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Paper: A Visual Vocabulary for Modeling Metamemory During the Information Search Process

Abstract: This paper reports on a series of five studies, two with teens and three with adults, that generated visual metaphors for modeling metamemory, the collection of knowledge and beliefs that one holds about one's own memory, in information seeking.

Résumé: Cette communication présente les résultats d'une série de cinq études, deux auprès d'adolescents et trois auprès d'adultes, qui ont généré des métaphores visuelles pour la modélisation de la métamémoire, l'ensemble des connaissances et des croyances qu'a une personne sur sa propre mémoire, lors de la recherche d'information.

1. Introduction

The goal of this study is to build a visual vocabulary for modeling metacognitive thinking during the information search process. This paper focuses on one aspect of metacognition – metamemory - which is the collection of knowledge and beliefs that one holds about one's own memory (Flavell & Wellman, 1977). The study follows upon a preliminary study that explored the use of design techniques in revealing metacognition (Bowler & Mattern, 2011) and is part of a larger project that will use design as a method of inquiry in the area of information behaviour. The long term goal of the project is to inform the design of developmentally appropriate information retrieval tools that scaffold metacognition with concepts derived from visual vocabularies that are grounded in the information practices of users. The study reported in this paper is situated in the ideation, or idea generation phase, of the design process.

2. Background

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 also 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 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 metacognitive knowledge (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: through verbal protocols (think-aloud and think-after) or through observation of behaviour. 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. Visual techniques used in design may offer a third way, one that asks people to project their knowledge and beliefs about their own metacognitive processes onto a design.

3. Theoretical Framework

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 behaviour. An information seeker who understands memory and its role in information seeking has a schema for how their own memory works, knows that it is difficult to remember everything, and understands how and when to use specific strategies in order to remember where information is located so that it can be retrieved later.

4. Methods

Five focus groups, three with adults (graduate students in a school of information sciences) and two with adolescents aged 13 and 14, 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 build a visual vocabulary that models metamemory in relation to information seeking. Participants from two distinct age groups were selected in order to provide a point of comparison between information seekers who might be expected to have better than average search skills and significant experience searching data bases (graduate students in a library and information science program), and those who do not (young teens).

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. Particular emphasis was given to techniques that use visual metaphor as an instrument for disclosing thought processes. Metaphors make connections between unrelated phenomena in order to describe, explain, and gain insight. They are particularly useful in bringing conceptually abstract ideas into sharp focus. 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.

This study applied two design techniques framed by metaphor. The first, metaphorical design (Madsen, 1994), focuses on objects or verbs that visualize abstract concepts, while the second, fictional inquiry (Dindler & Iversen, 2007), uses storytelling as a metaphor for thinking. Participants in this study were asked to brainstorm and then sketch an object that represents their own memory when they search for information, thus representing their awareness and beliefs about their own memory. They were then asked to sketch the "story" of an information search as a metaphorical journey through a forest or the urban

jungle. Participants then sketched two tools within their illustrated story - the first, a tool that would help them re-find information in the forest/urban jungle and the second, a tool that would remind them to remember the location of information *before* it was lost. This second tool was meant to represent a metacognitive strategy. Participants described their sketches out loud with the group, explaining the inspiration and rationale that lay behind the objects and tools they chose to sketch.

5. Results

Both the adult and teen participants were able to identify visual metaphors that represented their own conceptualization of metamemory and what they thought would aid them in re-finding information. The visual metaphors from all five focus groups were analyzed within and across the two age groups, and in their totality, form a visual vocabulary that models metamemory in information seeking. Gathering visual metaphors across two age groups allowed for comparisons between the adult and teen participants, suggesting developmental differences in the ways that teens and adults think about how their own memory relates to information seeking. The visual metaphors proposed by the adult participants were more complex than those of the teens. In their "story" of an information search as a metaphorical journey, the adult participants tended to sketch more memory tools and reminders to remember than did the teens, suggesting a deeper awareness of the infallibility of memory in information seeking, as well as knowledge of metacognitive strategies that might help one remember how to navigate complex information environments. For example, one adult participant, thinking of objects and tools that could help one remember and re-find the location of information, sketched a helicopter hovering over a forest, saying it would be a backup should markers along the path not work (See Figure 1). In contrast, teen participants typically only thought of one helpful object or tool at ground level, usually a marker, and did not anticipate the need for alternative strategies such as getting an overview of the field.
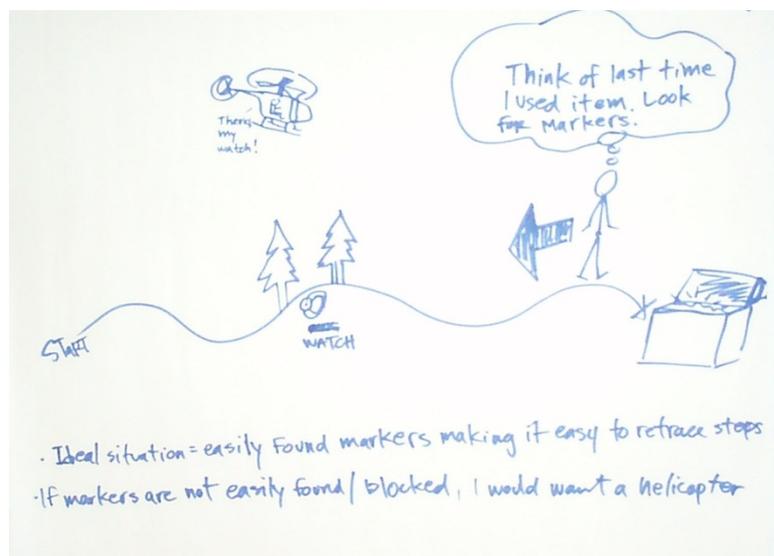

Figure 1:
"There's my watch!" Overview as a strategy for re-finding information.

6. Conclusion

Results from this study demonstrate that design techniques can visually reveal metamemory as it relates to information seeking and help to broaden the range of methodological approaches used in the study of information seeking behaviour. Facilitating metaphorical thinking is an effective tool for revealing thinking. Coupling this with brainstorming and sketching helped both the adult and teen participants communicate their ideas.

This study sets the stage for a multi-week project, to be framed by 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 model proficiency in information seeking and capture developmental differences in metacognitive thinking. This study enriches knowledge related to metacognition and its role in information-seeking. It will also provide the foundation for future work actualizing user-generated ideas in a prototype for a developmentally-appropriate application that scaffolds metacognition during the search process.

7. Conference Theme: This paper relates to the 2012 CAIS conference theme, *Information in a local and global context*, because it explores how information is searched, retrieved, used, made sense of, and understood. It fits into the topic area of mapping and visualization of information, social spaces, and networks.

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