Effects of Search Interface and Decision Style on Learning Material Search Behavior and Reaction

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Abstract. Fueled by the popularity of online learning and the widespread adoption of the Internet, educational materials are abundant online. However, it is unclear how the materials should be intelligently presented to different types of users. In this study, we examine how alternative search interfaces (list type vs. scatterplot type) influence users with different decision styles and consequently change their search behaviors and reactions to the interfaces. The two alternative interfaces were applied with different strengths while providing the same access to the underlying learning materials. A user study was conducted in a lab experiment setting, in which search interface was manipulated as a within-subject variable and presentation order as a between-subject variable. The findings indicate that the interface type has significant effects on the user behaviors and reactions with different decision styles.

Keywords: User interface; Decision style; Information search; Learning material

1 Introduction

The advancement of information technology has changed how people educate themselves. Online learning is widespread and popular as learning materials are abundant and mostly freely available on the Internet. Consequently, searching or sharing learning materials is an important aspect of learning that is supported by many commercial websites. Recognizing the importance of this phenomenon, IEEE Computer Society announced that "Supporting New Learning Styles" is a crucial trend in 2014 [1].

In processing and representing information, an emerging topic is the volume of data that can be visualized to reinforce human cognition. From this perspective, an important objective of information visualization is to project high-dimensional data onto low dimensional interfaces [4]. Users can understand complex information intuitively with well-designed visualizations, which can also reduce the amount of cognitive effort required of users to find relevant information. Thus, from the perspective of information visualization, it would be beneficial to provide a set of information to users in a better form than in a textual list.

In this study, we examined the effects of two alternative search interfaces on user search behaviors and reactions. The interfaces, designed for supporting online learning

activities, consist of (1) a list type that provides a list of learning materials, mostly in the form of textual descriptions and (2) a scatterplot type that plots learning materials represented by icons in a two-dimensional graph. In addition to the main effects of interface differences on user behaviors and reactions, we examined the possibility that those effects vary with respect to individual differences such as decision style so that we can develop a deeper understanding of the interface effects.

2 Test System

In this system, lists of educational materials are visualized in two modes: list and scatterplot types (see Figure 1). The two types of view can be used to visualize the same set of materials. The list type page comprises a list view and a tag search window, which can be commonly seen in general search engines and online commerce websites, while The scatterplot type has a two-dimensional view, with difficulty on the horizontal axis and popularity on the vertical axis. These two alternative interfaces provide access to the same underlying learning materials with different strengths. The text-driven list type provides search results in the form of textual descriptions, whereas the graph-driven scatterplot type in the form of nodes located inside a scatterplot.

Fig. 1. List (left) and scatterplot (right) views shown to users in our study

3 Evaluation Method

Total fifty-three volunteers served as the experimental participants. All subjects went through two experimental blocks, in which task execution was followed by evaluation (one block for the list type and the other block for the scatterplot type). To prevent ordering effects, one group performed the list type experiment before the scatterplot type experiment, whereas the other group performed the scatterplot type experiment before the list type experiment. The subjects were assigned randomly to each of the two experimental conditions. 29 subjects firstly performed list type and then used scatterplot type interface, while 24 subjects performed with opposite order of interface.

The overall experimental procedure is shown in Figure 2. In the pretest session, we obtained demographic information, decision styles, and web search self-efficacy. After each experiment, the participants evaluated each task and information format (list and

scatterplot types) using a questionnaire. Participants answered the questions about the cognitive decision effort, perceived ease of use, perceived usefulness, satisfaction of using the interface, and continuous intention to use to measure the task performance. All of the items used a 7-point Likert-type scale.

Data bookmarked by the participants were recorded in the system's database. To analyze the bookmarked data, we recruited 3 graders and let them judge the coincidence of the bookmarked materials with the given search topics. Every bookmarked record was graded by a 3-point scale where 0 = incorrect, 1 = partially correct, and 2 = correct. The majority of grades between three graders determined the final precision grade. If the three graders all had different opinions about the grade, a discussion among the three graders was additionally required to reconcile the differences. The average number of bookmarked materials and the precision score for each user were counted to measure the task performance.

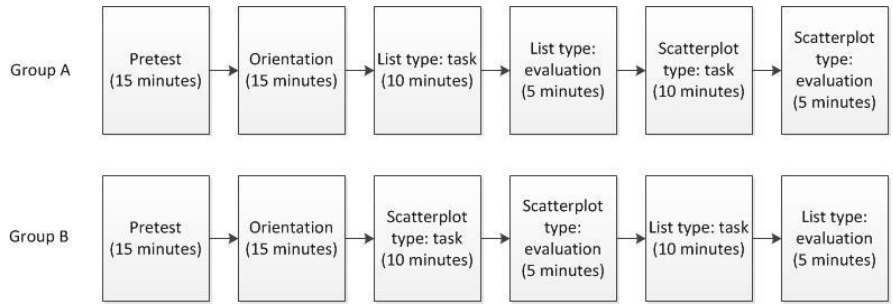

Fig. 2. Experimental procedure

4 Results and Conclusion

We performed quantitative comparisons of the user reactions and performances by analyzing the questionnaires. A paired samples t-test was performed to examine the effects of all information formats in the two interfaces Perceived ease of use ($t = 2.88$, $p < .01$), satisfaction ($t = 2.14$, $p < .05$), and the number of bookmarks ($t = 2.67$, $p < .05$) differed significantly between the two interfaces. In addition, the cognitive decision effort ($t = -1.84$, $p = .07$) and continuous intention to use ($t=1.80$, $p = .08$) had effects on borderline-significance between the two interfaces. This means that users perceived the list type much easier to use than the scatterplot type because the cognitive decision effort, perceived ease of use, and satisfaction scores were all higher for the list type than the scatterplot type.

To analyze the relationships between users' decision styles and reactions to the two interfaces, we performed a repeated measures ANOVA test to detect any moderating effects of decision making styles, measured along the sensing-intuition and thinking-feeling dimensions. Based on the decision making style questions, we found that there were 34 sensing-style subjects and 19 intuition-style subjects along the sensing-intuition dimension, while there were 25 thinking-style subjects and 28 feeling-style subjects along the thinking-feeling dimension.

For the sensing-intuition decision style, the perceived ease of use ($F = 6.67$, $p < .05$), satisfaction ($F = 7.67$, $p < .01$), continuous intention ($F = 11.24$, $p < .01$), and bookmarking precision score ($F = 5.53$, $p < .05$) differed significantly between the two interfaces. In addition, the cognitive decision effort ($F = 3.55$, $p = .07$) and perceived usefulness ($F = 2.92$, $p < .09$) had effects on the marginal significance between two interfaces. In case of the sensing style, the list type produced a lower cognitive decision effort score and higher perceived ease of use, usefulness, satisfaction, continuous intention, and bookmarking precision scores than the scatterplot type did. The opposite was true for the intuition style. This means that sensing-style users more easily and effectively used the list type interface, but intuition-style users found it easier and more effective to use the scatterplot type. This result confirms that sensing-style users performed better with the list type rather than scatterplot type interface, as opposed to intuition-style users who preferred the scatterplot type.

For the thinking-feeling decision style, the cognitive decision effort ($F = 4.70$, $p < .05$) differed significantly between the two interfaces. Moreover, the perceived ease of use ($F = 3.62$, $p = .06$) and bookmarking precision score ($F = 3.03$, $p = .09$) had marginally significant effects on the two interfaces. Specifically, thinking group users perceived that the scatterplot type demanded a lower level of cognitive decision effort than the list type did, in contrast to the feeling group users. At the same time, the thinking group users perceived that the scatterplot type was easier to use than the list type, in contrast to the feeling group users. Thus, people who prefer a thinking style theoretically tend to make decisions in a more reasonable, logical, and considered manner. In contrast, people with a feeling style tend to reach decisions by preferring a low tolerance for ambiguity and focusing on affections and intuitions [2]. Our results showed that feeling-style users perceived less cognitive decision effort and higher ease of use with the list type interface than with the scatterplot type.

In summary, we performed a laboratory experiment to determine their effectiveness across users with different decision making styles. Prior research [3] found that users' cognitive style did impact their search behavior; the current study extends those prior studies by examining the effects of cognitive styles on user reactions and behaviors in two alternative user interfaces. The study results can facilitate the improved design of online search interfaces by web designers. For example, our study show that a scatterplot type interface is a preferable choice for intuition-style users while a list type interface is a preferable choice for the remaining, highlighting the need to develop an adaptive system that can accommodate different users' decision styles and their preferences.

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