An empirical study on Chinese adolescents' web search behavior

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Abstract

Purpose – The purpose of this paper is to explore the web search behavior of adolescents from a Chinese secondary school and the factors affecting this behavior.

Design/methodology/approach – A controlled experiment was conducted to collect data on adolescents' background and their web search behavior. A total of 48 students were asked to perform three different search tasks on the internet within a limited time, and were then interviewed by researchers.

Findings – The results revealed three characteristics of Chinese adolescents' main behavior during the search process: mental set during the search process, poor information search skills, and poor ability to process the search results. In addition, this research found that cognitive style had only minor influence on students' use of embedded links. However, grade and task type had a significant impact on their search performance and behavior. In general, high school students performed better than middle school students, and adolescents acted differently when completing different tasks.

Originality/value – This research sheds light on Chinese middle and high school students' search behavior on the web. It also investigates how cognitive style, grade, and task type influence students' online search behavior.

Keywords Adolescent, User behaviour, Cognitive style, Grade, Task type, Web search behaviour

Paper type Research paper

Introduction

internet penetration among adolescents continues to rise: research has shown that in 2012, 95 percent of American teens aged 12-17 went online (Pew Research Center, 2012), and similar statistics are reported for Britain (Prigg, 2012). Compared with these two countries, the proportion in China is lower. According to statistics from the China Internet Network Information Center (CNNIC), in 2012 almost 66.4 percent of adolescents used the internet (CNNIC, 2013), but by 2013 the percentage had reached 71.8 percent (CNNIC, 2014), which shows a consistent growth in internet penetration. Faced with the growing number of adolescents online, it is important to study adolescents' web information behavior and improve their information literacy. Nowadays, many countries attach importance to adolescents' information literacy education. For example, the USA was the earliest initiator of information technology education, and the Big 6 model that develops students' information literacy has been widely used in the American primary and secondary curriculum. Britain officially included information technology education in the national curriculum in the 1980s. In comparison, China came late to information literacy education, so there is a need to conduct research on Chinese adolescents' web information behavior to understand their information search skills.

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The convenience of the internet encourages more and more adolescents to rely on the web to obtain information. Studies show that using the internet is the most common way for adolescents to search for information (Madden *et al.*, 2007; van Aalst *et al.*, 2007; Bowler, 2010). When searching on the web, adolescents' search behaviors have both general and individual features. In addition, a number of factors affect adolescents' web search behavior, including the structure of the search type, gender, age, and cognitive ability. Research has been conducted in some countries of North America and Europe on adolescents' web search behavior, whereas there have been no empirical studies in this field in China. The current research explores Chinese adolescents' web search behavior with the aim of providing educators and future researchers with a complete understanding of adolescents' web information behavior.

Literature review

Adolescents' web search behavior

A number of studies have focussed on adolescents' search behavior on the internet. Early research mainly explored novice adolescents' web search behavior owing to the limited access to the internet. Fidel *et al.* (1999) examined high school students' online search behavior for homework assignments. They found that students performed focussed and flexible searches, and enjoyed searching on the web, but that there was still a need to develop their online search skills. Large and Beheshti (2000) reported sixth-grade students' experience of searching for information online. The results revealed that the students were inefficient in using the web to find the required information. Bilal (2000, 2001, 2002b) studied children's cognitive, physical, and affective behaviors when they conducted three different types of tasks using the Yahooligan! search engine. The results exposed the students' inadequate skills in locating, using, and analyzing information effectively.

As the internet became more popular, researchers examined its use by more experienced adolescents. Guinee *et al.* (2003) analyzed secondary school students' internet search strategies and identified common patterns in their search processes. Madden *et al.* (2006) examined adolescents' search strategies and factors affecting their performance. Druin *et al.* (2009) explored children's search behavior using keyword interfaces. In an analysis of a query log produced by children, Torres *et al.* (2010) reported their search queries and sessions. These studies showed that although adolescents enjoyed searching for information on the web, they encountered many barriers to effective information search and use.

Several studies have explored adolescents' web search behavior from different angles. Agosto (2002a) found that the theories of bounded rationality and satisficing were related to adolescent females' decision making, and that personal preference played a role in evaluating websites. Subsequently Agosto (2002b) put forward a theoretical model of the criteria that adolescents used when they evaluated websites. Pickard *et al.* (2014) investigated high school students' evaluative criteria about information on the web. Foss *et al.* (2013) conducted a study of adolescents' internet searching process, and developed a framework of search roles according to the search trends that the students exhibited.

Factors influencing adolescents' web search behavior

Wersig and Seeger (1975) pointed out that information needs and information-seeking processes depend on the task of the user, because the task imposes information

requirements that must be met in order for the task to be completed. Studies have identified different types of search tasks, including simple and complex tasks (Hirsh, 1999), closed and open tasks (Marchionini, 1989). Several studies that investigated the effect of task type on adolescents' search behavior have suggested that different types of tasks influence search behavior. However, the findings from these studies were not always consistent because of the different purposes and subjects of the studies. For example, Hirsh (1999) found that the success of fifth-grade students decreased with the increase of the complexity of the search tasks. Schacter *et al.* (1998) examined the effects of task structure on elementary school students' web information-seeking behavior. They found that fifth- and sixth-grade students preferred to browse rather than employ analytic-based search strategies, and that students performed better on ill-defined tasks than on well-defined tasks. Bilal (2002b) investigated the information-seeking behavior and success of seventh-grade students in using the Yahooligans! search engine. They concluded that the students were more successful on full self-generated tasks than on fact-based and research-oriented tasks.

In a few studies that examined adolescents' web search behavior, the impact of gender was explored. Large *et al.* (2002) investigated the gender differences in collaborative web searching. The results revealed differences between boys and girls in some aspects, including the use of hypertext links and the time spent on individual pages. In general, boys were more active than girls. Another study found that boys browsed significantly more and engaged in more information-seeking processes than girls (Schacter *et al.*, 1998). Roy and Chi (2003) noted that boys tended to filter information at an earlier stage than girls, and that girls were more linear and thorough navigators than boys.

Because cognitive ability, expression ability, and problem-solving ability vary with age, users of different ages behave differently when searching for information on the web (Slone, 2004; Etcheverry *et al.*, 2012). Although Gerjets and Hellenthal-Schorr (2008) did not find that eighth-grade students were more competent at searching for information on the internet than seventh-grade students, Kafai and Bates (1997) reported in their study of elementary students' internet use that younger students had more difficulty in finding the relevant information resources. Bilal and Kirby (2002) compared children's and graduates' web search behavior and found that graduates' performance was better than that of seventh-grade students.

Another factor that affects web search behavior is search experience. Kafai and Bates (1997) found that adolescents with prior internet experience tended to control the whole search process when working with students who had little search experience. Tu *et al.* (2008) investigated eighth-graders' web search strategies and outcomes, and their results suggested that students with richer web experience did better in closed-ended search tasks. Lazonder *et al.* (2000) noted that the high school students who had more search expertise were more competent than novice students in finding the relevant information.

Research questions

Differences in social and cultural background could cause adolescents from different countries to exhibit different web information behaviors. The current research on Chinese adolescents' web search behavior can give local educators an in-depth understanding of adolescents' information behavior and improve students' information literacy according to their actual abilities. At the same time, it can make the researchers have an objective and deeper understanding of adolescents' information behavior

through learning the similarities and differences between Chinese adolescents' search behavior and those in other countries,. In Kuhlthau's Information Search Process (ISP) model, information-seeking incorporates physical actions, and affective and cognitive experience (Kuhlthau, 1991). The current research explored adolescents' main behavior on account of the difficulty of observing users' cognitive thoughts and affective feelings. And the search behavior referred to in the current research includes the following activities: selection of search tools; query formulation; and browsing and processing of the search results.

Although previous research included different ages of adolescence as participants, only a few studies have focussed on the specific differences between the search behavior of middle and high school students. Because middle and high school students are at different stages of adolescence, and have undergone different levels of information literacy education in China, it can be assumed that the two groups of students behave differently in their search behavior. Furthermore, although some researchers explored how cognitive style or other individual characteristics influence web users' search behavior (Kim, 2001; Ford *et al.*, 2005; Vilar and Žumer, 2008; Chan *et al.*, 2014), there have been no studies investigating how cognitive style influences adolescents' search behavior on the web. Moreover, no researchers have examined how the interactive effect of grade, task type, and cognitive style influences adolescents' web search behavior. Therefore, the objective of the current study was to examine Chinese adolescents' web search behavior, and the research questions to be explored were as follows:

RQ1. What are the characteristics of Chinese adolescents' behavior during the web ISP?

RQ2. How do cognitive style, grade, and task type influence adolescents' web search behavior?

Method

Participants

The 48 participants of this study were 34 male and 14 female students from a public secondary school in Luoyang, a medium-sized Chinese city. They were selected after being asked questions about their web experience. Eventually, eight students from each grade (grades 7-12) were recruited based on their willingness; they were given gifts as a reward for participating. All of them could easily access the internet in their own home. They had been using the web for an average of three years, and they spent an average of 10.3 hours per week surfing the web. To a certain extent, their web search behavior is typical for the majority of Chinese adolescents.

Search tasks

Three search tasks were assigned to the participating students. According to the categories used in previous research (Marchionini, 1989; Bilal, 2002a), the three tasks could be categorized as semi open-ended, closed-ended, and research-oriented (open-ended) tasks. In ordered to interest the students in searching for information online, three topics that were closely related to students' living and learning were chosen: English websites, films, and famous poems. The three search tasks were:

(1) List at least five free English learning websites on which you can learn English through listening to songs. Write down the specific names of these websites.

(2) There is a classic film from the Middle East in cinema history that won 11 international awards and told us a touching story about sibling affection. Find out the names of this film and its director, as well as the real and character names of the hero and heroine.

(3) According to the information you find on the internet, decide whether or not the author of the famous poem "The furthest distance in the world" is Rabindranath Tagore. If not, find out the true author. And whatever you think, please write down your opinion and list the specific information that supports your viewpoint.

Because of the long-term "English fever" in China, there are a lot of mature English learning websites that are designed especially for Chinese people. When searching for the information for the first task, students could obtain many correct answers from the result set just input some Chinese keywords. As for the second task, there were standard answers to it on account of the specific film information. However, there was no unique standard answer for the third task, because the internet provided many different viewpoints on this question, so participants needed to analyze and summarize the information they found.

In the current research, precision of the answer was used to evaluate adolescents' search performance, and it examines the relevance of the answer retrieved by participants, In this study, the researchers and two high school teachers who had long teaching experience in social sciences first discussed the specific scoring criteria. Each participant's answer was then judged by the two teachers and the final score was the average of the grades given by the teachers. The measure for evaluating each search task's performance was as follows: first, For the semi open-ended task, the precision of the answer was the number of correct websites given by the participant as a proportion of the total number of the websites given by the participant. Second, for the closed-ended task that had six answers, the precision of the answer was the number of correct answers given by the participant as a proportion of the total number of answers given by the participant. Third, for the research-oriented (open-ended) task, the reasonable answer involved four aspects: the information about different authors should be referred to; the answer should be complete; the answer should reflect the participant's own viewpoint; the information listed should be in accordance with the opinion of the participant. So the score for the answer's precision was the number of reasonable aspects involved in the answer given by the participant divided by four.

Procedure

The whole experiment lasted for 105 minutes for each participant. First, the participant was introduced to the contents and procedure of the experiment (ten minutes). Participants were then asked to complete the Cognitive Style Scale test and the background questionnaire (15 minutes). The next stage (75 minutes) was recorded by a video expert. Participants searched information online to complete the tasks using any search tools they wished. Every participant was given three required search tasks in a random way, and all the participants completed 144 tasks. Each task had to be finished within 20 minutes. Between the tasks, participants filled out more questionnaires about their performance. At the end, each participant was given a five-minute semi-structured interview.

Cognitive style scale test

Cognitive style can be defined as an individual's preferred and habitual approach to organizing and representing information (Riding and Sadler-Smith, 1997). The current

study used the Cognitive Style Scale developed by Tianjin Normal University's research group, "Investigation of Chinese Adolescence Mental Health Diathesis," to assess participating students' cognitive style. The scale was specifically designed for Chinese teenagers and mainly developed based on the Chinese teenagers' interview data and the Sternberg's "Think Style Inventory." It has been demonstrated to have good reliability and validity based on 50,000 Chinese teenagers' investigation results (Shen *et al.*, 2009). The scale is consisted of 23 items, which involved five dimensions: cognitive decision making, cognitive approach, cognitive processing, cognitive behavior, and cognitive disposition. The cognitive decision making mainly explores that teenagers like making decisions on their own or according to the established rules. The cognitive approach examines that teenagers like solving problems with a flexible style or a single style. The cognitive processing explores that teenagers like to handle the whole problems or specific problems. The cognitive behavior examines that teenagers like performing tasks alone or with others' help. The cognitive disposition explores that teenagers like new things or stable environment. The different scores obtained by adolescents can reflect their differences in these five dimensions. A higher grade indicates that the individual tends to make decisions based on the scenarios, and to handle problems in a flexible, independent, and risky way. It also indicates that the adolescent tends to deal with problems in the manner of holistic processing. In contrast, a lower grade suggests that the individual tends to make decisions alone, and to handle problems in a single, cooperative, and stable way. It also means that the adolescent tends to deal with problems in the manner of local processing (Shen *et al.*, 2009).

Results

Behavior during the search process

Selection of the search tools. All of the 48 subjects used search engines to seek information online. The experimental data indicated that the total number of times the students use the search engines was 153, and the top three most frequently used search engines were Baidu (68 percent), 360 (25 percent) and Sogou (7 percent). Most of the participants (96.5 percent) chose the default search engines as their initial search portals on many Directory Web Guides such as Hao123, 360 website navigation, Sogou website navigation, etc. This suggested that the participants were accustomed to use the services provided by the Directory Web Guides. In addition, according to observations during the process, participants would consider changing their search interfaces only when they could not find the information on one specific search portal, after modifying the search queries a number times. Moreover, they did not spend much time on the later search portals, which means that the students always returned to their first choice of search engine.

Query formulation. The search query formulation is one of the most important parts of the process of developing search strategies, and one that directly affects the search results. The search query is an expression of the user's information need. It mainly consists of search terms and logical operators, where the search terms could be natural language or keywords and the logical operators typically include a space, "+," "–," double quotation marks, and so on. The keywords involved in this study were defined as single concepts or combinations of several single concepts and logical operators. The natural language included both colloquial language and phrases composed of several multiple concepts. The length of the search query was measured in Chinese characters, and a punctuation mark was also counted as a Chinese character. Table I shows the participants' search query formulation behavior.

It can be inferred from the data in Table I that the mean number search requests for the 144 tasks was 5.28. The search queries constructed by the adolescents were generally long, and most of the participants tended to select the natural language as search terms. Furthermore, 22.6 percent of all queries used a full sentence as the search request, and the sentences were almost all in the form of questions. According to the interviews and observations, although 69 percent of the participating students made use of logical operators to improve search efficiency, only 38 percent of the 48 students applied the search skills actively without the help offered by the search engine. At the same time, a space was found to be the logical operator most often used by participants. Only one student used two types of logical operators: a space and "+."

Rieh and Xie (2006) summarized three facets and nine sub-facets of query reformulations, while Jansen *et al.* (2009) classified six patterns. In order to identify the relationship between the search queries formulated by the participants in this study, the query reformulations were categorized into three patterns and eight sub-facets that were developed by combining the types of query reformulation identified in previous studies. The definitions and examples of facets and sub-facets of web query reformulation are shown in Table II.

In these three search tasks, there were 486 query reformulation behaviors in total, and 684 times when query reformulations were identified (one query could be identified as two or three sub-facets of query reformulation at the same time). The query reformulation behavior in the whole experiment is shown in Table III.

As revealed in Table III, about 82 percent of the query reformulations were related to the transformation of the content alone. Here, the most used query reformulations were specification, modification and adjustment, generalization, and adoption of the search suggestion. In order to search for satisfactory results as quickly as possible, the participants were likely to improve the relevance of the search results by adding words gradually; this is shown by the fact that the frequency of specification was higher than that of generalization. At the same time it should be noted that in the interactive process between the participants and the retrieval systems, participants also tended to refine their queries in minor ways, since modification and adjustment accounted for a significant proportion of query reformulations, which may be associated with various aspects of the subjects in the search tasks. For example, in the closed-ended search task, many related keywords such as "film," "Middle East," "sibling affection," and "11 international awards" could be selected and the participants would formulate queries by combining these keywords to obtain the required information. Furthermore, the role of suggestions offered by search systems deserved attention. On the one hand, as a kind of external force, assistance from the search system could guide participants in the right direction. On the other hand, it could potentially interfere with the regular retrieval logic of the students and increase participants' blindness during the search process.

Total number of queries	Query formulation		Length of query			Number of participants using logical operators
761	Natural language	Keywords	Maximum	Minimum	Average value	33
	619	142	95	2	13.02	

Table I.
Query formulation

Facet	Sub-facet and definition	Example
Transformation of the content	Specification: adolescents narrowed the scope of the search results by adding keywords based on the previous query or choosing the terms that had more specific meaning to replace the terms in the former query	Film→film from the Middle East
	Generalization: adolescents expanded the scope of the search results by deleting keywords based on the previous query or choosing the terms that had more general meaning to replace the terms in the former query	Director of *The Children of Heaven*→*The Children of Heaven*
	Modification and adjustment: there were overlapping portions in meaning between the previous query and the follow-up query, or the two queries showed different aspects of the search topic	A classic film from the Middle East→a film about sibling affection
	Repetition: adolescents typed in the same search query as the previous one or clicked the former search query again	Film from the Middle East →film from the Middle East
	Adoption of the search suggestion: adolescents took the advice from the drop-down box of search engine or used the related keywords offered by the search engine to formulate their search queries	English→English websites (search suggestion from search engine)
Transformation of the format	Term variation: adolescents added or deleted auxiliary words such as "which", "what," and "?"	Name of heroine in *The Children of Heaven*→what's the name of heroine in *The Children of Heaven*?
	Operator use: adolescents used the Boolean operators such as a space and "+" to change the search strategy	The furthest distance in the world→the furthest distance in the world+Tagore
Transformation of the approach	Transformation of the search portals: students changed their search portals from one search box to another when seeking information	Baidu Knows→Baidu Site Baidu Site→360 Ask

Table II.
Definitions and examples of facets and sub-facets of web query reformulation

Sub-facets	Frequency		Sub-facets	Frequency	
Sub-facets	Number	Percentage		Number	Percentage
Specification	200	29.2	Transaction of the search portals	59	8.6
Modification and adjustment	127	18.6	Repetition	37	5.4
Generalization	107	15.6	Term variation	33	4.8
Adoption of the search suggestion	93	13.6	Operator use	28	4.2

Table III.
Frequency of sub-facets of query reformulations

In order to identify the model of adolescents' search query reformulations, the sequence of search query reformulations was analyzed. The results indicated that the pattern of reformulations was not distinct and linear. Participants were inclined to modify search queries from one to another again and again within the major types of reformulations such as specification, modification and adjustment, and generalization. The sequence of search reformulations was a dynamic process with a high level of instability and complexity.

Browsing and processing of the search results. In general, the participants assessed web pages according to the titles and abstracts in the list of search results. In this study, the depth of adolescents' hits, which is the ranking of the clicked webpage within the complete list of the results, was analyzed. The results indicated that the mean value of students' hit depth was 4.2 and the average maximum hit depth was 11.07. This indicates that participants tended to click the top-ranking webpage first, but would switch to check and click a lower-ranked page if no relevant information was found. In terms of browsing behavior, the results showed that nearly 74 percent of participants only browsed the first page of the search results. The first two pages were checked by 16 percent of participants, and about 10 percent of participants viewed more pages. This finding was consistent with previous research results. Deng (2003) found that nearly 70 percent of users only browsed the first page of Google's search results. iProspect (Sherman, 2006) investigated users' search engine usage behavior and found that 62 percent of users viewed only the first page of the results and nearly 90 percent browsed only the first three pages.

In order to verify whether the adolescents preferred certain types of webpage during the process of selecting answers, the webpage sources of the answers selected by students were analyzed. The results indicated that 503 answers were chosen by the students in the experiment as a whole. Of these answers, the largest proportion (37 percent) came from English learning websites, followed by interactive ask and answering systems such as Baidu Knows (about 19 percent). Other sources, in order of size, were internet encyclopedias, movie websites, Baidu Library, blogs, news web pages, and students' summaries. It was important to note that the considerable portion of answers came from the interactive ask and answering system, which could be inferred that adolescents preferred to locate the information from the interactive ask and answering system. Especially in the research-oriented task, 52 percent of participants selected answers from interactive ask and answering systems, and four participants even asked questions directly on these interactive ask and answering systems.

When participants saved their answers in Word documents, copying contents from relevant websites was very common. This could be explained by the principle of least effort in information search. For the semi open-ended and closed-ended tasks, there was no need to spend much time on organizing the answers, and the copying behavior would save time for participants. But for the research-oriented task, which required participants to consider and summarize the information they obtained on the web, only nine participants analyzed and summarized the information, indicating that the majority did not read or think about the information they had found.

Previous research from broadcasting media showed that adolescents lacked the ability to distinguish between commercial and non-commercial contents. Eastin *et al.* (2006) found that fourth- and fifth-grade students could not identify commercial information, and misunderstood such information. The current research identified the same phenomenon. In the semi open-ended task involving free English learning

websites, almost all the search result sets included commercial English learning websites; 73 percent of participants clicked onto these commercial websites, and of these, 66 percent eventually selected them as correct answers. This result revealed the importance of improving adolescents' ability to distinguish the correct information from the massive amount available.

Factors affecting adolescents' web search behavior

Three independent variables were involved: cognitive style, grade, and task type. Using the scores from the Cognitive Style Scale, participants were divided into two groups – high and low cognitive style performance – with each group made up of 24 students. For the classification of grades, there were two groups – high school and middle school – each with the same number of students. The types of information search task were semi open-ended, closed-ended, and research-oriented.

Two groups of dependent variables were chosen: search performance and search behavior. One dependent variable measured the search performance: precision of the answer. The search behavior covered the total number of search queries, average length of search queries, total number of search portals, total number of web pages opened, total number of embedded links opened, and total number of page turns.

Effects of cognitive style, grade, and task on search performance and behavior. Multivariate analysis of variance (MANOVA) was used to analyze the collected data, and the effects of each factor and the interaction between pairs of factors on the search behavior was analyzed. Table IV lists only those elements that had a significant effect on search behavior. The results suggested that adolescents' cognitive style had a minor effect on their search behavior, whereas the grade and task type did influence their search performance and behavior. In addition, significant interaction between grade and task type was identified: high school and middle school students performed differently in the same kind of search task, and at the same time, all the students performed

Source of variation	Dependent variable	Type III sum of squares	df	Mean square	*F*	Sig.
Cognitive style	Total number of embedded links being opened	24.306	1	24.306	3.034	0.084
Grade	Precision of the answer	10,065.760	1	10,065.760	17.887	0.000**
	Average length of search queries	297.131	1	297.131	7.817	0.006**
	Total number of embedded links opened	24.306	1	24.306	3.034	0.084
Task type	Precision of the answer	13,946.725	2	6,973.362	12.392	0.000**
	Total number of search queries	1,078.487	2	539.244	41.489	0.000**
	Average length of search queries	600.416	2	300.208	7.898	0.001**
	Total number of search portals	8.233	2	4.117	10.543	0.000**
	Total number of web pages opened	2,971.730	2	1,485.865	27.451	0.000**
	Total number of page turns	60.201	2	30.101	3.495	0.033*
	Total number of embedded links opened	154.279	2	77.139	9.630	0.000**
Grade × task type	Precision of the answer	6,223.862	2	3,111.931	5.530	0.005**
	Average length of search queries	243.616	2	121.808	3.205	0.044*

Note: * < 0.05, ** < 0.01

Table IV.
Effects of cognitive style, grade, and task type on search performance and behavior

differently in different types of search tasks. Moreover, the effect of grade varied depending on the task type when concerned with the average length of search queries.

Effect of cognitive style on search behavior. As shown in Table IV, cognitive style had a marginal significant effect on the total number of embedded links opened. The group of students with high scores in the Cognitive Style Scale used more embedded links than the group of students with low scores: $M_{\text{high score}} = 2$, $M_{\text{low score}} = 1.31$.

Effect of grade on search performance and behavior. As indicated in Table IV, grade had a significant main effect on the precision of the answer. Comparing the average scores in the three search tasks shows that the high school students' precision of the answer was significantly higher than that of the middle school students: $M_{\text{high school}} = 72.95$, $M_{\text{middle school}} = 56.66$.

Grade was also shown to have a significant effect on the average length of search queries. Middle school students typed in longer search queries than did high school students: $M_{\text{middle school}} = 15.1$, $M_{\text{high school}} = 12.02$. In addition, grade had a marginal significant effect on the total number of embedded links opened. High school students used embedded links slightly more frequently than did middle school students: $M_{\text{high school}} = 2$, $M_{\text{middle school}} = 1.331$.

Effect of task type on search performance and behavior. With regard to search performance, the MANOVA results suggested that search type had a significant main effect on the precision of the answer. That is, students completed the semi open-ended task better than the closed-ended and research-oriented tasks: $M_{\text{semi open-ended task}} = 79.38$, $M_{\text{closed-ended task}} = 58.52$, $M_{\text{research-oriented task}} = 56.58$. Moreover, analysis of the post-hoc test showed that the semi open-ended task was significantly different from the other types of tasks, whereas there was no significant difference between the closed-ended and research-oriented tasks.

Task type was found to have significant effects on six aspects of search behavior. There was a significant difference between the three search tasks in terms of the total number of search queries. Students formulated more search queries in the closed-ended task than in the semi open-ended and research-oriented tasks: $M_{\text{closed-ended task}} = 9.19$, $M_{\text{semi open-ended task}} = 4.19$, $M_{\text{research-oriented task}} = 2.48$. A significant difference was also found between the three search tasks in relation to the average length of search queries. Students constructed longer queries in the closed-ended task than in the other tasks: $M_{\text{closed-ended task}} = 16.17$, $M_{\text{semi open-ended task}} = 13.54$, $M_{\text{research-oriented task}} = 10.98$. With regard to the total number of search portals used, the students changed their search portals significantly more frequently in the closed-ended task than in the other search tasks ($M_{\text{closed-ended task}} = 1.62$), but there was no significant difference between the semi open-ended task ($M_{\text{semi open-ended task}} = 1.21$) and research-oriented task ($M_{\text{research-oriented task}} = 1$). With respect to the total number of web pages opened, there was a significant difference between the tasks, with the students opening more web pages in the semi open-ended task than in the closed-ended and research-oriented tasks: $M_{\text{semi open-ended task}} = 14.79$, $M_{\text{closed-ended task}} = 9.77$, $M_{\text{research-oriented task}} = 3.19$. Students also turned the pages more frequently in the semi open-ended task than in the closed-ended and research-oriented tasks: $M_{\text{semi open-ended task}} = 1.77$, $M_{\text{closed-ended task}} = 0.9$, $M_{\text{research-oriented task}} = 0$. However, the significant difference was found only between the semi open-ended and research-oriented tasks. With regard to the total number of embedded links opened, the students performed significantly differently in the three search tasks: $M_{\text{semi open-ended task}} = 2.9$, $M_{\text{closed-ended task}} = 1.81$, $M_{\text{research-oriented task}} = 0.25$.

Effect of interaction between grade and task type on search performance and behavior. As shown in Table IV, there was one significant interaction between grade and task type in relation to the precision of the answer, i.e. the effect of grade on the precision of the answer varied depending on the task type. According to the independent sample *t*-test and post-hoc test, there was no significant difference between the performances of the high school and middle school groups when completing the semi open-ended task. However, when completing the closed-ended task the high school students performed significantly better than the middle school students: $M_{\text{high school}} = 75.58$, $M_{\text{middle school}} = 41.46$. Similarly, for the research-oriented task, the high school students did significantly better than the middle school students: $M_{\text{high school}} = 59.92$, $M_{\text{middle school}} = 53.21$.

In terms of search behavior, there was no significant interaction effect except the one between grade and task type on the average length of search queries. When completing the semi open-ended task, the two groups of students did not show any significant difference. However, in the closed-ended task, the high school students formulated much shorter queries than did the middle school students: $M_{\text{high school}} = 13.25$, $M_{\text{middle school}} = 19.09$. Similarly, in the research-oriented task, the high school students formulated much shorter queries than did the middle school students: $M_{\text{high school}} = 11.5$, $M_{\text{middle school}} = 15.58$.

Discussion

Characteristics of Chinese adolescents' web search behavior

Mental set during the search process. Mental set is the tendency to solve certain problems in a fixed way based on previous solutions to similar problems (Öllinger *et al.*, 2008). Deng (2003) found that mental set played an important role in users' choice of search engines, and most users were accustomed to using one or two search engines with which they were familiar. Shenton and Dixon (2003) noted the "habitual pattern" of adolescents' use of search engines. In Foss *et al.*'s (2013) study, the adolescents all actively used Google to conduct search tasks. In the current experiment a similar phenomenon was observed. Adolescents used a limited number of search tools, with Baidu and 360 the most frequently used search engines. Most students entered their queries through the default search box on the Directory Web Guides, and it was the most common way of searching information revealed in the semi-structured interviews. Moreover, during the searching process, only when the students could not find the relevant information on one search portal after a number of query reformulations would they consider changing the search interfaces, and the range of this transformation was from large to small.

The mental set also had a certain influence on query reformulation behavior. On the whole, although the pattern of students' query reformulations was very complex, participants formulated their queries within four major sub-facets of query reformulation: specification, modification and adjustment, generalization, and adoption of the search suggestion. The inclination to select the natural language for the search terms accorded with adolescents' daily habits of consulting questions, which supported the findings of Guinee *et al.* (2003). Furthermore, long-term searching experience made participants more likely to browse the first page of results. All of these behaviors can reflect adolescents' mental set in some senses.

Poor information search skills. The background investigation and interviews revealed that adolescents' main purpose for web searching was entertainment, and the

majority of the adolescents assessed their web search ability as modest. These participants articulated that while computer courses were offered at school, such courses included little information on web search skills. Adolescents thought that their web search skills were mostly developed through their own ongoing exploration – what Peterson (2008) called the "trial and error" method. In the current research, adolescents' poor information search skills were further confirmed. When formulating search queries, adolescents were likely to select natural language for the search terms, and more than a fifth of queries were composed of interrogative sentences. Moreover, the length of search queries was generally long, which was consistent with Torres *et al.*'s (2010) investigation. In addition, adolescents only employed simple logical operators to search information, and the frequently used "space" was usually adopted following a tip from the search engine. Among the minority of participants who actively used logical operators, few students had mastered the usage of these operators, a finding that is consistent with the study by van Deursen and van Diepen (2013). Furthermore, an analysis of adolescents' pattern of search reformulations revealed that they submitted search requests very frequently. The sequence of their search queries was not regular and linear, and the whole process lacked stability, indicating that adolescents could not find the satisfactory information and did not know how to change the search strategies effectively to search for target information.

Poor ability to process the search results. The results of data analysis revealed that nearly 90 percent of the participants only browsed the first two pages of the search results, which indicates that adolescents had a tendency to view the search results superficially. Faced with thousands of search results, adolescents had insufficient time and patience to analyze and digest every piece of information. For example, in the semi open-ended task, because of the fact that too much information was returned from search engines, and other uncertain factors, a considerable number of participants could not differentiate between commercial and non-commercial English learning websites, and ultimately selected the wrong answers. In the closed-ended task, besides the lack of information search ability, some students could not find the correct answers, ignoring important hints because they thought they did not see any of the keywords appearing. This finding coincided with research by Wallace and Kupperman (1997), who found that sixth-grade students could not find the relevant information because they were concerned only with information that included the exact keywords that they were expecting. In the research-oriented task, 89 percent of the participants completely copied the exact information on the web as their final answer, demonstrating that they were only interested in finishing the search tasks as soon as possible without being aware of gaining knowledge by using the information. Moreover, of the many web pages that the answers came from, the information from the interactive ask and answering systems was more favored by adolescents, and the participants paid little attention to the accuracy of the information resource. As in the report commissioned by the British Library and JISC (Rowlands *et al.*, 2008), this showed that those from the "Google generation" rely heavily on information from search engines, and do not possess the critical and analytical skills to assess the information they find on the web. A later study suggested that teenagers' search statements tended to be the product of cut and paste (Nicholas *et al.*, 2011).

Effects of cognitive style, grade, and task type on adolescents' search behavior

Effect of cognitive style. Overall, cognitive style had the least effect on adolescents' search behavior, and the effect only existed in the embedded links used by the students.

Students who tended to make decisions based on the scenarios, deal with problems in a holistic processing manner, and handle problems in a flexible, independent, and risky way utilized more embedded links to find out the answer in different ways than students who tended to make decisions by themselves, deal with problems in a local processing manner, and handle problems in a single, cooperative, and stable way.

Effect of grade. On the whole, the high school students generally did better than the middle school students in terms of search performance, which could probably be explained using the theory of cognitive development across adolescence. From the perspective of proponents of information-processing approaches to cognitive development, adolescents' mental abilities grow gradually and continuously (Feldman, 2005). Furthermore, Eastin (2008) thought that the theories of cognitive development held for online information seeking. It can be inferred that high school students' perception is more purposeful and systematic, and they are more careful and more profound than middle school students. Moreover, high school students' critical thinking ability is better than that of middle school students. Hence, in the current study, the high school students completed the tasks more accurately than the middle school students, which also could be reflected in the task performance questionnaires. Compared with the middle school students, these high school students thought that they found the correct answers more positively In addition, when formulating queries the high school students typed in shorter requests than did the middle school students. The results revealed that the high school students opened embedded links slightly more frequently than did the middle school students, suggesting that the high school students tended to search for information more flexibly than the middle school students. Based on all of these findings, it can be assumed that the information literacy of adolescents increases with age.

Effect of task type. The results indicated that task type had a more significant effect on search performance than either cognitive style or grade. The task type significantly influenced all aspects of search performance and behavior. In terms of accuracy of the answer, the scores of each task were ranked in descending order as follows: semi open-ended task, closed-ended task, research-oriented task. The reason could be that these tasks had different degrees of difficulty, and that the difficulty of the three search tasks increased in turn. Although the structure of the semi open-ended task was less specific than the structure of closed-ended task, students could formulate queries more easily depending on the task requirements than in the closed-ended task, and this was confirmed by the questionnaires about task performance. Furthermore, the difficulty of the research-oriented task was embodied in the need to critically analyze and summarize the information found on the web. In terms of the number of web pages opened, pages turned and embedded links opened, students did the most in the semi open-ended task. Qiu (1993) found that users tended to employ browsing strategies in "general" tasks, while they frequently used analytical strategies in "specific" tasks. In the current study, the structure of the semi open-ended task was more general than that of the closed-ended task; thus, the students were likely to enter the relevant English learning websites to filter the answers, and open the embedded links to judge whether the websites met the task requirements. In contrast, in the closed-ended task there were several specific pieces of target information that the students were expected to search for, so they mainly decided whether to click on a web page according to the titles and abstracts in the search results; hence, the process of filtering the information was quicker. With regard to the research-oriented task, it appeared that the search task

required the students to locate a specific piece of information, and the relevant information about the task was easily found. However, the students had no patience to read carefully and consider the information they found. Thus, in the actual experiment the number of web pages opened, pages turned, and embedded links opened was least for this task.

In terms of the average length of search queries, the closed-ended task required the students to have a better ability to select the appropriate keywords than the semi open-ended task, and the research-oriented task, which the majority of students thought was the simplest of the three tasks, needed the students to formulate queries that were not very short, owing to the task itself. This may be why the average length of search queries in the closed-ended task was the longest, followed in turn by the research-oriented task and the semi open-ended task.

Conclusions and limitations

Conclusions

This research analyzed and discussed the characteristics of Chinese adolescents' behavior during the web ISP and the factors affecting adolescents' search behavior based on controlled experimental observation. The results suggest that the search behavior of Chinese adolescents and foreign adolescents share common characteristics. The information literacy of Chinese adolescents overall was not high, and adolescents showed an inadequate ability to search and process information, confirming previous research findings (Shenton and Dixon, 2004; Selwyn, 2009). During the process of searching for information on the web, it was no surprise that the performance of high school students was superior to that of middle school students. When completing different tasks, the search performance and behavior demonstrated by the adolescents were remarkably different. In addition, the students with different cognitive styles performed differently in terms of using embedded links. According to these findings, educators and all types of information service organizations should give more attention to improving adolescents' information literacy. During information literacy skills training, educators should use teaching methods that are appropriate for students' aptitude levels. Adolescents have different psychological traits and development needs according to their different age and cognition, so it is necessary to formulate a suitable plan for each adolescent to instruct them to search for information. In addition, educators should ensure that adolescents pay more attention to the development of search strategy in the closed-ended tasks. At the same time, students should be guided on the evaluation and use of information on the web in open-ended tasks.

Limitations

The study has a number of limitations in terms of its generalizability to the actual situation of Chinese adolescents' web search behavior. First, 48 participants is a small sample, and more large-scale data will need to be gathered in future research. Second, the search tasks involved in this study are imposed tasks in a sense, and the process was conducted in the presence of researchers, which could impose pressures on participants in terms of showing their actual search ability. Third, because the adolescents from different countries did not show their web search behavior in the same scenario, the study did not find the differences between Chinese adolescents' search behavior and those in other countries. Maybe more detailed and comprehensive research is needed. Finally, the research results revealed only a minor effect of

cognitive style on adolescents' search behavior. However, the study investigated the overall conditions of students' cognitive style; there are several sub-facets of cognitive style, including cognitive decision making, cognitive approach, cognitive processing, cognitive behavior, and cognitive disposition. The way in which each dimension relates to students' search behavior is to be explored further.

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