

A Framework for Sensemaking in Collaborative Information Seeking

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ABSTRACT

An important aspect of collaborative information seeking (CIS) is making sense of the information found, i.e., collaborative sensemaking. We conducted an ethnographic study of the CIS activities of healthcare providers in a hospital emergency department to gain a conceptual understanding of why and how sensemaking occurs during CIS activities. Based on these findings, we discuss a framework of collaborative sensemaking during CIS activities and design implications for supporting sensemaking in collaborative information retrieval tools.

INTRODUCTION

In recent years researchers [1, 2] have found that people often collaborate during information seeking tasks. Collaborative information seeking (CIS) has been defined as “the activities that a group or team of people undertakes to identify and resolve a shared information need” [3]. Resolving a shared information need often consists of finding, retrieving, sharing, understanding, and using information together. Most studies of CIS have focused on how people find and retrieve information collaboratively, while overlooking the important question of how people together *understand* the information found by group members. This *collaborative sensemaking* activity is an important aspect of CIS, but there is currently little understanding of how it occurs.

The term sensemaking has been used in a variety of fields [4-6] and is considered an important aspect of individual information seeking tasks. However, there has been little exploration of how sensemaking takes place in collaborative work, especially in CIS. Though studies of CIS have rarely focused on sensemaking, they’ve found that during CIS activities people not only share information but also their understanding of the information. For instance, Hertzum [7] stresses that CIS consists of not only information seeking activities, but also *collaborative-grounding* activities that enable actors to create a shared understanding of their work. Thus, an important aspect of the process of finding and using information in collaborative work is creating a shared understanding of information. The goal of our study was to understand why and how people collaboratively make sense of information during CIS activities and how sensemaking can be supported in collaborative information retrieval (CIR) tools.

We examined the CIS activities of healthcare providers in a hospital emergency department (ED). The ED is an ideal setting for examining CIS since emergency care is highly information-intensive and collaborative and healthcare

providers are routinely required to find and understand information quickly and efficiently. Using ethnographic techniques, we examined the occasions and characteristics of collaborative sensemaking in the ED. These findings have been reported in detail in previous work [8] and we briefly present them in this paper. Here we focus more specifically on a framework of collaborative sensemaking during CIS activities. We describe the framework and also discuss the implications of this framework for the design of sensemaking-support in CIR tools.

RELATED WORK

The term ‘sensemaking’ has been used in various fields such as organizational science [6], information sciences [4], and human-computer interaction [5]. There are three salient characteristics of the sensemaking literature from these various fields. First, sensemaking is about *meaning generation* and understanding. Second, sensemaking is an important aspect of *information seeking* tasks. Most of the models and theories of sensemaking have described it in the context of finding and using information. Third, most of the research in sensemaking has been at the *individual* level. While some studies [9, 10] have explored sensemaking in collaborative work, there is still a lack of understanding of the nature and characteristics of collaborative sensemaking. Furthermore, none of these studies have examined sensemaking in the specific context of CIS.

The information seeking literature has recognized sensemaking as an important aspect of individual information seeking [4]. Though few studies of CIS have focused on sensemaking, such studies have found that sharing the meaning of information, along with the information itself, is an important aspect of CIS. For instance, Gorman et al. [11] observed that ICU physicians used informal annotations and note-taking when selecting information sources and sharing information with other physicians. Hansen and Jarvelin [12] found that in addition to sharing information objects (such as documents), patent engineers also shared *contextual relationships* between information objects (in the form of annotations, references, etc.); representations of their information needs; and judgments, and assessments of the information available.

METHODS

Research site and participants

To explore how collaborative sensemaking takes place in CIS activities, we conducted an ethnographic study of healthcare providers in the ED of a 500-bed teaching hospital, HMC. HMC serves about 1.5 million people in

Pennsylvania and its 32-bed ED sees nearly 50,000 patients a year. Finding and making sense of information is an important aspect of the work of ED care providers and they utilize various digital and non-digital information artifacts. These include an electronic medical record, a computerized provider order entry system, paper forms, whiteboards, and phones and pagers. Participants in our study were clinical and non-clinical ED staff. The clinical staff included attending physicians, residents, physicians' assistants, nurses, and nurse practitioners. The non-clinical staff included emergency department technicians (EDTs), inpatient access associates (who perform administrative jobs), support assistants, and housekeeping staff.

Data collection and analysis

We collected data using ethnographic techniques during Feb 2007 – Nov 2008 for a total of 190 hours of fieldwork. Data was collected using observations, informal and formal interviews, 'shadowing' of participants, and critical incidents collection. In our observations, we focused on the interactions of care providers as they collaborated to find, understand, and use information during their work. During observations, we conducted informal interviews asking participants about their work, information needs, and information sources. We also shadowed participants and followed 'critical incidents' in the ED to examine how care providers interacted to share and understand information. Finally, we conducted formal semi-structured interviews to gain richer insights into observed information seeking and sensemaking activities.

Data collected during observations, shadowing, and informal interviews were noted using pen and paper and later transcribed. We used grounded theory [13] to analyze the data. We identified instances of CIS by drawing on previous work [22]. Then, using an open coding technique, we coded "sensemaking moments" as instances where group members were unable to perform their work due to their inability to understand the information found during information seeking activities. We further categorized these sensemaking moments as instances of "collaborative sensemaking" if group members collaborated to better understand the situation. "Sense" was deemed to be made when care providers were able to continue their work again.

FINDINGS

CIS activities in the ED consisted of an iterative pattern of searching-sharing-sensemaking-searching of information, until the right information was found [8]. Most CIS activities started with an information need that required multiple workers to search for information. As care providers shared information, they also made sense of the information together, and based on their evolving understanding, their information need evolved. We found three important "triggers" for collaborative sensemaking during CIS activities – ambiguity of the information found, role-based distribution of information, and lack of expertise. We also found that collaborative sensemaking

during CIS activities had three important characteristics – prioritizing relevant information, sensemaking trajectories, and activity awareness. These findings are reported in detail in [8] and are discussed briefly below. We organized these findings in a framework (Figure 1) for collaborative sensemaking during CIS activities.

Framework for collaborative sensemaking in CIS

The findings of our study can be organized into a framework that describes how CIS activities took place in the ED, with specific emphasis on the sensemaking part of this activity. The framework highlights why collaborative sensemaking occurs during CIS activities and how it is characterized. It is divided into three parts: part I represents the CIS activity, part II contains the triggers of collaborative sensemaking, and part III highlights the activities that make up collaborative sensemaking episodes.

Part I: CIS activity

Part I of the framework represents a CIS activity where multiple people engaged in work must fulfill a shared information need in order to continue their work. In Figure 1, Part I of the framework describes how CIS activities were conducted in the ED; however, this part of the framework can be modified to represent different types of CIS activities. CIS can occur in various ways: group members may be co-located or remote and may search for information synchronously or asynchronously. Furthermore, the CIS task may be split among group members or the task may be conducted such that all group members look for the information simultaneously.

As Part I shows, CIS activities are often initially split into tasks/sub-tasks and sub-tasks are performed by different group member, depending on their roles and expertise. Roles can be organizational (as in the case of a hospital) or might be assigned informally (as in the case of a generic Web search task). Each group member finds information pertaining to her sub-task and makes sense of this information. During this individual sensemaking, *action awareness* information is shared, i.e., group members keep each other aware of what they're doing. In other domains than emergency care, CIS activities might be conducted differently; Part I of the framework simply highlights that CIS activities often involve individual information seeking and sensemaking, but due to the factors stated in Part II, lead to collaboration.

Part II: Triggers for collaborative sensemaking

Part II highlights some important factors that trigger collaborative sensemaking during a CIS activity, namely, *ambiguity of information*, *role-based distribution of information*, and *lack of expertise*.

Group members often encounter ambiguous information that is hard to understand and this leads them to find others who might help them understand this information. Also, if information is not distributed equally among group members but distributed according to roles, each group

member may not have access to all the information needed to make sense of the given situation. This may lead to a situation where different group members having access to different pieces of information have different understandings of the situation. To successfully resolve their shared information need, group members might need to collaborate to synthesize the fragmented information. Finally, individual group members may lack the domain or search expertise to understand information during CIS activities, thus needing to collaborate with those who have the required expertise. These factors trigger collaboration for sensemaking during CIS activities.

Part III: Characteristics of collaborative sensemaking

Part III of the framework lists some characteristics of collaborative sensemaking, namely, *prioritizing relevant information*, *sensemaking trajectories*, and *activity awareness*.

Prioritizing relevant information is an important characteristic of collaborative sensemaking in CIS tasks. Making relevance judgments on information found is a key aspect of the individual information retrieval process. During CIS, group members share information with others depending on how relevant they think that information is for fulfilling a shared information need. Whether a piece of information is relevant, and hence important enough to share is often a crucial decision made by each group member. Prioritizing the ‘right’ pieces of information as relevant enhances group sensemaking and leads to a successful outcome for the CIS activity. But it is often challenging for group members to judge what the ‘right’ pieces of information are. On the other hand, failing to prioritize certain information as relevant may lead to undesirable consequences [8].

Sensemaking trajectories emphasize that collaborative sensemaking during CIS activities has a strong temporal aspect. Often, the “sense” made of information by one group member influences the sense made later of the same information by others. Thus, the products of sensemaking are passed on not only across time, but also across group members. Knowing the “path” that a group member followed to make sense of information helps other group members’ sensemaking. We call such paths sensemaking trajectories, that is, the steps in the sensemaking process and the “sense” made at each step. Sensemaking trajectories have implications for the outcome of the CIS activity. As sensemaking progresses during a CIS activity, ‘sense’ associated with the information *accumulates and evolves* over time. When individual sensemaking of group members is successful, the “correct” sense of the information is passed on, resulting in group members successfully fulfilling their shared information need. However, when individuals make “incorrect” sense of information, this negatively affects others’ sensemaking.

Since collaborative sensemaking has a temporal aspect, activity awareness [14], i.e. awareness about *longitudinal*

endeavors, enhances group sensemaking much more than just awareness about group members’ current actions. In a collaborative environment, the multiple actions that comprise an activity are performed by different actors over time. Understanding the relationship between these actions is important for collaborative sensemaking. For instance, in the ED, the activity of diagnosing the patient’s condition is composed of several actions such as triage (by the triage nurse), moving the patient to a room (by the charge nurse), recording the patient’s history and vitals (by the nurse), physically examining the patient (by physicians), and interpreting the results of tests to determine the diagnosis (by physicians). CIS activities often involve understanding the relationship between these actions and contextualizing the actions with respect to long-term activities.

Finally, as group members share and make sense of information, they create shared representations to store the information found and the sense made of that information. Creating and manipulating these shared representations often enhances group sensemaking. Finally, at the end of the CIS activity, the products of sensemaking are handed off to other group members who might continue the activity or utilize the results in other work activities.

It must be noted that none of the parts of the framework are all-inclusive. Part I does not represent the only way in which CIS activities take place, nor does Part II include all possible triggers for collaborative sensemaking. Similarly, Part III does not list all possible characteristics of collaborative sensemaking. Also, the framework does not assume that these activities take place in any fixed sequence; in fact most of the activities noted in Part III occur simultaneously and iteratively throughout the CIS task. This framework helps describe why and how sensemaking occurs during CIS activities and provides implications for the design of CIR tools for enhancing the users’ sensemaking. We discuss three important design implications in the next section.

DESIGN IMPLICATIONS

Supporting sensemaking trajectories

The importance of sensemaking trajectories indicates that making the temporality of the information seeking process persistent is important for supporting sensemaking. Thus, CIR tools should make explicit the persistence of the process and products of sensemaking by visualizing sensemaking trajectories. One way of visualizing such trajectories is through *timelines* [15] which show chronologically the information found by different group members and the sense made of the information. Users should be able to view information in such timelines by group member (e.g., all actions performed by nurse X on patient Y) or by type of information (e.g., all tests ordered for patient X in the last 24 hours). Comments made on information should be incorporated into the timeline so that the sense made of the information is stored and shown along with the information.

Supporting activity awareness

Few studies have examined how activity awareness can be supported during CIS tasks. Hayashi et al. [16] proposed the *temporally threaded workspace* model to support activity awareness. This model provides awareness of a set of interrelated activities, each of which is executed within an individual workspace. The temporal connection between the activities of different individuals pertaining to a collaborative task helps maintain activity awareness. Activity-based computing [17] represents activities as computational entities which are aggregations of services, resources, artifacts, and users relevant to a real world human activity. In such systems, the state of activities are made persistent and saved. These design ideas can be extended in the design sensemaking-support features in CIR tools. Activities can be represented as a sequence of actions by various actors (similar to the temporally threaded workspace model [16]) and can incorporate the characteristics of activity-based computing that help preserve and make explicit the temporal aspects of activities. Activity representations, called *activity timelines*, can store the information found by actors during various actions performed during an activity. For instance, a hospital information system can show *activity timelines* of the actions performed by care providers with respect to a particular activity like diagnosis of the patient's condition.

Supporting roles and expertise

One way to support sensemaking in the face of role-based information distribution is to provide visualizations of information *by roles* in activity timelines. For instance, in a hospital information system, timelines can show all information available about a particular patient for each category of role-players such as doctors, nurses, etc. Sensemaking can be further enhanced in such systems by allowing users to filter timelines by type of role player (e.g., enabling users to see all information available to doctors) and by type of activity (e.g., enabling users to see all information pertinent for diagnosing the patient's condition). Similarly, group members who lack the expertise to understand information can be supported by enabling experts' to comment on and annotate information found by others. Different experts might prioritize different pieces of information as important to the CIS activity. This challenge can be addressed by allowing group members to rate each others' expertise and weighting comments from experts based on their expertise rating.

CONCLUSION

We presented a framework that enhances our conceptual understanding of an important aspect of CIS, namely collaborative sensemaking. It also provides design ideas for supporting collaborative sensemaking in CIR tools. At the workshop, we would like to engage in discussion about our framework and the design implications, especially how these can be adapted to various domains of CIS.

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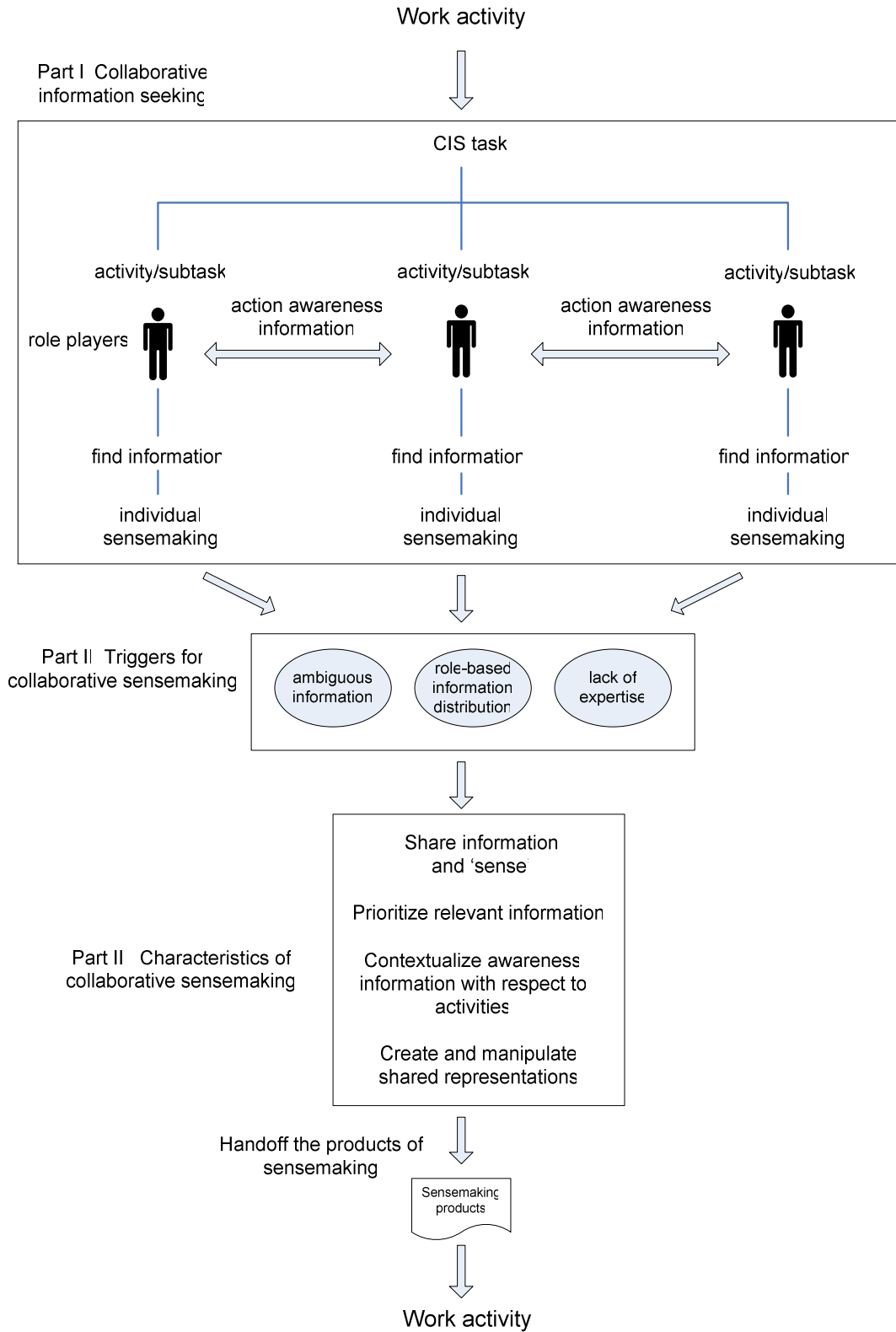


Figure 1: A Framework for collaborative sensemaking during CIS activities