

“Computer what's your favourite colour?”

Children’s information seeking strategies in the classroom

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ABSTRACT

This research investigates children’s information seeking in primary and intermediate school classrooms as seen by their teachers. We report the results of a series of semi-structured interviews with teachers of pre-teen children. The teachers discussed specific issues that children encounter during information search, including query construction and information triage difficulties. Further issues were identified during the interviews regarding motivation, frustration and poor strategies for overcoming barriers. We compare the results of our teacher interviews reported here with the results of an interview study with children. This paper concludes that even with significant advancements in technology, teachers and children still require further assistance in order to succeed in their inquiry practices.

KEYWORDS

Children’s information seeking; search strategies; interview study; digital literacy; information literacy

ASIS&T THESAURUS

Search behavior; Educational technology; Interviews.

INTRODUCTION

Information problem solving and information seeking is a common part of daily adult life. Information seeking is a complex process that necessitates using a range of technologies and techniques to locate, identify, collate, and organise information, and sources. During their education children are developing the skills they will need in adulthood and thus supporting both children and teachers in the development of information seeking skills is necessary. We used an interview study to reveal when and how information seeking is being conducted in children’s education.

Children are known to have difficulties when using the information technologies that are available to them effectively. Barriers to successful information seeking by children have been well-documented, dating back to the early days of search engines and Web access (Bilal, 2000) as well as work with digital libraries (Hutchinson, Druin, & Bederson, 2007). However, contemporary strategies for information seeking as taught to, and practiced by children in the classroom are less understood and have little recent investigation. This paper contributes to the investigation into best practices and research to support children’s digital

information seeking; we focus on current information seeking teaching and practices in New Zealand (NZ) educational settings. We provide new insight into when and where do children engage in information seeking activities; what processes of information seeking children engage in; and what contemporary issues children encounter. We highlight in this paper that teachers themselves may not have received training or education to be successful information seekers, and yet, we require these overworked professionals to prepare children to be daily information seekers.

This paper is structured as follows; related work focuses on children’s information seeking with details of the NZ education setting. We detail the *Study Method* for interviews with teachers. The *Results* section provides a snapshot of the information seeking practices of children. We next outline a model of the working process of children’s online search for information. Our *Discussion* provides an analysis of our study results with comparison to related work. Finally, we summarise the identified information seeking issues encountered by children and provide recommendations.

BACKGROUND AND RELATED WORK

We outline existing work on the use of Information Communication Technology (ICT) in classrooms, as well as research on children’s information seeking and use. Additionally, we describe the educational environment in which our investigation was undertaken so that readers may clarify any similarities to their own research environments.

ICT in Classrooms

Children are engaging in information seeking with contemporary ICT in both formal educational settings and in their daily recreational activities. In earlier work we observed how children in the NZ classrooms and homes used a broad range of technologies including digital whiteboards, laptops, and tablets and a range of child-targeted software for skill-based learning (e.g. reading and maths) (Timpany & Vanderschantz, 2011; Vanderschantz, Hinze, & Cunningham, 2014a). This is similar to the situation globally with studies confirming that, worldwide, child-specific software is seeing significant use in primary education: for example, for reading and searching (i.e. Hutchinson et al., 2007), and novel teaching of mathematics and programming using tablets, software and haptic devices (i.e. Hegedus, 2013). Recent research also explores use of contemporary

devices in the classroom including tablet and mobile devices such as iPods and iPads (Falloon, 2015), interactive whiteboards (Mellingsaeter & Bungum, 2015), and clicker classroom response systems (Moratelli & DeJarnette, 2014). While it is common to find a wide range of digital information seeking technologies in modern schools these technologies only enhance the learning through quality pedagogically driven implementation by teachers (Okojie, Olinzock, & Okojie-Boulder, 2006). Teachers require support to successfully implement technology into their teaching practice. This paper provides insight into what areas of support might be necessary for children and teachers.

Children's Information Seeking & Use

Early children's information seeking behaviour studies explored use of electronic databases (i.e. Spavold, 1990), OPACs (Online Public Access Catalogues) (i.e. Dinet, Favart, & Passerault, 2004) and digital libraries (i.e. Druin et al., 2001, 2003). Many researchers report the observation that children across a wide range of ages experience difficulties with many facets of digital information seeking and the findings of these numerous studies show that technological capability, searching, document selection, and triage all play a part in the issues experienced by children. Research has investigated the issues children experience when constructing search queries during Internet, library catalogue, and digital library search. These studies have included investigations of query formulation, miss-spellings, term repetition, and difficulties with text entry (Bilal, 2000; Large, Beheshti, & Rahman, 2002). Children experience many of the same difficulties with search that adults do: for example children struggle when using Boolean operators, choosing effective keywords, modifying queries, (i.e. Bilal, 2000; Kafai & Bates, 1997). Research of children's Internet use has examined children's evaluation of information when using the Internet as well as other digital resources (Hirsh, 1999; Kafai & Bates, 1997). McCroy et al., (2000) noted that children poorly access the validity, authoritativeness or correctness of information and often attempt to simplify the complex task of information seeking to simply finding an obvious answer. Recent focus has been on youth health related information seeking (i.e. Kodama, Jean, Subramaniam, & Taylor, 2017; Subramaniam et al., 2015) where young people's digital literacy and their information-credibility and quality decisions have been explored. Similarly recent investigations explored children's mental models of information seeking interfaces and computers (Robertson, Manches, & Pain, 2017; Taylor, 2018).

Given the speed of technology evolution, much of the existing research into children's information seeking and use is somewhat dated, and very few investigations into children's information seeking have appeared in the last five years. Among the more recent works, we find researchers have investigated children's search performance on commercial search engine interfaces designed for children (Jochmann-Mannak, Huibers, Lentz, & Sanders, 2010; Vanderschantz & Hinze, 2017) as well as on research led

search user interfaces for children (Gossen, Nitsche, & Nürnberger, 2012; Vanderschantz & Hinze, 2018), and in the home (e.g., Druin, Foss, Hutchinson, Golub, & Hatley, 2010), but little education or classroom based investigations of what and how children are interacting with technologies.

Overall, we found limited research explores the strategies used by children or the issues and successes encountered during online search for information, either in the classroom or at home. Therefore, where educational information seeking is happening, as well as what issues children are encountering during internet search, is still not fully answered by the related work.

The New Zealand Context

While roughly similar to the US and UK primary education systems we offer here a brief insight into the context in which these studies have been performed. NZ government-funded schools at pre-high school level (i.e., Years 1—8) are typically separated into *primary schools* (catering to new entrant Year 1—6) and *intermediate schools* (catering to Years 7 and 8). Our work presented in this paper focuses on teachers of Years 5&6 at primary level and Years 7&8 at intermediate level. Years 5&6 children are typically 9 to 10 years old while Years 7&8 students are 11 to 12 years. The Decile Rating System is the measure used to describe the socio-economic status of homes within a school's catchment zone (a Decile 1 rating indicates a high proportion of low socio-economic homes in the catchment zone).

Children in NZ are exposed to computer technology at home and in school very early in their education (Vanderschantz et al., 2014a). Information search is encouraged by the NZ school pedagogy through the "inquiry-based learning" framework. We have observed teachers set investigation tasks of broad topics that require the children to develop questions to explore independently. These investigations then take place inside and outside the school. Previous research has observed that children in NZ classrooms use this full range of technologies during their daily education (Vanderschantz et al., 2014a). These technologies have included digital books on CD-ROMs, eBooks, Internet resources, OPAC systems, along with specific educational software. No studies, have elicited the teachers' perspectives on the use of these technologies for information seeking.

STUDY METHOD

We conducted a series of semi-structured interviews with teachers of pre-teen children aged 9 to 12 years. The interviews took place in the teachers' classroom or in a space in the school selected by the interviewee. All interviews took place during the school day and therefore, the school was in operation while the interview was taking place. Interviews were audio recorded, and handwritten notes were taken.

Participants and Participant Recruitment

Our interview series was conducted in the Waikato School District, which is located in the central North Island of NZ. The participating teachers were recruited from two primary

schools and one intermediate school. The three schools that participated in this study are the same as those that participated in our related study that investigated children’s self-reporting of their information seeking (Vanderschantz, Hinze, & Cunningham, 2014b). The schools have Decile ratings of 4, 5 and 9. When inviting participant schools to contribute to our studies, the Decile Rating System has been taken into consideration in an attempt to fairly include a cross section of NZ schools in our research. While schools from across the full breadth of the rating system were approached to participate we were not able to gain participation from a school with a decile rating lower than 4.

We interviewed 10 teachers who had teaching experience ranging from 6 years to 25 years. We received only female participants, however this is in line with the Teacher Census 2016 that found almost 75% of NZ primary school teachers are female (Ministry of Education, 2016). Following our university ethics approval, we gained written consent from the school principal to conduct interviews with teaching staff at their school. The teachers were then invited and agreed without coercion to participate.

Interview Questions

Our interview questions (see Figure 1) were designed to allow comparison with the findings of our interviews with children reported in our corresponding paper (Vanderschantz et al., 2014b).

- 1) What types of topics did the students choose to investigate?

2) Where did the students investigate this topic?

3) What instruction or training did the students receive on how to investigate this topic?

4) What resources did you expect the students to use to investigate this topic?

5) What percentage of students used the following resources?

6) What issues did you notice children having when searching for digital information?

7) What issues did you notice children having when using digital information?

8) What issues did you notice children having when searching for printed books?

9) What issues did you notice children having when using printed books?

10) Do you have further observations regarding children's search for and use of information?

11) Can you describe the process when searching using printed material or books etc.?

12) Can you describe the process when searching using computers or iPads etc.?

13) What previous instruction or training did the students receive on how to investigate a task?

14) Do you have plans for further instruction or training on how to investigate a task?

15) How did the student submit a result of this?

16) What future topics will you set this year for investigation?

Figure 1. Teachers interview questions

The interview questions were developed in consultation with tertiary teacher educators. Demographic information was also gathered. No probes were used. Our results are structured through answers to questions 1 to 4 and 12 to 15 reported in the section *Information Seeking in Classrooms*; while questions 5, 6 and 9 to 11 are reported in *Issues and Successes Observed During Search*; and questions 7 and 8 are reported in *Preference for Print vs. Digital Information*.

RESULTS

We report here the results of our interviews about teachers’ observations of children’s information search practices.

Information Seeking in Classrooms

Questions 1 to 4 and 12 to 15 (see Figure 1) were designed to explore children’s information seeking as facilitated by

these teachers. The answers to these questions give insight into the way that teachers structure modern classroom education in an inquiry-based learning environment.

What Types of Investigations are Children Undertaking?

The teachers reported a range of topics that the children had just completed investigating or that they were currently working on, with some teachers listing more than one topic (see Table 1). The topics reported by the teachers covered sectors of the NZ primary school curriculum, which included science, history, social studies, and English. It is common for multiple classes across a single school level, as well as across many school levels to be investigating the same topics. All 10 teachers stated that the investigations described in Table 1 were teacher or school-initiated topics of inquiry with five of the teachers stating that students were required to choose sub-topics for their personal investigation.

Environmental Issues	3
Scientific Investigations	5
Identity & Culture	3
Human Rights	1
Labour Day	1
Book Initiated	3

Table 1. Information Seeking in Classrooms

Where are Students Undertaking these Tasks?

The 10 teachers stated that they expected all of their students to predominantly investigate these topics in the classroom. Nine of the teachers stated that typically all of the children in their class would conduct parts of their investigation in the school library, while five teachers stated that very few of their students would have explored the subject in a public library. Eight of the teachers stated that some children might investigate their topics at home and 1 teacher suggested some of their students would also use the school computer lab.

What Resources are Children Using?

Teachers reported that their students used a range of print and digital resources to complete the most recent inquiry task (see Table 2). All 10 teachers stated that some of their students used printed books, including school library books. Five teachers stated that their students used a dictionary during the last inquiry task. However, only T4 thought that students use an online dictionary. Five teachers assumed that their students used www.wikipedia.org, only two teachers thought that their students use an alternative digital encyclopaedia or printed encyclopaedia.

Digital searching was discussed as the most used or preferred source of information for children. For example, T8 stated that she “expected [the children] to use Google as their first port of call.” All 10 teachers referred to the Google search engine when describing internet searching (no other search engine was discussed). Five teachers believed that students use the school library catalogue to conduct a search, but many of the teachers discussed that children were as likely to wonder the shelves and seek advice from the librarian. It

was also discussed that the teachers regularly collected printed books from the school library for classroom use, which is likely why library and printed books were a feature of all 10 teachers' responses.

ID	Library Catalogue	Library Books	Printed Books	Printed Dictionary	Printed Encyclopedia	Digital Books	Digital Dictionary	Digital Encyclopedia	Wikipedia	Google	Specific Website	Videos
T1		✓	✓						✓	✓		✓
T2		✓	✓						✓	✓	✓	
T3		✓	✓						✓	✓		
T4	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
T5		✓	✓	✓					✓	✓	✓	
T6		✓	✓					✓		✓		✓
T7	✓	✓	✓	✓						✓	✓	
T8	✓	✓	✓							✓	✓	
T9	✓	✓	✓	✓	✓					✓		
T10	✓	✓	✓						✓	✓	✓	

Table 2. Expected Resources Used

Students at all three schools had access to a small number of desktop computers in the classroom, and bookable class sets of laptop or tablet devices, and weekly class visits to a computer lab, as well as computer lab access during lunch periods. This multitude of internet-capable devices was regularly used by students of all 10 teachers for conducting internet searches for the students' inquiry tasks. All three schools had school libraries with full time or part time librarians. Classes visited the library on a weekly basis, and the libraries were also available outside of scheduled visits for student use. All school libraries have a digital library catalogue (OPAC) that is accessible by the children. Teachers also selected relevant books from the school and public libraries for in class resources for use during inquiries.

No teacher reported any use of digital libraries or child-specific search engines, and none of the schools explicitly provide or promote these for their students to use. T1 also listed photocopies of resources and material from books that the she has supplied as a resource the children in her class will have used. T2 reported children emailing and phoning experts as an enquiry technique that she had promoted during the present inquiry task. T5 discussed the NZ School Journal series as a potential resource for her students and T7 reported that students likely used apps on the schools and the students' mobile devices during the recent inquiry task.

Instruction or Training

The teachers were asked about the specific training that children were given this year and in previous years. We have tabularised the answers to these questions in two separate tables, Table 3 (teaching related to information search practice) and Table 4 (teaching related to internet search).

While search skills are not specifically a part of the curriculum, information search skills are taught as a part of the larger literacy competencies of the curriculum as well as during library or computer lab visits. Teachers described teaching inquiry practice and the necessity of asking and

identifying a quality question. Three teachers reported teaching skimming and scanning of information sources to find information as well as the broader teaching of note taking, referencing and summarising.

Inquiry Practice	1
Good Question	2
Skimming & Scanning	3
Note Taking	1
Referencing	1
Summarising	1

Table 3. Information Search Teaching

Teachers noted that they must teach to the standards and the curriculum, which often does not allow time for teaching content that is outside of the scope of the curriculum. T8 noted that "we as educators could come up with specific search friendly things that should be taught within the curriculum. The problem is it doesn't really fit anywhere within the curriculum". T10 recommended that digital information literacy and search skills need to be integrated into the NZ curriculum within the ICT or Literacy units. All teachers reported that there was room for improvement with their own knowledge and what they were able to teach about information search. The teachers also felt that it would be helpful to have resources available for them. T8 stated "I think it needs to be age appropriate. Something that is designed as children go through the years, and through stages of intellectual development [i.e.] by year six you should be able to skim and scan and this is how you should teach it. Or this is a tool that you use to teach it".

Before listing the specific training, T10 said it was "not enough, in my opinion. I think I probably needed to teach them a little bit more about search engines and Google and that. Be more specific". There was indication of lack of confidence and knowledge in some of the finer details of the advances that are taking place around the teachers, with internet search being one of many areas of need. A further concern to the teachers was the pace at which information technology progresses and the difficulty for individuals to keep up to speed with the changes and processes for successful information search. T1 described the fact that she used to need to teach "a lot of 'who' / 'why' / 'when' / 'where' / 'what is,' [information problem identification techniques] but now Google is so good that doesn't seem to be a problem. They [the students] still seem to get to their result." Being aware of the changes in information search practices can be difficult for teachers who must also remain abreast of curriculum requirements, as well as the myriad of technologies that become a part of society and education.

When answering Q13 the teachers also offered a range of answers including many tools and techniques. For example, T5 stated "I do a big focus on keywords, because if they haven't got keywords, that's a problem." All 10 teachers discussed having given specific search instruction during the

current search topic and in previous topics this year. Six teachers specifically reported teaching children how to use the Google search engine — naming Google specifically. Seven teachers discussed teaching concepts of search query creation, while five teachers specifically described teaching the use of keyword search query constructions. T1 discussed teaching students to omit “small words” (i.e. pronouns and conjunctions) from queries. T10 described teaching the use of query qualifiers such as “for kids” or “for children” at the end of a search query. This technique was described as a method for focusing the content of returned searches to websites that are written with children in mind. Similarly, three teachers [T3, T9, & T10] described encouraging the use of the (now defunct) Google Basic Reading Level Filter to return websites at a level appropriate for the reader. Three teachers discussed triangulation of information sources for confirmation of truthfulness.

Specific Website	1
Google	6
Google Advanced Search	3
Search Query Creation	7
Keyword Search	5
Query Qualifiers	1
Triangulation / Confirmation	3
Trust / Truth	1

Table 4. Internet Search Teaching

Issues and Successes Observed During Search

Questions 5 to 11 explored the information seeking processes that teachers have observed during inquiry and search tasks.

Snapshot of Children’s Search Processes

When given a topic of inquiry, it was discussed that children look for information in digital format first. All 10 teachers described regular weekly school library sessions and in-class supply of books selected by the teacher for use during information search, and yet, all teachers listed Google as the primary tool for information seeking. Given this preference for digital search, the teachers still identified a number of issues the children experienced when searching for information on the Internet when answering Q7 (see Table 5).

Teachers identified an absence of effective skills in developing and identifying information need as being a fundamental issue for children when searching. They observed that when a child does not clearly identify their information need, they tend to use very broad searches in the hope of stumbling across information that they will be able to use. Teachers stated this was counter to what they considered best practice for children. All ten teachers aimed for the children to be able to identify a need before conducting a search, and searching with intent and purpose with well-constructed search queries rather than the scattershot approach that was observed by the teachers.

The construction of sound queries was an issue that all 10 teachers identified. T10 stated, “they type in the whole question; they have no concept of breaking it down to key

ideas.” T2 suggested that: “[some students will use] keyword searching, some will still be putting questions and sentences.” T10 also noted “they think that they can ask the computer ‘Computer what’s your favourite colour?’ they really do think it is like a little brain that is going to talk back to them.” T5 discussed further difficulties for query construction relating to the focus of a query believing that “if they [the students] narrow it too far they can miss vital information too.” Three teachers also described the children’s reading level as a barrier for identifying which websites to visit and for identifying useful results in the websites that Google returns.

Teachers noted issues that children encounter when they are looking through search engine results to identify potentially relevant Web pages. The teachers believed children would visit the first website in the search engine results page (SERP) list and then proceed sequentially down the list of SERP entries — stopping at the first website that they considered to include the relevant information. Over the preceding year(s), the teachers had taught a more formal approach, recommending that the children first review the SERP list and make relevance decisions to prioritise the websites to visit. The teachers also stressed the importance of reviewing multiple sources to validate the information found, rather than relying solely on a single source.

Six teachers observed that children struggle with comprehending the information presented on both SERPs and Web pages due to visual presentation and language level. Related to comprehension was children’s ability to triage the information that they were presented in the SERP list and on the relating web pages. Seven teachers identified this difficulty with triage of information. If the presentation appears too difficult for a child to read and understand due to the lack of headings and images, or to the over-saturation of text on a page, the teachers hypothesised that the children would be discouraged from attempting to read the page. The ability to synthesise the content that has been read and the time required to read, comprehend and to synthesise were additional barriers to success that teachers identified. These barriers may lead to frustration, abandoned searches or searches that result in poor responses to the inquiry task.

Search Terms	10
Reading Level	3
Spelling	1
Technology Access	1

Table 5. Issues Searching for Digital Information

Adult Intervention

Five of the teachers also discussed the importance of parents during information searching in the home. Teachers believed it to be standard practice for their students to work in close collaboration with parents to gain assistance with and guidance in search practices and search queries when conducting inquiry tasks at home. Teachers hypothesised that students whose parents have computer and information literacy skills and who use computers in the home are

noticeably more proficient in searching the Internet. Librarians were also described as sources of assistance and information during the search process. T3 also described emailing experts as a potential resource in information seeking for certain tasks.

Child-specific Search Engines

The teachers we interviewed did not observe any use of child-specific search engines. T7 suggested: “there are children's search engines, but they are too narrow.” Six teachers mentioned child-specific search engines and the need for presenting search results that are tailored to the children’s needs, but no teacher reported recommending or using child-specific search engines in the classroom.

Three teachers discussed the advanced search tools, including the basic reading level filter offered by Google. The Reading Level Filter that is available in Google (at the time of the interviews, but now defunct) is a tool that allows a searcher to specify search engine results at one of three reading levels (Basic, Intermediate, Advanced). At the time of writing this paper we are unaware of a similar feature in either of the other two major search engines, Bing or Yahoo!.

T9 also discussed the need for search engines and the websites the children visit to be well designed for young readers: “Websites cluttered with ads hinder them [the students] finding information. Visual presentation of information is needed for this young audience.” Teachers also discussed that systems that aid children more specifically may be helpful, but these would need to be built into Google, rather than a browser designed specifically for children. For the teachers, Internet searching seemed to be synonymous with using the Google search engine with no other search engines discussed by children in our related study or teachers in this study.

Frustration

Frustration was a sentiment expressed by all ten teachers throughout the interviews. T3 stated that “Google searches can be frustrating and can feel futile if the search is not working”. T4 noted that “[students] often get frustrated and do not put all of the words correctly into the search engine” when describing difficulties encountered with query construction. T6 said children “will type in something and get frustrated when the specific thing they are looking for doesn't come up”. While T8 could relate to the students and said “even myself when searching, I become overwhelmed sometimes by the amount that you receive back”.

Preference for Print vs. Digital Information

We asked teachers about children’s use of, and search for, printed information in Questions 7 & 8. All 10 teachers believed that, given the choice, children use the Internet as their primary information resource and that children will only search print resources if directed to do so. Teachers listed a range of issues that children encounter when using printed information (see Table 6). As was also reported in responses to previous interview questions, the teachers

described the children’s difficulty with spelling and a need for assistance by an adult, such as a teacher or librarian, when searching for information in a library. The schools’ OPACs were seen to be a significant barrier in locating relevant print documents; one teacher suggested that children might use the OPAC more successfully (and so access print material more frequently) if the OPAC offered greater assistance in search and query construction. A major cause of difficulty in using OPACs is that the children do not understand how searching on OPACs differs from searching on Google. Three teachers believed that children use the same initial strategy on OPACs as on Google—i.e., natural language querying—and that they are then stymied when the OPAC returns few results. Even when a child successfully identified a potentially useful book in the school OPAC, it may not have been accessible because often the entire school would be focusing on the same topic (4 teachers). And, of course, print material is not as easily searched and browsed as digital documents; two teachers detailed children’s difficulties utilizing the features of books such as tables of contents and indexes.

Comprehending	5
Ability to Synopsize	3
Catalogue	3
Dewey	3
Availability	6
Features	2

Table 6. Issues Using and Searching for Print Information

A MODEL OF CHILDREN’S ONLINE SEARCH BEHAVIOUR AS OBSERVED BY TEACHERS

We offer here a model of children’s online search behaviour as observed by teachers (see Figure 2). Teachers described children’s searching for information on computers as beginning with a new search in Google by entering either a question or a set of keywords (Figure 2, process 1). Children then select a search result using one of three methods (Figure 2, process 2). Once the children have clicked through to a page, the children then attempt to locate information on the page visited by skimming and scanning the text, likely from top to bottom of the page (Figure 2, process 3). The child must then decide if an answer to the question has been identified (Figure 2, decision A).

Decision A, requires the child confirm if they have answered their information need. If the student has confirmed their answers with a number of sources (Figure 2, decision B), the child would likely consider the search completed. If the child required further triangulation of their sources, they would likely either return to the SERP list to choose an alternative website or adjust their search terms (Figure 2, process 4).

Teachers described children as being easily distracted by in-page links, and tangents that may result in an infinite loop. Process 5 shows the potential for the student to delve deeper into the rabbit hole, losing track of time and sight of the task at hand. Teachers also discussed games and videos as distractions that could impede continued information search.

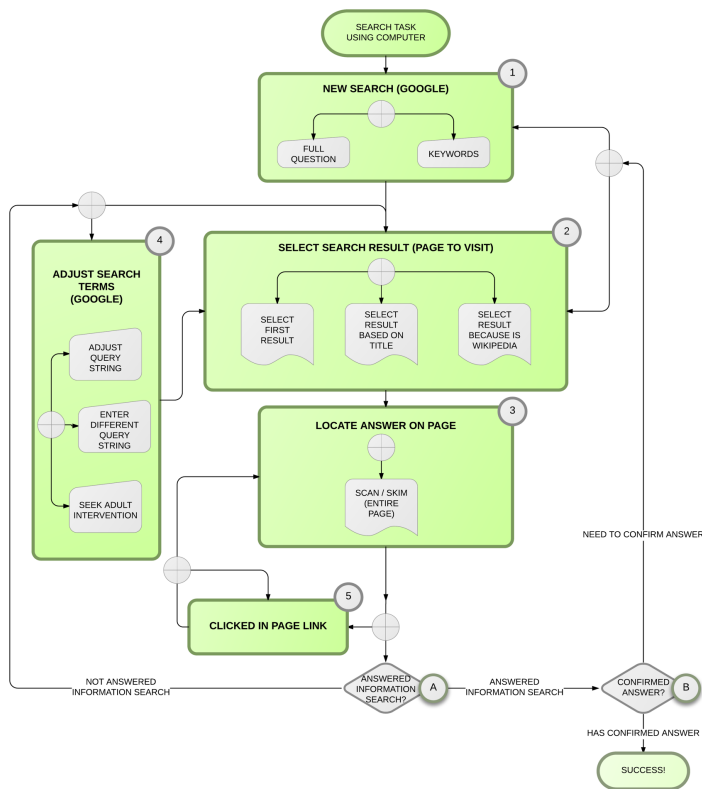


Figure 2. A model of children's online search behaviour as observed by teachers

Comparison to Children's self-reported Search Process

Our related interview study (Vanderschantz et al., 2014b) proposed a model of children's online information search processes. That suggested model was based on children's self-reported recollections of their own processes during information search. When we consider the model as described by the children in comparison to the model described by the teachers, we find very similar processes. We discuss the development of our two models here as well as their relationship to the related work. The children were able to describe the process in more depth than the teachers, presumably because the children were recounting their own actions, or describing processes they believe they should be doing (which they may or may not actually be doing), while the teachers were recounting the actions that they observed.

As we explained in more detail in (Vanderschantz et al., 2014b) children described their search activities requiring three points of decision (labelled as A, B, and C in Figure 3) and four processes (labelled as 1, 2, 3, and 4 in Figure 3). Children described beginning a new search by constructing one of three types of the search query using Google (see process 1 in Figure 3). A child would then decide (Figure 3, decision A) if they could identify a page to visit from the SERP (Figure 3, process 2) or would adjust their query (Figure 3, process 4). The child would select a search result page from the SERP in one of five ways, most often reported

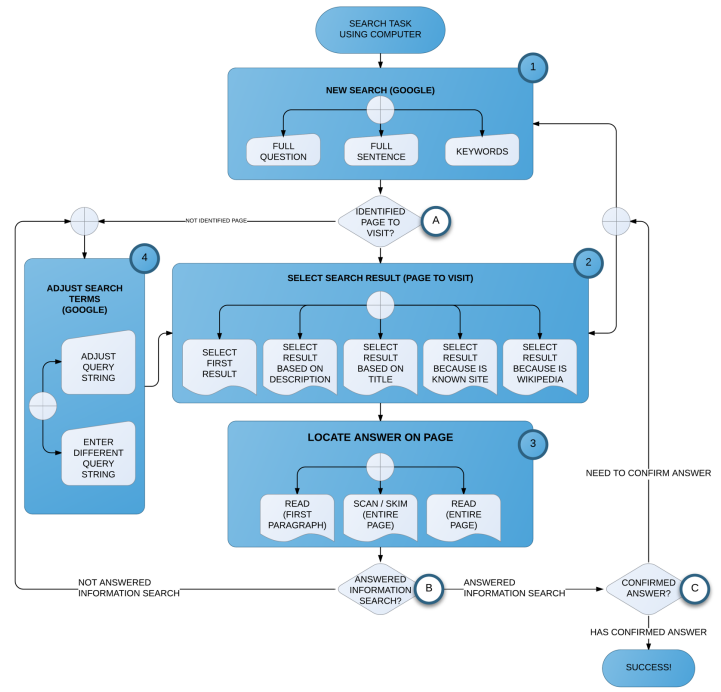


Figure 3. A model of children's online search behaviour (based on children's reports), from (Vanderschantz et al., 2014b)

was choosing the first entry or search for a specific web page (i.e. Wikipedia) from the SERP. The child would then locate their answer on the page by reading the first paragraph, skimming or scanning or reading the entire page (Figure 3, process 3). At this point, the child would be required to decide if the information search had been answered (Figure 3, decision B). The child would then either adjust queries (process 4 in Figure 3, decision C) or decide if the answer requires confirmation (Figure 3). If confirmation was required the child would revisit the previous SERP (Figure 3, process 2) or conduct a new Google search (Figure 3, process 1). Otherwise, the search was considered completed.

The robust model provided by students is a fuller picture than that observed by teachers. The model as garnered from teacher interviews does not significantly differ from the model proposed in (Vanderschantz et al., 2014b), however, the model presented in this paper does differ in Processes 1 to 4, with no Decision at A, and a new process labelled 5.

Query Construction

In Process 1 (Figure 3) children described using full questions, full sentences or keywords while teachers suggested children would use natural language as the very first query in most circumstances. Teachers observed students using keyword searches only if the keywords had been clearly identified in the inquiry task or work sheet;

otherwise, the students used natural language question queries. T10 discussed children's search processes stating, "these kids, seriously, they turn on their computer 'ok I'm going to go look for this.' What do they do? They go 'Okay I'm going to look for Google.' They type their question in. They don't think about eliminating the smaller words."

Search Results List Triage

Teachers reported less information triage by children than children reported. Therefore, Process A is not included in Figure 2 because teachers did not discuss a decision at this point; instead, teachers believed that children move directly from a query to selecting a result from the SERP. Teachers stated that children are likely to a) click the first link in a SERP or b) read only the titles of the top few SERP entries or c) scour the SERP for Wikipedia (see process 2 in Figure 2). Teachers did not mention selecting a result based on a description or known website, which children did report.

Locating an Answer

While children interviewed in (Vanderschantz et al., 2014b) cited three ways that they locate information on a page (see process 3 in Figure 3), our teachers believed that students would skim and scan a significant portion if not the entire page looking for their answer (see process 3 in Figure 2).

In-Page Link Use

Teachers noted that students were easily distracted and would link from one web page to another in a sporadic tangential search. Teachers suggested students may not go back to a SERP, instead needing to re-enter or begin a new query after some time surfing deeper into the Web on a whim. Teachers noted that children would suffer from distraction by information that appears related, and equally by content that is off topic. This is included in Figure 2 as Process 5, yet was not discussed by children in our related study. This looping behaviour and confusion was discussed in early web use investigations (i.e. Bilal, 2000; Large et al., 2002) and is reinforced by our interviews.

Adjusting Search Terms

Adjusting search terms was something that teachers felt students lacked confidence and ability. Children described adjusting search terms or entering new search terms during Process 4 in Figure 3. Early work in children's Internet search has shown that query reformulation is a difficult task (Bilal & Kirby, 2002) and this remains the case with children's information seeking today. Additionally, teachers in this study described the need for input from teachers, parents, and peers to successfully adjust searches (see process 4 in Figure 2). T3 stated: "most children rely on asking a question. They would prefer to sit down and ask for help from a parent or teacher. They would prefer to have someone assist them with a search."

Confirming Sources

Teachers reported confirming sources was necessary for students and something that they specifically taught. Yet, teachers were sceptical as to if students were confirming sources as part of their processes. Students in

(Vanderschantz et al., 2014b) claimed to confirm sources when searching. The decision to confirm sources is found at Decision B (Figure 2) and Decision C (Figure 3).

DISCUSSION

Our interviews with teachers confirm that information search issues persist for children using contemporary online information seeking systems. Search planning and mid-search assessment and development of search paths was discussed to be difficult for children. Teachers discussed a need to clarify the entire information search process for children so that they will fully understand the fundamentals of successful investigation strategies. Teachers believed that the search skills and information literacy of children in their classrooms was still very limited, even at Years 7&8. Children's difficulties in completely identifying their search questions and information needs were also seen to be impediments to successful information seeking. The children's most significant issues were reported to lie in search query construction, spelling, language level of websites, search query reformulation, and triaging of information. Correct spelling of search queries was identified to be difficult for children in both this study and (Vanderschantz et al., 2014b) as it has been in many studies of children's information seeking (e.g., Druin, 2009).

The teachers felt that adding information seeking strategies to the national curriculum would allow them to address these learning gaps formally; in the absence of recognition of information seeking as a legitimate topic of study, the teachers could only fold information literacy instruction into the recognized areas of the NZ curriculum. This situation was exacerbated by the fact that the teachers were not confident in their own information search skills; they were concerned that the resources and tools changed rapidly and they too could benefit from further professional development to update their own information search skills. These reported shortcomings in the curriculum, teachers own knowledge, and the difficulties experienced by children is evidence of the importance of both digital literacy and information literacy and the implications for both children and teachers.

Overcoming Frustration

Teachers reported a significant barrier to children's successful web searches were issues of confidence and frustration. We show in Figure 2 teachers reported Processes 1 to 4 were points in the search process that children have few strategies for overcoming barriers such as a search query returning poor results. Teachers believed this frustration is exacerbated when children are not able to identify for themselves what is not working or how to fix their issues. The teachers did not have solutions to assist the children when they encountered these points of frustration.

Bilal (2000) showed that successful keyword queries were difficult for children to create. Our findings differ from Bilal's in that we note that teachers and children describe difficulties with keywords and a preference for natural language queries. Query reformulation is a difficult task

(Bilal & Kirby, 2002), as is knowing when a query reformation is necessary. We recommend search engine features that offers related searches in the form of search reformations or refinements along with improved visibility of Related Searches will assist users to evaluate their searches and to reformulate searches more successfully.

Teachers in this study, and children in (Vanderschantz et al., 2014b), discussed students seeking adult assistance at points of frustration or when they had given up on their own search. Adults serve as an integral tool in assisting children to overcome motivational and frustration issues that arise during Internet search. Systems that support self-reliance and assist with error correction during search require further investigation. Related to this is the importance placed on librarians by teachers and children alike. NZ school librarians are responsible for managing loans and acquisitions as well as collection maintenance, and can also be found to work with students and teachers in locating information sources and performing information seeking tasks. Certified teacher-librarians (as seen in the US American school system) who are involved in the teaching of information literacy are not typically found in NZ schools.

Digital Compared to Printed Information Seeking

Overall children appear to be less competent information seekers when using printed sources. Teachers even suggested that children “[only] turn to books for pleasure and leisure, not for information” [T2]. Teachers noted that books relevant to many of the inquiry tasks in NZ classrooms often become out of date very quickly or simply are unavailable when students require them. The language in the books is often not at the children’s reading level, or is too shallow for the educational purposes. It seems from the interviews with teachers that children’s print information search skills are diminishing and the perceived value of print information is also fading in today’s educational environment.

Limitations

Our models (see Figures 2 and 3) were developed based on studies with comparatively small numbers of participants, using interviews with children that rely on children’s self-reporting and on the posthoc recollections of teachers. However, our chosen methodology allowed us to tease out fine-grained insights into the difficulties experienced by children as well as the instruction given by teachers that would have been difficult to identify in large-scale studies. These models have been confirmed in subsequent observational studies.

CONCLUSION

Our study provides first-hand observations of the regular habits of young information seekers in NZ classrooms. We found that the inquiry-based model used in these classrooms often requires children to choose and investigate sub-topics of a class-wide area of investigation and for this reason development of good information problem-solving techniques and quality digital and information literacy is a requisite of modern education. We show that children require

assistance to better understand the information seeking process, and teachers require assistance to teach children how to effectively conduct information searches. Our comparison of the children’s perceived online search behaviour to the teachers perceived model of children’s online search behaviour provides new opportunities for researchers to develop targeted investigations into children’s information seeking in educational environments.

When/where do children search for information

Our interviews have revealed that children engage in educational information seeking most predominantly in the school with only some conducted in the home. Children are given opportunities to work with digital and printed information seeking resources, yet given the choice will use Google to search the internet. The teachers reported that children do not choose to use print sources unless directed to do so and prefer the more easily accessed digital sources.

Further our interviews revealed that teachers desire to be better equipped to facilitate Internet searching and digital and information literacy. Teachers regretted the few opportunities to teach information seeking and information searching practices and skills—but also discussed their lack of confidence in their own skills. We recommend professional development support for teachers as well as clear identification of the appropriate space in the curriculum for inclusion of this type of learning for children.

Children’s information seeking processes

Teachers did not recommend search engines designed for children and discussed children’s use of commonly available tools – i.e. Google. We compared our model of teachers’ reports of children’s information seeking to Vanderschantz et al. (2014b) model of children’s self-reports. These two models identify areas of need for educational interventions and software interventions to support children’s information seeking. We recommend software support for (1) topic expansion; (2) tailoring of typographic presentation of information to highlight details relevant to the triage phase of information seeking; and (3) specific tools for the three decision points identified in our models. Tools that support the complete inquiry process in the form of extended features of mainstream search engines, rather than dedicated children’s search engines, are likely to be well received by both children and teachers.

Issues children encounter during information search

The teachers in our study confirmed three major difficulties: (1) constructing searches, (2) identifying potentially relevant information in search results lists, and (3) locating relevant information within a web page. These provide themes for future work in this area globally.

In summary, our study investigated issues for contemporary information search in an educational environment. Its results highlighted the concerning fact that many issues identified for digital search a decade ago are still prevalent showing opportunities for research and technology intervention. We

therefore identify the need to support teachers with their pedagogy of technology integration and information literacy in today's rich digital information world.

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