ideal information, the study aims to find items which can be used as the measurement of SD. As a result, the following three research questions, which are associated with the first question, are presented:

RQ2: What visual information needs are formulated in web-based visual information searching?
RQ3: How do users express their positive experience in sense discovery?
RQ4: What items can be used to measure users' sense discovery?

Methodology

To answer the above research questions, an online survey study was conducted and both quantitative statistical and qualitative textual analyses were performed to examine the existing UES and explore the items related to sense discovery. As students in higher education largely use web-based visual information for their daily learning and life (Almobarraz 2018; Wittebols 2016), this study selected users from college students to test the viability of the existing UES and explore SD as one of UE attributes in web-based visual information searching.

Survey

The previous studies conducted survey researches to develop and validate the UES in multiple applications and suggested that the scale needed to be further examined and validated in the context of information searching (O'Brien and Toms 2010b, 2013). This study employed an online survey to examine the applicability of the UES in the context of visual information searching. An online information sheet attached with the survey questionnaire was distributed and the participants' consents were obtained before they took part in the survey.

The User Engagement Scale (UES)

There are two models of user engagement scale (UES) proposed by prior studies. The original six-factor model proposed by O'Brien and Toms (O'Brien and Toms 2010a) includes six subscales: 7-item focused attention (FA), 3-item felt involvement (FI), 5-item aesthetic appeal (AE), 3-item novelty (NO), 8-item perceived usability (PUs), and 5-item endurability (EN).

The four-factor UES model proposed by emergent studies (O'Brien and Cairns 2015; O'Brien, Cairns, and Hall 2018) includes four subscales: 11-item reward (RW), 5-item AE, 7-item FA and 8-item PUs. It is suggested that the four-factor model can be administered flexibly according to different contexts.

Testing the inter-item reliability and internal consistency of all six subscales, the current study examined the applicability of the six-factor UES in web-based visual information searching. The inter-item reliability of regrouped RW was also tested in this study.

Questionnaire

A questionnaire, including a slight modification of the original 31-item UES questionnaire and two open-ended questions, was adopted to answer the four research questions: (1) Is the existing UES applicable in visual information searching? (2) What visual information needs are formulated in web-based visual information searching? (3) How do users express their positive experience in sense discovery? (4) What items can be used to measure users' sense discovery?

In addition to slightly modifying the wording of the UES to better fit the visual search environment in which IIR interaction occurred (O'Brien and Cairns 2015), the current study employed the format of AttrakDiff questionnaire to express the UES. This modification was based on a pilot study and did not change the meaning of each UES item.

AttrakDiff questionnaire was originally developed to evaluate user experience with interactive product (Hassenzahl, Burmester, and Koller 2003). AttrakDiff employed pairs of antonyms describing two opposite and extreme perceived user experience (e.g., "disagreeable vs. likable"), assisting participants in rating their experience using a 7-point Likert scale. The format of AttrakDiff has been used to examine user experience in visual context in some studies (Kaspar, Weber, and Wilbers 2019; Moshagen and Thielsch 2010).

Two native English speakers who were graduate students in a library and information studies program participated in the pilot study. Answering the original UES questionnaire with slight wording modifications, the two participants reported their confusions with some questions. They reviewed a revised version of the UES in AttrakDiff format and indicated that

this version was more understandable and straightforward. In the following one month, one of the participants worked with the author on further editions and revisions to make the revised version accurately express the meaning of each UES item.

Overall, only slight modifications of the UES questionnaire were made for the purpose of the current study. Each UES item contained a pair of two extreme contrasts of search experience (e.g., "frustrated vs. inspirited," "annoyed vs. pleased"). Participants were asked to rate their search experience using a 7-point Likert scale. As such, the slightly modified UES questionnaire was adopted to answer the first research question.

To answer the three research questions related to sense discovery, two open-ended questions were designed:

1) What were your information needs?
2) What were your selection criteria of ideal items?

The above two open-ended questions were about users' information needs and selection criteria of ideal information items. This design was grounded in the argument that a clear task and task goal and a good balance between perceived challenges and perceived skills are the flow conditions (Csikszentmihalyi 1990). Exploring the participants' cognitive and emotional elements in formulating/describing search task and presenting/assessing search task goal, the current study investigated how users' hedonic/positive searching experiences were perceived and expressed (O'Brien and Toms 2013; O'Brien and Cairns 2015), and revealed how cognitive and emotional elements interweaved user search experience (Savolainen 2015). Based on the findings about users' cognitive or cognitive-affective experience regarding sense discovery (SD), items which can be used to measure SD were categorized. As such, the three research questions regarding sense discovery were answered.

Participants

College student participants (N = 536) were recruited from a university research pool. The participants ranged in age from 17 to 30 (M = 19, SD = 1.83). The largest group were 17 to 19 years old (70 %), and the second largest group were between the ages of 20 and 24 (29.7 %). There were 79 percent female and 21 percent male. Most participants (N = 343, 63.5%) indicated that they searched visual information every day, and 30.9 percent had weekly visual information searching activities.

Recalling a most recent visual information searching, 45.9 percent of the participants indicated that they searched images only, 26.9 percent searched videos only, and 27 percent searched both images and videos. The majority (N = 386, 71.5%) searched for personal activities or interests, 25 percent for academic-related assignments, and 3.5 percent for work-related tasks.

The participants used a variety of web-based systems performing their search tasks. Except for 10.9 percent who indicated that they could not remember the systems that they used for searching, the majority (87.8%) employed a single system for searching while only 1.3 percent used multiple systems. More than 45.6 percent (N = 246) searched on Google, 24.1 percent (N = 130) used YouTube, 5.2 percent social media like Pinterest, Facebook, Instagram, Twitter, etc., and the rest 12.9 percent used about 60 different websites.

In the group of Google users, the majority (N = 168, 68.3%) searched images only, some (N = 53, 21.5%) searched both images and videos, and some (N = 25, 10.3%) searched videos only. In the group of YouTube users, the majority (N = 91, 70%) searched videos only, some (N = 33, 25.4%) searched both images and videos, and few (N = 6, 4.6%) searched images only.

Information Systems

Instead of using a uniform information system, this study asked the participants to report their searching experience from their most recent visual information searching. This method was adopted as this study aimed to investigate the psychological UE attributes in a web-based visual information searching in which the free navigation across different systems could happen. For the purpose of this study, the variety of information systems was acceptable as it reflected the scenario in the real world.

In addition to testing the applicability of the UES in a general visual context (general), this study also validated the UES in specific contexts, such as image searching on Google (ISG) and video searching on YouTube (VSY). The results from the three different contexts were compared and discussed to examine the generalizability of the UES in web-based visual information searching.

Procedure

An online survey was administrated and distributed through a college research pool for three months. Participants took part in the study voluntarily. Using an online questionnaire, the study asked the participants to recall their last memorable visual information searching and report their searching experience.

The participants were asked to briefly describe their search needs and search steps and provide the names or the URLs of information systems or websites that they used for searching. Then, the participants were asked to rate their search experience using a 7-point Likert scale. Further, the participants were asked to provide their criteria for selecting an ideal searching result. Finally, the demographic information of the participants (e.g., age, gender, major, visual information searching experience, etc.) was collected.

Data Analysis

The data was collected through Qualtrics and exported to SPSS and NVivo for data analysis. While 576 participants were processed, some participants' data were removed because they did not complete the questionnaire. After screening the data, 536 respondents' records were retained. In preparation for data analysis, four of the UES items were reverse-coded. The response rate to all the items was 100 percent (no missing values).

Cronbach's Inter-item reliability tests were performed to examine the applicability of both the six- and the four-factor UES in web-based visual information searching. Participants' experience in the three visual contexts (i.e., general, ISG, and VSY) were examined. Further, Principal component analyses (PCA) were conducted to examine the internal consistency of the six UE subscales in the three visual contexts.

The above quantitative statistical analyses were performed using SPSS 25. The results were interpreted to answer the first research question if the UES is applicable in the context of visual information searching. Suggestions and propositions were presented based on the resultant findings.

The participants' answers to the two open-ended survey questions regarding their information needs and selection criteria were collected to explore users' positive experience with ideal information. The data were coded and analyzed using both Qualtrics and NVivo 12. Thematic and sentiment analyses were conducted to answer the three research questions regarding sense discovery.

Results

Results of Statistical Analysis

First, the inter-item reliabilities of the UES were examined in a general context (general)—visual information (e.g., image and/or video) searching on information system(s)—and two specific contexts—image searching on Google (ISG) and video searching on YouTube (VSY). As some UE subscales (e.g., FI and NO) had very limited test items and participants had a broad range of visual information needs, 0.45 was considered as an acceptable Cronbach's alpha threshold value (Berger and Hänze 2015; Taber 2018). The test results indicated that all six UE subscales had acceptable reliability (Table 1).

AE, EN, FA, and PUs showed high alpha values, while the inter-item reliabilities of FI and NO were poor but acceptable. It was noted that FI and NO showed a better reliability in VSY than that in ISG. The grouped 11-item Reward attribute (RW) showed good inter-item reliability across the three contexts. This should result from the increased number of test items, item inter-relatedness and reduced dimensionality (Cortina 1993).

Next, the correlations of subscales were examined (Table 2 and Table 3). Correlations in ISG were not reported because they were broadly similar to the ones in general. The FA was moderately correlated ($.4 < r < .7$) with FI in both the general and VSY. AE was moderately correlated with EN in VSY and with four subscales in general. The PUs was moderately correlated with EN in VSY; while it was strongly correlated ($r > .7$) with EN but moderately correlated with three other subscales in general. The above results suggested that FA, AE and PUs should be distinct components in different visual contexts though some of their items may overlap with other subscales'.

Table 1: Cronbach's Alpha for UE Subscales in General, ISG and VSY

Subscale	*General (N= 536)*	*ISG (N = 166)*	*VSY (N= 90)*
FA	.85	.84	.85
FI	.49	.47	.56
NO	.57	.53	.55
PUs	.74	.72	.70
EN	.88	.86	.80
AE	.88	.86	.83
RW	.86	.82	.76

Note: ISG – image searching on Google, VSY – video searching on YouTube. RW - grouping 3 NO items, 3 FI items and 5 EN items.

Table 2: Pearson Correlations for the UE Subscales in General

	FA	*FI*	*NO*	*PUs*	*EN*
FA	1				
FI	.48**	1			
NO	.08	.58**	1		
PUs	-.13*	.43**	.53**	1	
EN	-.07	.49**	.60**	.71**	1
AE	-.08	.44**	.50**	.49**	.66**

*Note: *p < .05, ** p < .001. In general - visual information (e.g., image and/or video) searching on information system(s)*

Table 3: Pearson Correlations for the UE Subscales in VSY

	FA	*FI*	*NO*	*PUs*	*EN*
FA	1				
FI	.63**	1			
NO	.25*	.48**	1		
PUs	-.06	.33**	.39**	1	
EN	.03	.23*	.31**	.66**	1
AE	-.18	.14	.30**	.29**	.43**

*Note: *p < .05, ** p < .001. VSY – video searching on YouTube.*

Source: Xu

Moderate correlations were observed between NO, FI, and AE, and NO, EN, and PUs in general; while moderate correlations were observed between FI and FA, and PUs and EN in VSY. The above results might also suggest item overlaps among these subscales.

Further, principal component analyses (PCA) with Promax (Oblique) rotation were conducted to examine the factor structure of 31 items in general (Table 4) and two relatively specific ISG and VSY (Table 5). The Kaiser-Meyer-Olkin (*KMO* = .93 in general, *KMO* = .85 in ISG, *KMO* = .79 in VSY) and Bartlett's Test of Sphericity (x^2 = 9485.51 in general, x^2 = 2891.64 in ISG, x^2 = 1613.05 in VSY; *df* = 465 and $p < .001$ in the three contexts) both indicated a sampling adequacy for factor analysis in the three contexts.

In the initial extraction of components with the eigenvalue-one criterion, the analyses yielded six factors explaining 66 percent of the variance for the entire set of items in general, six factors explaining 64.7 percent of the variance in ISG, and seven factors explaining 68.3 percent of the variance in VSY. Loadings above 0.35 and below -0.35 were highlighted in Table 5 (Kline 2000).

It was noted that only one subscale (AE) loaded on one factor where all items strongly loaded across the three contexts. Considering the diversities of search tasks and information systems where the participants might navigate more than one information system, the results suggested that there may be some conceptual overlaps among other five subscales in a web-based visual information searching (O'Brien and Cairns 2015).

In the general context, factor 1 needed a new label as it was strongly loaded by 4 EN items (EN1-4), 5 PUs items (PUs1-4 and PUs7), one NO item (NO2) and one FI item (FI3). Factor 2 was labeled AE as it was strongly loaded by all five AE items. Factor 3 was labeled FA as it was strongly loaded by six of seven FA items (FA1-5 and FA7). One EN item (EN5) loading on factor 2 and one FI item (FI1) loading on factor 3 may suggest a conceptual overlap. The above three factors respectively explained 32.7 percent, 14.0 percent and 6.4 percent of the variance.

Table 4: PCA with Promax Rotation for the UES Items in the General Visual Context

Item	*1*	*2*	*3*	*4*	*5*	*6*
AE1: The information system was unattractive (vs. attractive)		.60				
AE2: This information system was aesthetically appealing		.82				
AE3: I didn't like (vs. liked) the graphics and images used on the system		.87				
AE4: To my visual sense, this system was repulsive (vs. appealing)		.82				
AE5: The screen layout of this system was unpleasant (vs. pleasing)		.87				
EN1: I felt searching on this system was unworthy (vs. worthwhile)	.72					
EN2: My searching on this system was unsuccessful (vs. successful)	.81					
EN3: My searching was not (vs. was) working out the way I had planned	.96			-.31		
EN4: My searching was unfruitful (vs. rewarding)	.93					
EN5: I would recommend searching on this system to my friends and family		.61				
FA1: Searching on the system, I didn't lose myself (vs. I lost myself)			.61			
FA2: Searching on the system, I didn't lose (vs. I lost) track of time			.76			
FA3: When searching, I didn't block (vs. I blocked) out the things around me			.77			
FA4: When searching, I didn't lose (vs. I lost) track of the world around			.83			
FA5: Searching on the system, I felt time went slowly (vs. time slipped away)			.67			
FA6: Searching on the system, I felt unoccupied (vs. absorbed)				.85		
FA7: Searching on the system, I didn't let (vs. I let) myself go			.77			
FI1: Searching on the system, I was not drawn (vs. I was drawn) into search			.71			
FI2: Searching on the system, I felt uninvolved (vs. involved)				.82		
FI3: My searching was boring (vs. fun)	.63					
*NO1: I continued (vs. discontinued) searching out of curiosity (vs. disinterest)						.93
NO2: The content of the system discouraged (vs. incite) my curiosity	.60					
NO3: Searching on the system, I felt uninterested (vs. interested)				.64		

Item	*1*	*2*	*3*	*4*	*5*	*6*
PUs1: Searching on the system, I felt frustrated (vs. inspirited)	.65			.39		
PUs2: The information system was confusing (vs. clearly structured)	.47	.40				
PUs3: Searching on the system, I felt annoyed (vs. pleased)	.75					
PUs4: Searching on the system, I felt discouraged (vs. encouraged)	.71					
*PUs5: Searching on the system, I felt it was mentally easy (vs. taxing)					.87	
*PUs6: My searching experience was easy (vs. demanding)					.80	
PUs7: Searching on the system, I felt uncontrollable (vs. controllable)	.50			.39		
*PUs8: I could not do some of the things I needed to do on this website.					.64	

Note: The item with an asterisk (*) was reversed-coded; AE2 and PUs8 used "strongly disagree vs. strongly agree". Factor 1 - reward (RW), factor 2 - aesthetic appealing (AE), factor 3 - focused attention (FA), factor 4 – felt involved (FI), factor 5 – perceived usability (PUs), factor 6 – Novelty (NO).

Source: Xu

Table 5: PCA with Promax Rotation for the UES Items in ISG and VSY Contexts

Item	*ISG*							*VSY*						
	1	*2*	*3*	*4*	*5*	*6*		*1*	*2*	*3*	*4*	*5*	*6*	*7*
AE1		.68								.48	.41			
AE2		.84								.89			-.34	
AE3		.92								.71		-.32		
AE4		.84								.74				
AE5		.83								.80				
EN1	.69							.50			.44			.36
EN2				.72							.77			
EN3				.77							.86			
EN4	.37			.63							.89			
EN5		.61								.62				
FA1			.54		-.41				.63					
FA2			.74		-.31				.75					
FA3			.77						.79					
FA4			.80						.85		.32			
FA5			.71						.70					
FA6	.67			-.47				.85						
FA7			.82						.75					
FI1			.72						.67					

Item	*ISG*							*VSY*						
	1	*2*	*3*	*4*	*5*	*6*		*1*	*2*	*3*	*4*	*5*	*6*	*7*
FI2	.83			-.31				.93						
FI3	.38					.35							.39	
**NO1*						.84							.93	
NO2	.44					.40		.44					.35	
NO3	.80							.81						
PUs1	.88							.90						
PUs2					.33					.39	.40			
PUs3	.78							.65			.30			
PUs4	.83							.55			.40			
**PUs5*	-.31			.31	.77							.76		
**PUs6*					.42							.79		
PUs7	.75							.41						.72
**PUs8*					.80			.51	-.40					-.39

Note: ISG – image searching on Google, VSY – video searching on YouTube.

Source: Xu

Meanwhile, factor 4 was labeled FI as it had strong loadings by one FA item (FA6), one FI item (FI2) and one NO item (NO3) and they all stressed how the participants were involved in a search task (Csikszentmihalyi 1990). Factor 5 was labeled PUs as it had strong loadings by three PUs items (PUs5, PUs6 and PUs8). Factor 6 was labeled NO though it only had one strong loading by NO1. The above three factors respectively explained 5.5 percent, 4.1 percent and 3.4 percent of the variance.

In both ISG and VSY, similarly, AE and FA emerged as distinct components though FA6 loaded on factor 1. Meanwhile, EN5 merged with AE items while FI1 merged with FA items across the three contexts. In addition, factor 1 in the three contexts were strongly loaded by the same 5 items – EN1, NO2, PUs1, PUs3, and PUs4.

Comparing to the general context, the following differences were observed in both ISG and VSY. Items EN2, EN3 and EN4 loading on factor 1 in general shifted onto factor 4 in both ISG and VSY; while FA6, FI2 and NO3 loading on factor 4 in general shifted onto factor 1 in the two contexts. Moreover, PUs2 loading on factor 1 in general shifted onto factor 4 in VSY while it did not strongly load on any factor in ISG. Differences were also observed across the three contexts. For example, PUs8 loading on factor 5 in both general and ISG shifted onto factor 1 in VSY, while FI3 and PUs7 loading on factor 1 in both general and ISG respectively shifted onto factor 6 and factor 7 in VSY.

The above results suggested that (1) there were broad similarities in searching experience between image and video searching, (2) the nuances between image and video searching might result from the different visual contents, and (3) the varieties in different visual contexts might result from the variety of search tasks and information systems.

The PCA tests indicated that AE was the most stable subscale as it emerged as a distinct component across the three visual contexts. Secondly, FA was relatively stable though FA6 shifted away from other six FA items. Thirdly, across the three contexts, two items in PUs (PUs5 and PUs6) were stable with a strong loading on the same factor; three PUs items (PUs1, PUs3 and PUs4) mixed with items in EN, FI and NO on factor 1; and PUs2, PUs7 and PUs8 were discrete from others. In addition, EN, FI and NO were unstable across the three contexts.

In summary, the original six-factor UES was basically applicable in a daily web-based visual information searching though further studies are needed with a control of searching tasks and information systems. The applicability of the UES was validated by an overall acceptable inter-item reliability, moderate correlations among subscales, and six- or seven-factor structures yielded by PCA. Due to the item discreteness in FI and NO and the overlap among EN, FI, NO and PUs in factor 1, more explorations may be needed to find how users' hedonic searching experience are perceived and expressed (O'Brien and Toms 2013; O'Brien and Cairns 2015).

Next, a qualitative analysis was conducted to explore how the participants perceive and express their searching experience regarding ideal visual information. Based on the results, the latent items related to sense discovery (SD) is generalized. As the above statistical results demonstrated room for adjustment in the original UES for a better application in visual information searching, a refined four-factor UES is also proposed based on the findings in this study.

Results of Qualitative Analysis

Thematic and sentiment analyses were conducted to answer (1) What visual information needs are formulated in web-based visual information searching? (2) How do users express their positive experience in sense discovery? (3) What items can be used to measure users' sense discovery? The textual data—the participants' answers to the two open-ended questions (1) What were your information needs? 2) What were your selection criteria of ideal items?—were coded and analyzed.

About 92 percent of the participants answered the question about their search tasks. The themes coded for visual information needs were categorized into two parent groups (1) searching for specific information objective, and (2) searching for something non-specific. The specific information objective was coded into two children categories: a) visual aid for understanding or solution, and b) specific details needed for task. Something non-specific was coded into three children categories: a) gathering something for a topic, b) comparing something for decision making, and c) looking for something to get ideas. In addition, the specific search tasks included searching for person, content elements, and time (Table 6).

About 67.6 percent of the participants answered the question about selection criteria of ideal information items, and 12.1 percent of them described their positive experience. The results of sentiment analysis showed that the representative cognitive expressions (i.e., "good quality," "reliable sources," "relevant to the subject," "understandable," "easily understood," "presentable," "clear," "popular," etc.) were used to assess the ideal items. Meanwhile, the representative emotional (i.e., "preferable," "enjoy," "funny", "motivational", "inspirational", etc.) and cognitive-affective expressions (i.e., "interesting," "get involved," "success," etc.) were applied to describe hedonic experience with ideal items (Table 7).

Table 6: Summary of Participants' Visual Information Needs

Information Needed	*Representative Responses*
Specific objective: a. visual aids for understanding or solution	▪ Sometimes when I am studying, I try to look up visual aid in order to better retain my notes from class. ▪ I needed pictures to help make a visual aid to go along with my Spanish presentation on the rivalry between the Yankees and Red Sox.
b. Specific details: (1) person	▪ I was looking for a picture of Richard Nixon giving a speech to use in a book I am working on.
(2) content elements	▪ I needed to find high-quality, detail images of the apse mosaics in the Basilica of Sant'Apollinare in Classe. ▪ I needed to look at a picture of characters of Beauty and the Beast so that I could see all the details I needed to include in my work.
3) time	▪ A picture from the modernist period in Europe. And a video from YouTube describing the modernist period as well.
Something for: a. a topic	▪ I needed to incorporate images relating to Mark Twain's travels. ▪ I had to create my own documentary for my photography class and my topic was fear. I interviewed different people and to create some humor, I decided to try to get video of what that person feared. For example, one person had a fear of dogs, so I searched different videos of dogs doing different things, I tried to put what they feared in a positive light.
b. a decision making	▪ Discovering whether or not the singer Ariana Grande was previously an actress on Nickelodeon. ▪ I needed video and images for a French project about cooking. I needed to present my teacher with an imaginary restaurant of my own imagination and needed to attach photos to it.
c. getting ideas	▪ I was looking at pictures of painted coolers so I could get ideas for a cooler I was painting myself. ▪ I wanted to find an example of a crafting idea that I had found prior to my current search.

Source: Xu

In addition to the characteristics of visual contents such as good quality (e.g., high pixel, high resolution, fast loading, etc.) and specific feature needed (e.g., temporal duration, spatial structure, size, color, style, etc.), the participants emphasized much on sense discovery of visual information. Their selection criteria for ideal visual information mainly focused on the following six aspects: (1) semantic relevance—whether the information accorded with the topic or agreed with genres; (2) making sense—whether the information was clear on what it was trying to describe; (3) inspiring idea—whether the information evoked ideas; (4) aiding understanding—whether the information facilitated understanding; (5) feeling relevance—

whether the information corresponded with topical feeling; (6) assisting with decision making—whether the information was helpful to decision making.

Table 7: The Summary of the Participants' Selection Criteria of Ideal Information Items

Criteria	*Representative Responses*
Quality (e.g., high pixel, high resolution, fast loading, etc.)	▪ I prefer good quality pictures and ones that I can resize without them becoming pixelated. ▪ It needed to be a good shot, high resolution, which gave me a good idea of the outward appearance of the vehicle. ▪ It must be in high-quality. It must load quickly.
Physical characteristics (e.g., temporal duration, spatial structure, etc.)	▪ Less than 30 minutes. ▪ Display lyrics on screen.
Visual content (e.g., content structure, model, color, style, size, etc.)	▪ Correct image, not blurry, preferably with text of the quote on the picture. ▪ The video was clear and started with the beginning of the song instead of a lengthy intro. ▪ Black and white images, vectors, clip art/not realistic images, fit well in a circle frame.
Relevance a. semantic relevance (e.g., relevant topic, aiding understanding, evoking idea, etc.)	▪ I wanted the video to really show the fear. ▪ Visual aid, clear, and easily understandable. ▪ Do the images make sense, is it clear on what it is trying to describe, will it explain in words I will understand?
b. feeling/emotion	▪ It must be cute; it must be appealing. ▪ It has to be motivational, inspirational, or comedic. ▪ I needed something funny. ▪ Attractive to the eye. ▪ Made me more interested and wanted to get involved. ▪ Videos I enjoyed or that were popular.
c. period	▪ I was search for something to help me with my defense and it had to be recent and up to date. ▪ Find a self-portrait in the baroque period.
d. other (e.g., popularity and genre)	▪ I looked at the views total to determine which videos were more popular than others. ▪ Does the plot go well with the lyrics? ▪ It was a comedic video.
Source reliability/accuracy/credibility	▪ I wanted to watch videos about the band that were good, like their interviews or official music videos or concert footage, not fan made videos. ▪ They had to be from a credible source/credible website. ▪ I wanted the video to be legal and good quality.

Criteria	*Representative Responses*
Comprehensive criteria (including the above)	▪ Length, Quality, Title, Tags. ▪ Was the information accurate? Was the information easy to understand? Was the video not too short/long? ▪ Clear, informational, and from a reliable source.

Source: Xu

The close exploration of coded data demonstrated that sense discovery of visual information, including physical visual contents and interpretive visual meaning, was an essential element of the participants' positive searching experience. Their cognitive, cognitive-affective, and emotional expressions were interweaved in the assessment of ideal information. As such, the following eight items were categorized and proposed to measure Sense Discovery (SD), users' important cognitive or cognitive-affective experience during visual information searching:

1) The information which I encountered in my searching aided my understanding and/or helped me find solution.
2) The information which I encountered in my searching met my idea about the composition of the image and/or video.
3) The information which I encountered in my searching evoked my idea.
4) The information which I encountered in my searching helped me make a decision.
5) The information which I encountered in my searching were relevant to my topic.
6) The information which I encountered in my searching let me understand well and/or let me get ideas.
7) The information which I encountered in my searching met my needs such as quality, size, color, time duration, and/or time period.
8) The information which I encountered in my searching gave me enough useful information clues.

The above explorations also demonstrated that ideal information was associated with positive emotions such as "get involved," "interested," "motivational," and "enjoy," which supported the expression of items FI1-3, NO2-3 and EN1-4, PUs1 and PUs3-4 in the original UES. This suggested that the conceptual overlaps may exist in some items of RW and SD.

Discussion

This study examined the applicability of the original UES and explored sense discovery (SD) as a UE attribute in the context of web-based visual information searching. The statistical tests were conducted to verify the inter-item reliability and factor structure of the UES in three visual contexts—a general visual context, image searching on Google (ISG), and video searching on YouTube (VSY). The thematic and sentiment analyses were employed to further explore users' positive searching experience related to SD.

In terms of inter-item reliability, all three visual contexts showed the acceptable internal consistency of the six subscales though the reliabilities of FI and NO were relatively poor. The six- (general and ISG) or seven-factor (VSY) structure emerged in PCA showed the stability of AE and FA across the contexts though FA6 shifted away and EN5 merged with all AE items. This finding is consistent with the findings in different applications (i.e., online-shopping, social networking, online news, etc.), which implies that different system users have very similar positive experience with the aesthetical design and user-system interaction in web-based environments.

Like the finding in an IIR context in which PUs items loaded on two factors (O'Brien and Toms 2010b), they merged with FI, EN and NO items and loaded on two (general and ISG) or three (VSY) factors across the three visual contexts. This further verified that UES, which is built upon human-computer interactions, cannot be "plug-and-play in IIR studies" (O'Brien and Toms 2010b, 336) mainly due to different tasks and systems. For instance, online shoppers may not be directed by goals while users usually perform search tasks oriented by information needs. IIR systems generally have more complex and specialized information organizations than do online shopping websites.

The above findings suggested that the UES may need adjustments when it is applied in an IIR setting. For instance, factor 1 in the three visual contexts was made up by 10 (ISG and VSY) or 11 (general) items in EN, FA, NO and PUs. The item with highest loading in factor 1 varied by EN3 (general), PUs1 (ISG) and FI2 (VSY) across the three contexts. The differences may result from different visual information needs, visual content features and information systems.

The close exploration suggested that factor 1 demonstrated users' overall positive searching experience. This experience interweaved with the perception of overall rewarding (EN4), worthwhile (EN1), fulfillment (EN3), success (EN2), inspiriting (PUs1), pleasant (PUs3), encouraging (PUs4), controlling (PUs7 and PUs8), clear (PUs2), inciting (NO2), interesting (NO3), and intensely immersing (FA6, FI2 and FI3). For this reason, factor 1 can be labeled reward (RW) representing intrinsically rewarding (Csikszentmihalyi 1990; O'Brien and Cairns 2015; O'Brien, Cairns, and Hall 2018). The rewarding experience can be represented by an overall inspiring experience (PUs1) in image searching, intensely involved experience (FI2) in video searching, or accomplishment feeling (EN3) in general visual information searching.

The exploration of information needs and selection criteria showed that users tend to get interested, involved, and absorbed in a search task when the topic or content conveys pleasing moods like fun, ease, and freshness; or when the content is informative and understandable. Stressing much on making sense of visual contents, the participants showed a deep dependence on visual aids for understanding. The findings suggested that discovering information meaning was an indispensable element of positive experience during the searching process, and sense discovery (SD) therefore should be a facet or attribute of user engagement in visual context. The findings also support the arguments in previous studies that content is supreme and can be a determinant of users' engagement when interacting with information systems (Dvir and Gafni 2019; O'Brien 2011; O'Brien, Freund, and Kopak 2016; O'Brien, Freund, and Westman 2014; O'Brien and McKay 2016; O'Brien and Toms 2013; White and Roth 2009).

The close explorations revealed that SD was an important cognitive or cognitive-affective experience in visual information searching. Discovering the meaning or making sense of information was a positive experience accompanied with affective-cognitive expressions such as "interest" and "relevance" (Savolainen 2015). The explorations suggested that the eight items regarding ideal information can be used to measure the intensity of SD by inquiring if information encountered assisted in understanding or solution; if the information evoked idea; if it aided a decision making; and if it was relevant to a topic or a certain feeling, etc.

Based on the findings, the current study proposed a refined four-factor UES model to measure users' psychological involvement in web-based visual information searching. The subscales of the four-factor UES model include RW (EN/PUs/FI/NO), AE, FA, and SD. RW retained the following 15 items loading on factor 1 in the three visual contexts:

RW1: I felt searching on this system was worthy.
RW2: My searching on this system was successful.
RW3: My searching was working out the way I had planned.
RW4: My searching was fruitful.
RW5: Searching on the system, I felt absorbed.
RW6: Searching on the system, I felt involved.
RW7: My searching was fun.
RW8: The content of the system discouraged my curiosity.
RW9: Searching on the system, I felt interested.
RW10: Searching on the system, I felt frustrated.
RW11: The information system was confusing.
RW12: Searching on the system, I felt annoyed.
RW13: Searching on the system, I felt encouraged.
RW14: Searching on the system, I felt controllable.
RW15: I could not do some of the things I needed to do on this system.

It is suggested that 11 of the above 15 items could be administered in a general visual context (e.g., searching images and/or videos using one or more than one system). The 11 RW items were RW1-4, RW7-8, RW10-14. Meanwhile, the 10 of 15 items—RW1, RW6-10 and RW12-14—were suggested for image searching on one system; while the 9 of 15 items—RW1, RW6, RW8-13 and RW15—were suggested for video searching on one system.

The original EN5 "I would recommend searching on this system/website to my friends and family" is suggested to be administered as one item of AE because it merged with all AE items on one factor across the three visual contexts. This implies that EN5 might be an outcome of AE in visual contexts. The original FI1 "Searching on the system, I was not drawn into search" was suggested to be administered as one item of FA as it merged with six of seven FA items on one factor across the three visual contexts.

In addition, three items in original UES are not retained in the suggested four-factor model. They are NO1 "I continued searching on the site out of curiosity," PUs5 "Using the system was mentally easy" and PUs6 "My searching experience was demanding." This is in consideration of three main reasons: (1) NO1 singly loaded on factor 6 (general and ISG) or factor 7 (VSY) and explained a very small variance across the three contexts, (2) PUs5 and PUs6 loaded on factor 5 and explained a very small variance across the three contexts, and (3) generally usability is more relevant to system evaluation than user experience (O'Brien and McKay 2018).

In summary, the current study suggests a refined four-factor UES model with a flexible administration of RW in visual context. That is a 29-item UES (i.e., 11-item RW, 6-item AE, 7-item FA and 8-item SD) for a general setting; a 28-item UES (i.e., 10-item RW, 6-item AE, 7-item FA and 8-item SD) for image searching; and a 27-item UES (i.e., 9-item RW, 6-item AE, 7-item FA and 8-item SD) for video searching. It is noted that the conceptual overlaps may still exist in the proposed model, and this leaves room for a more parsimonious model, which will be discussed soon in further research.

Conclusion

In conclusion, the current study found evidence supporting the applicability of the user engagement scale (UES) in the context of web-based visual information searching. The six-factor structure of the original UES was confirmed in a general visual information searching and image searching on Google though it was not confirmed in video searching on YouTube.

Like prior studies, the item stability and consistency in AE and FA (six of seven items) were found but it was not demonstrated in EN, FI, and NO. The item stability and consistency

in PUs, which were found in some applications, were not confirmed in this study. The item instability implied conceptual overlaps among those subscales. The exploration of ideal visual information revealed the potential conceptual overlap among the shifting items.

The exploration also revealed that sense discovery (SD) was an indispensable element of positive searching experience and suggested eight items related to ideal information. Based on the findings, this study proposes a four-factor UES model and argues that it can appropriately measure users' psychological involvement in the visual context. The four-factor UES model includes four subscales: reward (RW), focused attention (FA), aesthetic appealing (AE), and sense discovery (SD).

As the first empirical study examining the UES in different visual information searching contexts, this study contributes to the validation and generalizability of the original UES. Also, as the first empirical study proposing SD as one of user engagement attributes, this study suggests eight items to measure SD. Due to the limitations of this study, the stability of PUs in the visual context needs to be further examined in future studies. The item reliability and consistency of SD and its correlation with other UE subscales also need to be further examined.

The limitations of this study mainly lie in three aspects. First, the study used the convenience sampling technique. The data was collected from a college research pool, and the subjects were volunteers or were required to participate in the research for credit. This led to a sampling bias that the sample did not ideally represent the entire college population. Moreover, the psychological attributes of college students may vary significantly with other user groups (i.e., researchers or industry professionals). It is possible that users' behavioral and psychological experience vary in different user groups. The four-factor model suggested by this study therefore needs to be examined and validated using other user groups in future studies.

In addition, instead of testing the UES on one system in an experimental setting, this study examined the applicability of the UES in a daily web-based visual information searching without a control of the factors such as information system and search task. The diversity of information system and search task may impact the stability of UE subscales, especially the stability of PUs. Although the two settings that image searching on Google and video searching on YouTube were controlled for the examinations, the variety of search tasks was still a noisy factor impacting the findings.

It is impossible to find measures that do not vary across context (Serenko and Turel 2007). The findings and limitations of this study call for more studies to examine the UES and validate the proposed four-factor UES model in the visual context. Meanwhile, the findings call for a more parsimonious UES model further reducing the items with conceptual overlaps or perplexes. In addition, this study argues that UE is a multidimensional concept integrating users' psychological involvement and physical participation, yet the existing UES mainly focuses on perceived psychological involvement. The current study therefore calls for more studies to investigate searching actions and examine the relationship between psychological and physical elements during a visual information searching process.

Acknowledgement

The author would like to thank Dr. James Leeper (University of Alabama) and anonymous reviewers for advising with analyses, comments, and proofreading the manuscript.

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ISSN 1832-3669