The Metacognitive Knowledge of Adolescent Students During the Information Search Process

Leanne Bowler
lbowler@sis.pitt.edu
School of Information Sciences
University of Pittsburgh

Abstract

The study used naturalistic methods to investigate the metacognitive knowledge of 10 adolescents as they searched for, selected, evaluated, and used information for a school-based, inquiry project. The study identified thirteen attributes of metacognitive knowledge related to the information search process: *Knowing your strengths and weaknesses, knowing that you don't know, building a base, scaffolding, communicating, changing course, balancing, understanding curiosity, understanding time and effort, understanding memory, pulling back and reflecting, connecting, and parallel thinking.* The results contribute to the understanding of adolescent information-seeking behavior and have implications for information literacy instruction.

1. Introduction

Adolescents, on the cusp of adulthood, face many complex information problems in both their academic and personal lives, and decisions taken to solve these information problems may impact their studies and life choices. To solve complex information problems effectively, background knowledge in the domain is usually helpful (Allen, 1991; Hollands & Merikle, 1987; Hsieh-Yee, 1993; Marchionini et al, 1990, 1991, 1993; Hirsh, 2004). However, as "novice adults", adolescents' depth of knowledge on most topics may be shallow simply by virtue of the fact that they have only experienced life for a handful of years. Complex problem solving also requires cognitive abilities that for the adolescent may be new and unpracticed or even,

according to recent brain research, in development (Giedd et al, 1999).

To add to the problem, adolescents' information problems are more likely, at least in Canada, to be negotiated via the Web, a complex environment where information can be from a variety of inconsistent and often incompatible sources (Environics Research Group, 2001). For Canadian youth, searching for information is as popular as playing games online (Environics Research Group, 2004, p. 11). Canadian adolescents enjoy using the Web to find information and willingly choose it over other information sources. Ironically, although they prefer to use the Web to find information, young people recognize that it is not always the best or easiest way to find information (Environics Research Group, 2004). Perhaps this is because in the open-ended information environment of the Web, the difficulty may not be in finding the information, but in filtering and integrating it into a cohesive whole. These acts assume a level of understanding about one's own information needs, goals and abilities – a kind of self-knowledge that many adolescents may not have or at least, do not know how to reveal.

It has been argued that reaching a level of self-knowledge requires a different kind of thinking, a second stream of thought that is focused, controlled and reflective (Dewey, 1933; Flavell, 1979). Called *metacognition*, this under-current of thinking about one's thinking is essential to information literacy, the package of competencies needed to negotiate complex, open-ended information systems. Metacognition, "thinking responsibly" about our thinking, is seen by educators as a critically important life skill required for "successful academic studies, in demand in the workplace, needed for good citizenship, and valued in the development of the whole person" (Foster, Sawicki, Schaeffer & Zelinski, 2002, p. 24).

This study looks at one aspect of metacognition - the knowledge that underlies metacognitive behavior. Called *metacognitive knowledge*, it is knowledge about cognition in general as well as awareness of and knowledge about one's own cognition, the cognitive demands of a task and the strategies to employ when unsuccessful (Anderson & Krathwohl, 2001). Patterns of metacognitive

knowledge, within the context of information seeking, have been largely unexplored in any age group. The need for such studies becomes more acute when we consider the problems of adolescent information-seeking behavior.

2. Adolescent Information-Seeking Behaviour

Although technologically adept, adolescents still find information seeking to be a difficult task (Fidel et al, 1999; Agosto, 2002). While this study was not specifically about the use of information technologies, the statistics, at least for Canada, do tell us that information technologies do play a large role in the information seeking behavior of young people: 94% of young people in grades 4 to 11 (ages 9 to 17 years) report going online from home. Sixty-one percent of Canadian online youth have high-speed access and 23 % have their own cell phone, 44 % of which have Internet capability. For Canadian youth, searching the Internet for information is as popular as playing games online and they willingly choose the Internet over other information sources (Environics Research Group, 2004).

Much of the recent research into school-related information-seeking behavior has, not surprisingly, looked at it through the lens of Web-based searching. Research indicates that adolescents, far from being technological wizards and information gurus, actually have weak information seeking skills (Watson, 1998; Fidel et al, 1999; Agosto, 2002; Branch, J., 2003, Todd, R., 2003; Neilsen, J., 2005; Dresang, 2005; Chung & Neuman, 2007). More recently, a study designed to forecast the behavior of future researchers explored the published literature related to young people's information behavior over the past 25 years and conducted a deep log analysis comparing different age groups' use of the same platform (CIBER, 2008). Findings from this study suggest that young people's information search skills have not improved over time. The idea that young people are expert searchers, the authors suggest, is "a dangerous myth" (2008, 20). Despite the whole-hearted adoption of information technology into the lives of adolescents, teaching and support in the area of information-seeking remain critical.

3. Metacognitive Knowledge

Metacognitive knowledge consists of three interrelated components: *self-knowledge* (awareness of one's own cognition, including knowledge of one's strengths and weaknesses and the awareness of one's motivational beliefs); *task knowledge* (knowledge about the cognitive demands of the task); and *strategic knowledge* (procedural knowledge of cognitive strategies to employ when unsuccessful) (Flavell, 1979; Garner & Alexander, 1989; Pintrich, Wolters & Baxter, 1996; Anderson & Krathwohl, 2000).

Metacognitive knowledge and can provide individuals with the intellectual support needed to negotiate complex information problems. Information seeking often occurs in response to open-ended questions, in open-learning environments or large information spaces, where information is from a variety of inconsistent and often incompatible sources. In such ill-defined problem spaces, metacognitive knowledge that can be applied to a wide range of information problems may provide the kind of scaffolding needed to move information seekers through the process successfully. Land (2000), in her study of project-based learning with the Web, found that metacognitive knowledge compensated for a lack of system and domain knowledge, suggesting that metacognitive knowledge can act as a scaffold in knowledge integration from Web sources.

4. The Information Search Process Model

Kuhlthau's (1991) Information Search Process (ISP) model identifies six stages in the search process, each stage representing a specific task: *task initiation, topic selection, pre-focus exploration, focus formulation, information collection and search closure (presentation).* In the ISP model, cognition, affect and behavior are intertwined, the pattern of feelings paralleling the specific tasks that information seekers undertake to make sense of knowledge during the search process. As information seekers move through the process, their feelings reflect their understanding of their research topic. High anxiety is associated with cognitive uncertainty and is related to difficulty integrating information from various sources into a meaningful whole. A turning point in the process comes when

Proceedings of the 36th Annual Conference of the Canadian Association for Information Science (CAIS), University of British Columbia, Vancouver, June 5-7, 2008

2

information seekers are able to find a focus for their information-seeking mission. Cognitive uncertainty turns to certainty and is soon thereafter accompanied by feelings of confidence, helping to launch the information seeker forward in the search process. One way for information seekers to effectively deal with uncertainty is to learn to expect it and see it as a normal part of the process. This implies a certain level of metacognitive awareness. If information seekers are to acknowledge uncertainty, they must first be able to identify it.

5. Research Questions

The primary question guiding this research is: *What is the role of metacognitive knowledge during the information search process of adolescents?* Two secondary questions frame the study and provide conceptual categories for data analysis:

1. Within the context of the search process, what are the qualities of adolescent metacognitive knowledge?
2. How does the metacognitive knowledge of adolescents map on to the cognitive, affective and behavioral dimensions of the search process?

The study attempts to answer these questions by investigating metacognitive knowledge through the lens of two models: Flavel's model of metacognition (1977) and Kuhlthau's (1991) Information Search Process model (ISP), a multi-dimensional model of users' thoughts, feelings and actions during the information search process.

5. Methods

The study used naturalistic research methods to investigate the metacognitive knowledge of ten adolescents, aged 16 to 18. The study was conducted in two phases: 1) A pilot study conducted during Spring 2006 and; 2) the principal study conducted six months later in Fall 2006. Data derived from the pilot study has not been included in this analysis.

5.1 The Setting

The principal study was conducted within a Montreal-area, English-language, junior college, commonly called a CEGEP. The acronym CEGEP stands for "Collège d'enseignement général et professionnel" or, "College of General and Professional Education." There are two program streams in the CEGEP system - a two-year pre-university program and a three-year professional program. In either case, the first year is roughly equivalent to Grade 12 elsewhere in Canada because high school in Quebec ends at Grade 11.

Like Grade 12 students everywhere else, students in CEGEP are at a critical time in their life vis à vis academic performance and personal decisions – the outcome of their educational experience has an impact on their future. While CEGEP students negotiate the same complex world of information as adolescents in the rest of North America, they do so in a new learning environment, many having just graduated from high school the year before. This puts an interesting twist on their search behavior because the CEGEP library and information systems available through the library are completely new to them. As well, the position of teacher-librarian does not exist in Quebec public high schools and most private high schools, and therefore information skills instruction at the high school level is limited. New CEGEP students are, in a sense, a *tabula rasa* – a clean slate as it were – and, at least in terms of library experience, they may have little else to guide them but their metacognitive knowledge.

5.2 The Participants

Ten adolescents, aged 16 to 18, participated in the study. All were academic achievers in their first term at CEGEP, having graduated from high school the previous year. All were also in the same required humanities course at the same CEGEP. (Note: Initially, an alternative site in a larger, comprehensive, public CEGEP had been investigated for the study, but was dropped when difficulties recruiting participants arose. Only one participant volunteered for the study from this second CEGEP and, while the researcher did collect data from this participant, the data has not been included here).

Proceedings of the 36th Annual Conference of the Canadian Association for Information Science (CAIS), University of British Columbia, Vancouver, June 5-7, 2008

3

5.3 The Information-Seeking Task

The research design was bounded by an information-seeking task that was created and assigned by the teacher. The 10 participants were asked to write a seven to eight- page argumentative essay exploring continuity and change in western civilization, on a topic of their choice. To do so, they searched for, selected, evaluated, and used information from a variety of sources.

5.4 Data Collection Protocols

The study used a combination of *Think Aloud* and *Think After* verbal protocols in order to provide as many venues as possible for the expression of thoughts, feelings and actions experienced by the participants during the search process. In this way, the data could be triangulated. Five types of data collection protocols were used in this study: 1) a series of three telephone interviews; 2) written and/or audio journals kept by the participants over the course of the semester; 3) an in-person interview immediately following the final submission of the essay; 4) a visualizing exercise (a timeline) and; 5) a follow-up interview conducted several months later.

5.5 Data Analysis

Analysis was inductive and grounded in the data, using the words and actions of the 10 participants to tell the story of their journey through the information search process. Atlas.ti 5.2 qualitative data analysis software was used to organize, code, and sort the data into interpretive categories.

5.6 Limitations

Due to the small sampling size, generalizations beyond the context of the study will be difficult to infer. The 10 participants in this study were high academic-achievers in a Montreal-area private school, and their behavior may not reflect that of the general population. As well, some of their behavior may have been shaped by the type of information task assigned to them by the teacher. The results of this study are specific to an area of domain knowledge – the history of western civilization – and are not generalizable to other domains of knowledge. In addition, the extent of the students' prior domain, information system and metacognitive knowledge, in relation to other students of their age, were not known as the qualitative methods to be used in this study precluded the use of a control group or wide sampling procedures. Only 2 of the 10 participants in this study were male and therefore the study presents no findings regarding gender-based behavior.

6. Attributes of Adolescent Metacognitive Knowledge

The 10 participants in this study had a wide range of metacognitive resources which they used to complete their information-seeking task. Gaps in the participants' knowledge were found as well, but perhaps more interesting was the concrete evidence of the awareness and application of metacognitive knowledge that was woven throughout each participant's story.

Thirteen attributes, or categories, of metacognitive knowledge related to the information search process were identified:

- Knowing your strengths and weaknesses;
- Knowing that you don't know;
- Building a base;
- Scaffolding;
- Communicating;
- Changing course;
- Balancing;
- Understanding curiosity;
- Understanding time and effort;
- Understanding memory;
- pulling back and reflecting;
- Connecting;
- Parallel thinking

The metacognitive knowledge of the adolescents in this study was surprisingly varied and wide-ranging. However, although most of the adolescents in this study demonstrated each of the thirteen attributes of metacognitive knowledge, they generally did so in idiosyncratic ways, so that it cannot be said that one pattern of metacognitive thinking overlays the entire Information Search Process model. Rather, an array of metacognitive tools emerged, to be used as required to solve the information problem of the moment.

Proceedings of the 36th Annual Conference of the Canadian Association for Information Science (CAIS), University of British Columbia, Vancouver, June 5-7, 2008

The participants in this study were hindered in their searches by a lack of procedural knowledge related to information problem solving *and* a lack of conceptual knowledge in the domain of history. These roadblocks were mediated by metacognitive knowledge, which was used as much as an emergency strategy as it was a deliberate line of attack. So while the young people in this study did show evidence of thinking ahead and planning, their use of metacognitive knowledge was as often as not reactive, rather than predictive – a paradox perhaps for a knowledge that is associated with planning. Each of the thirteen attributes of metacognitive knowledge is described below:

6.1 Knowing your strengths and weaknesses

In order to use your strengths you must first know what they are. Sometimes your strengths can only be revealed when you analyze your weaknesses. Self-knowledge is directly related to self-assessment, the ability to critique one's own cognitive and affective states being a commonly accepted attribute of metacognition.

With this type of metacognitive knowledge, the participants were able to put a name to what they knew and then take advantage of it. They were also able to pinpoint what they *didn't* know. With this self-awareness, the participants were able to assess the usability of the information vis à vis their own information needs. Often there seemed to be a mismatch between their own knowledge of history and the way that history was represented to them in the information resources they use. It seemed to them that they, the students, were the wrong audience. As one participant explained:

> "Articles from journals are really quite useless at my level. They expect you to have a fountain of knowledge…They go on this itsy-bitsy topic they've been studying for three weeks or, I don't know, months."

6.2 Knowing that you don't know

"Knowing that you don't know" is a type of self-knowledge and is related therefore to "Knowing your strengths and weaknesses" and to the larger category of self in Flavell's general model of metacognition. There are, however, differences between "knowing that you don't know" and "knowing your strengths and weaknesses". While "knowing your strengths and weaknesses" is dependent upon one's ability to put a name to what you know and then taking advantage of it, "knowing that you don't know" is a state in which you can identify a gap in your knowledge base but you cannot always say what that gap is. In other words, you cannot put a name to it. In the context of information science theory, "knowing that you don't know" is associated with Belkin's (1980) anomalous states of knowledge (the ASK) and Dervin's (1986; 1999) sense-making framework. Both models suggest that information seekers are prompted by an awareness of a gap between order and chaos.

As simple as it may seem, "knowing that you don't know" is a critical piece of metacognitive knowledge during the information search process because it alerts the information seeker that there is a problem and it is time to revise or make adjustments to the search strategy. However, in order to know that you don't know, you still need some knowledge of the territory, a paradox that prompts one to ask, how much do you need to know in order to know that you don't know?

6.3 Building a base

The information search process is sometimes perceived in metaphorical terms as a process of construction, where one makes sense of information step by step, brick by brick (Kulthau, 1991; Dervin, 1999). As with all construction, knowledge that emerges from the information search process must be built upon a strong foundation that can support the structure that rests upon it. The realization of this metaphor was fully expressed in the actions of the participants in this study. The metacognitive knowledge related to these actions was labeled "building a base" and it refers to the strategic use of exploratory tactics to help build foundational domain knowledge. As one participant explained, the Web proved to be a good environment in which to do this:

> "I just looked through really broad sites. I wasn't going for details yet and I sort of had an idea of what I was interested in - the topic - so I was just looking for information that was out there…I didn't look at articles. I just

Proceedings of the 36th Annual Conference of the Canadian Association for Information Science (CAIS), University of British Columbia, Vancouver, June 5-7, 2008

5

looked at web portals, some general information."

6.4 Scaffolding

Knowledge of metacognitive strategies, knowing when to apply them and being able to anticipate their "pay off", is a critical piece in the metacognitive knowledge toolkit. The students in this study, perhaps knowing full well that they "didn't know", actively implemented a range of metacognitive strategies to help them see what they should know, one of which was "Scaffolding".

"Scaffolding" refers to the act of searching for and using a cognitive support, or reinforcement, to help map out a conceptualization of the information environment. The participants looked for support structures to help them map out the information environment, often in the very information they were searching. For the students in this study, it did not matter where the structure came from – a person, a book or even *Wikipedia* - the important thing was its availability at the right time, providing some signposts to help guide them through the information search process.

The structure of books helped several students. Asked to identify something that helped her focus in on her topic, one participant explained how the organization of a book helped her:

"Well there was one book in particular. I really liked the way it was organized. It had two chapters that were related to my topic and then I looked at how they explored that. I looked at the introduction and it explained how they could deduce all this from the artifacts and then it went on to the facts…and it came back to queenship in general."

Tools contained within books, such as bibliographies and indexes, acted as pathfinders – a kind of travel guide to the information environment – and several students actively used these tools as a scaffold.

While the attribute of "scaffolding" is certainly an attempt to build knowledge, it is different from "building a base" in that "scaffolding" is a deliberate use of a pre-existing structure to help map the information environment while "building a base" is a more open-ended exploration of the environment, akin to browsing.

6.5 Communicating

This attribute of adolescent metacognitive knowledge involves the use of people as information mediators and information sources during the search process. Quite simply, it is knowing that talking to people is a useful cognitive strategy. Talking to people serves many cognitive purposes during the search process. "Talk" can help to clarify points of confusion about conflicting information or it can help to unite information into a cohesive unit. "Talk" can also be a quick source of information, helping to build a knowledge base, or can provide a road map for the next steps in the process.

Information seeking can be seen as a solitary process – if one has an information problem one searches, for example, the library's catalogue, the book shelves, online data bases or web portals, alone, for a solution. And yet the participants in this study used information mediators frequently and in a deliberate manner to help them solve their information problems. They turned to people in their network of relationships because they knew it was a good strategy for helping them to make sense of the problem. Knowing that the strategy exists, when to implement it and why, is representative of metacognitive knowledge.

6.5 Changing course

Changing course is metacognitive knowledge that is used to guide the choice of new tactics and strategies when the search is stalled or less fruitful than expected. Most of the change in tactics and strategies made by the participants in this study related to information retrieval – the selecting and gathering of resources during the stages of *Pre-focus Exploration* and *Collection*. But the participants also made adjustments to their topic selection, a tactic designed to make it easier to find and use information later in the search process.

What makes this metacognitive? *Changing course* is dependent on the ability to assess one's status during the search process. Information

Proceedings of the 36th Annual Conference of the Canadian Association for Information Science (CAIS), University of British Columbia, Vancouver, June 5-7, 2008

6

seekers who decide to change course realize that tactics and strategies previously applied either did not work or only worked up to a point. *Changing course* is also representative of the ability to plan and predict an outcome because it reflects evidence of thinking ahead to the next step. Without this type of metacognitive knowledge, information seekers will not know which changes to implement and will continue along an unsuccessful path toward an uncertain future.

Implicit in this attribute of metacognitive knowledge is the assumption that information seekers are actually on a self-directed course of action, and not just making random decisions. The study found that while the participants had the metacognitive means to adopt new tactics and strategies, these changes were applied to immediate cognitive difficulties, and not necessarily to the long term problem. So while the participants were able to predict an outcome, for many of them it was the outcome for the *next* step in the process, and not the final outcome of the school assignment.

6.7 Balancing
   Balancing relates to the cognitive task of making choices, sometimes between two desirable options, and knowing that making choices helps to move you forward in the search process because if you *don't* make a choice, the search will be stalled. *Balancing* is also about weighing the options and making compromises. For example, choosing between feeding curiosity or finishing the assignment; choosing between precision or recall; choosing one of two interesting topics; finding a balance between "good" information and information that is "good enough".

   Balancing has a strong evaluative component to it and although there was evidence that the students were aware of the cognitive complexities of the task of choosing *and* that they had an ability to make critical choices, many of the students actually found this aspect difficult. The problem for them, however, was not just that there was too much information – what is commonly called "information overload" – but that there was a choice between a few equally credible but contradictory sources. Perhaps for the first time in their lives, the students faced an information problem whose

answer lay in shades of grey, rather than in black and white.

6.8 Understanding curiosity
   The participants in this study often found themselves forced to make stark choices between their need to discover versus their need to fulfill the requirements of the school assignment. The regulation of this conflict represents a special type of metacognitive knowledge which has been labeled as *Understanding curiosity*. It involves a risk/benefit analysis that hinges on understanding how far curiosity can take you before it becomes a liability, rather than a benefit, for the task at hand. A few of the participants did not grasp the relationship between curiosity and control and, as a consequence, gathered too much information and then found it difficult to compress it into a neat package.

6.9 Understanding time and effort
   Successful outcomes are often the result of sustained effort, attention to detail and a consistent level of persistence. Woven throughout the data is evidence that the participants understood the connection between effort and results at a general level but that this understanding did not always translate into action. In other words, "knowing" did not always relate to "doing". The problem was perhaps related to the participants' understanding of the task at hand – completing a research paper for college. While the participants understood that effort generally pays off *in life*, many of them simply did not see the specific task of searching for information as something that required effort. This points to a lack of metacognitive awareness related to the cognitive demands of the information search.

   Another facet of effort is the understanding associated with knowing when *not* to invest effort in a task. While effort is often necessary in order to complete cognitively demanding tasks, sometimes the wisest action to take is to do nothing (or at least very little). Taking a shortcut, or doing something that simplifies the process, may certainly require less effort and if by doing less, one avoids wasting cognitive effort then it is a useful strategy.

Proceedings of the 36th Annual Conference of the Canadian Association for Information Science (CAIS), University of British Columbia, Vancouver, June 5-7, 2008

7

Managing time is a crucial skill for students. With obligations and deadlines to consider, how much time one devotes to each task, as well as when to work on it, becomes a critical decision. School projects that last the term present a particular "time management" problem for many students. As one participant said, long term projects are difficult because, "it's always the last on my list of priorities. Everything else comes first."

6.10 Understanding memory

Exploring an information-rich environment, such as a large academic library, an electronic database, or just surfing the Web, is like deep sea fishing: The information seeker casts a wide net into a big ocean and draws in all manner of information sources. Not everything in the net is useful but sometimes this is not known until many of the sources have been sorted. By this time, some information seekers forget where the critical pieces of information are located. If they have not used techniques to help them find their way back to the information, it could be lost to them forever.

Remembering where information is located is an important part of the information search process. Understanding the role of memory in information seeking, knowing that it is difficult to remember everything, knowing how one's *own* memory works and, knowing how and when to use specific strategies in order to help one remember where information is located so that it can be retrieved later, are all important metacognitive aspects of the information search process. Remembering is no doubt assisted by a strong conceptual understanding of the information environment, but since novice information seekers do not always have this, they must depend on the little tricks that help them remember the pathway back to relevant information.

6.11 Pulling back and reflecting

Taking the time to back away from a problem and think about it proved helpful to some of the participants in this study. As one participant advised, when confused, it helps to "leave for an hour. I find when I'm working on it too long it gets frustrating and I stop focusing." As little more than half of the students showed an awareness of the metacognitive benefits of reflecting, reviewing and just stepping away from the problem, this category presents itself as much as a gap in knowledge as it is a strength. Perhaps this is more a reflection of the tight deadlines and heavy workload carried by the students in this study than it is of any strength or weakness in metacognitive knowledge

6.12 Connecting

Participants who used this type of knowledge saw knowledge building as a process of construction and they understood that in order to make sense of the disparate pieces of information they had gathered, they now had to implement strategies for making connections. This type of metacognitive knowledge was demonstrated by one participant who, when looking at all the information he had gathered, asked himself, "How I can make the links more coherent or obvious?" He now understood that his conceptualization of the information was more important than having to find more.

Although related to *Building a base* and *Scaffolding* (because it is about finding ways to model and construct knowledge), this category of metacognitive knowledge is distinct because it is about the specific task of creating links between pieces of information. Much of this activity occurred in the final stages of the information search process.

One could conceive of *Connecting* as a linking process – the act of defining the relationships between nodes in a mental map. If each piece of information found in a search represents a node, then the relationships that bind them together represent the links. During the course of information seeking many nodes may be found but, unless linked together, the information seeker will not understand how all the nodes fit together into a whole. *Connecting* is dependent on *Knowing that you don't know*, an attribute of metacognitive knowledge that triggers the steps involved in linking information. Information seekers who know that they *don't* know say to themselves, I have all these pieces of information but now I need to connect them so that they make sense to me. What steps can I take to tie this information together?

Proceedings of the 36th Annual Conference of the Canadian Association for Information Science (CAIS), University of British Columbia, Vancouver, June 5-7, 2008

8

6.13 Parallel thinking

The participants' thinking in this study was not always "in-the-moment"; while doing one thing (and thinking about it) they were also thinking about something else. They frequently reviewed the past and predicted the future – even as they acted in the present. Some of this thinking represented deliberate planning - thinking about the next steps to take or forecasting one or two stages down the road. At other times, the thinking was more of an envisioning of the outcome or merely a vague curiosity about how the information search would unfold. To capture the image of two streams of simultaneous thought, the term *Parallel thinking* was applied to this attribute of metacognitive knowledge.

Parallel thinking was most closely linked to the latter stages in the information search process - *Collection* and *Presentation* - even though, in terms of actions, the participants were still located in early stages of the search. In other words, the participants were anticipating outcomes even as they worked their way through the first tasks in the search process. For example, one participant, wondering about the relevance of information she was *currently* gathering, asked herself, "Is this pertinent to my topic?" But, thinking ahead to when she would have to construct the essay, she then asked, "Can I actually use this info? Could I integrate it?"

7. Implications for Information Literacy

Information literate students have the set of competencies required to "recognize when information is needed and have the ability to locate, evaluate, and use effectively the needed information." (American Library Association, 2006). Underlying these abilities is a deeper layer of thinking that acts to guide decisions during the search process.

Teaching students how to use search tools like indexes, search engines and catalogues, while important, may not be enough. Librarians also need to teach students how to think about their own thinking. Kuhlthau (1994) suggested that teaching students about uncertainty - telling them that it is a normal part of the search process, that it should be expected, and that it is an indicator of work to be done – would help to keep them in the search process. So an important task for librarians, according to Kuhlthau, is to raise in information seekers a self-awareness about their own cognitive state and to teach this alongside the traditional skills of locating and evaluating information. But, as this study shows, there are many other types of "self-awareness" that students need to be taught.

For librarians thinking about how to teach metacognitive knowledge, what is the starting point? Metacognitively speaking, what should information literate students be aware of?

- The connection between expertise in domain knowledge and the ability to search for information. Acknowledging that you *don't* know is an important first step.
- The role of curiosity – it can help or hinder, depending on where one is in the search process;
- The limits of memory when searching in complex information environments and the steps that can be taken to facilitate it;
- Searching for information requires cognitive effort;
- More specifically, information seeking is an extended process of knowledge construction and not an instantaneous "Google" moment;
- Talking to people is a useful cognitive strategy for building knowledge. Interacting with an information mediator can help one monitor one's own thinking;
- In order to evaluate one's status more objectively it is helpful to gain distance from the information problem. Pausing to reflect is a critical metacognitive strategy;
- Choice-making is an inherent part of information seeking but the more conceptual and abstract the information, the more difficult it is to make the perfect choice. Even the right choice might involve a certain level of uncertainty;
- It's important to look toward the final outcome, to try to envision how the search will end, even as one begins the search process.

Proceedings of the 36ᵗʰ Annual Conference of the Canadian Association for Information Science (CAIS), University of British Columbia, Vancouver, June 5-7, 2008

9

9. Conclusion

The attributes of metacognitive knowledge identified in this study may provide a a roadmap for the development of a metacognitive tool kit that, if taught to young people, may help them search for information. The 10 young people who participated in this study helped to lay out this map by showing how they were helped or hindered by the geography of their own metacognitive knowledge. It is hoped that the map they set out will be used to assist other adolescents who will be stepping into the adult world and navigating through new, uncharted territory.

References

Agosto, D. E. (2002). A model of young people's decision-making in using the Web. *Library and Information Science Research*, *24*(4), 311-341.

Allen, B. (1991). Topic knowledge and online catalog search formulation. *Library Quarterly*, *61*(2), 188-213.

American Library Association. (2006). *Information Literacy Competency Standards for Higher Education.* American Library Association. 2006. Retrieved April 13, 2007, from Association of College and Research Libraries web site: http://www.ala.org/acrl/ilcomstan.html

Anderson, L.W., & Krathwohl, D. R. (Eds.), (2001). *A Taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives*. Abridged edition. New York: Addison Wesley Longman.

Belkin, N. (1980). Anomalous states of knowledge as a basis for information retrieval. *The Canadian Journal of Information Science*, *5*, 133-143.

Branch, J. (2003). Instructional Intervention is the Key: Supporting Adolescent Information Seeking. *School Libraries Worldwide*, 9 (2), 47-61.

Centre for Information Behaviour and the Evaluation of Research (CIBER). (2008). *Information behaviour of the researcher of the future: A CIBER briefing paper.* Retrieved January 21, 2008, from http://www.ucl.ac.uk/slais/research/ciber/downloads/

Chung, J. S., & Neuman, D. (2007). High school students information seeking and use for class projects. *Journal of the American Society for Information Science and Technology*, 58(10), 1503-1517.

Dervin, B. (1999). Chaos, order, and sense-making: A proposed theory for information design. In R. Jacobson (Ed.), *Information design* (pp. 35-57). Cambridge, Mass.: MIT Press.

Dewey, J. (1933). *How we think. A restatement of the relation of reflective thinking to the educative process* (Revised ed.), Boston: D. C. Heath.

Dresang, E. (2005). The information-seeking behavior of youth in the digital environment. *Library Trends*, *54*, (2), pp. 187-196.

Environics Research Group. (2004). *Young Canadians in a Wired World. Phase II. Focus Groups.* Retrieved December 7, 2005, from Media Awareness Network web site: http://www.media-awareness.ca/english/special_initiatives/surveys/phase_two/upload/yccww_phase_two_report.pdf

Proceedings of the 36th Annual Conference of the Canadian Association for Information Science (CAIS), University of British Columbia, Vancouver, June 5-7, 2008

10

Fidel, R., Davies, R. K., Douglass, M. H., Holder, J. K., Hopkins, C. J., Kushner, E. J. et al. (1999). A visit to the information mall: Web searching behavior of the high school students. *Journal of the American Society for Information Science*, *50*(1), 24-37.

Flavell, J. (1979). Metacognition and cognitive monitoring: A new area of cognitive-developmental inquiry. *American Psychologist, 34* (10), 906-911.

Foster, G., Sawicki, E., Schaeffer, H., & Zelinski, V. (2002). *I think, therefore I learn!* Markham, Ontario: Pembroke Publishers.

Garner, R., & Alexander, P. A. (1989). Metacognition: Answered and unanswered questions. *Educational Psychologist, 24*, 143-158.

Giedd, J. N., Blumenthal, J., Jeffries, N. O., Castellanos, F. X., Hong, L., Zijdenbos, A. et al. (1999). Brain development during childhood and adolescence: A longitudinal MRI Study. *Nature Neuroscience 2*(10), 861-863.

Hacker, D. J., Dunlosky, J. & Graesser, A. C. (1998). *Metacognition in educational theory and practice.* Mahway, NJ: Erlbaum.

Hirsh, S. G. (2004). Domain knowledge and children's search behavior. In M. K. Chelton & C. Cool, (Eds) *Youth information-seeking behavior: theories, models, and issues* (pp. 241-270). Toronto: Scarecrow Press.

Hollands, J. G., & Merikle, P. M. (1987). Menu organization and user expertise in information search tasks. *Human Factors, 29*, 577-586.

Hsieh-Yee, I. (1993). Effects of search experience and subject knowledge on the search tactics of novice and experienced searchers. *Journal of the American Society for Information Science*, *44*(3), 161-174.

Kuhlthau, C. C. (1991). Inside the search process: Information seeking from the user's perspective. *Journal of the American Society for Information Science, 42*(5), 361-371.

Kuhlthau, C. C. (1994). Students and the information search process: Zones of intervention for librarians. *Advances in Librarianship, 18*, 57-72.

Land, S. & Greene, B. (2000). Project-based learning with the World Wide Web: A qualitative study of resource integration. *Educational Technology, Research and Development, 48*(1), 45-68.

Marchionini, G., Dwiggins, S., Katz, A., & Lin, X. (1993). Information seeking in full-text end-user-oriented search systems: The roles of domain and search expertise. *Library and Information Science Research, 15*(1), 35-69.

Marchionini, G., Lin, X., & Dwiggins, S. (1990). Effects of search and subject expertise on information seeking in a hypertext environment. In D. Henderson (Ed.), *ASIS '90 : proceedings of the 53rd ASIS annual meeting, Toronto, Ontario, November 4-8, 1990* (Vol. 27, pp. 129-137). Medford, N.J.: Learned Information.

Marchionini, G., Meadow, C., Dwiggins, S., Lin, X., Wang, J., & Yuann, W. (1991). A study of user interaction with information retrieval interfaces: Progress report. *Canadian Journal of Information Science, 16*(4), 42-59.

Neilsen, J. (2005, January 31). Usability of websites for teenagers. In *Jakob Neilsen's alert box, January 31, 2005.* Retrieved April 4, 2007, from http://www.useit.com/alertbox/teenagers.html

Proceedings of the 36th Annual Conference of the Canadian Association for Information Science (CAIS), University of British Columbia, Vancouver, June 5-7, 2008

Pintrich, P. R., Wolters, C. A., & Baxter, G. P. (1996). Assessing Metacognition and Self-regulated Learning. In G. Schraw, & J. C. Impara (Eds). *Issues in the Measurement of Metacognition* (pp. 43-97). Lincoln, Nebraska: Buros Institute of Mental Measurements.

Todd, R. (2003). Adolescents of the information age: Patterns of information seeking and use, and implications for information professionals. *School Libraries Worldwide. 9* (2) (July 2003): 27-46.

Watson, J. S. (1998). "If you don't have it, you can't find it." A closer look at students perceptions of using technology. *Journal of the American Society for Information Science*, 49(11), 1024-1036.

Proceedings of the 36th Annual Conference of the Canadian Association for Information Science (CAIS), University of British Columbia, Vancouver, June 5-7, 2008