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Applying Recommendation System to Facilitate Exploratory Online Learning - An Empirical Study at Graduate Level

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Abstract: Information exploration has become an essential part of exploratory learning that encourages students to acquire new knowledge and solve problems. However, conducting web search is complex and challenging, and learners may fail to acquire valuable information they really need. Recommendation systems have been proposed as a potential means to facilitate learner's web search. Nevertheless, few recommendation systems were developed to help learners obtain more suitable keywords toward a specific field. In this paper, an empirical study was conducted to examine the effectiveness of a proposed recommendation system in facilitating learners to specify keywords more precisely for searching.

Keywords: Recommendation Systems, Exploratory learning, Information searching strategies, concept association techniques

1. Introduction

With the rapid development of information technologies, World Wide Web has become an important information repository involving varieties of resources [6]. Learners often search for and collect information what they desire on the specific sites or academic databases, such as Google, Yahoo, Wikipedia, ISI Web of knowledge. These sites do not only provide alternative opportunity for learners to explore specific domain knowledge, but also build the relationship among information to form a Web of knowledge to help learners expand the scope of knowledge.

However, a number of studies showed that learners often face difficulties, such as information evaluation [4] and disorientation [5][6]. The difficulties might increase learners' cognitive load and impede their exploratory learning on the web. More specifically, they do not know how to query appropriate keywords and are unfamiliar with the specific domain. To address the difficulties above, numerous recommendation mechanisms have been proposed, such as content-based filtering [3] and collaborative filtering [1]. The former applied the Term Frequency-Inverse Document Frequency of information retrieval technique to extract important keywords from collected documents, and then recommend the suitable information based on learner's past experience. The latter used the association rule mining of data mining technique to discover the relationship among a group of learners who have similar experience, and then recommend relevant information based on collaborative filtering to help learners.

With the advantages of the two filtering mechanisms, the recommendation system with the concept association techniques was proposed by previous study [2], which demonstrated the

technique is an efficient approach to facilitating learners to exploratory learning. However, the previous study only evaluated learners' exploratory performance. There is still a lack of strong evidences to demonstrate the effect of the concept association techniques on exploratory learning. Several factors have been identified might influence learners on seeking information on the web. For example, Tasi and Tasi's study found that learners with low self-efficacy might not use high-level searching strategies [6]. In addition, Tu et al. study indicated that learners with high metacognitive skill had better searching outcome [7]. Therefore, it is necessary to understand learners' perceptions toward using the concept association techniques in exploratory learning

The purpose of this study was to supplement the findings of previous study [2]. It is similar to the previous study which focuses on the effect of the concept association techniques on learners' searching behavior. It differs from previous study, however, in the way learners' perceptions toward the techniques is evaluated. To this end, this study conducted an empirical experiment to evaluate how the concept association techniques influence learners' behaviors and perceptions of information searching.

2. Method

2.1 Participants and activity

This study conducted an experiment to investigate the effect of the concept association techniques on exploratory learning. The participants of this study were 30 graduated students in Taiwan. All of them participated in two exploratory learning activities, and each activity lasted 90 minutes. Participants had to search for information on the ISI database to perform the assigned task in two different settings. The task is open-ended questions related to the digital technologies learning domain.

2.2 Research instruments

2.2.1 The exploratory learning of two settings

The participants were asked to use database provided by ISI web of knowledge to seek information in the first exploratory learning activity. The ISI provided basic and advanced query function and also provided the refined function to re-query based on additional criteria from the searched results. Participants used these functions to search relevant information and organized collected papers to complete their reports.In the second activity, participants only used the recommendation system with concept association techniques provided by previous study [2]. The system is providing keywords recommendation function in light of the keywords identified by participants and providing the search interface made of concept map tool to assist learners in organizing information.During exploratory learning activity, participants' searching behaviors on screen were captured by Camtasia application for further analysis. After each activity, each participant was asked to fill out a questionnaire about their perceptions toward their information seeking strategies.

2.2.2 Onscreen searching behaviors

In order to better understand how learners search for information in the two different settings, the onscreen searching process were analyzed to gain in-depth behavioral

attributes. A total of six searching behavioral attributes were identified. The attributes are described in detail as follows:

- Frequency of keyword searching: The number of times keyword searches were queried by the learners to search for information.
- Number of keywords: The number of keywords shows that the number of distinct keywords that a student used to search for information. All keywords identified by a student are similar that were considered as the same keyword.
- Frequency of logical searching: This attribute indicates the number of times that learners used logical expressions to query database in light to multiple criteria.
- Frequency of repeated search: The learners may repeat using the same keyword to search for information. The frequency of repeated search reveals the number of times that the students performed such repeated searches.
- Number of papers downloaded: This attribute reveals the quantity of information that learners considered useful during searching information process.
- Number of papers cited in reports: This attribute displays the valid impact of the information seeking activity on learning as the students may have used only a small portion of the papers they found to complete their reports.

2.2.3 Questionnaire

A questionnaire was used to examine how learners perceived their information searching strategies in the two different sittings. Therefore, this study adapted the Online Information Searching Strategies Inventory (OISSI) proposed by Tsai [5] to understand the learners' perception of information searching. The questionnaire provides a well framework, and presents good validity and reliability (.91). Thus, the questionnaire is a suitable instrument to assess the learners' perceptions toward applying information searching strategies in two settings. To meet the context of this study, the questions items of OISSI were moderately revised by this study. The Cronbach's alpha value of adapted questionnaire is .913, which serve as a reliable instrument.

2.3 Data analysis

To answer the questions concerning difference of the two different setting toward exploratory learning, the method of paired t-test was used to analyze participants' responses to the questionnaire on the five parts. Furthermore, participants' exploratory learning activities were extracted searching behavioral attributes. These behavioral attributes were also analyzed with the dependent t-test to understand the difference of the two different settings. By way of t-test analysis, we gain a better understanding of how the concept association techniques might facilitate learners' information searching behaviors and searching strategies.

3. Results and discussion

3.1 Information searching behaviors

It is shown that the learners demonstrated different searching behavior in the two settings, as shown in Table 1. The learners used higher frequency of keyword searching in the recommendation setting than they did in the ISI setting ($t = -2.65$, $p < .05$). In addition, the learners significantly cited more useful information in their reports in the recommendation

setting than they did in the ISI setting ($t = -3.36$, $p < .01$). Although the frequency of logical searching behavior has no significant difference between the two settings, the behavior p value is .56 which almost approaches significant difference. It may be indicated that the learners used fewer logical searching behavior in the recommendation setting than they did in the ISI setting. There are no significant differences between the two settings for the number of keywords, frequency of repeated search and number of papers downloaded.

The results revealed that the recommendation setting with the concept association techniques may influence learners' searching behaviors. More specifically, the recommended techniques provide more appropriate keywords for learners to expand effectively their searching directions. Moreover, the techniques alleviated their cognitive overload on orchestrating different keywords to seek the correlation between different keywords. In particular, increasing rate of cited papers in their reports demonstrated that the supporting of recommendation with the concept association techniques can greatly assist them in seeking relevant papers.

Table 1. The results of information searching behaviors in the two settings

Behavioral attributes	Settings	N	Mean	SD	t-value
Frequency of keyword searching	ISI web of knowledge	30	8.87	4.41	-2.65*
	Recommendation system	30	12.53	5.78	
Number of keywords	ISI web of knowledge	30	4.33	4.16	-.73
	Recommendation system	30	5.03	3.48	
Frequency of logical searching	ISI web of knowledge	30	6.10	6.41	1.99
	Recommendation system	30	3.87	3.44	
Frequency of repeated search	ISI web of knowledge	30	1.47	2.60	1.60
	Recommendation system	30	0.73	1.08	
Number of papers downloaded	ISI web of knowledge	30	4.53	1.61	-.64
	Recommendation system	30	4.83	1.88	
Number of papers cited in reports	ISI web of knowledge	30	2.33	1.16	-3.36**
	Recommendation system	30	3.67	1.58	

*p <.05; **p< .01

3.2 Perception of information searching strategies

The learners' responses to the question items were averaged to obtain an overall understanding as shown in Table 2. The results showed that there are significant differences between the two different settings for the dimensions of system control ($t= -7.01$, $p < .001$), disorientation ($t= 3.72$, $p < .01$), problem-solving strategies ($t= -2.84$, $p < .01$), purposeful thinking ($t= -7.9$, $p <. 001$) and evaluation ($t= -8.62$, $p < .001$). However, there was no significant difference between the settings for problem solving strategies ($t= -1.987$, $p<.05$). Overall, the results reveal positive effects of using recommendation system with concept association techniques on information searching strategies. Learners intended to consider that the searching interface of the recommendation system is easier to use than the ISI setting. Moreover, they perceived their disorientation problem decrease obviously in the recommendation system setting. That is, the recommendation system can effectively alleviate their cognitive load due to suggesting the searching direction. In addition, they felt that the recommendation system help them apply the searching strategies to solve problem. It could be supposed that the recommendation system provided appropriate keywords and clear association between concepts. The learners agreed strongly that the recommendation system can facilitate self-monitoring fit for searching purpose.

The interface with concept map tool may provide visual searching history to support their searching process since they were instantly aware of what they search status for the moment. In addition, the relationships between concepts and information were represented with linking form on the concept map in which they were easy to evaluate collected papers.

Table 2. The questionnaire results of learners perceptions toward information searching

Dimensions	Settings	N	Mean	SD	t-value
System control	ISI web of knowledge	30	3.64	0.88	-7.01***
	Recommendation system	30	4.73	0.58	
Disorientation	ISI web of knowledge	30	2.85	1.07	3.72**
	Recommendation system	30	2.14	0.65	
Problem-solving strategies	ISI web of knowledge	30	4.25	0.68	-2.84**
	Recommendation system	30	4.67	0.59	
Purposeful thinking	ISI web of knowledge	30	3.07	0.69	-7.90***
	Recommendation system	30	4.71	0.72	
Evaluation	ISI web of knowledge	30	3.17	0.81	-8.62***
	Recommendation system	30	4.72	0.54	

*p <.05; **p< .01; ***p< .001

4. Conclusion

The study administrated an empirical experiment to investigate the effects of the recommendation system with concept association techniques on learners' information searching strategies and their perceptions. The results shown in this study demonstrated that the recommendation system with concept association techniques is a useful approach to facilitate learners' searching direction and expand the scope of domain knowledge. Moreover, they perceived the recommendation system can help them to reflect upon the status of their searching and solve searching difficulties in disorientation and information evaluation. However, this study was a small-scale investigation. Further work is needed to conduct a large sample to support the findings of the study. In particular, the participants of the study are graduated students. It would be interesting to see the effects of the concept association techniques on the different ages of learners.

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