The Trouble With Think Alouds:
Generating Data Using Concurrent Verbal Protocols

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Abstract
Verbal protocol analysis is a methodology that is frequently used in cognitive psychology and education. The use of this method in library and information studies, however, is still very limited. Verbal protocol analysis aims to find cognitive processes while solving a problem. However, concurrent verbal protocols have been seen to cause problems when the task involves a high cognitive load, when the information is difficult to verbalize because of its form, i.e., visual data, or when the processes are automatic for the participants. This paper looks at studies using concurrent verbal protocols and summarizes the findings of this research. Then, this paper compares and contrasts the analysis of 130 concurrent verbal protocols (Think Alouds) gathered from twelve junior high school students from Inuvik, Canada. These Think Alouds are from a case study of the information-seeking processes of junior high students when accessing information from CD-ROM encyclopedias. Preliminary analysis indicates that several of the participants experienced difficulty with Think Alouds. A discussion of possible reasons for these difficulties will be included.

1. Introduction

J: This time I want you to find the first man in space. Remember to talk and tell me.
I am just putting first man in space.
(No topics found) I clicked okay. (clicked search by word - no topics found) I clicked okay again. I am clicking articles. I am clicking go.
(no topics found) I am clicking okay.
(no topics found) Clicking okay.
I’m looking at the picture of the article.
(sitting and thinking)
Typing in man space. (typed in space) Clicking search by word.
(Mary, Grade 9 student)

I knew as this search was happening that this participant was having difficulty generating a Think Aloud protocol. It did not happen with every participant but there seemed to be some participants who just could not do a Think Aloud. What was happening? Why were some students so comfortable with Think Alouds? Why were some students able to do the Think Alouds while others barely said a word, even with prompts?

Concurrent verbal protocols are increasingly used as a source of data for process inquiry tasks such as reading, writing and problem solving (Stratman & Hamp-Lyons, 1994, p. 89). The verbal protocol analysis method is now accepted by a large part of the psychological community and is being used in a variety of different research areas. Hayes and Flower (1983) and Ransdell (1995) have used it in research in the area of writing. Whitney and Budd (1996) used the method to study text comprehension, and other researchers have used the method to study reading comprehension strategies. Murtaugh (1984) used verbal protocol analysis to study the grocery shopping decision-making process. Sullivan and Seiden (1995) assessed the online catalog user education needs using the method. Verbal protocol analysis has been used to look at chemistry, physics, and math problem solving, and the development of expert systems, and it can provide diagnostic information for teachers. Cacioppo, von Hippel and Ernst (1997) cited the many uses of verbal protocol research in clinical and counseling psychology (e.g., social phobia, snake phobia, test anxiety, social anxiety, romantic relationships and group therapy).

Concurrent verbal protocols should provide a "dramatic increase in the amount of behaviour that can be observed when a subject is performing a task while thinking aloud compared to the same subject working under silent conditions"
Yet in this research study, some of the participants had difficulty with Think Alouds. Stratman and Hamp-Lyons (1994) call it the "reactivity problem" (p. 90). This is the notion that something can happen when participants are required to do Think Alouds while carrying out a task. They suggest there are five factors that may cause reactivity in concurrent verbal protocols:

1. experimental task directions to subjects that elicit an inappropriate level of verbalization;
2. limited short-term memory capacity for talking and attending at the same time;
3. hearing one’s own voice;
4. learning that occurs because thinking out loud increases subjects’ critical attention to their activities; and
5. direct or indirect experimenter influence through verbal or nonverbal cues (Stratman & Hamp-Lyons, 1994, p.95).

It is the second point that is the most interesting to this researcher. The focus of this paper will be the work of Biemiller and Meichenbaum and their colleagues (1992, 1992, 1998, 1998). Using part of the coding scheme of Biemiller and Meichenbaum (1992), Think Aloud data from the 144 protocols was coded. The results of this coding and the implications for future research will be discussed.

2. Literature Review

This literature review will explore the three main areas of this study. Firstly, an overview of concurrent verbal protocols and the Ericsson and Simon’s theory of information processing will be discussed. A brief presentation of recent information-seeking research using the think aloud method follows. The major part of the literature review will describe the work of Biemiller and Meichenbaum.  

2.1 Verbal Protocol Analysis

For qualitative researchers interested in getting a rich source of data, the verbal protocol analysis method is an excellent choice. Wilson (1994) emphasized that
inspiration can be gained from people’s conscious thoughts. Pressley and Afflerbach (1995) expanded the idea by noting that “spoken language is the data used in protocol analysis and the richness and variability of language are the greatest assets and liabilities of the verbal reporting methodology” (p. 2). Verbal protocol analysis is a way to gain information about a participant’s cognitive using verbal reports. Verbal reporting is bringing thoughts into consciousness, making the ideas verbal if needed and then verbalizing them (Ericsson & Simon, 1984). Concurrent verbal reports are also referred to as talk aloud, think aloud or thought-listing techniques. For this study, the concurrent verbal protocols are referred to as Think Alouds. Data gathered by Think Alouds can provide information to test hypotheses and models of behavior (Ransdell, 1995). Protocols done properly, according to Russo, Johnson, and Stephens (1989), report the thoughts of participants but do not explain them. Ericsson and Simon (1984) based their work on verbal protocol analysis on the constructs of short-term and long-term memory from information-processing theory. They hypothesized that all human cognition is information processing and stated “that a cognitive process can be seen as a sequence of internal states successively transformed by a series of information processes” (p. 11). Long-term memory contains a vast amount of knowledge, both procedural and factual, that can be accessed. The way that this information is organized is highly individual. Short-term memory, on the other hand, is extremely limited if the information is not acted upon. External stimulation and associations from long-term memory are the basis of short-term memory. According to Pressley and Afflerbach (1995), short-term memory can be quickly accessed and the contents reported. It is this short-term memory that verbal reports tap. Ericsson and Simon (1984) used this conclusion to validate the think aloud data that was gathered earlier in the century and to promote its continued use today.

2.2 Information-Seeking Research

Researchers interested in information-seeking behavior have used verbal protocol analysis. Yang (1997) used verbal protocol analysis and observation to
study six cases of information-seeking behavior in university students as they accessed information in the Perseus Hypertext System. She had her participants practice thinking aloud and then asked them to think aloud while working on the problem. Hughes, Packard and Pearson (1997) also used the think aloud method in looking at reading in a hypertext environment. They introduced the method to the participants using a video of other computer tasks so that the method was demonstrated without “suggesting strategies for using the intended target of research” (p. 5). Xie and Cool (1998) used think aloud to study end-user online searching. They found, through the use of this method, “much insight is gained into the problems encountered by searchers and the adaptive strategies they employ in such situations” (p. 329). Hirsh (1999) used the think aloud method to study elementary students’ relevance criteria and search strategies during a school project. Her results have implications for how we teach students about information literacy and for the design of systems (p. 1265). All of these researchers used the Think Aloud method for data collection, yet none discuss reactivity or any difficulties with the method in generating their data.

2.3 Work of Meichenbaum and Biemiller

The interest of Biemiller & Meichenbaum and their colleagues (1992, 1992, 1998, 1998) in the self-directed learner seems, at first, totally incongruous with this work on information-seeking processes and verbal protocol analysis. Yet, on closer study, the researchers are interested in the very same thing – the nature of thinking out loud as one does a task. Their research, conducted over the past 15 years, involves studying the most and least self-directed students in elementary schools as identified by their teachers and peers. In a study involving 70 high and 70 low self-directed learners, the researchers recorded what the students did and what the students said. This involved recording the students’ self-talk, their talk to peers, and their talk to teachers. As a result of this work, Biemiller and Meichenbaum (1992) developed a coding system to analyze the “children’s discourse about tasks” (p. 76).
This coding system enabled the researchers to compare high and low self-directed learners and to “infer the nature of their cognitive and metacognitive self-regulatory activities” (p. 76). This task-related speech, or Think Alouds, provided the researcher with a way of accessing the cognitive processes of a learner. Biemiller and Meichenbaum (1992) determined that “children whose level of cognitive development exceeds the complexity of tasks they are being taught have “surplus mental capacity” permitting them to “think” (self-dialogue) about what they are doing” (p. 76). On the other hand, children who are less cognitively advanced approached a task with fewer skills. As a result, they encountered an overload or, at the very least, needed their full attention to complete the task. These low self-directed learners had “little or no capacity left for verbal thought processes while conducting the task” (p. 76).

Specifically, Biemiller and Meichenbaum (1992) found that highly self-directed learners generated more than twice as many statements as less self-directed learners. The statements were coded as defining, planning, conditional planning, monitoring, or evaluating. The following is an explanation of the coding categories:

**Defining:** Statement or question labels and notes features of tasks, procedures, and objects (“It’s John’s game.” “That’s red paint.”).

**Planning:** Statement or question about what will or should happen next (“Can I do X?” “Mix some soap in the paint.” “Where are the sparkles?” “I need…”).

**Conditional Planning:** Statement or question related a plan to a condition or specifies the basis for choosing between alternative plans (“If we make noise, then we won’t have recess.”).

**Monitoring (ongoing task):** Statement or question notes progress, or lack thereof, on the task (You’re going too fast.” “Slow down.”).
Evaluating (completed or aborted task): Statement or question concerns conclusions on ending the task – regarding the product, the child’s ability, or the experience of doing the task (“This is my best one so far!” “I can’t do it!” “The math squares are fun!”) (Biemiller & Meichenbaum, 1992, p. 78).

Both groups had similar rates of defining and evaluating statements but highly self-directed learners had more planning and monitoring statements. The authors suggest that “spontaneous planning and monitoring statements are crucial indicators of the degree to which a child is functioning with expertise in a specific situation” (Biemiller & Meichenbaum, 1992, p. 76). Seventeen task-directive statements per hour were received by less self-directed learners from their teachers. Highly self-directed students received only two statements per hour from their teachers. Teachers were “thinking for” the less self-directed learners by giving them planning and monitoring statements (Biemiller & Meichenbaum, 1992).

Meichenbaum and Biemiller (1998), in their book Nurturing Independent Learners: Helping Students Take Charge of Their Learning, present a three-dimensional theory of mastery.
Based on the constructivist model, this theory consists of the Skill and Vocabulary Dimension, the Planning/Application Complexity Dimension and the Self-Direction Dimension. The Skill and Vocabulary Dimension “refers to the level of difficulty or complexity of the skills and concepts required for successful accomplishment of the task” (p. 70). While one goal of instruction is to teach students to perform more difficult tasks, another goal is “to teach students to transfer skills and strategies they have learned to analogous tasks in new situations” (p. 72). The Planning/Application Complexity Dimension refers to this second goal. The third dimension, the Self-Directed Dimension, refers to the range of tasks that a learner encounters. These tasks can “range from being other-directed (others guide the learner through the performance of the task on a step-by-step basis), to being self-directed (the learner is responsible for all aspects of accomplishing the task)” (Meichenbaum & Biemiller, 1998, p. 75). Meichenbaum and Biemiller (1998) identified “three phases of self-direction: acquisition, consolidation, and consultation” (p. 75). These three phases fall within Vygotsky’s Zone of Proximal Development.
In the acquisition role, the learner “observes, imitates and acts under the guidance of the instructor” (Meichenbaum & Biemiller, 1998, p. 75). In this role, learners are less likely to be able to do the task and to also be able to talk about it at the same time. In the consolidation role, the task begins to become more automatic. This automaticity “reduces the attentional and memory load associated with the skill, freeing up cognitive capacity to attend to other features of the task or to talk or think about the task while doing it” (Meichenbaum & Biemiller, 1998, p. 76). In the consolidation role, the learner becomes more able to plan and ask questions, and, as a result, becomes more efficient. Learners who have reached the consultation role “can perform requisite skills and plan specified applications, provide assistance to others as needed, collaborate effectively with others in planning large tasks, and consult with themselves when they encounter difficulties or problems in accomplishing tasks” (Meichenbaum & Biemiller, 1998, p. 77).

Biemiller and Meichenbaum’s work is very interesting, especially when considering the problems that some of the participants in this study appeared to encounter when doing Think Alouds while searching CD-ROM encyclopedias. Stratman and Hamp-Lyons’ (1992) list of reactivity factors includes “limited short-term memory capacity for talking and attending at the same time” (p. 95).

To determine if the acquisition, consolidation and consultation roles could be applied to junior high information-seeking processes, the coding scheme developed by Biemiller and Meichenbaum (1992) was used.

3. The Study
The piece of transcript and the comments from the researcher at the beginning of this paper are part of a larger research project that looks at the information-seeking processes of junior high students as they access information using CD-ROM encyclopedias. The study took place in Inuvik, Northwest Territories, Canada in the autumn of 1999. Twelve participants, recommended by their teachers, participated in the study. Each participant completed 12 searches so that at the end of the study there were 144 Think Aloud protocols. The participants searched the encyclopedia for answers to four researcher-generated questions, four teacher-generated questions, and four self-generated questions. While transcribing the 144 Think Aloud protocols, I started to notice that some participants had what I would call incomplete Think Alouds, that is, very brief Think Alouds or very procedural Think Alouds. Some of the participants were not able to generate complete Think Alouds while performing the task. There has been much written about why this can happen. Stratman and Hamp-Lyons’ (1994) list of factors is a good one. These include poor Think Aloud directions, limited capacity in short-term memory to do task and Think Aloud, hearing the sound of one’s own voice, increase in learning due to Think Alouds, and influence of researcher’s verbal and non-verbal cues (Stratman & Hamp-Lyons, 1994). It is the notion that some participant’s may be unable to do a task and Think Aloud at the same time that is most interesting to this researcher.

The work of Meichenbaum and Biemiller provided one way of looking at the participants in this study and their ability to generate Think Alouds. Using Biemiller and Meichenbaum’s (1992) coding scheme for task directive speech, the 144 Think Aloud Protocols were analyzed. This involved coding each statement as defining, planning, monitoring or evaluating. For this study, planning and conditional planning were combined under the planning task function because only two examples of conditional planning were found after coding all of the Think Alouds.

Search session 1 required all of the participants to search for the answers to four researcher-generated questions. The questions were:

- Who was the first woman in space?
• Describe the cardinal, a bird.

• Who was the first man in space?

• Describe the boxer, a dog.

Search session 2 had four teacher-generated questions based on the social studies curriculum for each grade, i.e., Alaska for Grade 7, Egypt for Grade 8, and inland Canadian Waterways, Latitude and Longitude for Grade 9. The final search session required participants to search for the answers to four self-generated questions. These question included topics on sports (hockey, soccer and rugby), Halloween (scary stories, trick or treat, black cats and witches), Northern topics (Fort McPherson, Inuvik, snowmobiles, and the Northwest Territories), popular culture (Pokemon, Blair Witch Project, and horror movies), Anne of Green Gables, world countries and major cities.

4. Results

The data was coded using coloured stickers to represent each of the five coding categories. A total of 2221 statements were coded from the 144 Think Alouds. This section will report the overall results of the coding during the three search sessions. It will also compare all of the participant’s Think Alouds during Search Session 1. Who was the first woman and man in space, questions 1 and 3 in Search Session 1, required quite complex searching. Questions 2 and 4, i.e., describe the cardinal, and describe the boxer, were more simple searches. It is interesting to look at the differences between participant’s Think Alouds in simple and complex searches. The first table below shows the results of the coding. The tables use the following:

D – defining; P – planning; M – monitoring; E – evaluating; and, T – total.

4.1 Overall Results

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Table 1: Number of Statements Coded by Search Session
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A quick look at the table above shows that there was a range in the number of Think Aloud statements in each search session. In Search Sessions 1, 2, and 3 there was a total of 1037, 583, and 601 statements, respectively. In Search Session 1, Fran had 278 statements while Sue had only 27, a difference of 251. In Search Sessions 2 and 3, the range was smaller, 82 and 124, respectively. The first session had many more statements because students had a more difficult time finding the answers to the questions. Also with practice students became more efficient searchers. The mean number of statements decreased from 86.4 in Search Session 1 to 58.6 in Search Session 2 to 50.1 in Search Session 3.

Participant Carol had no planning, monitoring or evaluation in her first session but planning and monitoring did increase over time. Fran, Chris, and Bob had planning and monitoring statements in each of the search sessions. Fran and Sue were the only participants with evaluating statements in each search session. Several of the participants did very little planning or monitoring during all three of the search sessions.
The graph shows the differences in the number of statements by each participant. The average number of statements was 181. Chris, Paul and Fran generated a lot of Think Aloud data. Other participants such as Sue, Mary, Ken, and Eric generated much fewer statements than the average. Biemiller and Meichenbaum (1992) noted in their research that highly self-directed learners generated more than twice as many statements as less self-directed learners.

4.2 Results of Search Session 1

It is impossible to compare between grades for Search Session 2 because different questions were asked. Search Session 3 also can not be compared as each participant generated search questions of his/her own. However, it is interesting to look at Search Session 1. Participants had two very different types of questions. The answers to the first question “Who was the first woman in space?” and the third question “Who was the first man in space?” were quite difficult to find. These questions were chosen because they were quite complex.

4.3 Results of Complex Searches

<table>
<thead>
<tr>
<th>Name</th>
<th>First Woman in Space</th>
<th>First Man in Space</th>
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Four of the participants, Carol, Lynn, Mary and Sue did not have any planning or monitoring statements in the first search. However, the searchers were very different. Carol and Mary are novice searchers and admitted in the initial interview that they didn’t know anything about computers. Lynn and Sue, on the other hand, are experienced searchers and found the answers quickly and easily. Explanations for the few planning and monitoring statements can be explained by the work of Biemiller and Meichenbaum (1992). When learners in the acquisition role are faced with a new task it “creates overload”, or at least occupies the student’s full attention” (p. 76). Mary and Carol were unable to do the task and also think about it at the same time. Lynn and Sue, on the other hand, were very familiar with the task and searching for an answer was an automatic process; one that needed little self-talk or thought.

Several of the participants had a high number of planning and monitoring statements. These participants, Chris, Bob and Eric, were likely in the consolidation or consultation role. They felt comfortable doing the Think Alouds and generated more planning statements than the group as a whole. They were all familiar with computers, had one at home and spent time searching on the Internet. When searching for the answer to “Who was the first man in space?” a few more of the participants had planning statements. It may not be surprising
to note that the boys tended to be more familiar with computers and to do some planning and/or monitoring in each search. Two of the participants had no planning or monitoring statements in either search. Mary and Carol are both novice users and were very quiet during their searches. A piece of Mary’s Think Aloud is included in the introduction to this paper. Although Mary continued to be very quiet during her searches, Carol actually began to use more planning and monitoring statements as she progressed through the searches. This may indicate a movement from the acquisition role to the consolidation role.

4.4 Results of Simple Searches

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Table 3: Number of Statements in Search Session 1 (Questions 2 and 4)

The second and fourth questions were much easier for most participants. Most of the participants typed in the word cardinal or boxer and immediately found the answer. It is interesting to note how much Think Aloud data was generated by Fran even in these very simple searches. She was very talkative throughout the study and had more evaluating statements than any other participant.

Even though finding the answer to these two questions was easy, Bob, Paul and Chris still did some of planning and/or monitoring in each search. Bob was a very interesting participant. He had just moved to Inuvik from California about a month before the study began. He spontaneously used language to solve the task and also to relate this search to his own background knowledge and experiences.

Meichenbaum and Biemiller (1998) propose that students like Bob are in the consultation role and “they come to understand the task, and to be able to call upon the associated skills (in a literal, verbal sense) when new situations occur in which the skills are relevant” (p. 77).

5. Discussion

Learners are unique and brings to a task their own skills, experience and vocabulary. The researcher has to keep this in mind when using concurrent verbal protocols as a way of gathering data. The work of Biemiller and Meichenbaum helps to explain why some searchers experienced difficulty generated complete Think Alouds. Those students who are not in the consolidation or consultation role in the given task may have difficulty generated Think Alouds. To get the best and most complete data then, researchers must ensure that learners are given time to become familiar enough with the task so that they can speak about what they are doing. However, learners must not be so familiar with the task that it becomes automatic and they are unable to think out loud about the task.
It is a delicate balance that must be reached by the researcher and, obviously, one that is difficult to do with a group of junior high students. Biemiller and Meichenbaum (1992) suggest that sometimes “teachers and more advanced peers sometimes “think for” less self-directed children” (p. 77). It may be unreasonable to expect those students to generate complete Think Alouds. Some students have spent seven or more years in school becoming other-directed. These learners come to depend on others to act as their support systems. Others in the classroom end up doing the defining, planning and monitoring activities for the less self-directed learner. As a result, this becomes a “self-maintaining cycle” (Biemiller & Meichenbaum, 1992, p. 77).

One example of this can be seen in the following piece of transcript with Dave.

J: Alrighty, so now who was the first man in space? So you’ve had some experience with this. What are you going to type in?
I am typing in the first man in space. There’s no topics found.
J: Okay, so now what are you going to try?
Who was the first person in space?
J: What else do you know? What other topics might it be under?
Try search by word rather than go. So no matches found. Okay. So close that with the x and find to search again. Try something else.
Delete that and try something else.
(types in who was the first man in space)
J: Okay, what other words can you try? So, who was the first man in space isn’t working. Where else might you try? Any ideas?
What’s going through your head? What other words are you thinking about? Or are you thinking about other words you can try?
Do you know the names of any astronauts?
Neil Armstrong
J: Why don’t you give it a try? He may not be the first but he may be a place to start, eh?
(types in Neal Armstrong)
J: Just try Armstrong or maybe you spelled Neil wrong.
Neil A. Armstrong.
J: Try that. Okay, that’s his picture. Go back and see if there’s an article or you can see. What does this say? So who was he?
He was man on the moon.

This learner was experiencing difficulty with the search. As a teacher, I began, unconsciously, to do the defining, planning and monitoring for the learner. Dave was a less self-directed learner. Everything I knew about him told me this. Without knowing anything about the work of Biemiller and Meichenbaum, I began to act as a “mental crutch” for Dave as he searched.

Lynn’s transcript reveals another pattern. This exchange was quite different from Dave’s. Lynn was highly self-directed and quite familiar with the task.

J: I want to know what the cardinal looks like, the bird looks like.
A cardinal?
J: Umm.
I don’t know if this is going to work but I will try it again. (types in bird, cardinal) So just the appearance?
J: Um hum.
Okay.
J: Just the appearance.
Is this a picture?
J: I think so. Then you can click on cardinal, I think. It gives the sound or something.
J: Um hm.
So is that all you need?
J: Yup.

Biemiller and Meichenbaum (1992) suggest that “teachers should strive to systematically monitor their students’ social and self-discourse in order to infer the children’s level of knowledge, strategies, and motivation” (p. 77). These
are important clues to each student’s level of competence and expertise. A researcher should do the same thing. In this case, I should have spent time observing and listening to the self-talk of each student as they searched so as to infer what role they were in. Those students who were in the consolidation or consultation role would then be ready to generate Think Alouds. However, those students in the acquisition role should be allowed more time to become familiar with the task before being asked to do Think Alouds.

6. Conclusion

Biemiller and Meichenbaum (1992) suggest that “students who are more expert have the ability to nurture their own self-regulatory skills” (p. 77). Because teachers often provide planning and monitoring information, they may not “provide the less competent child with the same opportunities or tasks to practice to develop his or her self-regulatory competence” (p. 77). As a teacher and a researcher, it is disheartening to hear my own talk during the search sessions. At the time, I was just “trying to help” but now realize that I was influencing the kind of Think Alouds that some of the student’s generated. The work of Biemiller and Meichenbaum will be very important when designing future research.

There is no way to know whether the ability to generate Think Alouds in this research study can be attributed only to the role the learner was in, i.e., acquisition, consolidation, or consultation. As Stratman and Hamp-Lyons (1994) suggest there are several other factors that may have influenced the Think Alouds. There could have been confusion as to what the researcher wanted when asking for the participant to Think Aloud. There was a cultural difference between the researcher and some of the participants that may have influenced the Think Alouds. There may have been gender issues or learning style issues that influenced the Think Alouds. Any or all of these may have contributed to incomplete Think Alouds.

However, the Biemiller and Meichenbaum present a very interesting theory that appears to hold true in this situation. Their suggestions for helping all learners
become more self-directed are good ones. Teachers and researchers will have difficulties because students “ vary in the areas in which they have expertise” (Biemiller & Meichenbaum, 1992, p. 77). Researchers need to be aware that differences exist and help learners move from the acquisition role through the consolidation role to the consultation role. Not only will this be of benefit to the learner; it may also help to generate the best Think Alouds possible.

References
http://readingonline.org/research/explorer/.
Yang, S. C. (1997). Information seeking as problem-solving using a qualitative approach to uncover the novice learners' information-seeking processed in a