Help Feature Interactions in Digital Libraries:

Influence of learning styles

Chunsheng Huang
School of Information Studies,
University of Wisconsin,
Milwaukee, WI 53201
E-mail: huang22@uwm.edu

Iris Xie
School of Information Studies,
University of Wisconsin,
Milwaukee, WI 53201
E-mail: hiris@uwm.edu

ABSTRACT
Little is known about how learning styles may have an impact on users' help-seeking behaviors. In this paper, we report the results of a study investigating the effects of learning styles on help feature interactions in the digital library environment. The Felder-Silverman Index of Learning Styles was employed to measure users' four different style dimensions: Active/Reflective, Sensory/Intuitive, Visual/Verbal, and Sequential/Global. Multiple data collection methods, including questionnaires, think-aloud protocols, transaction logs, and interviews, were employed to collect data from 27 participants. Findings of this study demonstrate that learning styles influence the way that participants interact with help features of digital libraries. The results suggest that the designs of IR systems, including digital libraries, need to support different learning styles by offering different types of help features, different formats of help, and different organization and presentation of help content.

Keywords
Learning styles, help-seeking, digital libraries, interactions.

INTRODUCTION
Previous research in IR has shifted from a system-centered approach to a user-centered cognitive approach. A user-centered cognitive approach incorporates users' knowledge, interests, and preference into system design. Cognitive differences, particularly in cognitive styles, influence how users seek and retrieve information. Cognitive style refers to individuals' preferred ways of processing information (Sternberg, 2001). Individuals may process all sorts of information across many areas of activity, e.g., perceiving, thinking, problem solving, and learning. Cognitive style unconsciously serves as an adaptive control mechanism between the inner self-need and external interacting environment. Attention has turned to cognitive styles in learning activities, which researchers have termed "learning style." Many dimensions of learning style have been developed to describe and classify learners. For example, the Field-Dependence/Independence (Witkin, 1973), Wholist/Analytic and Verbalizer/Imager (Riding &

Cheema, 1991), Active/Reflective (Kolb & Kolb, 2005), and Sensing/Intuitive (Felder & Silverman, 1988) are used to categorize learners based on how they perceive, organize, and process information.

Help-seeking represents a mini information search process. The factors, that influence information seeking and retrieving, also affect users' help-seeking. Help is defined as assistance or clarification from either an IR system or a human in the search process when people encounter problems (Xie & Cool, 2009). Help features refer to any system features that assist users in solving their problems in the search process.

However, there has been inadequate research focusing on how learning styles affect information seeking and retrieving, in particular help-seeking. Few studies examine the issue in the context of using digital libraries where more novice users need to seek help in their search processes. Novice users have to learn how to search digital libraries by interacting with their help features. This study aims to fill the gap and explore the issue. This research intends to investigate the following research question: How do learning styles affect user interactions with help features in the information search process?

LITERATURE REVIEW
While most learning styles theories classify learners into few groups, the Index of Learning Styles (ILS) describes learners in more details and dimensions. ILS is a 44-item forced-choice instrument developed in 1991. The learning style dimensions of ILS were adapted from a model developed in 1987 by Dr. Richard M. Felder and Dr. Linda K. Silverman from North Carolina University. In ILS model, there are four proposed scales and associated dimensions: Active/Reflective, Sensory/Intuitive, Visual/Verbal, and Sequential/Global.

The first dimension distinguishes between an active and a reflective way of processing information. The second dimension covers sensory versus intuitive approaches of perceiving information. The third, visual-verbal dimension deals with the preferred sensory channel in providing information. For the fourth dimension, learners are characterized according to their sequential or global ways

of understanding information (Felder & Silverman, 1988; Felder & Brent, 2005; Felder & Soloman, 2010).

The reason for choosing ILS in this study was that it is widely used in educational and academic environments and therefore suitable to be applied in the online searching setting. Another important reason for selecting the ILS is that it provides broader dimensions and deeper descriptions of learners and distinguishes between preferences on four scale and eight dimensions. It enables any adaptive information system to provide an interactive environment that can better accommodate learners' preferences. In addition, it is considered to be a reliable model since the scores of test-retest reliability measurements are satisfactory and stable across different studies (Felder & Spurlin, 2005).

Several dimensions of cognitive styles/learning styles were employed to explore how human preferences on information processing may influence the ways of searching and retrieving in different interactive environments. The major dimensions include Field dependent/independent, Reflective/Active, Wholist/Analytic, Verbal/Visual, and Sequential/Global (Ford et al., 2002; Kolb & Kolb, 2005; Felder & Silverman, 1988).

Among the various dimensions, Field Dependent/Field Independent (FD/FI) is probably the most studied dimension. When processing incoming material, FI individuals would impose their own structure, take individual elements out of context, and employ analytical approaches toward learning, whereas FD persons would accept ideas presented to them, focus on global experience, adopt more of an observer role, and be easily distracted by unimportant, but more dominant, cues. FD individuals need more guidance to assist them to find out relevant and meaningful information (Lee et al., 2005; Clewley, Chen, & Liu, 2010). Liu and Reed (1994) conducted a study and found a significant relationship between participants' cognitive styles and their use of a hypermedia system. The FI subjects explored the hypermedia system in a nonlinear mode, whereas the FDs navigated in a relatively linear mode. This result seemed to be supported by other web searching studies (Frias-Martinez, Chen, & Liu, 2008). In the web searching environment, FD individuals were also found to spend more time on searching, to visit more nodes (Wang, Hawk, & Tenopir, 2000), to make more use of search operators (Kim, Yun, & Kim, 2004), and to navigate in a passive mode (Palmquist & Kim, 2000).

Riding and Cheema (1991) surveyed many dimensions and concluded that styles may be grouped into two principal groups: the Wholist/Analytic and the Verbal/Imagery dimensions. The Wholist/Analytic dimension describes whether an individual tends to organize and perceives information in wholes or parts. The dimension is similar to Field Dependent/Independent. The Verbal/Imagery dimension characterizes whether people are inclined to perform better in tasks or situations that require the associated form of information represented in visual or verbal form. A number of studies related specific information behavior patterns to Wholist/Analytic as well as to Verbal/Imagery styles. Links were found between the Wholist style and a preference in step-by-step logical progression and passive browsing. Analytic individuals engage in more active, exploratory, and serendipitous behaviors, including clearer and more focused thinking, greater changes in problem perception as searches progress, greater engagement in differentiating, and more complex phrase-oriented expressions in search transitions (Ford, Miller, & Moss, 2005). Compared to Imagers, Verbalisers display more extensive distinctive use of linguistic search transformations (Ford et al., 2009), spend less time viewing text-based content (Frias-Martinez, Chen, & Liu, 2008), and visit more web pages in hierarchical architecture than web pages in relational structure (Graff, 2005).

Kolb's Experiential Learning Theory (ELT) comprises four types of learning styles: assimilating, converging, and two other styles (Kolb & Kolb, 2005). The ELT portrays an assimilating style individual as one who is strong in the areas of abstract conceptualization (AC) and reflective observation (RO). People with this style are best at understanding a wide range of information. They prefer reading ideas and abstract concepts, exploring analytical models, and having time to think things through. In contrast, converging style learners are stronger in abstract conceptualization (AC) and active experimentation (AE). People with this learning style are best at finding practical uses for ideas and theories. In formal learning situations, people with this style prefer experimenting with new ideas, simulations, laboratory assignments, and practical applications. Tenopir et al. (2008) found that people associated with the assimilating learning style searched longer, moved slightly faster, paused slightly fewer times, and paused more on search results pages, while those associated with the converging learning style paused more on document pages and home pages.

As stated above, ILS has four dimensions: Active/Reflective, Sensory/Intuitive, Visual/Verbal, and Sequential/Global. Papaeconomou (2008) conducted an exploratory study to examine the Global/Sequential dimensions of ILS to determine their influence on webpage relevance assessment and eye-tracking pattern. Global learners applied "Depth/Scope" and "Web layout" as major criteria while Sequential learners depended strongly on "Link anchor text" and "Topic of Web page" criteria. More interestingly, the results also showed different eye-tracking patterns between the two style learners. When interacting with web pages, Sequential learners gazed from left to right and followed the layout of the page. Global learners, on the other hand, applied more diffuse modes of gazing at the same page. It was not possible to create a common hot spot pattern of gazing the page.

Help-seeking is generally regarded as an important problem-solving skill to achieve goals in different contexts.

Many educational scholars believe that help-seeking is one of the most important skills in overcoming learning difficulties (Nelson-Le Gall, 1985). In information-seeking and searching environments, while a user is engaged in the process of interacting with an IR system, he/she may easily encounter problematic situations and need some kind of help in that searching process either from the system or from a human (Xie & Cool, 2009). Previous research has demonstrated that the existing help systems in digital libraries as well as other IR environment cannot fully satisfy users' needs. While viewing help systems as important, people generally find these systems to be ineffective in a variety of areas, and thus they tend to use help mechanisms less frequently (Cool & Xie, 2004; Mansourian, 2008).

Since digital libraries were developed during the past decade, most users are unfamiliar with them. Novice users, who never use or rarely use digital libraries, are in need of help when being situated in a totally strange searching environment. They are vulnerable in the beginning stage and need assistance to get through the searching process and fulfill their information needs. It is also clear that the problematic situation will worsen when a novice user faces a new digital library environment (Nahl, 1999). Xie & Cool (2009) identified different help-seeking situations and related factors experienced by novice users in digital libraries. User knowledge (domain, system, and retrieval), searching experience, and searching style and preference emerged as the most influential factors. In addition, search task; system factors, such as content and interface design; and interaction outcomes also play important roles in the help-seeking process.

Another study identified users' help-seeking strategies when they failed to satisfy a specific information need in the web searching environment (Mansourian, 2008). In the study, the researcher defined help-seeking as "coping strategies" and classified these strategies into active and passive approaches. Searchers usually prioritize their help-seeking strategies according to the importance of the search, their determination to change a failed search, and the overall context. Therefore, more context-sensitive help has been suggested by many researchers (Othman, 2004). A full understanding of why people choose not to seek help in searching environments is still under investigation. In addition to the system side problems, users' characteristics, such as users' ability and preference in using help and cognitive state, also play a major role in the decision of using system help (Dworman & Rosenbaum, 2004).

Previous research has two main limitations: 1) while there are studies focusing on how cognitive styles/learning styles affecting search behaviors, less research has been on the influence of learning styles on help-seeking; 2) there is even less research examining the issue in digital library environments. This study aims to fill the gap and explore how learning styles affect users' interactions with help features in searching digital libraries.

METHODOLOGY
A user study was designed to address the proposed research question. Both qualitative and quantitative methods were employed to systematically collect and analyze the data. Two digital libraries were selected for this project based on their diversity of content and completeness of help features. They are the University of Wisconsin Digital Collection (UWDC) (http://uwdc.library.wisc.edu index.shtml) and American Memory (AM) http://memory.loc.gov/ammem/index.html).

Sampling
Recruitment took place through flyers, referrals, listserv, etc. within the University of Wisconsin Milwaukee (UWM) campus and Milwaukee area. A total of 28 novice users were recruited, including undergraduate and graduate students of UWM and other universities. Twenty-seven participants completed the study. These participants represent general academic users with different genders, races, ethnicities, educational backgrounds, computer skills, and other demographic characteristics. Characteristics of participants are summarized in Table 1.

Demographic Characteristics	N	Percentage
Gender		
Male	14	52%
Female	13	48%
Age		
18-21	6	22.2%
22-29	10	37.0%
30-39	7	25.9%
40-49	3	11.1%
50-59	1	3.7%
Computer Skills		
Expert	3	11.1%
Advanced	7	25.9%
Intermediate	16	59.3%
Novice	1	3.7%
Educational Background: Universities: UWM, U. of Wisconsin Madison, U. of Wisconsin La Crosse, and Northwestern U. Disciplines: anthropology, architect, business administration, film, chemistry, ecology, education, information studies, mechanical engineering, psychology, and social welfare.		

Table 1. Characteristics of participants (N=27).

Since novice users are more likely to encounter problems in searching digital libraries, novice users are the main subjects of this study. An individual who never uses or rarely uses digital libraries is defined as a novice user in this study. The main inclusion criterion was experience in using digital libraries. Any potential participants who have frequently used digital libraries were excluded from the study. Other inclusion criteria were: (1) participants must be adult users and 18 years or older, (2) they must speak English although they don't have to be native speakers of English, (3) they must be residents of the Milwaukee area, (4) they must have basic computer literacy skills, and (5)

they must have academic or general interest in digital libraries.

Data Collection

Three types of search tasks were assigned to participants: looking for known items, looking for specific information, and looking for items with common characteristics (Xie, 2008). These tasks were chosen to represent the popular tasks that users generally search in digital libraries. They were also chosen to fit the coverage of the two selected DLs.

A pilot study was first carried out in order to test the research design. After reviewing pilot testing results, some of the assigned tasks were found to be too easy for the participants to answer and were modified accordingly. The complexity of tasks 'forces' participants to interact more with digital libraries.

In this study, participants were asked to perform three different types of tasks using the two chosen digital libraries. The first task was to find known items (pictures of Abraham Lincoln with beard) using three different approaches from both DLs. The second task was to search for specific information. Participants were asked to find the name of the first chancellor of University of Wisconsin Madison in UWDC and the number of signers of the Declaration of Independence in AM. The third task was to find resources related to women's voting rights in both digital libraries. In order to reduce the bias caused by the sequence of searching the two digital libraries, half of the participants started UWDC first, and the other half started AM. Multiple data collection methods, including questionnaires, think-aloud protocols, transaction logs, and interviews, were applied.

Pre-Questionnaire

The consent forms and pre-questionnaires were sent to the potential participants by emails. The consent form included information explaining the purpose, procedures, benefits, and risks of the study. The pre-questionnaire collected information in relation to participants' demographic characteristics and their experiences in using DLs.

Cognitive preference of learning questionnaire

The questionnaire of Index of Learning Style (ILS) was used in order to identify participants' cognitive preferences in information processing in four different dimensions, including (1) processing, (2) perception, (3) input, and (4) understanding (Felder & Soloman, 2010). The ILS questionnaire is one of the most popular instruments used to identify people's cognitive preferences; it consists of 44 questions, 11 for each dimension. After completing the questionnaire, a combination of ILS scores of the four dimensions was obtained for each participant. According to Felder & Soloman (2010), an individual learner has a personal distinctive preference for each of the four information processing dimensions, which is indicated by values from -11 to +11 with an increment of 2. These learning styles can be classified as Active/Reflective, Sensory/Intuitive, Visual/Verbal, and Sequential/Global. For example, for the first processing dimension, the subject would receive either a positive or a negative score, which can be categorized as "active" or "reflective" respectively.

Think aloud protocol and transaction logs

Each participant was asked to come to the Intelligence & Architecture Research Lab of UWM for the experiment. Participants were instructed to perform searches in digital libraries for the tasks assigned to them. They were asked to "think aloud" about what they were doing and why during their searches. Their behaviors in interacting with the systems were recorded by a usability testing software called MORAE. The software helps researchers capture not only audio and facial expressions of participants, but also their on-screen interactive activities.

Postinterview

After all the searches were done, participants were interviewed to elicit their perceptions of the help systems in the digital libraries, elaborating and clarifying the answers that they provided.

Data Analysis

The investigators analyzed both qualitative and quantitative data collected from the pre-questionnaires, questionnaire of Index of Learning Styles, think-aloud protocols, and post-interviews. Demographic characteristics were analyzed based on the data collected from the pre-questionnaire. Then, learning styles of participants were identified based on the calculation of values obtained from the Index of Learning Styles. Finally, types of interaction adopted by different learner styles were explored and investigated based on open coding of data collected from the verbal protocols, transaction logs, and post-interviews.

The values of participants' ILS scores were divided into three groups. Taking the processing dimension as an example, the three groups are (1) active, (2) balanced, and (3) reflective preferences. Other dimensions were analyzed following the same approach. These groups were recommended by Felder and his colleagues (Felder & Silverman, 1988; Felder & Spurlin, 2005) to improve reliability and have been applied by other researchers. According to Graf and his colleagues (2009), if the value of ILS is equal or greater than +4, it indicates a preference for one end of that particular dimension. If the value is lower or equal to -4, then it indicates a preference on the other end of the dimension. Values between the two ends indicate a balanced learning style. Felder & Spurlin (2005) pointed out that any researcher applying ILS should examine only moderate (5-7) to strong (9-11) preferences of a particular style in order to find the differences in behavior or attitude. Based on previous research, the cutting criteria value for this study was set to 7. If the values in the processing dimension were 7, 9, or 11, the preference were considered active and vice versa for reflective. The value between 5

and -5 were considered to be in the balanced or mild preference.

The qualitative data collected from pre-questionnaires, verbal protocols, log data, post-interviews, and observation notes were first transcribed and aggregated. Then the data were analyzed using open coding, which is the process of breaking down, examining, comparing, conceptualizing, and categorizing (Strauss & Corbin, 1990). Types of interactions with help features were linked and related to different learning styles. Because of space limitations, a detailed discussion of types of interactions, definitions, and examples is presented in the Results section. Mann-Whitney U test and descriptive analysis were also performed to validate qualitative findings. In performing Mann-Whitney U tests, the authors set the cutting value for learning styles to 0 instead of 7 because the groups can be more comparable. In conducting descriptive analysis, the cutting value for learning styles is set to 7 to show more distinctive characteristics of each type learning style.

RESULTS

The finding of this study focuses on answering the research question in regard to how learning styles affect users' interactions with help features in the information search process. Table 2 summarizes how learning styles affect users' interactions with help features.

Active Learner

Active learners learn best by working actively with the learning material, by applying the material, and by trying things out. "Let's try it out and see how it works" is an active learner's statement. Furthermore, they tend to be more interested in communication with others and prefer to learn by working in groups in which they can interact and discuss the material. Active learners understand new information by doing something with it.

Trying different types of help features

One major characteristic of active learners is that they prefer learning by trial and error. They process information through active experimentation. They are more willing to take some risks in trying things out to achieve their goals (Felder & Brent, 2005; Kolb & Kolb, 2008). In this study, active learners tended to work actively with the digital libraries and tried as many helpful functions provided by the system as possible. They did not speculate on the help features before trying them out. As one participant stated, "For this time, I will go to ABOUT. Well, I am not so interested in history. So I will look at the Technical Information. [Go back to home] I will go to FAQ. [did not go through the description of FAQ provided by DLs] I don't see anything easily there (S6)." This participant used several help features within a very short period of time: ABOUT –> FAQ –> Technical Information –> Audio Preservation Project –> Electronic Exhibition. Active learners are inclined to keep actively trying, and there

seems to be no logic between active learners' different moves.

Dimensions/ Learning Styles	Types of help feature interactions	N
Processing Active	*Trying different types of help features* *Selecting short and simple help features* *Selecting interactive help features*	4
Reflective	*Limited use of help features* *Selecting help features after thoughtful planning*	*4*
Perception Intuitive	*Selecting help feature by analyzing the principle of its design* Analyzing and comparing help features	5
Sensing	*Consistency in using familiar help features* *Preferring concrete information in help features*	*6*
Input Visual	Preferring visual help features Preferring help content in visual format	15
Verbal	*Preferring verbal help features* *Evaluating detailed verbal description*	4
Understanding Sequential	*Preferring sequential organization of information in understanding help content*	3
Global	*Interacting with different help features in order to make sense*	2

Table 2.Types of help feature interactions by learning styles

Selecting short and simple help features

Active learners do not learn much in situations that require them to be passive. They are not patient with given details. They want to be actively involved in the presentation, including talking, moving, reflecting on the learning material instead of passively reading, watching, and listening (Felder & Silverman, 1988). One explanation for this specific behavior is the capacity of working memory. Several studies support the same view with the evidence that active learners have a low capacity of working memory compared to reflective learners (Hadwin & Kirby, 1999). The testing results from a study on 297 Austrian undergraduate students show a significant relationship between active/reflective learning style and working memory capacity, and draw the conclusion that Active learners are associated with a low capacity of working memory (Graf et al., 2009). Active learners in this study selected short and simple help features, such as FAQ, Search Tip, and Featured Images. For example, a

participant explained her criterion to select help features: "FAQ was easy to use, straightforward. I like something that I can just jump onto and intuitively work through, with short, simple FAQ-type guidelines - as opposed to long, detailed paragraphs of information about how to do things" (S6). At the same time, some of the participants complained about a helpless feeling when interacting with help features that provide long and detailed information in DLs: "I am just looking at … [browse down the help description]. It just looks very confusing [with a long sigh]. Cause it looks like so much. It looks like a lot of work" (S22).

Selecting interactive help features
Active learners are not only more willing to explore different functions or links provided by digital libraries, but also may change their plans and select help features in the interactive process of using these digital libraries. They prefer interactive help features. In the search process, one participant originally planned to email questions to librarians for help and later changed his mind and used chat functions, which provides more interaction and involvement for the user. Here is the verbal protocol from the participant: "If you do not know how to search, you can go to "Ask Librarian" [email]… Let's try it. So let's type in the question. Oh, you can do chat with a librarian. Oh, Eastern time. Yeah, you can do it right now" (S2). In addition, active learners opt for jumping into a learning situation without thinking much beforehand. In order to validate this result, an analysis was performed to test the association between types of learning styles and usage of interactive help features. The interactive help features include 'Ask Librarian', 'Contact AM' and 'Contact UWDC'. The Mann-Whitney U analysis was performed to test the qualitative finding. The result shows that the active learners significantly used more interactive help features than the reflective counterparts (Mdn=0, z=-2.382, p<0.05).

Reflective learner
Compared with active learners, reflective learners are more analytic and prefer to think about and reflect on the material. They prefer to process information through self-introspection (Felder & Silverman, 1988). In this study, the reflective learners showed interesting interaction patterns. They used limited types of help features and selected help features after thoughtful planning.

Limited use of help features
Reflective learners used only limited types of help features. One reflective participant tried different terms to find the picture of Abraham Lincoln for some time without trying other help options. For example, in order to search for a picture of Abraham Lincoln with a beard, S17 tried changing search terms to synonyms as well as other related terms to help accomplish the task, including "president 1865," "civil war president," "16th president," and "John Wilkes booth assassination." The reflective participants used seven times less of help features in average in their search process compared to their active counterparts.

Selecting help features after thoughtful planning
Unlike active learners, who jump into system functions without careful thinking, reflective learners tend to think over the usefulness of help features before trying them out. This suggests that reflective learners are less risk-taking and tend to avoid uncertainty (Kolb & Kolb, 2008). Reflective participants expressed their feelings of hesitation and uncertainty about the choice of help features. One participant offered the personal account of selecting different browsing options: "I think it is arranged....or displayed A to Z. Abraham …oh, maybe it is not a good way [for browsing]…I'll try another approach. Okay, I see the subject guide. Lincoln may be a history subject…but I don't see that here….Nothing there. Statistics, no. Copyright, no. Maybe keep trying collection" (S5). Another participant offered a reason for disliking one of the help features and hesitating to try it out: "The categories [for browsing] are confusing and not intuitive enough" (S11). One participant also criticized one help feature because of its organization structure: "I think the alphabetical order does not seem to be the best way to organize things [participant was hesitant in selecting an appropriate collection]" (S12).

Intuitive Learner
Intuitive learners are more interested in learning abstract material, such as concepts, theories, and the underlying meanings. They appreciate innovative approaches and dislike repetition (Ford & Chen, 2000). Research based on a hypermedia-based environment shows that intuitive subjects, like field-independent learners, appear to favor a less-explicit hypermedia environment, and their performances are impeded by the predefined structure of the learning material's presentation (Lee & Boling, 2008).

Selecting help feature by analyzing the principle of its design
Intuitive learners want to know more about general principles (Graf, Liu, & Kinshuk, 2008). After searching several search tasks in the digital library environment, intuitive participants discussed their preferred overall design. One participant commented, "I like the picture view and text view in American Memory. Collections [in American Memory] is my favorite [function] to use because the information was classified. Add more search bars after clicking on a specific link. It would be nice if I could search within that" (S22). This was echoed by another participant: "The American Memory web design is boring. It is not as attractive as the other one in my first impression. But when I need to look for something, I think the American Memory is a very useful design with clear BROWSE functions. UWDC, on the other hand, provides a bad collection presentation. It is not helpful to look at the long list of collection in alphabetical order. It does not help users" (S23).

Analyzing and comparing help features
Previous research shows that intuitive learners are more analytical in processing information and would tend to use

relationship options in a hypermedia environment (Liu & Reed, 1994). Intuitive participants analyzed specific system functions compared with the features with which they were familiar. Participant 7 said, "That would be a lot faster if I put first name down here. I could do guided search. You cannot type in here. No record found. [Enter] "Abraham" AND "Lincoln" [select "in any field"]. No records found. Oh, Abraham OR Lincoln. The guided search, there is pretty much the same things with Boolean operator, right?" Another participant revealed a similar thread of thought by comparing guided search and advanced search: "Guided search is a kind of like advanced search. So I suppose I can try this. Let's try 'Lincoln' and then put 'president'…Oh, this is interesting. This is a different picture. And there is an audio file" (S2). Participant 25 discussed how to enhance Featured images by borrowing an idea from Gallery view. "Now we are in featured images. But I don't know how to narrow that down. There is just numbers up here [number of pages for browsing on featured images in UWDC]. There is no alphabetical order. If there is alphabetical order, I can look down 'L' for Lincoln. I think something is missing there. I need [some system function] to take me from that information [to another information]. It should give an organization so that you can narrow down your result. That helps you. Gallery view sort of did that. But it needs to be more, I think. It is not obvious" (S25).

Sensing Learner
Sensing learners like to learn by means of observing and gathering data through the senses. They like concrete learning materials, such as facts, data, and experimentation. They prefer solving problems by standard methods and dislike surprises (Felder & Silverman, 1988).

Consistency in using familiar help features
In searching digital libraries, sensing learners are more comfortable with their own standard searching routines and avoid exploring unfamiliar functions. Participant 1 described his search routine and criteria for selecting search features: "Women voting. I am not familiar with the collection. I use search box. If I use BROWSE, that means I know how they organize their content. But I don't know. It will be difficult for me to pick one. For me, I probably will start with search. I prefer to see the facts. I want to search and try their ... that kind of process. Maybe somebody will look around to get a general idea … BROWSE or to see the ABOUT …, you know, collect information before they search. If I have a task, clearly defined task, then I will go to search first." Later in the search session, sensing learners become more familiar with the system and try to connect past searching experience. This participant explained his selection of subject headings: "When I click the link [subject headings], I will get more of them. That's related. The data shown are like the one on the screen. Actually, they look more like a library system. They look familiar" (S1). A quantitative descriptive analysis was performed on the consistency of using familiar help features by sensing and intuitive learners. Results showed that sensing learners

tend to use more familiar features, however, the difference is around 1%. Mann Whitney U test shows that sensing learners do not use more familiar help features than intuitive learners (Mdn = 0.16, z=-0.823, p>0.05).

Preferring concrete information in help features
Sensing learners prefer learning from concrete examples in the material and gradually understanding the whole picture. Based on what they gather through their senses, they can develop a better picture of an IR system. In this study, sensing learners tried several functions that contain concrete information in the digital libraries. As one participant said, "The first place that I go is the 'Timeline,' so that [gives] chronological measures, what happened and when happened [facts and concrete data like date, time, and events]. Obviously, something at 1918 would be interesting because women's suffrage has not obtained. So I am going to look at pre-1920 events. I also take a look at a couple of books here at 1923, 1927. I look at things before as well as things afterwards" (S26).

Visual Learner
In a more general learning environment, visual learners remember well what they have seen, like pictures, diagrams, tables, and other visual demonstrations. If they are given text-only instructions, they encounter difficulties, and their academic performances deteriorate significantly (Lee, 2009). A similar argument can be made for learners with low working memory. According to Beacham & Alty (2006), learners with low working memory capacity would generally benefit from visual material and therefore prefer a more visual learning style.

Preferring visual help features
In a searching environment, visual learners are more inclined to notice information represented in a visual way. Several visual learner participants expressed their preferences. Some of the visual learners commented that they preferred the gallery view in American Memory. Participant 21 said, "I prefer the gallery view in the American Memory system." Participant 22 further explained: "[Gallery view] has the best organization for easy browsing. I like the picture view [compared to text view]." The average number of visual help features used by visual learners is 5.57 (SD=5.21), which is more than the average number used by verbal learners (M=1.67, SD=1.52). Mann Whitney U test shows that visual learners do not use more visual help features than verbal learners (Mdn = 3, z=-0.466, p>0.05).

Preferring help content in visual format
Visual materials are the first to come to visual learners' eyes, in particular visual display of information presented by digital libraries. Almost all of them mentioned they are inclined to visual display. One participant claimed, "I am a visual person. I would go for photo. I will be aided by things like that. I think that would have huge effect on my use of any system" (S14). Another participant claimed, "It

is harder for me just page through, read things to retain that information. I like visual" (S25). Another participant discussed the side- effect of not using visual materials, "I am very visual, get distracted by bad formatting" (S7).

Verbal Leaner
Verbal learners comprehend information through browsing textual presentations, including both written and spoken explanation. This particular behavior not only occurs in general learning environments, but also in information-retrieving contexts. A recent study showed that verbal learners tended to be more oriented to the use of text-based language than images. They are significantly linked to a greater use of distinctive linguistic search transformations (Ford et al., 2009).

Preferring verbal help features
Verbal learners preferred the verbal help formats. One verbal participant commented, "I think I am not visual at all. I am more verbal. I have problem visualizing things. Sometimes people learn better on hearing what it is" (S27). Another participant commented in a similar fashion: "I personally do not go right to the pictures. I learn in an auditory fashion, so it [picture] does not help me in a digital library. But I think my preference would go toward the text since things are not talking to me. But I think people who are more into language, either auditory or visual would go to the text or the image. So that would make a difference in how they get started and how they choose the view in DL" (S12). Verbal learners prefer verbal communication from people to online help via computer systems. S12 said, "If I need to come up with a third way, I would contact somebody. But I don't know it would help. People, I speak the same language. They know the language [about the system] but I don't. They are more familiar what collections that Abraham Lincoln is under." In addition, verbal learners tended to choose the text-based function, for example, the search full text function, to help themselves find the answer to solve the given tasks.

Evaluating detailed verbal description
In the study, verbal participants presented the tendency of choosing verbal approaches while performing the searching task. They were patient with verbal description of help features. For example, after carefully reading the textual description in the UW-Madison Collection, participant 19 chose to click on the "Badger Yearbook" link and then clicked on "The University of Wisconsin Alumni Directory, 1849-1919." After browsing and examining the detailed description, she continued to click on the list "University of Wisconsin chancellor and presidents" and found the correct answer on the right side of the page.

Sequential Leaner
Sequential learners tend to gradually gain understanding in a linearly incremental way. They follow linear reasoning processes when solving problems and prefer a logically ordered and progression in presenting learning materials (Felder & Silverman, 1988; Lee et al., 2005).

Preferring sequential organization of information in understanding help content
In this study, most of the participants are balanced between sequential and global characteristics. Only three participants are sequential learners. In the searching environment, they would avoid non-logical subsequent organization of information results that followed the previous searches. Instead, they tried to understand help content that is organized logically and step by step. For example, Participant 19 said, "I think it's really helpful when the help mechanism [in digital libraries] includes screen shots with step-by-step guidance of what you are supposed to do, but many of them don't." Another participant preferred a sequential organization. According to him, "Dates are helpful. I'd like to have the function to sort them by date" (S12).

Global learner
Global learners tend to learn in large leaps, arbitrarily absorbing large amount of material almost randomly chosen. At first, they don't see connections among the learning materials. After they have learned enough about it, they get the point of it. Global individuals are better at structuring information and are in the habit of analyzing a phenomenon through its component parts. Then, they usually impose their own structures on unstructured fields (Ford, Miller, & Moss, 2005).

Interacting with different help features in order to make sense
Although there are only two global learners in this study, they exhibited unique ways in understanding help content in digital libraries. For example, one global participant commented that she prefers different approaches and dislikes linear way of understanding: "Yes, the more I can interact with different types of help, even though it is virtual interaction, the better. Perhaps if I were somebody, who thought more in this linear way, it would be easier for me to understand this particular one [UWDC] (S25)." In addition, global learners tend to look at overall information first before going to specific information. The same participant said, "Go to Government and Law [general topic]. Select 'Document from Continental Congress Collection'. For this collection [read the overview text under the collection] broadside collections related to the work. This looks pretty good appropriate. I haven't found the information, but I think it is the right place. I will use the Declaration of Independence [click an individual link embedded in the description text]" (S25). The average number of overall help features used by global learners is 9 (SD=2.82), slightly higher than those used by sequential learners (M= 7.5, SD=6.36). Mann Whitney U test shows that global learners do not use more overall help features than sequential learners (Mdn = 10, $z=-1.161$, $p>0.05$).

DISCUSSION AND CONCLUSION

The findings of this study demonstrate that learning styles influence the way that participants interact with help features of digital libraries. The results suggest that the design of IR systems, including digital libraries, need to support different learning styles by offering different types of help features, different formats of help, and different organization and presentation of help content.

Active and reflective learners prefer different types of help features and different ways to approach help features. Active learners try different types of help features, in particular, interactive help features. Digital libraries need to offer more interactive help features in addition to online chat. Simulation of human communication or dialog options can be incorporated into the design of interactive help features in order to help active learners play more active roles in the interactions. It is a challenge to attract reflective learners using more help features. It is helpful to present each help feature with a clear label and description for its function and usage, because reflective learners do not select help features for which the functionality is unclear.

Intuitive and sensing learners prefer different types of information for help. Intuitive learners learn how to use help features by analyzing principles of the help design and comparing different help features. This is missing in current digital library design. Digital libraries need to provide design principles to users so their understanding of the design of system features can assist them effectively interacting with digital libraries. In addition, it is also helpful to offer a clickable button next to a help feature presenting similarities and differences between this feature and other related features in one system. It is also helpful to provide an overview of the similarities and differences between system features in this system and other types of IR systems. Sensing learners prefer familiar help features and concrete information in help features. More help features that present tangible information can be created for users, in particular more options for browsing, e.g., timeline, most viewed. In addition, it is useful to create audio or physical sensations to attract sensing learners to use different types of help features.

Visual and verbal learners prefer help features with different formats. Not all users like visual formats of help. It is important to offer both visual and verbal formats of help features. For example, some of the help features, such as "how to search?" can offer two options: a visual display of how to search and a narrative presentation of how to search. In addition, visual versions can be presented in images or videos while verbal versions can be in text or audio.

Sequential and global learners prefer different ways of help content organization and presentation. The design of digital library help features needs to offer step-by-step instruction as well as a comprehensive view with context to facilitate both types of learners in understanding a digital library as a whole as well as its individual features. Since different learning style users would have different preference of interactions, an automated learning style detection mechanism is also recommended. Such mechanisms would enable digital libraries to provide adaptive and more contextual help features for users of different styles. Further research needs to quantitatively test the exploratory results identified by the qualitative analysis.

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