

# A Proposal for Studying Users' Behaviors in Collaborative Information Seeking through a Convergence Map

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## ABSTRACT

The complexity involved in the understanding of human collaboration leads to the design of novel approaches for its study. Particularly, in the context of information seeking little is known about collaboration, indeed only during the last years the study of collaborative information seeking (CIS) has become a subject of interest in the research community. Considering the lack of appropriate methods and resources for studying this phenomenon, in this paper I propose a methodology for collecting data in lab experiments and a multidimensional map, here introduced as the convergence map, for integrating the data collected, as well as describing and studying users' behaviors in CIS in terms of factors such as relevance, convergence, uncertainty, and affectiveness.

## Categories and Subject Descriptors

H.5.3 [Information Interfaces and Presentation]: Group and Organization Interfaces—*Collaborative computing, Computer-supported cooperative work*

## General Terms

Design, Human Factors.

## Keywords

collaboration, information seeking, convergence, map, users' behaviors.

## 1. INTRODUCTION

In the context of information science, information seeking has been widely studied from different points of view. For many years the predominant focus on this matter was the implementation of information retrieval systems based on concepts such as aboutness, topicality, and relevance; however, since the paradigm shift [5] the focus has been on the understanding of users' behaviors. During the past thirty years most of the studies in this regard, particularly those that arise from information science, have proposed theories and models for explaining human factors that participate in the information seeking process. Regardless the source of such theories and models, the main point is that users' behaviors are key aspects for developing better information systems.

An important effort for understanding the role of users' behaviors in information seeking is seen in the variety of theories, models,

methodologies, and studies developed by authors such as Belkin [2], Bates [1], Dervin [4], Kuhlthau [[8][9]], Wilson [16], and Nahl [10], among others. Works like these suggested that in information seeking, there are several factors, not only internal but also external, that affects the way in which people seek information. This situation has led to define complex models and theories that in general are hard to be appraised and implemented technologically.

Considering the wide range of studies regarding information seeking from a users' perspective, this work is based on an implicit aspect that several authors have discussed, but that has not been explicitly included in their proposals. This factor is referred in this paper as convergence, which is presented here through a dimensional scale with two opposite poles, namely: divergence and convergence. The former is referred to a particular user's behavior, in which users explore information sources that are unrelated or indirectly related to the information need, while the second corresponds to a state of focus in which users seek information directly related to the original information need.

The notion of convergence presented in this paper was devised as an extension of the uncertainty principle described by Kuhlthau [9]. As a result, the convergence map proposed in this paper provides an integration of different models and theories, a taxonomy of information seekers, a map of the paths that users follow when they engage in information seeking tasks, and a design for technological applications of awareness (both emotional and cognitive) in information retrieval systems, either for single or collaborative scenarios.

The following sections provide a general overview of the literature from where the notion of convergence arose, a description of the convergence map as well as the methodology for collecting data, and the implications in the study of CIS.

## 2. BACKGROUND

As mentioned above, some researchers have touched implicitly the notion of convergence in their theories and models for explaining the behavior of users in the information search process (ISP). Others, very few indeed, have stated this idea explicitly but from a completely different perspective; for instance, Straw [12] addressed a quantitative study about the methods, sources, and other aspects with regard to the behavior of historians and political scientists. What he found is that people in both disciplines, converge and also diverge with respect to the resources they use. In this sense the concept of convergence was used in the sense of finding commonalities and differences between two disciplines. This notion of convergence differs from the one presented in this paper, in that the latter is used for describing the dynamic of users' behaviors in information seeking tasks.

More implicitly the convergence dimension can be explained through the concept of specificity discussed by Belkin [2] at the cognitive and linguistic level. Although this concept was presented as a binary dimension; this reflects the problems derived for example of having an inappropriate language or of being facing a problem completely new for the user, and how this situation affect the way in which users express their information needs.

In a similar way, the affective load theory (ALT) as it was explained by Nahl in [7] included the emotional component as an important part for understanding users' behaviors during the ISP. ALT also involves the idea of convergence and divergence implicitly; as expressed in following quote:

“[I]f they [searchers] unexpectedly find some new information they want, they switch activity midstream. The new affective behavior interrupts and takes over the ongoing activity and continues in a new direction with new cognitive activity” [7]

This description as well as others such as “information overload”, corresponds to divergent behaviors.

According to the ecological theory of information behavior (Williamson in [7]), it was also pointed out that certain aspects may lead users to divergent behaviors because of unexpected access to information. As the author explained “people find information unexpectedly as they engage in other activities, with information acquisition becoming an ‘incidental concomitant’” [p.128]. This is common not only in everyday life information seeking [11], but also occurs when people seek information regarding to an specific topic and they realize they do not know much about related and also interesting topics, so they opt for exploring them through the acquisition of new information that lead users to obtain even more information that occasionally is unrelated to the original topic.

In general, models and processes like those developed by Ellis in [7], Kuhlthau [8], and Wilson [16] state that while people engage in information seeking activities, they do not go directly from uncertainty to understanding, but they have to return to previous stages in order to change strategies, queries, focus, and so on. For example, Ellis included implicitly the convergence dimension in two of the stages of his model. Firstly, in the chaining stage, users diverge by following the connections among resources; secondly, the browsing stage leads users to focus or converge by “searching in an area of potential interest” [7]; finally, in the extracting phase, users seek information in “a particular source to locate material of interest” [p.139], which is also a convergent behavior.

Another early work related to the idea of convergence, is the berrypicking model [1]. As the author stated, in information seeking, queries evolve while users are searching for information; in this sense, information seeking was described as an iterative and incremental process in which users gets the information they need. The variations on users' queries lead them to visit information sources that are directly related, indirectly related, or even completely unrelated to the original information needs; such exploration of different sources makes the ISP a non-linear process.

Besides the works mentioned above, there are various models and theories in the literature related somehow to the idea of convergence presented in this proposal; examples of this are the studies about uncertainty [6], cognitive authority [15], context

[13], media richness theory [3], affective events theory [14], and sense-making theory [4]. These and other works are not presented in this section, however they were considered in the development of the model presented below.

### 3. CONVERGENCE MAP

The convergence map, as presented in this section, is a resource that can be used by researchers for describing the behavior of users when they seek information either individually or in collaboration with others. In particular, this paper focuses on the use of the map for studying users' behaviors in CIS.

According to the convergence map, people who seek information can be situated in four different scenarios during the ISP. Each scenario (or quadrant) represents particular behaviors, feelings, and the valence of uncertainty on it. It is worth mentioning that this map does not attempt to establish specific stages in the ISP – though it would be possible to use traditional models of ISP as complements - but rather, it offers a multidimensional view of the behaviors of users while they seek information.

As shown in Figure 1, each scenario provides a way of classifying users' behaviors in terms of the following aspects:

1. Level of uncertainty and convergence.
2. Feelings that users experience (pleasant and unpleasant).
3. The polarity of the uncertainty.
4. The establishment of boundaries.
5. Time.
6. Context.

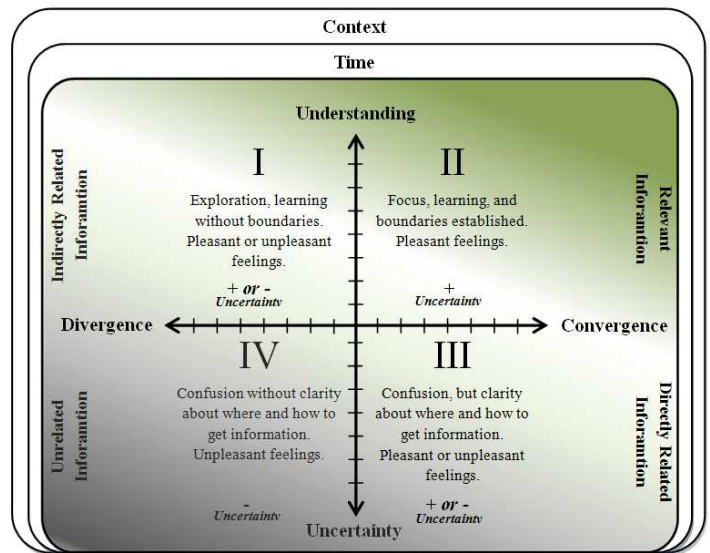
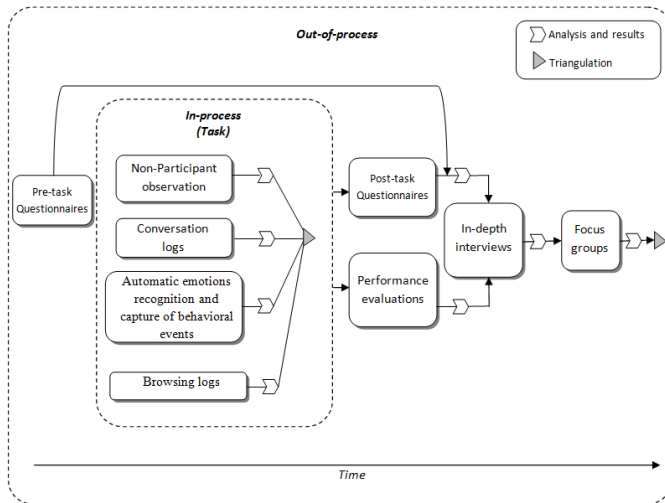


Figure 1. Convergence Map.

In order to place users' behaviors in this map, it is required data of different kinds. As show in Figure 2, data should be collected through both quantitative and qualitative methods when studies are conducted in the laboratory. In this sense, surveys, logs, observation, and interviews are essential for having a holistic view of the collaboration process of individuals in the information seeking process. Questions (either in surveys or interviews) should be addressed to understand users' familiarity or prior understanding of the search topic, their motivations, and interests.

In addition, it is necessary to record affective data of users at different stages of the search process, identify particular speech acts in conversations, strategies, search history, and so on.



**Figure 2. Sketch of a data collection process based on mixed methods for CIS studies.**

Once the data is collected through methods like those sketched in Figure 2, it is necessary to run analyses in time, so that it is possible to observe the behavior of users in different instants in CIS tasks. In order to identify where users must be located in the map in a specific moment, it is necessary to have an idea of what each quadrant in Figure 1 represents. The description of the map presented below provides an idea for mapping users' behaviors in the corresponding quadrant.

When users are in the fourth scenario (IV), they feel disoriented and confused about the information they are looking for. They do not know exactly how and where start the search to get what they need. In this kind of scenarios, information is unrelated to the topic; moreover, it is very likely that multiple fields of study are involved, so users do not have clear delimitations or boundaries of the problem (I call this phenomenon divergence). In this sense, the uncertainty is negative and users experience unpleasant feelings.

The transition out from this quadrant to another sometimes requires the intervention of other people - like collaborators or cognitive authorities - who may help users to identify a way of getting focus and orientation. This is considered the worst scenario in which users can be situated when they seek information.

The third quadrant (III) is more encouraging because despite the levels of uncertainty that users experience, they have a more clear focus about what they are looking for (convergence). In this sense, uncertainty can be either positive or negative and feelings can be either pleasant or unpleasant, allowing users to get rapid access to higher levels of understanding. However, in this scenario users may also lose focus in the original task, situation that leads them to the fourth quadrant.

In the second quadrant (II), users have a complete understanding of what they need and how they can get access to the information they are looking for, so their behavior in this scenario is

completely convergent. Here users experience pleasant feelings and the learning process allows a significant and progressive reduction of uncertainty. This is considered the best possible scenario that users can reach when they engage in information seeking tasks.

Finally, the first quadrant (I) is a scenario in which users do not have established boundaries because it is very likely that their research involves more than one discipline or it is a broad topic (divergence); however, they know exactly what they need in relation to the original information need, but the abundance of indirectly related information, personal motivations, or the availability of time, lead them to a wide exploration of the topic. In this manner, the influence of uncertainty and feelings can be either positive or negative.

#### 4. IMPLICATIONS IN THE STUDY OF CIS

The major challenges of studying collaborative information seeking through the notion of convergence are the data collection process and the analyses that have to be performed for placing users' behaviors in the convergence map. In fact, the method proposed for collecting data in CIS studies is time consuming, but the main benefit is that it offers a complete view of the information seeking process of users from two different but complementary perspectives (out-of-process and in-process).

Although the data can be analyzed both qualitatively and quantitatively, the convergence map is a useful visual resource for summarizing and integrating both kinds of data. By having this visual representation of users' behaviors in a particular context, in different moments, and considering a set of variables; it would be possible to study how the behaviors of users change in time and how factors such as personal motivations, feelings, interests, task complexity, and initial understanding of the topic, among other aspects, affect the synergy of teams.

Generally speaking, analyses of the convergence maps of teams would help to identify behavioral patterns (as show in Figure 3) and also it would provide useful information with regard to the conditions under which teams work better. This is particularly important in different contexts where it is necessary to form teams, but where there is not a clear understanding of how their dynamics will be affected by certain initial conditions like personality, professional skills, and attitude, among others.

Region of Behavioral Patterns	Und	Und
Time Avail.	+	-
Moti./Inter.	+	-
Complexity	-	+
Initial Und.	+	-
	<b>Best Scenario</b>	<b>Worst Scenario</b>

**Figure 3. Examples of regions of behavioral patterns that could be identified through the representation of users' behaviors in the convergence map.**

## 5. CONCLUSIONS

In this paper I proposed a notion of convergence through a map. This notion as well as the map arose mainly from the integration of different theories and models developed originally for individual information seeking. In addition, I suggested a data collection procedure based on mixed methods that allow researchers have a complete view of the collaboration process of individuals in information seeking tasks.

Both the convergence map and the data collection procedure are useful resources that can be used in in-depth exploration of CIS in laboratory studies. As stated above, the major limitation of this approach is the time required for collecting and analyzing data so that it can be summarized and combined in the convergence map.

On the other hand, the main benefit of using this approach in the study of CIS is that data of different kinds can be easily accessed through a unique visual representation, which facilitates further analyses as well as the process of interpretation of the results.

Even though this proposal is mostly based on previous works, preliminary studies conducted through interviews and focus groups revealed that convergence and divergence are common behaviors among users in the process of reducing uncertainty. Moreover it was found that the quadrants in the map represents somehow what users feel and think when they perform CIS task in different contexts, even in those that are not supported by computers.

It is worth mentioning that this version of the convergence map is a first approach that will be evaluated and improved through empirical studies in the context of CIS. Regardless this fact, this initial version is open to be improved by those who study information seeking of individuals and groups.

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