

MODELING TASKS AND BEHAVIOR

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Search systems have been designed to support discrete, transactional searches despite wide recognition that search behavior, and information behavior more generally, is often embedded in and motivated by work tasks that prompt search processes that are often lengthy, iterative, and intermittent, and are characterized by distinct stages, shifting goals and multitasking. Furthermore, searching does not happen in isolation: ubiquitous access to networks, online content and search technology has created an environment in which searches are interwoven with other kinds of information seeking behaviors, such as reading, learning, communicating and acting in the real world. Our group discussion on the first day of the workshop focused on the question of how to represent and model this broader conception of task-based searching, with a focus on the transition points from one kind of activity to another, and from one goal or task to another. We were interested in modeling the way that search fits into people's lives.

Our discussion began by acknowledging that human information behavior occurs at many different task levels, including work tasks, information seeking tasks and information retrieval tasks, as articulated by Byström and Hansen (2005), and that existing models and conceptions of these different levels do not fit together well. Models of searching tend to be low level and overly simplistic, offering some guidance as to the probability of state transitions within a single search session, e.g., between querying and viewing results, but not considering task-switching, multi-tasking, human collaboration activities, system switching and the interplay of other kinds of information behaviors with search. On the other hand, models of information behavior tend to be underspecified with respect to search tasks, often treating the use of search systems simply as one of many possible sources of information (e.g., Leckie, Pettigrew & Sylvain, 1996).

This led us to focus on how we might establish a framework that connects models of information seeking tasks and information search tasks by focusing on the transitions between them, the probabilities of transitions taking place, and the triggers. We discussed the work task level and recognized that modeling at this level would be the most challenging, due to variation in work tasks across domains that would reduce the likelihood of strong general patterns. Rather, we consider the work task as an overarching problem or project: the motivating or embedding task for information seeking and searching. While essential in terms of establishing the information seeking goals and providing a basis for evaluating outcomes, we decided not to attempt to model the work task further than that. We used gardening as an example of an everyday life work task to frame our discussion: specifically, a back-yard landscaping/fencing project with a well-defined goal (to keep deer out of the yard), but an uncertain path and unknown set of inputs and constraints. We imagined the project and its requirements as evolving over time and prompting multiple cycles of information seeking and searching tasks as well as cognitive and physical tasks, such as selecting and purchasing supplies and doing landscaping work.

We considered a number of existing models and frameworks and discussed aspects of them that could be relevant to our goals:

- The Information horizons approach (Sonnenwald & Wildemuth, 2001), which considers the wide range of information seeking sources and strategies available to an individual when carrying out a task

- Early cognitive models of information retrieval interactions (e.g., Ingwersen, 1982, 1996; Belkin, 1980, 1990), as well as more recent cognitive models (e.g., Hung, Johnson, Kaufman & Mendonca, 2008)
- Information seeking and interaction models that take into account process and iteration:
 - Marchionini's (1995) Information Seeking Process Model
 - Toms' (2002) Information Interaction Model
- Models that represent tasks longitudinally and incorporate the concept of task stages:
 - Vakkari's (2001) Task-Based Information Seeking framework
 - Kuhlthau's (1991) Information Seeking Process Model
- Theories and models that focus on human activity and articulate different task/activity levels:
 - Activity theory (Kaptelinin & Nardi, 2006)
 - Goals, Operators, Methods and Selection Rules (GOMS) (Card, Moran & Newell, 1983)
- Models that identify the key elements of information seeking activities
 - Järvelin & Ingwersen's (2005) Information Seeking Model

In discussing our design scenario, we established three key steps for developing a working model. Our initial thoughts on each are summarized below.

Identify the elements of the model

We consider the elements of the model to be the searchers' options for task-based information seeking activity at any point in time. Some of the options we identified are shown in Figure 1.

Identify the structure of the model

We believe that this model of the process should focus on transitions and changes that occur over time and at different task stages. To represent its structure, we chose a simple state transition model with all elements at play at each point in time. The process is represented as the state of the user at ordered points in time (T1, T2, T3). The model could be developed further by incorporating hierarchical relationships and adding more depth to the hierarchies.

Identify task-based factors that are likely to influence the model

Such factors might include:

- task type, at any of the levels (for example: Work Task: administrative vs. managerial tasks or routine vs. complex tasks; Information seeking task: collaborative vs. individual; Search task: lookup vs. exploratory)
- task stage, at any level
- prior knowledge and expertise of the person completing the task; this factor will affect the extent to which tasks are habituated, conscious.

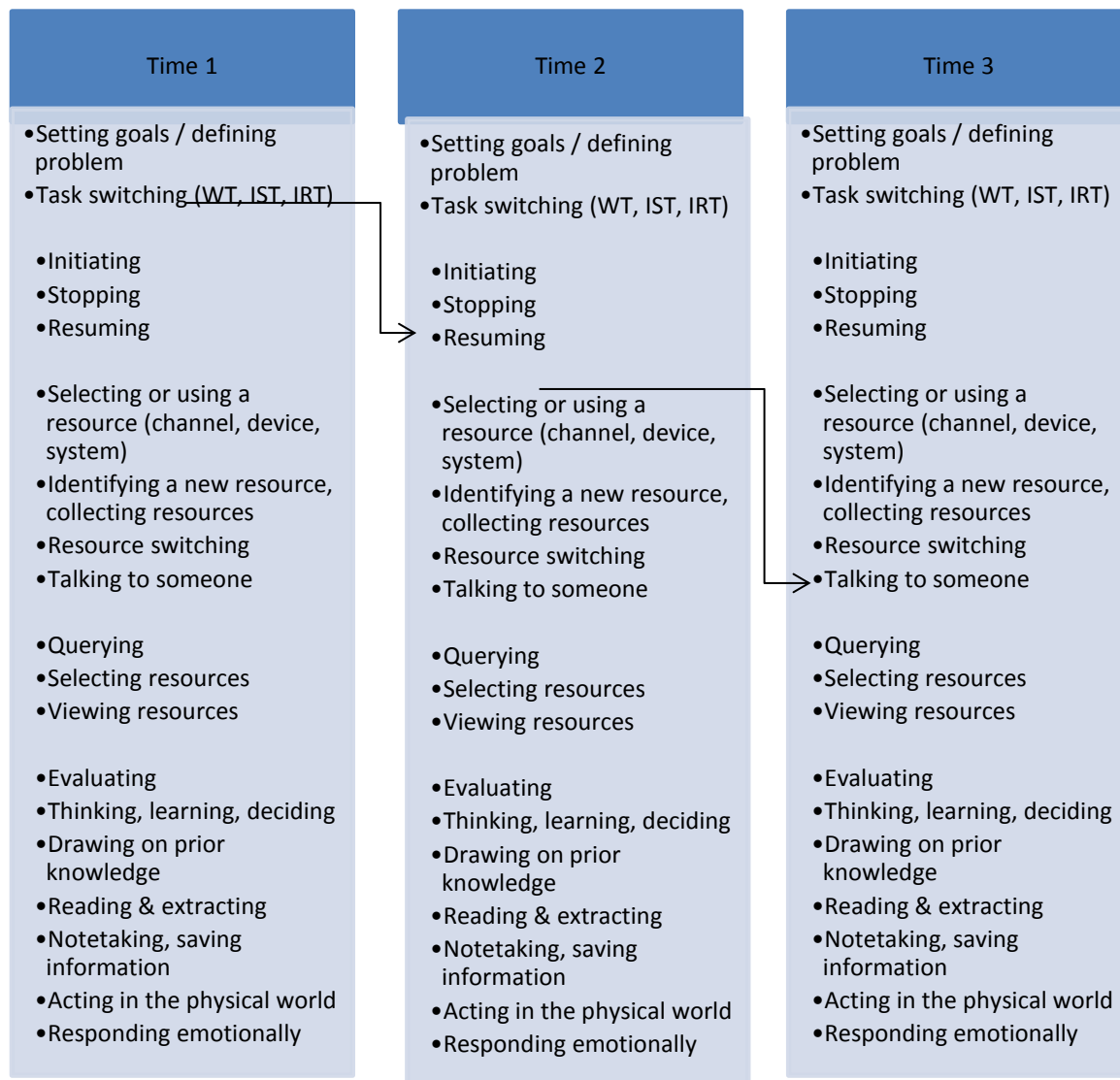


Figure 1: Simple state transition model of task-based information seeking

We expect that the main benefit of developing this model would be to provide support for searchers' moves and decisions (e.g., recommend tools, provide a means of maintaining and preserving state, and moving content back and forth) and to identify ways to integrate search into broader life activities. It may hold particular value for conceptualizing mobile search applications, as mobile search is likely to be tightly integrated with other types of information seeking activities. However, we also identified a number of challenges in developing and testing this model empirically. Because information behavior is domain dependent, the model can only function at a high level and therefore may be too abstract to offer significant value in understanding human behavior and/or informing design. Another difficulty arises out of the limitations of data collection methods with respect to tasks performed over time. Relatively simple methods such as transaction logging or interviews will always be incomplete, as the underlying intentionality of the searcher is either inferred or may be misrepresented through self-reporting. For this reason, more costly and intrusive naturalistic studies are needed. Evaluation is another challenge, as it will be necessary to

assess the extent to which people are able to perform tasks which extend beyond the boundaries of a single system. This will require longitudinal data collection and the availability of benchmarks for comparison.

A number of types of studies could be designed to help develop and test this model. Any given study might focus on different levels of task or activity, and the part of the model not under consideration could be black boxed for purposes of that study. In this way, the model could serve as a general framework connecting many studies with different aims and focusing on different components of the model. In particular, studies focusing on compelling, real life information use environments would provide an effective grounding for the development and testing of this model. We discussed a range of data collection methods, targeting those that could function across different systems and types of activities and that would capture naturalistic behaviors. These included: diaries, transaction logs, photos, video recording, email and chat.

Our discussions on day two of the workshop carried on from these initial discussions to consider specific research proposals. These are presented in the sections to follow.

Information-Related Tasks of Patient Care Teams

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Building on the discussion on day 1 of the workshop, we focused on the goal of understanding how information search tasks are part of and complement other information seeking activities. We developed plans for an ethnographic study focusing on an information environment with a rich interplay of information related activities, including both interpersonal interactions among groups of professionals and non-professionals and online searching in a range of information systems. We chose the medical domain and focused our plans on team-based patient care as a study environment.

Research questions:

We identified two primary research questions to be addressed by the study:

- What information seeking tasks occur within this activity, and with which specific work tasks are they associated?
 - Selection of particular information resources
 - Transitions from one resource to another
 - Searches of existing information systems
 - Use of information
- Under what circumstances are transitions made from/to information seeking/use tasks and other tasks?

We conceptualized the problem at a high level, as one of identifying and distinguishing between different levels and types of tasks and examining the transition points between them. For example, within the team-based patient health care context, a common Work Task would be to develop a patient treatment plan. Within that Work Task would be a number of Information Seeking and Use Tasks as well as other types of tasks, such as communicating the plan to the patient and documenting the plan. Within each Information Seeking and Use Task there would be a number of Information Retrieval Tasks as well as other types of tasks (see Figure 2). The challenge in this project is to focus on the interplay and shifts between these different types of task, rather than

isolating a particular kind of task, such as Information Retrieval tasks, and studying those in isolation.

Study setting and participants

The study will focus on team-based care of aging patients. In order to increase the research frame and external validity, we propose to conduct a cross-cultural parallel study in three locations: Canada, Norway and the United States. Working with a designated hospital in each location, researchers will follow the work of healthcare teams as they work with 2 to 3 patients over an extended period of time.

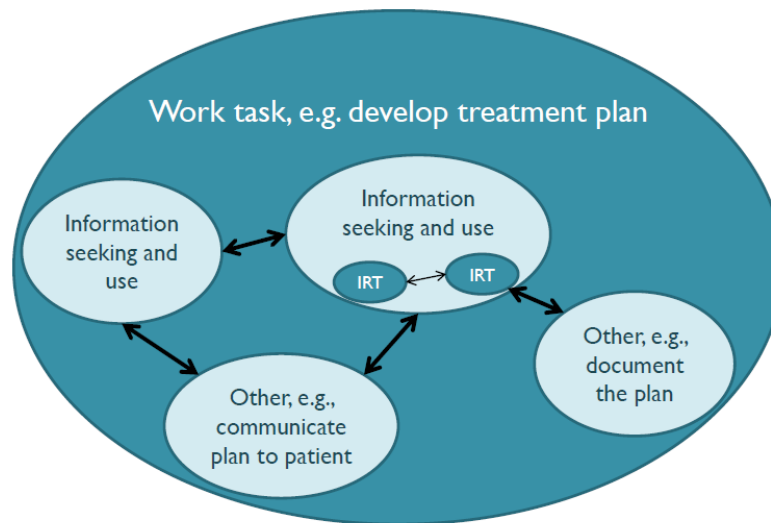


Figure 2: Conceptualization of the problem: task-based information seeking and retrieval

Data collection and analysis

Multiple methods of data collection will be used in order to capture the full range of activities of team members, as well as their information needs, goals and strategies. Particular attention will be paid to documenting transition points between information-related tasks, and the situations and triggers that prompted the transitions. The following data collection methods will be used:

- Direct observation of team activities, documented in field memos
- Interviews with all team members
- Additional notes/diaries from team members
- If possible, logging of activity on PDAs or other mobile devices, as well as the hospital's electronic medical records system

A range of qualitative data analysis methods will be used:

- Inducing concepts of interest directly from the data
 - Incorporating findings/concepts/models from prior studies
- Multiple levels of coding
 - Overall activities
 - Transitions between states
 - Specific search behaviors
- Constant comparative method
 - Comparing raw data with codes

- Comparing codes across multiple data sources
- Comparing codes with the categories in which they are grouped
- Comparing categories and their definitions

Challenges and impact

A study such as this, which aims to capture a holistic perspective on a complex, real world, professional environment, is not without its challenges. The main challenges include the need to ensure patient privacy and maintain clear ethical boundaries, the difficulty of gaining access to treatment teams and the cooperation of all team members, and the diligence required to successfully observe and document information behaviors and activity shifts that could occur at any time.

Despite the obvious challenges, we believe it is important to take this broader perspective on information behavior. Such a perspective will lead to better understanding of the role of information seeking and search tasks within the broader context of specific work tasks. On a more practical level, this research has the potential to improve our understanding of how information resources are linked in the ecology of information use in this domain. Given the critical importance of coordination and collaboration in team-based health care, results can have a genuine impact in optimizing workflows, and informing the design of better tools and practices.

Health information seeking in everyday life: Stages, behaviors, and assistance

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In day 1's group discussion, Group 2 discussed that information seeking should be put in a larger context of work task accomplishment instead of considering search tasks only. We came up with two general research questions: 1) What are the elements in and structure of a task-based information seeking activity model? 2) What are the transitional probabilities in this model?

Based on day 2's discussion, Group 2b proposed a research project that aims at exploring the above questions, as well as providing assistance to the information seekers based on the information seeking activity model. Considering the likelihood of variations in a user information seeking behavior model across domains, we thought it both practical and reasonable to start exploring these questions within a specific domain. We chose the health domain because a quantitative approach to building a model in the health information seeking area is needed, despite a rich literature mainly using qualitative methods.

The specific research questions for the proposed research are:

- What are users' information seeking behaviors (both cognitive and emotional) in different stages of a health acceptance model?
- Can we predict the health information seekers' stage in the health acceptance model based on their behaviors, for providing assistance/support for their future information seeking based on what is needed in the stage?
- What kinds of assistance can be provided to the health information seekers?
- What is the effectiveness of the assistance?

To answer these research questions, we plan to conduct a series of three studies.

First, we will conduct a qualitative study to collect data on what people diagnosed with a specific health condition do to seek information and emotional support. We plan to examine various health related discussion websites/forums/boards to collect the questions asked and answers/discussion provided. Content analysis will be conducted to explore the following aspects:

- What questions do people ask?
- What information do they want?
- What sources do they go to?
- What is the stage of their health condition?

Second, we will conduct a quantitative study to collect data on people's health information seeking activities. We plan to recruit people diagnosed with a certain illness. We will observe and record their activities related to seeking information and emotional support on this illness, in both digital devices (including the computer, smart phones, ipad, etc.) and non-digital devices (such as face-to-face communication). We will also collect data on other activities that they perform, including all other tasks that are not directly related to this specific health condition. These will help build users' information activity model, with transitional probabilities.

We will look at both individual and group information seeking behaviors. Some people that already participate in online group discussions will be considered as group information seekers. Others that do not seek information through a group will be considered as individual information seekers.

We will use multiple methods to collect data. As mentioned above, some activities are supported through digital devices, and we will collect logs through these devices. For activities supported by non-digital devices, we will ask participants to record and report such activities, at intervals, through diaries, journals, questionnaires, and focus group discussions. We will also ask about their stage diagnosed with this condition.

Data analysis will be two-phased. Phase 1 will look at the behavioral patterns at different stages. Phase 2 will attempt to predict the stage based on users' behaviors. The purpose of including both descriptive and predictive approaches to the data analysis is that, if and once we are able to detect the stage that someone is in based on his/her behaviors, we will be able to provide suggestions/assistance of what sources to go to in order to obtain information and/or emotional support.

Third, we will conduct a controlled lab experiment to evaluate the effectiveness of the suggestions/assistance that are provided to the health information seekers based on their stage as indicated by their behaviors. An interface will be built that can provide suggestions/assistance to information seekers. In the evaluation study, a controlled group of participants will not be provided any assistance, and an experimental group of participants will be provided assistance. We will compare these two groups in terms of their health information seeking behaviors, their perceptions of the assistance's usefulness, and other aspects of their interactions during information seeking.

There are challenges in various aspects of these proposed studies. Participant recruitment, collection of people's information seeking behaviors (especially non-device supported activities), and data integration are all challenging. The impact of this research is to provide assistance to people's health information seeking and emotional support.

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