A New Efficient Retrieval Interface for Primary School Students

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Abstract: Through the Internet, users can conveniently get their desired information. However, in general, it is not quite easy for the users get what they just want though the Internet by using some keywords to do the conventional full-text searching. Most notably, such a searching process will be a heavy load for primary school students who are not able to choose the proper keywords because they are not familiar with the knowledge and semantic words about their desired topic. Therefore, in this paper, we will propose a new retrieval interface for primary school students, called leading-question retrieval interface, which applies a series of questions to inquire and analyze the answers from the users to understand their queried intentions. Such an inquiring process is embodied with the spirit of Construction and can omit the difficult task to choose proper keywords.

Introduction

Background Information for This Study

In recent years, as the fast process of computer and network technologies, computers connected in the Internet will soon become the indispensable electrical appliances of our daily life. Via the Internet, many schools, research institutes, academic associations, museums and the various research centers are making much efforts to provide many valuable and useful information on the World Wide Web (WWW), which currently become a highly interactive and distributed distance education environment for personal learning activities. Through the browser, users can conveniently get their desired data on the WWW. However, with the rapid increase of the amount of data on the WWW, it becomes a urgent challenge for all the Internet learning resource centers to support an efficient information retrieval interface to help users to easily and quickly get their really desired data from the resource centers. Most of them apply the conventional full-text retrieval with keyword-based techniques, which require users to provide some keywords and combine them to form a Boolean expression for information retrieval. However, it is much difficult for most users, especially for primary school students, to choose some proper keywords and construct them with Boolean expressions. Such a task is indeed a heavy burdens for primary school students whose knowledge concept and semantic configuration is still infantile (Zorn, Emanoil, Maarshall, & Panek, 1996; Soloway & Wallace, 1997).
By browsing and searching the useful data on WWW, primary school students can independently act on their own learning activities, but the students have no enough controls over them to manage their own learning activities (Dick, 1991). Consequently, it is very important to properly guide the students in the complicated linked structures of homepages to avoid going astray, and at the same time, also maintain the free-learning activities of students. Therefore, in this paper, we propose a new efficient retrieval interface by using a leading-question strategy to guide the students to the correct searching direction.

Related Researches and Motivations

Related Works in Designing a Retrieval Interface

Bruner (J. Bruner, 1961) advocates that learners should explore knowledge on their own initiative, and discover the structure of every kind of knowledge. The Learning theory of Constructivism supports that knowledge is consisted on the initiative of those individuals with ability of recognition. Thus, we have to offer a really and interactively learning environment. While the learners are exploring new knowledge, they can also adjust their cognitive structure. Furthermore, the role of a teacher should exchange from a knowledge transmitter into a learning promoter (Bagley & Hunter, 1992).

The leading-question teaching is a learning activity in which teachers ask students one question after one, and through those relative questions-asking teachers guide their students from the surface of the question into the deeper point, and let students figure out new knowledge and some universal principles in their own experiences. This method coheres with the basic spirit of the Learning theory in Constructivism. Actually, the theory of Constructivism emphasizes on learning methods those guide students to find by themselves (Guided Discovery Approach) (Yackel, Cobb, Wood & Merkle, 1990).

Moreover, in the conventional full-text searching interface, users have to submit a set of alphabetic strings as keywords, which may be combined with Boolean operators, to form a Boolean expression (Wilkinson & Fuller, 1996). However, it is so difficult for most users to construct such a Boolean expression without being well trained. Ideally, a good information retrieval interface should not only return what the users really want but also help users to easily develop their searching process (Becker & Dwyer, 1994; Hedberg & Harper, 1996; Stoney & Wild, 1998).

Therefore, in this paper, we will apply the leading-question manner to the user interface for information retrieval in order to not only make the users kept with the basic spirit of Constructivism but also help the users to easily get their really desired data.

Hypothesis of This Study

In this paper, we will propose a new retrieval interface called leading-question retrieval interface to help users to construct their real retrieval processes and implement an Internet learning database system with referential connections. Then, we will discuss the four hypotheses as below by taking vertebrates as subject in the following study. Because the vertebrates, such as like cats, dogs, birds, and fishes, are usually seen in the daily life of primary school students. They can arouse students' interests in understanding what they are by searching their related information in the Internet.

1. The primary school students who use the leading-question retrieval interface to retrieve information on line will have better computer attitude than those who use the full-text retrieval interface.
2. The retrieval precision of the retrieved data for the primary school students who use the leading-question retrieval interface will be better than the one for those who use the full-text retrieval interface.
3. The retrieval recall of the retrieved data for the primary school students who use the leading-question retrieval interface will be better than the one for those who use the full-text retrieval interface.

Method for the Study

In this study, we will implement an Internet learning resource with subject of vertebrates in a web server and propose some database techniques to create a retrieval interface with leading-question method to help pupils to get their desired data. There are 4 issues in our method, which are investigative design, investigative object, investigative implement, and experiential procedure.

Investigative Design

We apply the nonequivalent-control group design of quasi-experimental research, dividing randomly those who are going to receive the experiment into two groups to process the information retrieval activity according to the independent variable. To avoid the original computer attitudes of those who receive the experiment to interrupt the dependent variables, we take the results of the pretest of their original computer attitudes as the covariates, applying the method of statistical control to exclude their influences.

Independent Variable

Retrieval interface: We implement two the retrieval interfaces, respectively, which are “the leading-question retrieval interface” and “full-text retrieval interface”.

Dependent Variable

1. Computer attitude: The score of the ones who receive the posttest of computer attitude test.
2. Retrieval precision: The retrieval precision means the proportion of correct results, replied by the retrieval system. The method of measure: the retrieval precision = (the amount of correct results in the search) / (the amount of total results in the search).
3. Retrieval recall: The retrieval recall means the proportion of the amount of the correct results in the amount of entire correct results that assume the users retrieval intention, replied by the retrieval system. The method of measure: the retrieval recall = the amount of correct result / the amount of the entire correct result.

Investigative Objects

We regard the six grade students of the primary school as samples for this study. To avoid students’ culture background to effect the results of the study, we sample the students from four schools where geographical distance and learning environment are far away from each other, and have many differences. Totally we choose 160 pupils as our experimental sample.

Investigative Implements

Database System

We takes vertebrates as the investigating subject, using relational database (Microsoft SQL Server) and Web server (Microsoft Windows NT Server & Microsoft IIS) to build an Internet learning database system. The following is the general introduction of its major contents and functions:

1. The retrieval system offers both the “leading-question” retrieval interface and the “full-text” retrieval interface.
2. Users can use the leading-question retrieval interface to input their retrieval intentions while answering the questions on the referential interface; they do not have to key any keyword by themselves.
   For each answer of the questions, there will be one or some attributes which are determined. The basic principle of the leading-question retrieval interface is using a set of questions to ask users their answers in order to collect users’ retrieval intentions. After knowing users’ intentions, the system will check and automatically construct the retrieval condition with the collected attributes related to the answers.
3. The retrieval system offer many sets of leading questions designed by some professionals, users can choose one set of the leading questions by themselves.
4. There could exist a conflict during the question-answer process, where a conflict denotes that two values of answers made by the users are opposite. For example, there are two questionnaires (**i, j**) (**i** < **j**, that is, the order of the presentation of questionnaire **j** are after that of questionnaire **i**). Suppose in the group of questionnaire **i**, users select the answer with value “having hair on skin” which is a characteristic only belonging to mammal. Then in the group of questionnaire **j**, they select the answer with value “having a pair of wing” which is a characteristic only belonging to birds. Obviously, there is a conflict between these two values of answers because there do not exist an animal which is a mammal and is also a bird, such that no retrieved results will be returned. The reason why a conflict occurs is that the users may have wrong judgement on the observation or wrong recognition about the vertebrates. To avoid this conflict to occur, our retrieval system can automatically eliminate such a situation by disabling the conflicting values in the following process of answering, to help users not to make the mistake above.
5. While users are selecting the answers of vertebrate characteristics, this retrieval system will also present the vertebrate category that conforms to the users’ demand, and achieve the effect on “learning by doing”. For instance, when users select the answer “Having feather covering on the body”, then, the system will present the category—Aves-- that conforms to the answer at the same time.

6. After users answer the whole set of questions, or stop answering, the system will start checking according to users' answers, and present a list of retrieved results.

The measure of Computer Attitude

We apply the measure of computer attitude, designed by W. Lin (1994). This measure can be divided into three minor measures: the confidence toward computer, the application of computer in education, and the utilization of computer. There are 24 questions in the whole measure which includes 14 positive questions and 10 negative ones. The interior the interior accordance Cronbach's á coefficient is .81.

The Procedure of Carrying Out the Experiment

The study was done during June in 1999 and the procedure is:
1. Dividing those students whom receives the experiment into 2 groups with random drawing.
2. Letting those students receive the pretest of the measure of computer attitude.
3. Training those students how to use the Internet about 10 minutes, and then starting the information retrieval activity on line about 40 minutes. During the retrieval process, the system will record the retrieval results and calculate the retrieval precision and retrieval recall.
4. Letting those students receive the posttest of the measure of computer attitude.

Results of the Study

The Statistic of Valid Sample

During the process of retrieval activity, we find that some students are not familiar with the control of computer. To avoid affecting the statistic results by those students, we will regard them as invalid samples. After excluding those invalid samples, we have 145 valid samples left. During the pretest and posttest of the measure of computer attitude, some of those students have the tendency of choosing the same scale, or not answering the question completely during the test, they will be also regarded as invalid samples. And excluding those invalid ones, we still have 112 valid samples of the assumptive test of computer attitude presentation.

The Assumptive Test of Computer Attitude Presentation

We take the pretest results of the measure of computer attitude as the covariate. And, we take groups as independent variable, where Groups A uses the leading-question retrieval interface and Groups B uses the full-text retrieval interface, taking the posttest results of the measure of computer attitude as dependent variable. And, we are going to process one way analysis of covariance of independent samples to test investigative Assumption 1 (i.e., the computer attitude of the primary school students who use leading-question retrieval interface to retrieval information will be better than the one of those who use full-text retrieval interface.). Before doing the analysis of covariance, ANCOVA, we have to process the test of homogeneity of within-class regression coefficient (F=1.853, p>.05), not meeting obvious class, conforming to the basic assumption of ANCOVA, then we can go on the step of ANCOVA. From Table 1, we know that the group that use the leading-question retrieval interface has better presentation at the posttest of the measure of computer attitude than the group that use the full-text retrieval interface.

Resource of Change	SS	df	MS	F
Retrieval Interface	1462.444	1	1462.444	39.84*
Error	4001.2	109	36.708	

Table 1: Summery of ANCOVA of the Posttest of the Measure of Computer Attitude (*p<.05)

The Assumption Test of the Retrieval Precision

We take the average number of the retrieval precision of Group A that uses the leading-question retrieval interface and the average number of the retrieval precision of Group B that uses the full-text retrieval interface to perform the **t**-test of independent sample in order to test the investigative Assumption 2 (i.e., the retrieval precision of the primary school pupils who use the leading-question retrieval interface to process the information retrieval is better than the one of those who use the full-text retrieval interface.).
From the Table 2, we can find that the retrieval precision of the leading-question retrieval interface is better than that of full-text retrieval interface when the retrieval targets are hard for students to guess their names, such as Formosan Whistling Thrush and Crab-eating Mongoose. However, we get opposite results while the retrieval target is familiar to the students, such as, Asiatic Elephant. The reason is that the students can easily guess some letters or words, which will be a part of the names of the retrieval targets, and submit them to the full-text retrieval interface. Thus, when the retrieval targets are familiar to the users, the retrieval precision of the leading-question retrieval interface is not obviously superior.

The Assumption Test of the Retrieval Recall

We perform the **t**-test of independent sample with the average number of the retrieval recall of Group A and the average number of the retrieval recall of Group B to test the investigative Assumption 3 (i.e., the retrieval recall of the primary school pupils who use the leading-question retrieval interface to process the information retrieval is better than the one of those who use the full-text retrieval interface.).
From the Table 2, due to similar reasons for the retrieval precision, the retrieval recall of the leading-question retrieval interface is better than that of the full-text retrieval interface, especially for those unfamiliar vertebrates. Moreover, since for each target vertebrate, there is only one correct animal in our database, the reciprocal of the retrieval recall can be used to denote the number of searching operation needed to get the correct result as stated before. Therefore, by using the full-text retrieval interface, the number of searching operation needed to get the correct result are usually increased due to wrong-typing of the target animal's name by students. Such a case also becomes a factor in decreasing the retrieval recall by using the full-text retrieval interface, but can be absolutely avoided by using the leading-question retrieval interface.

Retrieval target	Retrieval interface	**t**-test of Retrieval Precision				**t**-test of Retrieval Recall			
		N	Mean	SD	**t**	N	Mean	SD	**t**
Duck-billed Platypus	Leading-question	62	.1383	.2048	.048	62	.6022	.3740	.054
	Full-text	61	.1361	.2826		61	.5982	.4266	
Formosan Blue Magpie	Leading-question	63	.0141	.0441	-.0168	63	.5685	.3828	3.096**
	Full-text	59	.0216	.0327		59	.3522	.3883	
Koala	Leading-question	55	.0288	.0690	-1.185	55	.4270	.4048	-.374
	Full-text	54	.0462	.0836		54	.4559	.4019	
Formosan Whistling Thrush	Leading-question	55	.0315	.0470	4.673**	55	.6447	.3962	7.978**
	Full-text	57	.0018	.0027		57	.1585	.2214	
Red-eared Guenon	Leading-question	54	.1022	.1698	-.318	54	.5427	.4018	1.002
	Full-text	53	.1124	.1616		53	.4613	.4380	
Crab-eating Mongoose	Leading-question	54	.0680	.0706	3.528**	54	.6713	.3860	5.477**
	Full-text	61	.0299	.0386		61	.3053	.3228	
Asiatic Elephant	Leading-question	60	.0137	.0139	-2.364*	60	.5317	.3659	-.164
	Full-text	55	.0880	.2328		55	.5436	.4133	
Black-faced Spoonbill	Leading-question	57	.0264	.0139	-.244	57	.8172	.3256	2.440**
	Full-text	58	.0276	.0335		58	.6499	.4060	
Average of all above	Leading-question	71	.0603	.0745	.526	71	.6196	.2395	5.225**
	Full-text	74	.0544	.0589		74	.4059	.2530	

Table 2: Summery of **t**-test of Retrieval Precision and Retrieval Recall (*$p<.05$, **$p<.01$)

Conclusion

From this study, we find that the computer attitude of primary school students who use the leading-question retrieval interface is obviously better than that of students who use the full-text retrieval interface. The reason could be that most experimental samples, using the full-text retrieval interface, feel puzzled while keying in the retrieval keywords, especially while facing those retrieval targets whose names are unknown or hard to guess. They could also feel frustrated when the system returns the useless results by submitting the wrong keywords again and again. This situation will also affect the positive computer attitude indirectly.

In general, the retrieval precision of leading-question retrieval interface for the primary school students' is obviously better than that of full-text retrieval interface. But it is not always true. The reason is that for some familiar vertebrates, the students have already known the names or easily guess the partial names of the vertebrates. Moreover, on the other hand, for some vertebrates, which outside characteristics are not special or apparent, it is difficult for students to distinguish the differences among these vertebrates such that they would make a wrong choice during the question-asking process. To sum up, the retrieval precision will be promoted by using the leading-question retrieval interface to retrieval the targets that users are not familiar with.

In addition, the retrieval recall of the primary school students who use the leading-question retrieval interface to retrieval information is better than that of those who use the full-text retrieval interface. The reason is that for the unfamiliar retrieval targets, users who use full-text retrieval interface have to guess blindly several times before getting the correct results. They could be frustrated by the wrong keyword they choose and that results in a decrease in the retrieval recall.

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