Design Techniques for Revealing Adolescent Memory Processes Related to Information Seeking:
A Preliminary Study

Leanne Bowler
lbowler@sis.pitt.edu
412-624-7679
University of Pittsburgh
135 North Bellefield Avenue
Pittsburgh, Pennsylvania, 15260

Eleanor Mattern
emm100@pitt.edu

University of Pittsburgh
135 North Bellefield Avenue
Pittsburgh, Pennsylvania, 15260

ABSTRACT

This study investigates the effectiveness of design techniques as a means for uncovering metamemory, an attribute of metacognition, and its role in information seeking. A focus group with four adolescents aged 13 and 14 used design techniques such as brainstorming and sketching, metaphorical design and fictional inquiry, to help express their thinking about their own memory processes during the information search process. Results showed that metaphorical design and fictional inquiry are both effective tools for revealing conceptual thinking about metamemory and information seeking. Coupling these techniques with brainstorming and sketching helped the teens to visualize and communicate their ideas. Results from this study will contribute to knowledge about adolescent thinking, metamemory, and information seeking behavior, broaden the range of methodological approaches used in the study of information seeking behavior, and will provide cognitive models for the design of information systems and tools that scaffold metacognition.

Keywords

Adolescents, youth information-seeking behavior, focus groups, cognitive modeling, metacognition, metamemory, design techniques, ideation, metaphorical design, fictional inquiry, sketching, brainstorming.

1. INTRODUCTION

Metacognition is commonly defined as thinking about one's own thinking (Flavell, 1979). It involves an awareness of one's own cognitive state and the ability to monitor and evaluate the use of metacognitive problem-solving strategies (Brown, 1987; Lajoie, 2008). Metacognition is particularly helpful in the open-ended information environment of the Web where the difficulty is not just related to finding information, but in filtering and integrating it into a cohesive whole (Land & Green, 2000). These acts assume a level of understanding about one's own information needs, goals and abilities – a kind of self-knowledge that comes from focused, controlled, and reflective thinking.

The purpose of this study was to test the use of design techniques as a method for uncovering an attribute of adolescent metacognition, specifically the understanding of memory and its role in information seeking. The problem this study seeks to tackle is related to the difficulty in studying metacognition and information seeking. Bowler, in a paper describing methods for uncovering metacognition (2007), compared it to the difficulty in determining the location of the sun based on the shadow it casts on the earth - metacognition is a mental operation that expresses itself through words and actions and, like the sun, it can rarely be observed head on. As a result, metacognition has traditionally been studied using two inferential methods: verbal protocols (think-aloud and think-after) or by observation of behavior. Such methods were employed in the work of Bowler (2007, 2010a, 2010b, 2010c) in her study into the metacognitive knowledge of adolescents during the information search process. Design-based research may offer a third way, one that asks people to project their understanding of metacognition onto a design.

This study applied techniques from design as a means for uncovering one aspect of metacognition, specifically metamemory, and its role in information seeking. Particular emphasis was given to techniques that use metaphor as an instrument for disclosing thought processes.

A focus group with four adolescents, aged 13 and 14, used techniques such as brainstorming and sketching, metaphorical design, and fictional inquiry, to help express their thinking about their own memory processes during the information search process. The participants were then asked for feedback on their experience in order to help the researchers refine the methods for future iterations of the study. The study enriches knowledge related to metacognition and its role in information-seeking and will provide the foundation for future work actualizing user-generated ideas in a prototype for a developmentally-appropriate application that scaffolds metacognition during the search

2. BACKGROUND
2.1 Understanding memory
The study was framed by Bowler's taxonomy of adolescent metacognitive knowledge during the information search process (2010), which consists of 13 attributes: *balancing, building a base, changing course, communicating, connecting, knowing that you don't know, knowing your strengths and weaknesses, parallel thinking, pulling back and reflecting, scaffolding, understanding curiosity, understanding time and effort*, and *understanding memory*. This study looked specifically at the last attribute - *understanding memory* – which is a type of metamemory related to information seeking behavior. (First defined by Flavell and Wellman (1977), metamemory is the collection of knowledge and beliefs that one holds about one's own 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 as well as their understanding (or at least, belief) as to how their memory works in such situations.

Understanding memory, then, represents an information seekers' schema about how their *own* memory processes when they search for information. Information seekers who have acquired the metacognitive knowledge of *understanding memory* will know, first of all, that it is difficult for them to remember everything and, secondly, will understand how and when to use specific strategies in order to remember where information is located so that it can be retrieved later.

2.2 Focus Groups With Young People
This research study employed a variant of a focus group methodology and was intended to elicit feedback from the participants about their understanding of their own memory and information seeking behavior. As Large and Beheshti (2001) indicate, the focus group is a common research methodology, but one that is less frequently employed in LIS research with young people. The institutional procedures for research with children and teens may contribute to not only a dearth in studies with focus groups of young participants but LIS studies that involve children as research participants at all.

Focus groups are generally described as interviews conducted with a small group of participants, individuals who are united by some common characteristic and who are asked a series of questions that are intended to unveil their understandings and perceptions (Patton, 1990; Hughes-Hassell and Bishop, 2004). In the case of this study, the focus group method was employed non-traditionally, with students responding to a set of questions first through drawing and then through verbal explications of their created images. Although Everhart et al. (2002) notes that young children are not able to provide written feedback on library services, a child's inability to write does not preclude expression through drawing. Drawing, as Cox (2005) describes, can be seen as "a constructive process of thinking in action" (p. 123).

Drawing upon Richard Krueger's work (1994), Large and Beheshti (2001) stipulate that it is best for focus groups with children to be small, with five to six participants, and for the length of time to be limited to one hour. In reflecting on their focus group study involving seven to eleven year-olds, Harris and McKenzie (2004) find that an even smaller group of four is more appropriate for this particular age group. "Anything much more than that," they write, "invites more playfulness between the children and makes transcription complex" (p. 13). As is the case with all focus groups, there is the possibility that participants may be swayed by others or may even experience peer pressure to conform to the majority opinion. The formation of single-gender groups, particularly while working with young children, may mitigate peer pressure (Large and Beheshti, 2001). Researchers differ on whether participants should know one another or whether they should not have pre-formed relationships. Large and Beheshti maintain that prior relationships could inhibit the participants' willingness to freely share during the focus group session. Conversely, Harris and McKenzie note that the opposite might be true when a focus group is addressing a sensitive topic. Participants may feel more at ease in this environment and more likely to express themselves than they would in a group of strangers.

As Meyers, Fisher, and Marcoux (2009) indicate, research that involves groups of young people requires "procedural elements" that are necessary for the effectiveness of the study. When creating the schedule for the study, researchers must be cognizant of developmental needs of the children or teens involved. In working with "tweens," Meyers, Fisher, and Marcoux note that the methodology reflected the fact that children "need to move, eat, and talk with each other in a relaxed atmosphere… regular activity change was essential to preventing boredom and fatigue, as well as impolite, aggressive, or disruptive behavior" (p. 310). Moreover, consideration must be given, and is likely mandated by home universities, to what Meyers, Fisher, and Marcoux characterizes as "child protection." Assent information should be provided to both parents and children in transparent and age-appropriate language (p. 310). These logistical elements were certainly a focus of this study's methodology.

The location of the focus group is among the logistical aspects of the study discussed in the literature. Everhart et al. (2002) encourage the use of a private space where the young people will feel comfortable expressing themselves freely. Harris and McKenzie place value on locating the study in what they describe

as a "neutral territory" (p.13). While special permission will be needed, schools may be an appropriate site for focus groups (Everhart et al.), given that this may aid the researcher in successfully finding a group of young people to participate.

Focus groups with young people in the LIS field may be employed in strengthening the design of information services or tools geared toward their age group (for example, Hughes-Hassell and Bishop, 2004). It is here that a relationship with participatory design methods emerges. Allison Druin's work with cooperative inquiry as a methodology, for example, involves working directly with children to create technologies for children (Druin, 1999). In Druin's cooperative inquiry, groups of children play a more active role in research than as traditional "users" or "testers" of a design; instead children work as "design partners" as part of a collaborative that includes adult researchers (Druin, 2002). Large et al.'s (2006) bonded design methodology is related to Druin's cooperative inquiry but distinct in one central way. While both methodologies involve a group of children as co-designers, bonded design has "reservations concerning the extent to which true equality can exist within an intergenerational team" (p.79); children are seen as "experts in being children" while adult researchers are "experts in design" (p.78). Both cooperative inquiry and bonded design differ from the focus group methodology in that children are active participants, involved in a much more significant way than as interviewees.

2.3 Metaphor in design
In this study, techniques that use metaphor as an instrument for disclosing thought processes were employed in order to open a window on metacognitive thinking related to information seeking. Using metaphor may seem to be a rather circuitous method for revealing cognitive processes. Why not simply ask people what they are thinking? In actuality, *all* methods for investigating the deepest layers of thinking are necessarily inferential because metacognition can only be observed indirectly, through verbal protocols (self-reporting during or after a cognitive event) or simply watching how people behave. This study proposes a third way for revealing metacognitive thinking related to information seeking, and that is through the use of design techniques that are framed by metaphor.

Why might metaphor reveal something about metacognition? Metaphors are particularly useful in bringing conceptually abstract ideas into sharp focus. They make connections between unrelated phenomena in order to describe, explain, and gain insight. Computer interface design is rife with metaphor, two classic examples being the "cards and stack" metaphor used to describe HyperCard's architecture (HyperCard is an early hypermedia application) and Microsoft's "trash can", the virtual space where unwanted digital objects go.

Metaphor has had a rather checkered history in the relatively short lifespan of interface design. In the early days of user interface design, metaphor was magic. However, the overuse and misuse of metaphor created a backlash of sorts, typified by Nelson's claim that metaphors are one cause of poor design. Calling metaphors "mnemonic gimmicks" which get "in the way more than it helps", Nelson argued that metaphors inhibit the designer's creativity. [Nelson in Laurel 1990, p. 236]. Cooper mirrored this attitude, saying that "searching for that magic metaphor is one of the

biggest mistakes you can make in user interface design" [Cooper 1995, p. 53].

Coming full circle, some now argue that metaphor is in fact the "golden rule" for designers of human computer interaction (Blackwell, 2006, 523). Pirhonen, redefining metaphor for the needs of design, argues that metaphor has been used in too loose a manner. Its meaning depends on the context of its use (2005, 105). He makes the distinction between the *metaphor,* as something that comes from the user, and *metaphorical expression,* as the work of the designer. In other words, users create the metaphor: designers express the metaphor. The metaphor and its expression are not necessarily identical. Pirhonen further argues that Nelson and other critics of metaphor might have been confusing simulation with metaphor. A simulation (a button on a screen that is like a button in real life) is not a metaphor. A visual image of a bucket with water dripping over the edge to represent the leakage of memories from our thought processes is a metaphor because it reifies, or makes an abstract idea concrete.

3. METHODS
A focus group with four adolescents aged 13 and 14, was conducted during Spring 2011.The focus group was divided into two parts. In the first part, design techniques were used to explore *understanding memory*, a form of metamemory and one of the thirteen attributes in Bowler's taxonomy of metacognitive knowledge (2009). In the second part of the study, the participants were asked for feedback on the experience of thinking, drawing, and talking about their own memory.

3.1 Participants
Design techniques were applied during a two-hour focus group session with four teens, two girls and two boys, all of whom were between 13 to 14 years old. Two teens were African-American and two were Caucasian, all English-speaking. Convenience sampling was used to recruit the teens for this study. Other than the age range of thirteen to sixteen, no limitations were placed on the characteristics of the participants. We had prepared for up to eight participants but in the event, only four volunteered. Parental consent, as well as assent from the teens, was received just prior to the start of the focus group. (Parents did not stay in the room during the focus group).

3.2 Design Techniques
The design techniques used in this study were drawn from studies in interaction design and were selected on the basis of their ability to reveal metacognition in novel and creative ways. The participants were guided in the application of design techniques such as brainstorming and sketching (Large et al, 2004, 2006; Druin, 1999, 2002), metaphorical design (Madsen, 1994), and fictional inquiry (Dindler & Iversen, 2007) in order to explore *understanding memory*, an attribute of Bowler's taxonomy of metacognitive knowledge (2009).

Metaphorical design. Madsen's guidelines for metaphorical design use metaphor as a "kind of *seeing as* governed by previous situations and examples, rather than by rules and fixed categories" (1994, 58). There are three main activities in metaphorical design: generating metaphors, evaluating metaphors, and developing metaphors. This study focused the first activity - *generating metaphors* – by asking the participants to identify objects or

scenarios that visualize abstract concepts related to their own memory and information seeking.

Fictional Inquiry. Fictional inquiry is a collaborative design method which uses narrative to foster creativity (Dindler & Iversen, 2007). It serves to stage a design situation and evoke ideas for the future by framing fictional situations where participants "are less constrained in imagining" (Biskjaer, M.M., Dalsgaard, P. & Halskov, 2010). The playfulness of fictional inquiry makes it particularly well-suited to collaborative work with young people.

Brainstorming. Central to the ideation phase of the design process is brainstorming. Large et al. (2006) describe brainstorming as the "forum for all ideas to be put on the table," a stage in the design process that is intended to "foster innovative and creative ideas" (p. 75). When brainstorming, quantity of ideas is emphasized. In achieving this, Carroll et al. (2010) note that an environment in which participants feel encouraged and comfortable is essential. As Faust (2009) conveys, however, "design is more than discourse" (p. 1891). Instead, the design process involves fixing the results of brainstorming through the sketches, written description, and figures so that the product of the ideation phase will ultimately lead to design objects.

Sketching. In the design process, sketching is primarily located during the ideation phase and functions as a bridge between inspiration and implementation. Sketching is a useful technique for externally representing cognitive activity (Fish & Scrivner, 2004). Lane et al (2010) define sketching as a sense-making tool that supports two modalities of visual imagery: "seeing as" and "seeing that". "Seeing as" is a figurative form of thinking, one that has potential to be expressive of metaphor, while "seeing that" is more descriptive and literal. According to Lane et al, "seeing as" and "seeing that" both lie along an "observation" to "imagination" continuum, meaning that some sketches, even those that are metaphorical, will be grounded in the real, everyday world, while others will reflect new and imaginative ways of thinking. In the context of this study, sketching was used in the "seeing as" modality.

3.3 Procedures

The focus group occurred in the activity room of a Pittsburgh-area church and was facilitated by two researchers. Seats were set up around a large table, with paper and pens for each participant. An easel with large paper was propped at one end of the table in order to facilitate brainstorming activities. At the start of the session, pizza and beverages were offered to the participants, as the focus group occurred right after Sunday morning services. While eating lunch, we introduced ourselves to the teens and they in turn each told us something about themselves. We started brainstorming while they finished their lunch, beginning with the question "What does "looking for information" mean to you?" We followed with four other question prompts designed to facilitate sketching exercises. Each participant described their drawings to the researchers.

In total, the study lasted just approximately 90 minutes, including the time for eating. We had originally planned for two hours. Logistically, the focus group was divided into two parts. During the first part, the efficacy of design techniques was tested. We were looking for evidence that the methods could actually reveal aspects of understanding memory. In the latter part, we gathered feedback about the methodology from the participants themselves. The table below outlines the question prompts used in part one of the study, as well as the format of the data that was gathered.

Table 1. Question prompts and data format for Part 1 of the focus group with teens

Question prompt	*Activity*	*Format of data*
What does "looking for information" mean to you?	• Group brainstorming activity.	• Text written on sketch paper
What thing (object, action) best describes your memory when you look for information? When I search for information my memory is like a ….	• Individual free sketching activity	• Four drawings • Verbal reports from individuals as they sketched • Group conversation
What fairytale best describes your memory?	• Group brainstorming activity.	• Not able to answer.
Suppose you were on a treasure hunt in a forest (or urban jungle) and along the way, you dropped something and had to go back to retrieve it. What would help you remember where you left it?	• Individual free sketching activity	• Four drawings • Verbal reports from individuals as they sketched • Group conversation
Imagine that you enter a building that holds all the memories of the world. What would it look like?	• Individual free sketching activity	• Four drawings • Verbal reports from individuals as they sketched • Group conversation

4. RESULTS

We began the focus group by explaining to the teens that we were studying memory and how it works when people search for information. We explained the methods and used the term "metaphor", adding that we wanted them to think about things or objects that were *like* the way they think when they search for information. Examples of metaphor were given. The participants initially seemed perplexed, although they didn't ask any clarifying questions.

4.1 "What does "looking for information" mean to you?"

This prompt was not meant to be metaphorical. Rather it was meant to situate their metaphorical thinking within the particular task of searching for information. In response to this prompt, the participants' answers demonstrated a wide interpretation of "looking for information". They listed the following as representative of "looking for information": the library, books, the internet, Google, search engines, IM, email, Facebook, magazines, and, intriguingly, eyes.

4.2 "When I search for information my memory is like a …."

The next prompt asked the participants what thing (or object or action) best describes their memory when they look for information. They were asked to brainstorm as a group and complete the statement, "My memory is like a …." A researcher wrote their responses on a large sheet of sketch paper. Only two ideas surfaced: a notebook and an automatic search engine. In discussions later on, one participant mentioned Harry Potter's room of memories as a visual image that came to mind when he thought of memory. This was the same participant who referenced Sponge Bob Square Pants in one of his drawings, demonstrating the role of media and pop culture in the development of a theory of mind.
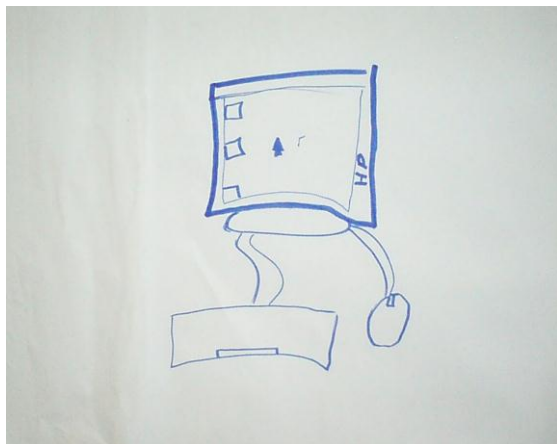

Figure 1. When I search for information, my memory is like a desktop computer.

Following the brainstorming exercise, the participants were asked to draw their own memory when they look for information. Participant A drew a picture of a desktop computer, complete with folders, a cursor, a mouse, a keyboard and even the name of the computer model, which we speculate was his own computer (Figure 1). Describing his drawing, the participant explained that he stores his memories like information in a computer, mirroring the classic information processing theory of mind.

Participant B drew a bucket, with information depicted as water flowing in and out (Figure 2). Interestingly, the bucket metaphor had been earlier provided by a researcher, as an example to help the participants understand how metaphor can represent memory. However, the participant did add the novel image of information as water overflowing the bucket.
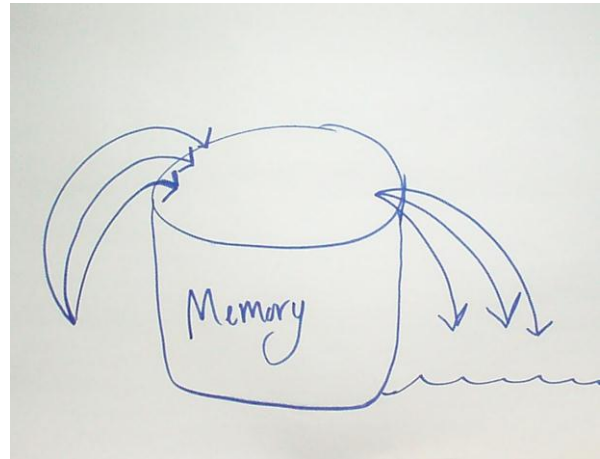

Figure 2. When I search for information, my memory is like a bucket overflowing.

Describing her drawing to the researchers, she said that when new information goes in to the bucket, some information is displaced and has to flow out. It falls into a larger sea of information. The water outside of the bucket represents lost memories because, as the participant explained, it's harder to remember things that have flowed out. This drawing expressed the participant's understanding that memory, at least her own memory, has boundaries and limits.

Participant C represented her own memory as a village with houses lining a main street down the middle (Figure 3). One enters the village via a portal or gate. One side of main street is sunny; the other side, rainy. Explaining her drawing to researchers, she said that each house has a memory inside. Some houses are good; some are bad. ("good" and "bad" in the sense of organized). Bad "memory houses" are messy and it's hard to know what's there. But memories that can be easily recalled on are the sunny side. So to this participant, good memories are ones that are orderly, organized.

Figure 3. When I search for information, my memory is like a village.

Participant D started out by writing "Q ? A". He then drew a filing cabinet, with a combination lock to hold secrets (Figure 4). "Whose secrets?", he was asked. "Mine". The filing cabinet stores information he's hiding from others, not information that he can't get to. While the filing cabinet is open to all, the safe on top is firmly locked. He referenced the cartoon Spong Bob Square Pants when describing his image of his own memory, citing an episode when Sponge Bob was trying to remember something and the cartoon showed a close-up of a filing cabinet in his brain.
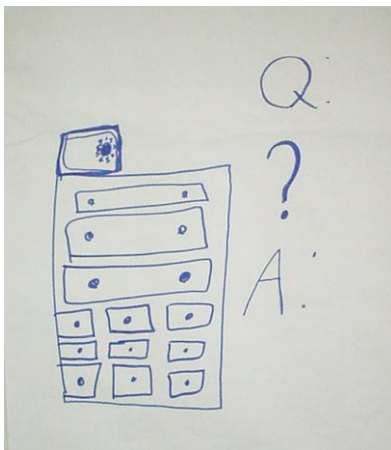

Figure 4. When I search for information, my memory is like a filing cabinet.

4.3 Suppose you were on a treasure hunt…

This prompt asked the participants to situate their memory processes in a story. They were asked to imagine losing something while on a treasure hunt. In order to re-find the object, they would have to retrace their footsteps, and in effect, retell the story of the treasure hunt. In response to the question, "Suppose you were on a treasure hunt in a forest (or urban jungle) and along the way, you dropped something and had to go back to retrieve it. What

would help you remember where you left it?" The teens thought of objects at ground level and did not anticipate the need for alternative strategies such as getting an overview of the field. All of the objects related to visual markers and included items such as street signs, distinct marks on trees, an empty bag of Doritos along the pathway, and a flower beside a rock.

4.4 A tool that reminds you to remember

In order to see if the drawing exercise could be executed in groups, the participants were asked to team into pairs and work together to think of and then draw an object that would *remind* them to remember (as opposed to simply "remember"). Not surprisingly, the girls worked together in one group; the boys in another. Large and Beheshti (2001) note that the literature on children and focus groups recommends the establishment of single-sex groups. Interestingly, during the introduction to the study, when one researcher told the teens that they would later work in teams, the second researcher observed the two girls nudge each other, likely indicating their interest in working together. This may have been visual evidence to support the notion that young people generally feel more comfortable working in single-gender groups at this age.

The girls' drawing of a stickman in the rain saying, "Oh man! Forgot to put my umbrella up", showed how, at least to them, context matters when it comes to being reminded to remember (Figure 5). As one of the girls explained, it is the rain, or the environment around you, that reminds you to remember. In other words, we remember the absence of important information when the effect of its absence is felt. Perhaps the larger lesson this drawing expresses is that, at least for these two teens, reminders to remember information happen in the moment, and are not something that one thinks about and plans in advance. So for these two teens, a tool that would remind them to remember either doesn't exist or isn't necessary.

Figure 5. Something that reminds you to remember.

4.5 What fairytale best describes your memory?

By far the most puzzling prompt for the participants was, "What fairytale best describes your memory?" This prompt asked them to

use a well know narrative to describe their own memory processes. The response was silence and they were simply not able to answer the prompt, let alone guess. We speculate that the exercise was either too abstract for the teen group or they lacked the literary background to draw from. Perhaps more simply, it was too embarrassing and childish for them.

4.6 A building that holds all the memories of the world

We wondered if the participants' notions of memory could be transferred to a broader, cultural context. This question was admittedly an anomaly, but as one of the researchers has a particular interest in memory institutions like museums and libraries, where the memories of a culture are stored, we asked the participants to imagine a building that holds all the memories of the world. What would it look like? We did not use the words "library", "museum", or "archive" in the prompt. All the participants interpreted the question in terms of personal memories, not cultural memories. This is not surprising, since the focus of the previous prompts had been on metacognitive aspects of memory, a distinctly personal and internal perspective. In the event, this prompt proved to be quite useful for eliciting an interior perspective of memory. For example, keeping with the filing cabinet motif, Participant D drew a room with filing cabinets filled with information about people. Two people walk down "memory lane", retrieving memories that are stored in the filing cabinets (Figure 6).

Figure 6. A building that holds all the memories of the world.

Given the unanticipated shift in focus, the participants needed further prompting to help them move from a personal to collective perspective of memory. Asked if he had ever been to a real place like the room filled with filing cabinets, the participant said no. "Can you think of a place like this?" we asked. "Maybe a police station", the participant responded, "because they have records and papers about people there", thus interpreting collective memories as data about people rather than the history and cultural works of a society.

4.7 Feedback about the methods

Once the design techniques had been applied, we then asked the participants to reflect upon their experiences using them.

Although we found that the participants were hesitant during the first half of the session, *after* they had completed the drawings and brainstorming they were quite forthcoming in their opinions.

Using metaphor with teens. The critical question for us was whether the participants found the methods confusing, particularly the use of metaphor as a method for revealing perceptions of memory. If so, we wondered, what could we do to make the process easier to follow. Initially it seemed that the participants were not sure what a metaphor was or how to think of a metaphor for memory. However, one participant said she found it helpful when we provided examples. While seeming to be confused about metaphor during the initial brainstorming activity, later, when asked whether they had heard of metaphor prior to the focus group, one participant confidently stated yes, "since grade four". Another participant agreed that she had learned about metaphor at school. The two other participants were silent. It did seem that the participants who claimed to have some experience with metaphor were also the ones to draw the most novel and elaborate metaphors to depict their memory. Clearly more scaffolding in the area of metaphor is needed, perhaps in the form of metaphor construction activities prior to sketching, so as to prepare participants who lack prior knowledge in this area.

How much scaffolding is required? We believe that concrete examples must be given, but care must be taken if those examples represent memory and information seeking. As seen in this study, one of the participants recycled the very metaphor we had provided as an example (memory as a bucket). But we wonder if teen participants would to be able to transfer an unrelated example of metaphor (For example, a metaphor used in literature such as "the slings and arrows of misfortune" from Shakespear's Hamlet) to the task of thinking about memory.

Talking to teens about memory. We asked the teen participants what they thought are the best ways to talk about memory with teens? What was confusing to them? And what made sense? As it turns out, all the participants were confused when we started the first brainstorming activity. One reason was that they had never thought about their own memory before, let alone how it might work when they search for information (although Participant D said a teacher had talked about memory and how the brain works in a health class). This confirms findings from an earlier study by Bowler (2009), which found that only two of ten participants (ages 16 to 18) were consciously aware of their own memory capacity while they searched for information. This, we feel, is where the use of metaphor succeeded. It created a bridge between two rather complex phenomena – memory and information seeking – for young people who had not spent much time thinking about either one.

We asked the participants how close to reality their predictions about their own memory came. In answering this question, all the participants elaborated further about their memory processes. One participant said that she believed she has poor short term memory, another that he has good long term memory (because he can remember his third birthday), a fourth participant claimed to have good directional memory, while the fourth said she had good visual memory. Clearly the drawings didn't capture everything the participants had to say about their own memory and therefore

follow-up discussions are necessary in order to capture a rich range of data.

And finally, we asked whether there are other ways to get teens to think about their memory and how they use it to look for information.The participants offered useful advice. Using more storytelling would be helpful, one participant said and the others agreed. Combining two questions into one drawing would also be useful. For example, asking participants to draw their own memory and *then* draw things that help their own memory (within same drawing).

Sketching and Brainstorming. Since the sketches are a key data source in this study, we wondered if it mattered to the participants if they felt they were not good at drawing. Interestingly, Participant C said she initially thought to sketch something more complicated but then changed her mind because she did not think she would be able to draw it, indicating a lack of confidence in her ability and potentially a loss of interesting data for the study.

We wondered what the best approach to sketching and brainstorming should be. Should drawing happen before or after brainstorming? Although the brainstorming activity was meant to provide a scaffold, one of the participants said it would be better to go straight to drawing and then work on group brainstorming. The general sentiment seemed to be that drawing, not group interaction, was best. But more time for drawing was not required, according to Participant D, who said the timing was just right. Participant B said it wouldn't be good if they had to think too long. It wasn't good to over think.

5. LIMITATIONS
Due to the small sampling size, generalizations beyond the context of the study will be difficult to infer. The extent of the students' prior information skills and metacognitive knowledge in relation to other people their age were not known as the qualitative methods used in this study precluded the use of a control group or wide sampling procedures.

6. DISCUSSION
In this study, design techniques framed by metaphor were used as a mechanism for revealing opaque thought processes. Our main concern prior to the study was that thinking about a metaphor to represent their own memory processes would be too abstract for the participants. And situating "memory" within the context of information seeking would, we worried, be an additional complication. In the event, the teens were able to create drawings of objects that represented their own conceptualization of memory and what they thought would aid them in re-finding information. (However, in at least one case, the metaphor used in the drawing was the same as the example provided by a researcher earlier in the session).

As one participant indicated, drawing skill did impact the content and complexity of drawing. Lane et al (2010) argue that sketching should be taught in order to support the visualizing instinct. This may be true, but for the purposes of this study, we simply had no way of predicting or teaching drawing skills in advance. Given this limitation, balancing the drawing exercise with other outputs such as group discussion was essential. Initially we were concerned that the participants, not knowing each other prior to the focus group, would feel inhibited talking to the group about their drawings. They were somewhat awkward with each other in the beginning. In the next iteration of the study, more time will be spent in an "ice-breaking" activity so that the participants engage in more dialogue with each other and with the researchers. We will also expand the use of fictional inquiry by including a storyboarding exercise (Teens might be more comfortable calling this a comic strip).

Results from this study demonstrate that design techniques can reveal metamemory as it relates to information seeking. Coupling this with brainstorming and sketching helped the teens to communicate their ideas. However, while it is possible to use metaphorical design with teens, it does require scaffolding, perhaps in the form of extended brainstorming, games, and scenario building, and it needs to be grounded in the world that they know. Even though the teen group could not think of any traditional tales as a metaphor for their thinking processes, they were particularly positive about the use of storytelling as a way to generate original stories, saying that they would have liked to have drawn storyboards to help flesh out the story of how they use their memory when they search for information.

7. CONCLUSION
One of the criticisms of metaphor in design is that users may not understand the metaphors that designers weave into the artifact. This is true if one takes a top-down approach to metaphorical design. Metaphors that originate in the mind of the designer require that the user map the workings of their own mind to the metaphor, rather than vice versa. The user is effectively the "recipient of a mental model constructed by the metaphor designer" (Blackwell, 513). This study, however, started from a different premise – design should start with the *user's* metaphor as a way to describe the user's mind and ways of thinking and *end* with the designer mapping the metaphor to the artifact.

This focus group study is a first step toward a multi week project, to be framed by each of the thirteen attributes in Bowler's taxonomy of metacognitive knowledge (2009), where two groups – one with adults; the other with teens – will use the design techniques tested in this preliminary work to mirror their metacognitive thinking. The ultimate goal of this research is to make the leap from ideation to implementation, using the users' metaphors of the mind as a basis for a prototype for a developmentally-appropriate, intelligent search agent that scaffolds metacognition during the search process. Taking that leap will not be easy, as it will require the difficult task of translating user's metaphors into "computational accounts of metaphor" (Blackwell, p. 511). But, as Madsen [1994] argues, the greatest benefactors of metaphorical design could be those who design systems for users.

8. REFERENCES
[1] Bishop, Kay and Sandra Hughes-Hassell. 2004. Using Focus Group Interviews to Improve Library Services for Youth. *Teacher Librarian* 32(1), 8-12.

[2] Biskjaer, M.M., Dalsgaard, P. and Halskov, K. 2010. Creativity methods in interaction design. *DESIRE '10. Proceedings of the 1st DESIRE Network Conference on Creativity and Innovation in Design*. Aarhus, Denmark. August 16 - 17, 2010.

[3] Blackwell, A. 2006. Reification of metaphor as a design tool. *ACM Transactions Computer-Human Interaction*, 13(4), December, 490-530.

[4] Bowler, L. 2007. Methods for revealing the metacognitive knowledge of adolescent information seekers during the information search process. *Information Sharing in a Fragmented World: Crossing Boundaries. Proceedings of the 35th Annual Conference of the Canadian Association for Information Science, McGill University, May 10-12, 2007. Montreal, Quebec: CAIS/ACSI.*

[5] Bowler, L. 2010a. The self-regulation of curiosity and interest during the information search process of adolescent students. *Journal of the American Society for Information Science and Technology, 61(7), 1332-1344.*

[6] Bowler, L. 2010b. Talk as a metacognitive strategy during the information search process of adolescents. *Information Research*, 15(4) paper 449. [Available at http://InformationR.net/ir/15-4/paper449.html]

[7] Bowler, L. 2010c. A taxonomy of adolescent metacognitive knowledge during the information search process. *Library and Information Science Research*. 32(1): 27-42.

[8] Brown, A. L. 1987. Metacognition, executive control, self-regulation, and other more mysterious mechanisms. In F. E. Weinert & R. H. Kluwe (Eds.), *Metacognition, motivation, and understanding* (pp. 65-116). Hillsdale, New Jersey: Lawrence Erlbaum Associates.

[9] Carroll, M., S. Goldman, L. Britos, J. Koh, A. Royalty and M. Hornstein (2010). Destination, imagination and the fires within: Design thinking in the middle school classroom. *The International Journal of Art & Design Education 29 (1), 37-53.*

[10] Cooper, Alan. 1995. The Myth of Metaphor. *Visual Basic Programmers Journal.*

[11] Cox, S. 2005. "Intention and Meaning in Young Children's Drawing." *International Journal of Art & Design Education* 24, no. 2 (May), 115-125.

[12] Dindler, C. and Iversen, O.S. 2007. Fictional inquiry – design collaboration in a shared narrative space. *Journal of Co-Design*, 3(4), 213-234.

[13] Druin, A. 1999. Cooperative inquiry: Developing new technologies for children with children. Paper presented at the *CHI'99*, Pittsburgh, PA.

[14] Druin, A. 2002. The role of children in the design of new technology. *Behaviour and Information Technology, 21*(1), 1–25.

[15] Faust, J. 2009. Positive design. *Journal of the American Society for Information Science and Technology 60 (9), 1887-1894.*

[16] Fish, J. and Scrivener, S. 2004. *Cognitive Catalysis: Sketches for a Time-lagged Brain*. In, Goldschmidt, G., Porter, W.L. (ed.). Design Representation. London: Springer.

[17] Flavell, J. H. and Wellman, H. M. Metamemory. 1977. In R. V. Kai], Jr., & J. W. Hagen (Eds.), *Perspectives on the development of memory and cognition.* Hillsdale, NJ: Erlbaum.

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

[19] Harris, P. and McKenzie, P. 2004. "What It Means to Be 'In-Between': A Focus Group Analysis of Barriers Faced by Children Aged 7 to 11 Using Public Libraries." *Canadian Journal of Information and Library Science* 28 no. 4 (December), 3-24.

[20] Kruger, Richard A. 1994. *Focus Group*s. 2nd ed. Thousand Oaks, CA: Sage Publications.

[21] Lajoie, S. P. 2008. Metacognition, self-regulation, and self-regulated learning: A rose by any other name? *Educational Psychology Review*, 20, 469-475.

[22] 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.

[23] Lane, D., Seery, N., and Gordon, S. 2010. A paradigm for promoting visual synthesis through freehand sketching. Design and Technology Education: An International Journal. October, 15 (3), 68-90.

[24] Large, A., Beheshti, J., Nesset, V. & Bowler, L. 2004. Designing Web portals in intergenerational teams: Two prototype portals for elementary school students. *Journal of the American Society for Information Science and Technology, 55*(130), 1140–1154.

[25] Large, A., Beheshti, J., Nesset, V. & Bowler, L. 2006. "Bonded Design": A Novel Approach to Intergenerational Information Technology Design. *Library and Information Science Research*, 28, 64 – 82.

[26] Large, A. and Beheshti, J. "Focus Groups with Children: Do they Work?." *Canadian Journal of Information & Library Sciences* 26, no. 2/3 (June 2001): 77-89.

[27] Madsen, K.H. 1994. A guide to metaphorical design. *Communications of the ACM*. December, 32(12), pp. 57-62.

[28] Nelson, T.H. 1990. The rightway to think about software design. In *The Art of Human-Computer Interface Design*. B. Laurel, ed. Addison Wesley, Reading, MA. 235–243.

[29] Pirhonen, A. 2005. To simulate or stimulate? In search of the power of metaphor in design. In, Pirhonen, A., Isomäki, H., Roast, C., & Saariluaoma, P. (Eds.), *Future Interaction Design*. London, Springer-Verlag, 105-123.