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Abstract

Purpose – The purpose of this paper is to investigate user experiences with a touch-wall interface featuring both clustering and categorization representations of available e-books in a public library to understand human information interactions under work-focused and recreational contexts.

Design/methodology/approach – Researchers collected questionnaires from 251 New Taipei City Library visitors who used the touch-wall interface to search for new titles. The authors applied structural equation modelling to examine relationships among hedonic/utilitarian needs, clustering and categorization representations, perceived ease of use (EU) and the extent to which users experienced anxiety and uncertainty (AU) while interacting with the interface.

Findings – Utilitarian users who have an explicit idea of what they intend to find tend to prefer the categorization interface. A hedonic-oriented user tends to prefer clustering interfaces. Users reported EU regardless of which interface they engaged with. Results revealed that use of the clustering interface had a negative correlation with AU. Users that seek to satisfy utilitarian needs tended to emphasize the importance of perceived EU, whilst pleasure-seeking users were a little more tolerant of anxiety or uncertainty.

Originality/value – The Online Public Access Catalogue (OPAC) encourages library visitors to borrow digital books through the implementation of an information visualization system. This situation poses an opportunity to validate uses and gratification theory. People with hedonic/utilitarian needs displayed different risk-control attitudes and affected uncertainty using the interface. Knowledge about user interaction with such interfaces is vital when launching the development of a new OPAC.

Keywords Information visualization, Information-seeking behaviour, E-book, Affective computing, Human information interaction, Interface usability

Paper type Research paper

Introduction

Owing to advances in network access and information technology, mass communication has undergone a transformation from one-way broadcasting to interactive media channels complete with user feedback. Uses and gratification theory (UGT) attests that an audience actively chooses the most desired channel from a variety of media channels, and their affective and cognitive states and behaviours affect their choices (Katz *et al.*, 1974; Weibull, 1985). UGT uses an audience-centred approach to illustrate how the users prefer to make decisions about which media channel they will be exposed to. This illustration encourages researchers to consider how new approaches and technologies might further affect the information-seeking (IS) methods of users.

A library is responsible for introducing new reading materials and new editions to its members. Introductions to books bear a similarity to information recommendations, which aim to inform the reader regarding library collections and brief accounts of each

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publication. In the past, physical books were placed at the entrance of a library to attract the eyes of visitors. The introduction of a book requires a higher visibility and reliable recommendations than ordinary information retrievals by keywords via OPAC. Hence this paper utilizes a vertical touch-wall display for information visualization in the hopes of increasing the visibility and checkout rate of e-books. This research study, based on human information interactions (HII) and UGT, attempts to understand the criteria by which these library members choose a certain media channel. In other words, we want to explore which framework is preferable when a member is presented with two knowledge structures, namely, clustering (web based) and categorization (hierarchical classification), for the selection of recommended e-editions, and what kind of affective state or perceived ease of use (EU) (cognition) will arise from their IS behaviour.

Relevant literature

Wilson (1981) proposed that with respect to information needs, classification should not be the sole factor for consideration; rather, researchers should to pay attention to the individual's motivation and how the disparity between individuals plays a part in the process of decision making. O'Brien (2011) explained information behaviour has advanced to focus on the HII between systems and users, to foster models that encompass user behaviour, cognition and affect, and to comprehend the ways in which context and tasks motivate information needs and identify IS and use. According to UGT, users select media channels according to their need for information; therefore, identifying the specific information need, motivation, or purpose of the user is very crucial in understanding why the subject chooses a certain channel or interface.

Information needs

Human information behaviour (HIB) models comprise anomalous states of knowledge (Belkin, 1980), sense-making methodology (Dervin, 2005), information search process (Kuhlthau, 2004), and the ecological constructivist model (ECM, Nahl, 2009). Within the ECM model, the role of affect in information acquisition, processing, and use is underscored (O'Brien, 2011). Previous research on the evaluation of interface usability, such as OPAC, has mainly used a utilitarian approach in order to meet users' demand for accuracy and utilization efficiency (Hornbaek, 2006; Otter and Johnson, 2000). People have since learned to embrace other interfaces that are designed for pleasure-related purposes (Agarwal and Venkatesh, 2002; Van der Heijden, 2004). Venkatesh *et al.* (2012) proffered that people use technology for utilitarian as well as hedonic purposes. Li and Mao (2015) explored how users felt about using virtual health consulting services. Li *et al.* (2015) also employed the theory of UGT to develop a hedonic IS continuance model that features three types of gratification: hedonic gratification, social gratification, and utilitarian gratification among online game players. Yet there is still a lack of research examining how library visitors feel about using touch-screen interfaces for e-books whether operating under utilitarian or hedonic motives.

Searching interfaces: clustering vs categorization

Individual's differences also lead to different IS behaviours among users. Bilal and Kirby (2002) suggested that adults are better than children at using advanced search techniques, including hierarchical linear methods or more systematic techniques. Adults are also adroit at navigating the internet without using too many hyperlinks or

backtracks, and can quickly find a new way to do keyword searches even if they encounter difficulties in the process. Betül Yilmaz and Orhan (2010) conducted research on the motivation and IS behaviour of secondary school students. The research findings indicate that superficial learners have done web searches more frequently than deep learners, although superficial learners are inclined to conduct searches that are irrelevant to the learning activity. This illustrates the fact that when it comes to seeking information, users with different motivations have very disparate IS patterns, both in the depth and breadth of searching. Hence we propose that interface design should help an information seeker to do website searches in accordance with their need for information. Visualization interfaces are presented with clustering and categorization frameworks, each of which offers different breadth and depth in searching.

Clustering methods are based on the principle of similarity and can be applied to text collections (Hearst, 2006). Yet a clustering interface is arranged in a somewhat incomprehensible pattern. Kleiboemer *et al.* (1996) revealed that the information generated from a "clustering" method appears to be more difficult for non-expert users to utilize, whereas category systems generate a representation that is designed on the basis of logic and continuity, and therefore more coherent and intelligible for users to follow (Kules and Shneiderman, 2008; Pratt *et al.*, 1999). The downside of category system use lies in its manual curation of each and every category, which may cause incorrect categorization of information (Sebastiani, 2002). Hearst (2006) demonstrated that clustering algorithms easily presented the idiosyncrasies of a given query's retrieval results, whilst demonstrating that the category system provided a representation of well-understood and predictable meaning units.

Anxiety and uncertainty (AU) and perceived EU

The effects of the affective state of users when they are operating an information interface have been called to attention by Gwizdka and Lopatovska (2011). Tenopir *et al.* (2008) advocated that searching strategies or online search tasks might trigger negative emotions, whereas highly efficient navigation systems are positively correlated with positive feelings. Chowdhury *et al.* (2011) examined the affective states of scholars during the process of data seeking and retrievals and discovered a sense of uncertainty. This finding discloses the non-linear and complex relationship between uncertainty and online search activity.

Chowdhury *et al.* (2011) advised that future researchers should first define the causes of uncertainty, pinpointing what constitutes negative uncertainty and what constitutes desirable uncertainty before shedding light on how these factors affect the IS and retrieval process. Ozcelik *et al.* (2013) asserted that uncertainty is associated with one's motivation and can be beneficial to one's learning as well. When an individual has a stronger motivation, he or she will generally be willing to spend more time to find solutions for the problem at hand. Rains and Tukachinsky (2015) resorted to the uncertainty management theory developed by Brashers (2007) to explain the sense of uncertainty reported by web browsers who are vulnerable to uncertainty owing to their expectations. This implies that appraisals from users have an impact on their demand for management of uncertainty in IS, whereas the desired uncertainty level may exert influence on appraisal intensity, which in turn serves as a predictor for information depth rather than breadth.

Overall, the prior literature has shown that according to UGT, when users are presented with a new media channel, they will probably interact with this channel based on their need for information. Here we propose the question: will library visitors

be inclined to seek pleasure or concrete information from digital interfaces such as an e-book touch wall? As we know, the clustering interface and categorization systems have each posed different challenges for users trying to comprehend search results; these challenges can inspire negative uncertainty in respondents and alter their perceptions of EU. A hybrid interface that incorporates clustering features with categorization systems was built for this study with the hope that we can provide a deeper understanding of what kind of emotions are produced in users when they interact with these interfaces. Since uncertainty is closely linked with motivation, users are likely to have different expectations for the management of uncertainty when they are operating under different purposes. We intend to determine how members with disparate motivations, such as utilitarian or hedonic purposes, might appraise the e-books touch-wall interface. Will they perceive the experience to be full of negative uncertainty, or will they view the system as being easy to use with the optimal level of desirable uncertainty? We trust that exploring these issues will be beneficial to those developing e-books interfaces in the future.

Research models

Observed variables for information needs

Scarpi (2012) pointed out that internet users are divided up into those that are hedonistic and are seeking pleasure, and those that are more utilitarian and mission oriented. At the mention of pleasure-based information needs, Carroll (2004) posited that "funniness" should be included in the notion of usability. O'Brien and Toms (2008) referred to the notion of user engagement, and a conceptual structure was established to define how consumers are engaged in technology. Amichai-Hamburger *et al.* (2007) explained that users with a low level of attention favour interactive (attractive) sites over sites with deeper hyperlink levels. Chung and Tan (2004) asserted that motivation for searching influenced perceptions concerning playfulness of websites.

The observed variables exposing utilitarian need are derived from a random sampling. Vakkari and Serola (2012) conducted a stratified random sample from among Finnish people aged 15-80 to know what role a public library plays in their daily lives, and to pinpoint their information needs and their purpose for visiting. Research indicated that the purposes for visiting a library can be divided into four categories: education, work and business, everyday activities, and cultural activities, and within these four categories there are 22 sub-categories. Therefore, the latent variable for the hedonic judgment comprises observed variables such as engagement (Enag), fun (Fun), attractive qualities (Attr), and motivation (Moti). The latent variable for the utilitarian judgment consists of observed variables as follows: everyday activities (Evry), cultural activities (Cult), education (Edu), and work and business (Work).

Observed variables of hybrid interface

The observed variables for the hybrid interface were derived from the following empirical research. Zhu and Chen (2005) examined the interconnectedness and characteristics of information shown on the visual configurations of hybrid interfaces, which are designed to help the user to discover useful data or desired information through various dimensions. Levie and Lentz (1982) expounded on the representation of text and pictures, asserting that a simultaneous and closely arranged representation enhances learning efficiency. Korfhage (1991) pointed out that the visual configuration of categorization interfaces renders easy access for the

user to navigate. Every object is presented with an icon, so people can click on the icon, check for the desired information, choose subsets of objects, and understand the relationship between objects. Paivio (2006) proposed dual coding theory, which provides an explanation of the dual cognitive system in humans, which consists of verbal cues and imagery. As these two systems work independently, they are indeed supplementary to each other, and vital to the development of cognitive memory in all humans.

The observed variables of a clustering interface are defined by interfacial functions. Lin *et al.* (1991) have designed a clustering search interface, on which similar themes are arranged together with words or phrases. When the cursor is moved to a certain block, main themes are displayed in a pop-up, where any content that is related to the theme is shown. According to the experimental results provided by Chen *et al.* (1998), more people like the representation of a clustering map because they are able to have the cursor moved back and forth within a block, instead of needing to change pages between stratifications when using a categorization interface. Therefore the latent variable of the categorization interface/faceted (FC) comprises such observed variables as the position of text and pictures (Posi), classification methods (Class) and dual-coding (Dual). On the other hand, the latent variable of the clustering interface/network (NT) comprises two observed variables: introduction to books (Intr) and related books slide (Slid).

Observed variables of affective state

Hearst (2009) propositioned that a clustering interface is rather unpredictable. Kleiboemer *et al.* (1996) also discovered that non-experts are incapable of understanding the retrieval results from the visualized icons, such as the circles that symbolize clustering phenomena and the lines linking documents. In other words, as long as the user does not read the content of the documents over the vertical display, they will have difficulty interpreting retrieval results. According to Kuhlthau (1991, 2004), people are inclined to feel confused, depressed, or doubtful at the exploration phase. With respect to perceived EU, Horton (1994) indicated that an icon system renders a metaphorical effect for users through visualization, and thus helps people better understand the message. Larkin and Simon (1987) alleged that even though both the image and text are intended to convey the same message, images, or pictures are prone to be communicative and intelligible to viewers. The statistical result provided by Sadler-Smith (2011) showed a significant correlation between "intuition and visual style" and "learning and education" from a dual-processing perspective. Therefore, the latent variable of AU comprises the following observed variables: reports of users being "exhaustive", "confused", and "difficult", whereas the latent variable of the easiness of use comprises "understanding", "inspiration", and 'intuition" as observed variables. Table I shows observed variables and related latent variables.

Hypotheses

Information needs

The classification structures of a search interface are often displayed as a tree-diagram, hierarchical, or faceted form. Using these systems, similar items or incidents are converged to render an easier environment for the user to operate (Hearst, 2009). Classification systems also provide a set of more logical and systemic data for users to utilize. Dumais *et al.* (2001) presented participants with several search tasks while monitoring how much time it took to finish each task so as to investigate the actual

Item	Observed variables	Question statements for subject responses
Hedonic (HE) – latent variable		
x1	Engagement (Enag)	I am attracted to the colour, visual representation and content of this e-book touch wall, and would like to navigate the user interface
x2	Fun (Fun)	The experience of navigating the interface was so much fun that I wanted to explore books of different fields
x3	Attractive (Attr)	The interface design featuring photos of book covers was attractive and drew my attention
x4	Motivation (Moti)	I think the e-book touch wall was inviting and I felt motivated to use it
Utilitarian (UT) – latent variable		
x5	Everyday (Evry)	Using this e-book touch wall I can find books that I want to read about everyday life
x6	Cultural (Cult)	Using this e-book touch wall I can find the books that I want to read about cultural activities
x7	Education (Edu)	Using this e-book touch wall I can find the books that I want to read in the field of education
x8	Work (Work)	Using this e-book touch wall I can find the books that I want to read in the field of work and business
Faceted/categorization (FC) – latent variable		
y1	Position (Posi)	I am satisfied with this functional search that places an icon alongside an e-book introduction as well as a group of icons asking to "choose the reason why you visited the library" at the right side of the e-book
y2	Dual-coding (Dual)	I think the above group of buttons and the combination of an icon and text give clues as to navigating the interface
y3	Classification (Clas)	I think the classification of the abovementioned buttons is very easy for me to follow
Network/clustering (NT) – latent variable		
y4	Slide (Slid)	When I click on the cover of an e-book, a group of books on similar themes pops up, and I know I will see a larger body of e-books by sliding left and right
y5	Introduction (Intr)	When I click on the cover of an e-book, a group of books on similar themes pops up, and I know I can view book introductions by clicking on the cover again
Anxiety and uncertainty (AU) – latent variable		
y6	Exhaustive (Ehtv)	I think the design of e-book touch wall is like a complicated game, and I have to spend a long time locating the book I want
y7	Confused (Cnfs)	I think this visualization is too complicated to make retrievals effectively
y8	Difficult (Dift)	I am not sure how to use the interface as there is a lack of clear instructions on how to operate it
Perceived ease of use (EU) – latent variable		
y9	Understanding (Unsd)	The icons are so helpful that I know clearly how to enter the interface configuration even without a text description
y10	Inspiration (Insp)	When I look at the interface, I know instantly how to navigate the e-book touch wall
y11	Intuition (Intu)	When I look at the interface, I know instantly how to seek information by pressing the buttons

Table I.
Observed variables and measured question statements

effect produced by different types of classification, namely category groupings, category names, document titles, and document summaries. Research results indicated that category groups resulted in shortening the time required for data retrievals. Therefore, we believe that when the user intends to fulfil a mission, he would likely

choose the categorization interface over the clustering one. Hence first hypothesis is presented as follows:

H1. Users prefer a categorization interface (FC) when they have a utilitarian goal rather than a hedonic purpose.

Clustering interfaces are reported to have intriguing yet unpredictable possibilities (Hearst, 2006). Researchers examining image collection presentation (Rodden *et al.*, 2001) have strived to understand why participants prefer to explore the hidden meaning of images through graphic interfaces created by clustering algorithm. Research findings by Chen *et al.* (1998) have shown that subjects prefer to use a clustering map rather than returning to the previous page between stratifications. Apparently, clustering interfaces are more apt to satisfy people who seek fun in exploration. Consequently, second hypothesis is as follows:

H2. Users prefer clustering interfaces (NT) when they have a hedonic desire rather than a utilitarian need.

Integration of clustering and categorization interfaces

Pirolli *et al.* (1996) stated that a clustering interface without search functions proved to be less effective than other search interfaces. Research by Kleiboemer *et al.* (1996) showed that non-experts encounter difficulties grasping the meaning of graphical depictions if they did not read some text in the documents prior to interface navigation. Research findings (Hearst, 2009) reported a more unpredictable and less comprehendible analysis in clustering systems than in category ones. Therefore, we presume that a clustering interface tends to cause higher negative uncertainty in people. Consequently, third hypothesis is as follows:

H3. The clustering interface (NT) tends to lead the user towards AU.

Research conducted by Kules and Shneiderman (2008) proved that a category system, aside from being systematic, also has more appeal for users as they tend to prefer stratified structures to haphazard clustering groups (Pratt *et al.*, 1999). Research results submitted by Chen *et al.* (1998) showed that Yahoo's description tags – a classification tool – are a big help to web surfers. Since library members are mostly non-experts, it is assumed that they will find a classification interface easier to handle. Consequently fourth hypothesis is as follows:

H4. Categorization interface (FC) provides more EU than clustering interface (NT).

Affective state

Feelings play a crucial part in interface interaction. Scherer (2005) examined the affective state of participants seeking data on an interface. The emotions of participants were categorized on a coordinate based on positive vs negative, and active vs passive. Previous research has shown that positive emotions motivate participants to conduct searches, while negative emotions prevent them from successful searching. Meanwhile, a few of satisfactory search results may reduce negative feelings such as anxiety (Wang *et al.*, 2000). Fifth hypothesis is as follows:

H5. Anxiousness and uncertainty have a negative correlation with the perceived EU of an interface.

Anselme (2010) discovered the causal relationship between uncertainty and user motivation. Howard-Jones and Demetriou (2009) demonstrated that game playing involves uncertainty, which provokes a sense of engagement and leads to more feedback and interaction, as they believed the fun of a game is closely related to uncertainty. Thus we apply the abovementioned principle of uncertainty in IS behaviour, proffering that when people seek information for pleasure, they allow for higher uncertainty. Hence sixth hypothesis is put forward as follows:

H6. When people seek information mainly for pleasure, they allow for higher uncertainty and anxiety.

Rains and Tukachinsky (2015) explained when the users have a higher desire for uncertainty, they will be inclined to see uncertainty as an opportunity rather than danger. Also, they will display more information depth over internet searches. Put differently, a user with utilitarian motives tends to make more effort to solve the problem at hand. Thus, these users have a high demand for perceived EU (or desirable uncertainty) and can hardly stand negative uncertainty (or experienced uncertainty). Consequently seventh hypothesis is stated as:

H7. When users have a utilitarian motive for IS, they care more about the perceived EU of an interface.

Figure 1 shows the conceptual model and all hypotheses.

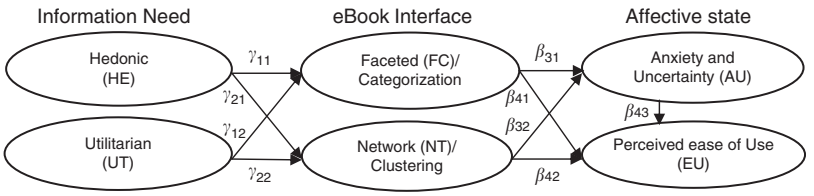
Research questions

According to the theories of UGT, the e-book touch wall must allow for a rapid dissemination of information for library members to utilize at will:

RQ1. People have different motives (hedonic vs utilitarian) for seeking information. What kind of interface would a hedonic or utilitarian user choose – a clustering interface or a categorization one?

RQ2. What kinds of emotions will the user experience when using a clustering or categorization interface – will they feel AU, or will they perceive the system as easy to use?

RQ3. For the user with a certain purpose (pleasure related vs task fulfilling), what kind of affective state (AU vs perceived EU) will he have while using a clustering or categorization interface?



Notes: *H1*: path values of UT → FC greater than HE → FC; *H2*: path value of HE → NT greater than UT → NT; *H3*: path value of NT → AU greater than FC → AU; *H4*: path value of FC → EU greater than NT → EU; *H5*: path value of AU → EU is negative; *H6*: path value of HE → AU greater than UT → AU; *H7*: path value of UT → EU greater than HE → EU

Figure 1.
Conceptual model of users seeking information

Methodology

Participants

Participants in this study were visitors to the New Taipei City Library who used the e-book touch wall and were over the age of age of 13. There were 251 participants in total, 127 of which were men and 124 of which were women (shown in Table II).

Measures

Located on the fifth floor of New Taipei City Library, the e-book touch wall is incorporated with eight large-scale screens and provides an independent searching service for up to four people simultaneously. As of the date when the experiment began, readers could find 702 digital copies of e-books via this touch wall. The design of the interface integrates the characteristics of both knowledge structures: clustering and categorization representations. Library visitors can browse, search and retrieve, and read recommendations for e-books via the interface.

In order to determine which books are worth recommending, the clustering interface for the e-book touch wall employs three parameters: the recommended value decided by the librarians; how many times an e-book has been loaned out by the reader's community; how many times each icon has been clicked in the process of seeking data. Visitors have to first scan their EasyCard (the EasyCard is a card that is typically used to pay for public transportation; it can also be used for library membership) and key in their age and gender, so the digital interface can locate the demographic to which they belong. Subsequently the interface presents a clustering display, on which the recommended digital books are shown as a result of the threshold value set by the information system.

The design of the e-book interface corresponds to the 22 reasons that are reported to be the reasons why Finnish people visit the public library. Then the 22 items are classified into four categories: education, work, everyday activities, and lastly cultural activities. We manually classified the 702 digital books into the abovementioned categories. When a reader wants to find e-books of one category, he can do searches via a categorization interface. For instance, if a reader would like to pick a digital book on child-care and schooling, all he has to do is click on the icon, wait for the system to call that category of e-books to the display, and view all the relevant titles on screen (Figure 2). The following website shows the process of operation: www.youtube.com/watch?v = l8uB0IfngsE

While this experiment explored the differences between visitors with hedonic or utilitarian purposes, we did not design tasks for those who were searching for fixed titles. Instead, when visitors were attracted by the touch-wall interface and came to use it, the librarian/examiner offered a brief introduction of the interface functions, and then subjects were left to operate the interface independently. Generally visitors used the interface for three to ten minutes. Subjects were then asked to fill out a questionnaire with the examiners present and ready to answer any questions.

Group (years old)	Male	Female	Total
13-18	12 (4.8%)	15 (6.0%)	27 (10.8%)
19-30	36 (14.3%)	39 (15.5%)	75 (29.8%)
31-55	68 (27.0%)	63 (25.1%)	131 (52.1%)
56-75	11 (4.5%)	7 (2.8%)	18 (7.3%)
Total	127 (50.6%)	124 (49.4%)	251 (100%)

Table II. Age and gender group

Figure 2.
An integration of both knowledge structures: clustering and categorization representations on the e-book touch wall

Notes: (a) eBook touch-wall: a clustering interface aimed at book recommendation; (b) eBook touch-wall: a categorization (faceted diagram) interface aimed at searching by theme

This questionnaire (shown in Table I) was designed to investigate user satisfaction with the e-book touch wall. All questions were ranked through the use of a Likert scale, with a score of 1 indicating that they strongly disagreed with the statement and a score of 5 indicating that they strongly agreed.

Equations for path analysis

This study employed structural equation modelling (SEM of LISREL8.72) as developed by Jöreskog and Sörbom (1996) to perform path analysis and confirmatory factor analysis. SEMs are a family of statistical methods designed to test causal relationship models. γ and β (as Figure 1) indicate the relationship between exogenous and endogenous latent variables. The corresponding SEMs are as follows:

$$\text{FC} = \gamma_{11}(\text{HE}) + \gamma_{12}(\text{UT}) + \text{measurement errors.} \quad (1)$$

This equation indicates that HE and UT influence FC:

$$\text{NT} = \gamma_{21}(\text{HE}) + \gamma_{22}(\text{UT}) + \text{measurement errors.} \quad (2)$$

This equation indicates that HE and UT influence NT:

$$\text{AU} = \beta_{31}(\text{FC}) + \beta_{42}(\text{NT}) + \text{measurement errors.} \quad (3)$$

This equation indicates that FC and NT influence AU:

$$\text{US} = \beta_{41}(\text{FC}) + \beta_{42}(\text{NT}) + \beta_{43}(\text{AU}) + \text{measurement errors.} \quad (4)$$

This equation indicates that FC, NT, and AU exert influences on EU.

Results

Test of dimensionality

This study employed exploratory factor analysis (EFA), using principal axis factor and Varimax for factor extraction and factor rotation. The value of KMO is 0.895, whilst the value of Bartlett's test of sphericity is 3,314.827, and p-value $= 0.000 < 0.001$. All these tests indicate that our research data are adequate for EFA.

Measurement model

Factor loadings present the correlation between individual variables and latent constructs, with a standardized value ranging from 0.40 and 0.80. All t-values of factor loadings reached the significant level (0.001). Our statistical data suggest that both convergent validity and identification of measurement model are acceptable (Kelloway, 1998, p. 107). The research findings are presented in Table III.

Squared multiple correlation refers to the coefficient value that is given by an independent observed variable to a latent variable (shown in Table III). For instance, the observed variable (Enag) explains 72 per cent of the latent variable "hedonic" (HE), whereas the observed variable (Ehtv) can explain 67 per cent of the latent variable "anxiety and uncertainty" (AU).

Structural model

With regard to overall fitness indicators, except $\chi^2 = 247.50$ (p-value $= 0.000 < 0.001$), the results have shown a good fit with the data that RMSEA $= 0.055$ (< 0.06), with AGFI: 0.87; NFI: 0.95; CFI: 0.98; IFI: 0.98; PNFI: 0.79; GFI: 0.91; SRMR: 0.057. From the above data, we are confident that this hypothetical model closely corresponds to the empirical data. Table IV shows that among the path coefficients (β or γ) of every latent variable and R^2 value, all the t-values have reached significant level, with FC→AU (-0.12, $t = -1.54$) being the only exception. This proves all path coefficients are eligible for subsequent path analysis.

Latent variables	Items	Measurement variables EFA loadings	SEM factor loadings λ (t-values)	Squared multiple correlations (SMC)
Exogenous				
HE	Enag	0.769	0.51 (15.44)***	0.72
	Fun	0.700	0.50 (12.36)***	0.52
	Attr	0.660	0.45 (12.65)***	0.54
	Moti	0.514	0.40 (10.65)***	0.41
UT	Evry	0.809	0.61 (18.19)***	0.82
	Cult	0.784	0.57 (17.31)***	0.78
	Edu	0.739	0.62 (16.22)***	0.71
	Work	0.471	0.44 (10.19)***	0.36
Endogenous				
FC	Posi	0.795	0.63 (13.27)***	0.68
	Dual	0.752	0.63 (13.74)***	0.74
	Clas	0.645	0.59	0.60
NT	Slid	0.727	0.58	0.79
	Intr	0.723	0.53 (10.33)***	0.59
AU	Ehtv	0.821	0.80 (10.22)***	0.67
	Cnfs	0.714	0.73	0.52
	Dift	0.700	0.79 (10.02)***	0.56
EU	Insp	0.439	0.74 (6.88)***	0.64
	Intu	0.430	0.68 (6.90)***	0.69
	Unsd	0.358	0.43	0.22

Note: ***$p < 0.001$

Table III.
Coefficients of reliability and convergent validity

Latent variables	FC	NT	AU	EU
HE	0.25 (2.97)**	0.36 (4.22)***	−0.14 (−3.48)***	0.21 (3.61)***
UT	0.44 (5.22)***	0.34 (4.12)***	−0.15 (−3.54)***	0.30 (4.53)***
FC			−0.12 (−1.54)^{ns}	0.50 (5.03)***
NT			−0.29 (−3.45)***	0.25 (3.09)**
AU				−0.18 (−2.35)*
Squared multiple correlations	0.38	0.39	0.13	0.43

Notes: ns, not significant (based on t (1.96), one-tailed test). *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

Table IV.
β and γ (t-value) of latent variables

Path analysis

An analysis of the path weights gives us the influential ratio exerted by the latent variables (Table IV).

Comparing the path weights of information need and interface, we obtained results as follows: utilitarian (UT) ($\gamma_{12} = 0.44$***) exerts heavier influence than hedonic (HE) ($\gamma_{11} = 0.25$**) on categorization interface (FC). Hence *H1* proves to be valid. However, when a patron has a hedonic (HE) ($\gamma_{21} = 0.36$***) purpose, this exerts a higher influence than the utilitarian user (UT) ($\gamma_{22} = 0.34$***) does on the clustering interface (NT). Hence *H2* is valid.

Comparing the path weights of interface and affective state, we discovered a negative correlation between clustering interface (NT) and AU ($\beta_{32} = -0.29$***), whereas categorization interface (FC) does not have a significant impact on AU ($\beta_{31} = -0.12^{ns}$). Therefore *H3* proves to be invalid. Meanwhile, categorization interface

(FC) ($\beta_{41} = 0.50$***) exerts a higher influence on perceived EU than a clustering one (NT) ($\beta_{42} = 0.25$**). Hence *H4* is established.

There exists a negative correlation between AU and perceived EU ($\beta_{43} = -0.18$*). This implies that when anxiety mounts, the perceived ease of use decreases. Therefore, *H5* is valid.

Whether the reader has hedonic or utilitarian purposes, or chooses a clustering (network) interface or a categorization (faceted) interface, these factors exert an indirect impact on uncertainty and perceived EU. By analyzing the path as a whole, it appears that hedonic (HE) (−0.14***) affects "anxiety and uncertainty" more than utilitarian (UT) (−0.15***) does. Consequently, *H6* proves to be valid. Another path analysis indicates that utilitarian (UT) (0.30***) makes a bigger impact on "perceived ease of use" (EU) than hedonic (HE) (0.21***) does. Hence *H7* is valid.

The relationship between information needs and interface

H1 is valid. A categorization interface (FC) provides data in a systematic and logical fashion that is easy for patrons to follow. We used the research results delivered by Vakkari and Serola (2012) and classified the e-books according to the purposes of the library patrons, an approach which differs greatly from traditional classification. For the reader who has a utilitarian purpose, this proves to be the most efficient way to retrieve e-books of similar types. Research findings are in line with UGT, which claims that users choose media channels to meet their purpose of use.

H2 is valid. Although both utilitarian (0.34) and pleasure-seeking (0.36) users liked the clustering interface (NT) almost equally. Our conjecture is that this is because both interfaces are well designed, drawing their attention with lively animations. As most participants did not have prior experience with such interfaces, they were believed to be temporarily attracted to the unpredictability and the lively display of clustering representation. We suggest a further investigation into this hypothesis, which could examine participant reactions once the participants got familiar with the interface.

The relationship between interface and one's affective state

H3 was not supported. When the participants used the clustering interface, they felt less AU (−0.29). This phenomenon is explored in detail in the section entitled clustering and categorization information representation.

H4 is valid. Participants generally regarded a categorization interface as having better perceived EU (or desirable uncertainty) than a clustering one. The categorization interface was set to be more predictable and intelligible than its clustering counterpart, with hierarchical stratifications and better organization, in addition to a combination of icons and descriptions. Not surprisingly, the participants would consider the categorization presentation to be more accessible and easier to use.

The relationship between latent variables and one's affective state

H5 is valid. When operating an interface, whether it is organized by clustering or categorization, people tend to feel AU, which in turn leads to perceived EU (or desirable uncertainty). In the meantime, anxiety or uncertainty makes people feel less confident. This explains why they do not experience EU when anxiety increases.

The relationship between information need and one's affective state

H6 is supported. The e-book touch wall was constructed with a number of large screens, aiming to provide the visitors with updates of new titles. Therefore it is of

utmost importance that the vertical display is able to draw people's attention and arouse their interest. The e-book interface is designed as a platform for the reader to freely browse, search and read book introductions unlike the OPAC which proffers precise search results or the internet where one can surf aimlessly. The patrons with a hedonic purpose (−0.14*) are inclined to feel a little more anxious and uncertain than their counterparts with a utilitarian purpose (−0.15*).

H7 is supported. When the user has an explicit purpose, rather than just seeking pleasure, he perceives more EU (or desirable uncertainty).

Discussion

When a visitor enters a library, what are his expectations for the books recommended by the library? Put differently, how can a library present its collection as beautifully as a museum exhibition, so that the library will be teeming with enthusiastic readers? Here we want to ask: how can we attract readers to visit a library more frequently? Aside from providing them with advanced OPAC for the purpose of information diagnosticity, a library may attempt to trigger people's curiosity by taking initiative in recommending books by providing services such as the e-book touch wall (information accessibility). Furthermore, a library should adopt different approaches to suit patrons' different needs and feelings. By taking positive and negative responses into consideration, we examined the following issues which may arise during use of the e-book touch wall.

Work-focused vs recreational IS behaviour

Nahl (2009) pointed out that research perspectives of HIB have shifted from rational and goal directed to affective and emotion oriented. Johnson (2009) stressed the irrational aspect of HIB, especially in everyday life contexts. Elsweiler *et al.* (2011) analyzed how the characteristics of information behaviour change from work to non-work (or recreational) situations, and found "Casual-leisure (TV and Twitter) information behaviour tasks are often motivated by being in or wanting to achieve a particular mood or state. […] therefore, (in casual-leisure situations) the finding of information is often of secondary importance to the experience of finding" (p. 227). Our research on the e-book touch wall examined users' experience of the information-visualized OPAC and their HII, which included information retrieval (work, goal directed, finding information), as well as information recommendation and experiencing (casual-leisure, emotion oriented, experience of finding). The results showed that utilitarian users preferred the categorization interface, and hedonic users preferred the clustering interface, thus the cognitive vs affective aspects of complex HIB were both confirmed in this touch wall.

Elsweiler *et al.* (2011) identified four kinds of casual-leisure information behaviour: time-wasting, hedonistic-need, experience-focused, and casual-information. Users within different scenarios may possess different motivations, value the characteristics of the system and success of the searches differently, and employ different IS behaviours. Such casual-leisure scenarios trigger an often-heated debate as to the appropriateness of using time as a metric. In conventional measures of information retrieval systems, a shorter time is often regarded as an indicator of higher performance, yet when people are engaged in casual-leisure information behaviour, high levels of engagement may increase the duration of information seeking (O'Brien and Toms, 2008). Lopatovska (2011) also found it difficult to identify when best to

review for the presence of emotions (before or after, and for what duration?). Thus, in order to evaluate the performance of the proposed touch-wall interface, it is important to differentiate between work-focused and recreational information behaviour.

Clustering and categorization information representation

Marchionini (2008) explained the rapid changes associated with information objects and content including the following: the dominance of textual representations for knowledge has been challenged by visual, aural, and various multimedia forms of expression; and large amounts of information can be copied or transferred easily and inexpensively. This has had a corresponding influence on HII. These important shifts go some way towards explaining the lack of evidence supporting *H3* and the validity of *H4*.

Dual-code theory explains how humans recognize text and images in different ways. When faced with the clustering interface, users did not experience high levels of uncertainty or anxiety. This could be because the e-book covers are shown as images rather than solely through text. According to Clark and Lyons (2004), captivating images or icons are helpful in reducing cognitive burden. Levie and Lentz (1982) explained how images exert remarkable influence over learning, and further investigated the beneficial effect of illustrations on people's comprehension, memory, and work performance. This evidence suggests that further efforts to reduce anxiety or uncertainty for users of the e-book touch wall might include the introduction of additional multimedia channels such as a voice recording guiding users through the operation of the interface.

The large amounts of information now accessible to a user have engendered novel strategies and capabilities. Pharo and Jarvelin (2006) explained that while most users understand the web as a complex information space, they may not always apply rational, optimal strategies, but may instead choose resources most familiar to themselves, and avoid extreme alternatives. According to sense-making methodology theory, (utilitarian) users in a cognitive (task-driven) approach seek information to fill information gaps in a systematic determined manner. This supports the notion that different professions stimulate different IS behaviours (Kwasitsu, 2003; Allard *et al.*, 2009; Leckie *et al.*, 1996). For example, Du (2014) identified five stages of information behaviour common among marketing professionals: determining need, IS, making judgements, making sense of and using information, and information sharing. It would be enlightening to study the strategies employed by general users (those without experience in dealing with huge amounts of information). This provides an avenue for future study, possibly through journal-keeping by utilitarian or hedonic users of the e-book touch wall.

Another unique development associated with the evolution of information objects and content is the blurring of the scope of knowledge structures. Specifically, open-ended topics lead to different ways of understanding given topics among interface-users. There are currently two approaches to classifying a document by topic: closed topic model (CTM) which employs a closed (fixed) system of categories (e.g. Dewey Decimal classification (DDC)), and open topic model (OTM) which is achieved by user tagging and in which topics change over time (e.g. the category system of Wikipedia). Mehler and Waltinger (2009) assessed content-related classifiers to explore open archives initiative metadata as a source of document representation. They employed the DDC as the system of target categories in order to overcome problems of data sparseness and survey web-based resources (such as Wikipedia) to enrich feature extraction and selection. Our research represented information through clustering

(by frequencies of user tagging) and categorization (by purpose of library visit Vakkari and Serola, 2012). These different representations resulted in different cognitive and affective states for the user. We sought to determine whether an integrated interface might reduce the frustration experienced by users locating information in a CTM/OTM, and how it affected time spent searching for information. To comparing user experiences (UX) of representations that we invented with DDC representation may be a good chance in researching topics openness in different classifying settings.

AU and other affective issues

Julien *et al.* (2005) pointed out that researchers in the field of library information services have historically exerted little effort in the identification of the affective states of users of primary indexing services. However, in recent studies, much attention has been paid to affective states related to information behaviour in everyday life contexts (Johnson, 2009). Johnson (2009, p. 598) highlights the ambiguous polarity of affective states, stressing that "people sometimes deliberately increase uncertainty [for purposes of] stimulation, [or] entertainment" (Johnson, 2009, p. 598). Nonetheless, current literature emphasizes the reduction of uncertainty (Kuhlthau, 2004). In the present study we therefore included this factor as an indicator of performance as well as perceived EU.

Our results show that hedonic users tolerate higher levels of uncertainty, while utilitarian users value EU more highly. Sim *et al.* (2006, p. 235) stated "(for the tested software), observed fun and observed usability were correlated (with each other)". The model developed by our research team can be used to test information needs in different contexts as motivators for IS; it thus helps to explore the interface design (information behaviour) presented by O'Brien (2011), which stresses an integration of HII and UX. While the acquisition of desired information (HII) may result in a rational (cognitive) state, it can also result in an emotional state (UX). Our research model thus links uncertainty reduction, interface usability, and the degree to which users enjoyed seeking information in a risk-attraction context. Different contexts such as flow (Schaik and Ling, 2012) and aesthetics (Sánchez-Franco *et al.* 2014), as well as additional affective factors, are worthy of further research.

When using interface attractiveness to boost recommended information, a number of premises should be considered. First, one's purpose affects what type of interface he will choose. Second, people have different responses (or emotions) when facing different interfaces. Third, people with differing purposes have different affective states. We believe that by setting related parameters, more dynamic OPAC or other media systems can be created for recommendations in public libraries.

Limitations

This study attempted to gain a better understanding of the behaviour and psychological states of information seekers through use of the e-book touch wall – a display that integrates elements of both clustering and categorization. Yet there are still many methodological issues that remain to be explored:

(1) This study addresses the uncertainty felt by users who conduct searches on a small database, without touching upon the depth and breadth of larger data searches. We suggest further investigation in the relationships between purpose of use, sense of uncertainty, and the depth/ breadth of data searches.

(2) We developed a large-scale touch-screen for this study. The operation differs from that of the tablet or smart phone. Hence future researchers might want to explore the effects of the size and privacy of the tool used for IS on anxiety and sense of uncertainty. The opportunities offered by large-scale devices for collaborative information retrieval are also worth exploring (Fidel *et al.*, 2004).

(3) We chose participants from a large body of library visitors without narrowing them down to a specific age range, gender, income bracket, educational background, or community. The question of whether these variables affect IS behaviour is worthy of further exploration.

Conclusions

One of the service goals of a library is to introduce books to visitors. This study examines the e-book touch wall that displays digital book covers and icons in the hope of increasing the visibility of e-books. This differs immensely from traditional OPAC, which relies on Metadata for retrievals and physical checkouts of books. For a relatively small database of roughly 700 copies of digital books, we have constructed an interface that incorporates the clustering and categorization presentations at the same time, in order to meet the utilitarian as well as hedonic needs of library members. According to UGT, users choose a desired media channel based on their likes or dislikes. Therefore we tried to understand what kind of readers (with utilitarian or pleasure-related purposes) would choose which type of interface (clustering vs categorization), and understand their psychological states (uncertainty vs perceived EU). It is our hope that these research findings will be helpful for those implementing developments in the current OPAC. For example, a recommendation function could be included to suggest a specific interface according to user characteristics, mood, and task attributes of the system. Research results are as follows:

(1) when the reader has a utilitarian need, he prefers the categorization interface;

(2) when the reader has a pleasure-oriented need, he slightly prefers the clustering interface;

(3) when the reader utilizes the categorization interface, he tends to feel less uncertainty or anxiety;

(4) anxiety or uncertainty has a negative correlation with perceived EU;

(5) when the reader seeks pleasure, he tends to tolerate a higher level of uncertainty or anxiety; and

(6) when the user searches to satisfy utilitarian needs instead of hedonic needs, he may have stronger perceptions of EU.

References

Agarwal, R. and Venkatesh, V. (2002), "Assessing a firm's web presence: a heuristic evaluation procedure for the measurement of usability", *Information Systems Research*, Vol. 13 No. 2, pp. 168-186.

Allard, S., Levine, K.J. and Tenopir, C. (2009), "Design engineers and technical professionals at work: observing information usage in the workplace", *Journal of the American Society for Information Science and Technology*, Vol. 60 No. 3, pp. 443-454.

Amichai-Hamburger, Y., Kaynar, O. and Fine, A. (2007), "The effects of need for cognition on internet use", *Computers in Human Behavior*, Vol. 23 No. 1, pp. 880-891.

Anselme, P. (2010), "The uncertainty processing theory of motivation", *Behavioural Brain Research*, Vol. 208 No. 2, pp. 291-310.

Belkin, N.J. (1980), "Anomalous states of knowledge as a basis for information retrieval", *The Canadian Journal of Information Science*, Vol. 5, pp. 133-143.

Betül Yilmaz, M. and Orhan, F. (2010), "The use of internet by high school students for educational purposes in respect to their learning approaches", *Procedia Social and Behavioral Sciences*, Vol. 2 No. 2, pp. 2143-2150.

Bilal, D. and Kirby, J. (2002), "Difference and similarities in information seeking: children and adults as web users", *Information Processing and Management*, Vol. 38 No. 5, pp. 649-670.

Brashers, D.E. (2007), "A theory of communication and uncertainty management", in Whaley, B. and Samter, W. (Eds), *Explaining Communication Theory*, Lawrence Erlbaum Associates, Mahwah, NJ, pp. 201-218.

Carroll, J.M. (2004), "Beyond fun", *Interactions*, Vol. 11 No. 5, pp. 38-40.

Chen, H., Houston, A.L., Sewell, R.R. and Schatz, B.R. (1998), "Internet browsing and searching: user evaluations of category map and concept space techniques", *Journal of the American Society for Information Sciences*, Vol. 49 No. 7, pp. 582-603.

Chowdhury, S., Gibb, F. and Landoni, M. (2011), "Uncertainty in information seeking and retrieval: a study in an academic environment", *Information Processing and Management*, Vol. 47 No. 2, pp. 157-175.

Chung, J. and Tan, F.B. (2004), "Antecedents of perceived playfulness: an exploratory study on user acceptance of general information-searching websites", *Information and Management*, Vol. 41 No. 7, pp. 869-881.

Clark, R.C. and Lyons, C. (2004), *Graphics for Learning: Proven Guidelines for Planning, Designing, and Evaluating Visuals in Training Materials*, Pfeiffer, San Francisco, CA.

Dervin, B. (2005), "What methodology does to theory: sense-making methodology as exemplar", in Fisher, K.E., Erdelez, S. and McKechnie, L.E.F. (Eds), *Theories of Information Behaviour*, Information Today, Inc., Medford, NJ, pp. 25-29.

Du, J.T. (2014), "The information journey of marketing professionals: incorporating work task-driven information seeking, information judgments, information use, and information sharing", *Journal of the American Society for Information Science and Technology*, Vol. 65 No. 9, pp. 1850-1869.

Dumais, S.T., Cutrell, E. and Chen, H. (2001), "Optimizing search by showing results in context", *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI'01) ACM Press, Seattle, WA*, pp. 277-284.

Elsweiler, D., Wilson, M.L. and Kirkegaard Lunn, B. (2011), "Chapter 9 understanding casual-leisure information behaviour", in Spink, A. and Heinstrom, J. (Eds) *New Directions in Information Behaviour*, Emerald Group Publishing, Bingley, pp. 211-241.

Fidel, R., Pejtersen, A.M., Cleal, B. and Bruce, H. (2004), "A multidimensional approach to the study of human-information interaction: a case study of collaborative information retrieval", *Journal of the American Society for Information Science and Technology*, Vol. 55 No. 11, pp. 939-953.

Gwizdka, J. and Lopatovska, I. (2009), "The role of subjective factors in the information search process", *Journal of the American Society for Information Science and Technology*, Vol. 60 No. 12, pp. 2452-2464.

Hearst, M.A. (2006), "Clustering versus faceted categories for information exploration", *Communcations of the ACM*, Vol. 49 No. 4, pp. 59-61.

Hearst, M.A. (2009), *Search User Interfaces*, Cambridge University Press, Cambridge.

Hornbaek, K. (2006), "Current practice in measuring usability: challenges to usability studies and research", *International Journal of Human-Computer Studies*, Vol. 64 No. 2, pp. 79-102.

Horton, W. (1994), *The Icon Book: Visual Symbols for Computer Systems and Documentation*, John Wiley & Sons, Inc., New York, NY.

Howard-Jones, P.A. and Demetriou, S. (2009), "Uncertainty and engagement with learning games", *Instructional Science*, Vol. 37 No. 6, pp. 519-536.

Johnson, J.D. (2009), "An impressionistic mapping of information behavior with special attention to contexts, rationality, and ignorance", *Information Processing and Management*, Vol. 45 No. 5, pp. 593-604.

Jöreskog, K. and Sörbom, D. (1996), *LISREL 8: SEM with the SIMPLIS Command Language*, Scientific Software International, Lincolnwood, IL.

Julien, H., McKechnie, L.E.F. and Hart, S. (2005), "Affective issues in library and information science system work: a content analysis", *Library and Information Science Research*, Vol. 27 No. 4, pp. 453-466.

Katz, E., Blumler, J.G. and Gurevitch, M. (1974), "Utilization of mass communication by the individual", in Blumler, J.G. and Katz, E. (Eds), *The Use of Mass Communications: Current Perspectives on Gratifications Research*, Sage, Berverly Hills, CA, pp. 19-32.

Kelloway, E.K. (1998), *Using LISREL for Structural Equation Modeling: A Researcher's Guide*, Sage, Thousand Oaks, CA.

Kleiboemer, A.J., Lazear, M.B. and Pedersen, J.O. (1996), "Tailoring a retrieval system for naive users", *Proceedings of the Fifth Annual Symposium on Document Analysis and Information Retrieval (SDAIR '96)*, *Las Vegas, NV*, *15-17 April*.

Korfhage, R.R. (1991), "To see or not to see – is that the query?", *Proceedings of the 14th Annual International ACM SIGIR Conference on Research and Development in Information Retrieval (SIGIR '91)*, *Chicago, IL*, pp. 134-141.

Kuhlthau, C.C. (1991), "Inside the search process: information seeking from the user's perspective", *Journal of the American Society for Information Science*, Vol. 42 No. 5, pp. 361-371.

Kuhlthau, C.C. (2004), *Seeking Meaning: A Process Approach to Library and Information Services*, 2nd ed., Libraries Unlimited, Westport, CT.

Kules, B. and Shneiderman, B. (2008), "Users can change their web search tactics: design guidelines for categorized overviews", *Information Processing and Management*, Vol. 44 No. 2, pp. 463-484.

Kwasitsu, L. (2003), "Information-seeking behavior of design, process and manufacturing engineers", *Library and Information Science Research*, Vol. 25 No. 4, pp. 459-476.

Larkin, J.H. and Simon, H.A. (1987), "Why a diagram is (sometimes) worth ten thousand words", *Cognitive Science*, Vol. 11 No. 1, pp. 85-100.

Leckie, G.J., Pettigrew, K.E. and Sylvain, C. (1996), "Modeling the information seeking of professionals: a general model derived from research on engineers, health care professionals and lawyers", *Library Quarterly*, Vol. 66 No. 2, pp. 161-193.

Levie, W.H. and Lentz, R. (1982), "Effects of text illustrations: a review of research", *Educational Communication and Technology Journal*, Vol. 30 No. 4, pp. 195-232.

Li, H., Liu, Y., Xu, X., Heikkila, J. and Van der Heijden, H. (2015), "Modeling hedonic is continuance through the uses and gratifications theory: an empirical study in online games", *Computers in Human Behavior*, Vol. 48, pp. 261-272.

Li, M. and Mao, J. (2015), "Hedonic or utilitarian? Exploring the impact of communication style alignment on user's perception of virtual health advisory services", *International Journal of Information Management*, Vol. 35 No. 2, pp. 229-243.

Lin, X., Soergel, D. and Marchionini, G. (1991), "A self-organizing semantic map for information retrieval", *Proceedings of the 14th Annual International ACM SIGIR Conference on Research and Development in Information Retrieval (SIGIR '91)*, pp. 262-269.

Lopatovska, I. (2011), "Emotional correlates of information retrieval behaviors", 2011 IEEE Workshop on Affective Computational Intelligence (WACI), available at: http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=5953145 (accessed 17 February 2016).

Marchionini, G. (2008), "Human-information interaction research and development", *Library and Information Science Research*, Vol. 30 No. 3, pp. 165-174.

Mehler, A. and Waltinger, U. (2009), "Enhancing document modeling by means of open topic models: crossing the frontier of classification schemes in digital libraries by example of the DDC", *Library Hi Tech*, Vol. 27 No. 4, pp. 520-539.

Nahl, D. (2009), "The centrality of affect in human behavior", in Nahl, D. and Bilal, D. (Eds), *Information and Emotion: The Emergent Affective Paradigm in Information Behavior Research and Theory*, Information Today, Inc., Medford, NJ, pp. 3-37.

O'Brien, H.L. (2011), "Weaving the threads of experience into human information interaction (HII): probing user experience (UX) for new directions in information behaviour", in Spink, A. and Heinstrom, J. (Eds), *New Directions in Information Behaviour*, Emerald Group Publishing, Bingley, pp. 69-92.

O'Brien, H.L. and Toms, E.G. (2008), "What is user engagement? A conceptual framework for defining user engagement with technology", *Journal of the American Society for Information Science and Technology*, Vol. 59 No. 6, pp. 938-955.

Otter, M. and Johnson, H. (2000), "Lost in hyperspace: metrics and mental models", *Interacting with Computers*, Vol. 13 No. 1, pp. 1-40.

Ozcelik, E., Cagiltay, N.E. and Ozcelik, N.S. (2013), "The effect of uncertainty on learning in game-like environments", *Computer and Education*, Vol. 67, pp. 12-20.

Paivio, A. (2006), "Dual coding theory and education", paper presented at pathways to literacy achievement for high poverty children, The University of Michigan School of Education, Ann Arbor, MI, 29 September-1 October.

Pharo, N. and Järvelin, K. (2006), "'Irrational' searchers and IR-rational researchers", *Journal of the American Society for Information Science and Technology*, Vol. 57 No. 2, pp. 222-232.

Pirolli, P., Schank, P., Hearst, M.A. and Diehl, C. (1996), "Scatter/gather browsing communicates the topic structure of a very large text collection", *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '96), Vancouver*, pp. 213-220.

Pratt, W., Hearst, M.A. and Fagan, L. (1999), "A knowledge-based approach to organizing retrieved documents", *Proceedings of 16th Annual Conference on Artificial Intelligence (AAAI 99), Orlando, FL, 18-22 July*.

Rains, S.A. and Tukachinsky, R. (2015), "An examination of the relationships among uncertainty, appraisal, and information-seeking behavior proposed in uncertainty management theory", *Health Communication*, Vol. 30 No. 4, pp. 339-349.

Rodden, K., Basalaj, W., Sinclair, D. and Wood, K.R. (2001), "Does organisation by similarity assist image browsing?", *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '01), Seattle, WA*, pp. 190-197.

Sadler-Smith, E. (2011), "The intuitive style: relationships with local/global and verbal/visual styles, gender, and superstitious reasoning", *Learning and Individual Differences*, Vol. 21 No. 3, pp. 263-270.

Sánchez-Franco, M.J., Peral-Peral, B. and Villarejo-Ramos, Á.F. (2014), "Users' intrinsic and extrinsic drivers to use a web-based educational environment", *Computers & Education*, Vol. 74, pp. 81-97.

Scarpi, D. (2012), "Work and fun on the internet: the effects of utilitarianism and hedonism online", *Journal of Interactive Marketing*, Vol. 26 No. 1, pp. 53-67.

Schaik, P.v. and Ling, J. (2012), "A cognitive-experiential approach to modelling web navigation", *International Journal of Human-Computer Studies*, Vol. 70 No. 9, pp. 630-651.

Scherer, K.R. (2005), "What are emotions? And how can they be measured?", *Social Science Information*, Vol. 44 No. 4, pp. 695-729.

Sebastiani, F. (2002), "Machine learning in automated text categorization", *ACM Computing Surveys (CSUR)*, Vol. 34 No. 1, pp. 1-47.

Sim, G., MacFarlane, S. and Read, J. (2006), "All work and no play: measuring fun, usability, and learning in software for children", *Computers & Education*, Vol. 46, pp. 235-248.

Tenopir, C., Wang, P., Zhang, Y., Simmons, B. and Pollard, R. (2008), "Academic users' interactions with Science Direct in search tasks: affective and cognitive behaviors", *Information Processing and Management*, Vol. 44 No. 1, pp. 105-121.

Vakkari, P. and Serola, S. (2012), "Perceived outcomes of public libraries", *Library and Information Science Research*, Vol. 34 No. 1, pp. 37-44.

Van der Heijden, H. (2004), "User acceptance of hedonic information systems", *MIS Quarterly*, Vol. 28 No. 4, pp. 695-704.

Venkatesh, V., Thong, J.Y.L. and Xu, X. (2012), "Consumer acceptance and use of information technology: extending the unified theory of acceptance and use of technology", *MIS Quarterly*, Vol. 36 No. 1, pp. 157-178.

Wang, P., Hawk, W.B. and Tenopir, C. (2000), "Users' interaction with world wide web resources: an exploratory study using a holistic approach", *Information Processing and Management*, Vol. 36 No. 2, pp. 229-251.

Weibull, L. (1985), "Structural factors in gratifications research", in Rosengren, K.E., Wenner, L.A. and Palmgreen, P. (Eds), *Media Gratifications Research: Current Perspectives*, Sage, Beverly Hills, CA, pp. 123-147.

Wilson, T.D. (1981), "On user studies and information needs", *Journal of Documentation*, Vol. 37 No. 1, pp. 3-15.

Zhu, B. and Chen, H. (2005), "Information visualization", in Cronin, B. (Ed.), *Annual Review of Information Science and Technology*, Vol. 39, Information Today, Medford, NJ, pp. 139-177.

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