Effects of Learning Styles on the Application of Search Tactics: A Preliminary Result

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ABSTRACT

In this study, we investigated how searchers' learning styles would influence their application of search tactics. We measured searchers' learning styles including Active/Reflective and Sensing/Intuitive dimensions using Felder and Silverman's (1988) instrument. Then, based on multiple regression, the effects of learning styles on searchers' application patterns of search tactics were examined. Preliminary results of this study indicates that (1) active searchers spent more time in accessing forward tactics, (2) sensing searchers spent more time in visiting previous pages and in evaluating search results, and (3) reflective searchers spent more time in evaluating individual items.

Keywords

Learning style, search tactics, Felder-Silverman Index of Learning Styles

INTRODUCTION

In information seeking and retrieval studies, cognitive factors have been a focus of research for past decades. It is widely accepted that an information search process consists of the application of multiple search tactics. During this process, several different factors, such as task type, user characteristics and knowledge, and search stages, influence searchers' search tactic selection (Xie & Joo, 2012).Since users apply different types of search tactics to complete a searching task, learning styles could be one of the cognitive factors that affect searchers' tactic selection patterns. Researchers found significant association between learning styles and search behaviors (Ford et al., 2009; Kim & Allen, 2002; Palmquist & Kim, 2000; Tenopir et al., 2008). However, there were few studies that examined the causal relationships between learning styles and searchers' tactic selection. In this poster, we present some preliminary results of quantitative analyses in our ongoing project that investigates the relationships between learning styles and search tactic selection.

RELATED WORK

Search Tactic Selection

A search tactic refers to a single movement or an action to achieve specific search goals and objectives during the search process (Xie, 2008). Several researchers have identified different types of search tactics and investigated their patterns (Bates 1979; Fidel, 1985; Xie, 2008; Xie and Joo 2010). In addition, researchers explored different factors related to searchers' search tactic selection. The factors include task type (Byström and Järvelin, 1995; Xie, 2009), search experience (Palmquist & Kim, 2000), domain knowledge (Hsieh-Yee, 1993), search stage (Vakkari et al., 2003; Xie & Joo, 2012), and among others. However, few studies investigated the effect of learning styles on the selection of search tactics in information retrieval (IR) settings.

Code	Types of search tactics	Objectives
AccF	Accessing forward	Go to a specific item or web page that has not been accessed in the search by using direct location, tracking meta-information, or hyperlinks.
AccB	Accessing backward	Go back to a previous page by using direct location, tracking meta-information, or hyperlinks.
Query	Creating or modifying search statement	Come up with a search statement for searching or change the previous search statement to specify or broad search results.
EvalR	Evaluating search results	Quickly assess the relevance of search results.
EvalI	Evaluating individual item(s)	Assess relevance/usefulness of an item, or authority of an item.
Xplor	Exploring	Survey information/items in a specific site.

Table 1.Six frequently observedtypes of search tactics during the search process

In the present work, we focused on six frequently used search tactics in search processes. In Xie's (2008) planned-situational interactive IR model, twelve types of search intentions were identified, which lead the search process to accomplish search goals. Recently, Xie and Joo (2010) identified a series of search tactics based on Xie's (2008) identification, e.g. accessing forward and backward; query creation and modification; evaluating search results and items; browsing; among others. Six frequently observed search tactics are selected out of twelve tactics suggested by

Xie and Joo (2010). Table 1 summarizes the six search tactics and their objectives.

Learning Styles

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'. Novice users, who never use or rarely use IR systems, need to learn how to use new IR systems.

Several dimensions of earning styles were employed to explore how cognitive preference would influence the ways of information searching in different environments. The major dimensions include Field dependent/independent, Reflective/Active, Wholist/Analytic, Verbal/Visual, and Sequential/Global (Felder & Silverman, 1988; Ford et al., 2002; Kolb & Kolb, 2005). Field dependent learners needed more time and visited more nodes than did the Field independent counterparts (Palmquist & Kim, 2000). Sequential learners focus on step-by-step logical progression and display consistency in their choice of search strategies, while intuitive individual prefer engaging more in exploratory and serendipitous behavior (Ford et al., 2002). Verbal learners visit a higher proportion of web pages (Frias-Martinez et al., 2008). It can be concluded that learning styles have impact on users searching strategies and perceptions, which can be measured through search time spent (Tenopir et al., 2008; Wang et al., 2000), search effort devoted (Kim et al., 2004), search strategies utilized (Frias-Martinez et al., 2008), help-seeking (Huang & Xie, 2011); retrieval performance and satisfaction (Ford et al., 2009; Kim & Allen, 2002).

While most learning style theories classify learners into few groups, the Index of Learning Styles (ILS) describes learners in more details and dimensions. Items of ILS were adapted from a model developed by Dr. Richard M. Felder and Dr. Linda K. Silverman from North Carolina University. In the model, there are four proposed dimensions: 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 dimension deals with the preferred sensory channel in providing information; the fourth dimension characterizes learners according to their sequential or global ways of understanding information (Felder & Silverman, 1988; Felder & Brent, 2005). 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 dimensions. In addition, it is considered to be a reliable model across different studies (Felder & Spurlin, 2005; Litzinger, Lee, Wise, and Felder, 2007).

There are previous studies focusing on how learning styles affecting search behaviors, less research has been on the influence of novice users' learning styles on selection of search tactics. There is yet even less research examining the issue in digital library environments. This study aims to fill the gap and answer the following research question: How do learning styles affect users' selection of search tactics? The corresponding six hypotheses are: Searchers learning styles of active/learning and sensing/intuitive dimensions affect their time spent on applying [AccF/AccB/Query/EvalR/EvalI/Xplor] tactics respectively.

METHODOLOGY

Sampling and Data Collection

Since novice users are more likely to encounter problems 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. Any potential participants who have frequently used digital libraries were excluded from the study. Other inclusion criteria were: participants must be/have (1) 18 years or older, (2) native speakers of English, (3) residents of the Milwaukee area, (4) basic computer literacy skills, and (5) general interest in digital libraries. Twenty-six students completed the study. Characteristics of participants are summarized in Table 2.

Demographic Characteristics	Category	Frequency (%)
Age	18-30	20 (76.92%)
	31-40	3 (11.54%)
	41-49	3 (11.54%)
Gender	Female	12 (46.15%)
	Male	14 (53.85%)
Search skills	Intermediate	16 (61.54%)
	Advanced	10 (38.46%)

Table 2. Demographic information of participants

To observe searchers' behaviors and measure learning styles, multiple methods were employed to collect data, including questionnaire, observation, and search log. Participants were asked to conduct three different types of search tasks, including known-item search, specific information search, and aspectual recall-oriented search, using Library of Congress Digital Libraries (LOCDL). In this poster, we present part of the preliminary results that analyzed the data from the aspectual recall-driven task. Using LOCDL, participants were instructed to collect as many relevant aspects as possible within 10 minutes. The topic of the task was "Jackie Robinson and his career as a major league baseball player".

Participants' search activities were recorded using MORAE, a usability software. Their search activities were

coded into six types of search tactics, and the time spent on each type of tactics were measured. To ensure the inter-coder reliability, about 15% of sessions were coded by two coders. If there was disagreement in the coding, the two coders worked together to reach an agreement. In addition, we measured each subject's learning styles using Felder and Silverman's Index of Learning Styles. Out of four dimensions of ILS, active/reflective and sensing/intuitive dimensions were of interest in this study. Since the response distributions of the other two dimensions (visual/verbal and sequential/global) were extremely skewed, they were excluded from this preliminary analysis.

Data Analysis

In this poster, we present the quantitative analysis part of the project. Statistical analyses using multiple regression were applied to examine the effect of cognitive learning styles on search tactic application. The dependent variable is time spent on applying each type of search tactics. Two independent variables (predictors) are (1) active/reflective style score and (2) sensing/intuitive style score. Each cognitive learning style score was measured by 22 point scale. Higher score indicates more reflective (less active) and more intuitive (less sensing) respectively. Using multiple regression, we examined the effects of these two predictors on time spent on tactics at the same time.

RESULTS

To examine the effects of cognitive styles on users' search tactic selection, six multiple regressions were conducted. In these regression analyses, the predictors were the two dimensions of cognitive styles and the dependent variable was time spent on each type of search tactics. Table 3 presents the multiple regression results. Due to the page limitation, we describe only the results of statistically significant effects.

Tactic[a] (R^2)	Cognitive style[b]	B[c]	β[d]	t	Sig.
AccF $(R^2=.171)$	(Constant)	13.259		4.398	.000
	Act./Ref.[e]	-.509	-.436	-2.177	.040
	Sen./Int.[f]	.133	.161	.801	.431
AccB $(R^2=.442)$	(Constant)	8.176		6.593	.000
	Act./Ref.	.065	.112	.679	.504
	Sen./Int.	-.288	-.693	-4.213	.000
Query $(R^2=.073)$	(Constant)	49.119		3.435	.002
	Act./Ref.	-1.334	-.255	-1.203	.241
	Sen./Int.	-.140	-.038	-.178	.860
EvalR $(R^2=.276)$	(Constant)	122.083		3.776	.001
	Act./Ref.	2.328	.174	.929	.363
	Sen./Int.	-5.267	-.554	-2.959	.007
EvalI $(R^2=.258)$	(Constant)	93.080		2.906	.008
	Act./Ref.	5.493	.419	2.212	.037
	Sen./Int.	1.698	.183	.963	.346
Xplor $(R^2=.090)$	(Constant)	36.622		1.307	.204
	Act./Ref.	-.309	-.030	-.142	.888
	Sen./Int.	2.259	.308	1.464	.157

[a]dependent variable; [b]predictors; [c]unstandardized regression coefficients; [d]standardized regression coefficients; [e] Score for the active-reflective dimension (higher score indicates more reflective, and vice verse.); [f] Score for the of sensitive-intuitive dimension (higher score indicates more intuitive, and vice verse.)

Table3.Effects of Cognitive Styles on Time Spent on Each Search Tactic

Active searchers spent significantly more time in accessing forward (AccF) to achieve their tasks ($\beta=-.436$, $p<.05$). The tactic of AccF requires not only the intention to move forward but also the actual action (e.g. clicking on the hyperlink) from the searchers. Such requirements fit into the style of active learners, who like to try things out rather than read passively. This preference can be reflected by how they navigate through the online search process. They actively interact with different features and hyperlinks provided in the system.

Sensing learners like to learn from concrete examples and tend to be more careful with details whereas intuitive learners prefer to learn abstract material and like challenges (Felder & Silverman, 1988). These characteristics can lead to two specific navigation patterns. First, sensing searchers spent significantly more time than intuitive searchers in accessing backward (AccB) during the search process($\beta=-.693$, $p<.05$). Sensing searchers prefer less challenge. Instead, they like to be well-prepared using already learnt procedures when solving their problems. Such preferences are represented by their unique pattern of frequent accessing back to pages they visited. In this study, sensing searchers' AccB tactics were frequently observed to take place from the actual item page back to an embedded link or to search results, or from search result page back to search page. Secondly, the results of this study reveal that sensing searchers showed the tendency of spending more time in evaluating results (EvalR: $\beta=-.554$, $p<.05$). Their learning style influences their tactic patterns as they repeatedly examine the details and carefully go through the search result list. Intuitive learners, on the other hand, are usually not so patient with details and do not like repetition of tasks where they have to apply the same standard procedures. Thus, when reviewing a list of search results, intuitive searchers tended to spend comparatively less time and quickly skim through the results.

Reflective learners were likely to spend more time in evaluating individual items (EvalI: $\beta=.419$, $p<.05$). Unlike active learners who like trying things but not wanting to read carefully, reflective learners are more deliberate and willing to carefully read and examine the more detailed description about their learning material (Felder & Silverman, 1988). Therefore, searchers with a higher score in reflective style would put more efforts in evaluating the relevance or credibility of items they accessed.

Tentatively, current results indicate that query creation (Query) and exploration (Xplor) are not significantly associated with the selected dimensions of learning styles.

CONCLUSION

This poster presents the preliminary result of relationship between learning styles and searchers' search tactic application. The preliminary results revealed that learning styles influence the time that some types of search tactic were applied. Active searchers would spend more time on AccF tactics, while reflective searchers spent more time on

EvalI tactics. Also, sensing searchers tended to spend more time applying EvalR and AccB tactics. Searchers selected different patterns of search tactics based on their unique characteristics or preferences determined by learning styles. Results of this research will help to design a user model that better facilitates users' preferences. More specifically, the implication is to integrate learning styles into the users' selection process of search tactics and develop a micro-user model, which serves as the theoretical basis to enhance retrieval effectiveness of novice users.

However, this study also has some limitations. First, sample size is small to generalize the findings. Second, this study simply investigated the effect on time spent. Sequential patterns (transitions) of search tactics would be also important to investigate. Third, only two dimensions of Felder and Silverman's ILS were used because of the skewed responses in the other two dimensions. Fourth, the quantitative findings have limitations to explain the underlying reasons why searchers' tactic patterns would differ by learning styles. By recognizing these limitations, further research needs to expand preliminary results by analyzing both quantitative and qualitative data.

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