Physicists´ information behavior: a qualitative study of users♦

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Resumen

El propósito de este artículo es examinar la conducta informativa en el proceso de búsqueda y uso de la información de físicos que están en proceso o han concluido recientemente su tesis doctoral. Este estudio se realizó desde el abordaje del *sense making* centrado en el usuario. Se intenta explicar las situaciones comprendidas dentro del proceso de búsqueda y uso de la información, en términos de elección de fuentes, criterios de juicio de relevancia utilizados, estrategias de organización, y estrategias de presentación de la información, tanto como los sentimientos de los físicos y la definición que dan de la información

<NECESIDADES DE INFORMACIÓN> <BÚSQUEDA DE INFORMACIÓN> <USO DE LA INFORMACIÓN> <ESTUDIOS DE USUARIOS>

Abstract

The work analyzes information seeking behavior of students who are in the process of getting a PhD in Physics or who have recently done so. The analysis was made within the sense making approach which is centered in the user. An attempt is made to explain situations in the seek and use of information in terms of the sources, the relevance judgment criteria, organizational strategies as well as information presentation strategies. The study also looks at the physicists feelings during the information seeking process and the way the idea of information evolves in their minds throughout their PhD.

<INFORMATION NEEDS><INFORMATION SEEKING> <INFORMATION USE> <USER STUDIES>

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1. Theoretical framework

The theoretical framework for this work is Brenda Dervin´s *sense-making* approach, examining the way in which people build meaning and how they use information in that process. Information is understood as the meaning created at a specific moment in time-space by one or more humans.

Dervin´s theory's main concepts to interpret the situation are the *sense-making* triangle situation-gap-uses/help (Dervin, 1983: 9-11). Terms are defined as follows:

* situation refers to the time and space context in which sense is built;
* gap includes the standstills or barriers to movement (that is, a cognitive gap that may be solved according to the questions stated or the information needs related by the individual);
* gap definition and gap bridging represent the cognitive strategies that have proven useful to answer these questions;
* uses/help show how those cognitive bridges (that is answering questions) are set to work: how the individual sees the information, internally derived or recovered from external sources, e.g. colleagues or libraries helping (facilitators), or sometimes impeding (blocking) the activity of problem solving.

Dervin (1992, 61-83) builds the idea of gap as a theoretical assumption and as a scheme guiding the method: for framing the questions, interviewing and analyzing. Focusing on the idea of gap, she suggests taking the research to a new kind of more abstract and fundamental generalization.

Savolainen (1993, 13-28) in an article devoted to the analysis of the *sense making* theory, identifies three questions concerning the interests in Dervin's theory. Epistemological interests: a set of philosophical commitments and theoretical assumptions that generally guide the search of epistemic units (that is, of new scientific knowledge). Then the practical interests of the theory, the results of the study of information seeking and use applied in different practical contexts, such as the use of information in a process of doing a research work as a doctoral thesis. Finally, the problems of developing the theory and its paradigmatic demands in the studies of information seeking and use.

This article will be devoted to the practical interests of the theory, among them, the central technique of the *sense-making* approach which is the Time-Line Interview, studied by Savolainen and used in this research, which involves three main steps:

1) The interviewee is asked to describe in detail what happened in a situation step by step: what happened first, second, third, etc. Descriptions establish the time-line events (for example, "I was seeking bibliography about that subject in the library", "I decided to start seeking in books", etc.)

2) The time-line events are analyzed one by one, asking the interviewee to indicate some questions, puzzles or confusions associated with the events (e.g. "I found out that there weren't any books because the subject was too new so I had to look up in journal articles").
3) The nature of each of those questions (confusions, puzzles) is analyzed presenting a series of specific questions that reveal the dimensions of the "situation", "gaps" and "uses/help". Questions such as: "Did you find yourself blocked when you asked that question" "In what way?" (as a measure of the situation) "How easy was it to find an answer? (a measure of the gap), and "Did you expect the answer to help?" (a measure of uses/help)

For Krikelas (1983: 19 : 5-10) information seeking behavior is any activity undertaken by an individual to identify a message that satisfies a perceived need.

Given the characteristics of the research it may be classified as qualitative of context or descriptive (Slater: 1990: 107-127).

2. Research question.

The aim of this article is to approach and know the informative behavior of physicists in the process of getting a PhD and it is analyzed as the completion of an informative process. An attempt is made to answer the question: What kind of information seeking and using process (ISU) do physicists follow to complete their research?

3. Methodology

Nine recent PhD in Physics or Doctorate students in the last stage of obtaining their PhD (writing their thesis) from the Faculty of Exact and Natural Sciences from the University of Buenos Aires, were interviewed to solve the research question, with the purpose of exploring their experience in the ISU to complete the theses. PhD in Physics were chosen because they are known to be scientists in training who need to seek, collect, evaluate and use information to finish the research process implied in a doctoral thesis.

One of the hardest problems of the research was finding the population, since when the Physicists get their PhD, and as part of their training, immediately after getting the PhD, they usually go abroad to do post doctorate studies. Interviewing recent doctors from '98, during 1999 was taken into consideration. However, it was impossible to gather the population, so a decision was made to interview the recent doctors from '99 and 2000 who were finishing their

thesis. According to Slater (1990: 107-127) normal sample statistic rules, if they are strict, may be inapplicable to recruit the participants. However the principles still apply as guidelines to proceed. As it has been explained, in this particular case the sample is represented by Physicists found in the country who agreed to the interview.

It has to be considered in the analysis that the average time for finishing the PhD is 5 years, the interviewees' average age is 33; all the interviewees had a scholarship from the University of Buenos Aires or from the National Commission of Scientific and Technical Research (CONICET) to do their PhD; they have all been in teaching functions for an average of 10 years, 80% as Assistant Professors. 4 of the interviewees were females and 5 males; finally as regards the orientation 5 were theoretical and 4 experimental. From now on when I mention "the physicists" I will be referring to the interviewed population.

The Time-Line interview questions were the following

1. What were your initial questions to outline your thesis subject? or What questions went through your mind in the course of completing your thesis? What were the general circumstances that took you to that incident? When did that incident take place?
2. What strategies did you use to get answers to your questions? Why? or Tell me exactly what that person or source did that was so useful at that moment.
3. What problems did you have in getting answers?
4. How did each answer help (or fail to help) to carry on with your research?
5. When did you feel that the work was over and started writing?

The interview data was recorded, transcribed and analyzed. Cheuk's article (1998: 30-38) was taken as a basis for the characterization of situations. The categories called "situations" were modified, refined or abandoned as the analysis proceeded. First, each transcript was read and physicists singled out all ISU situations that they perceived they were involved in. Then, the order of the perceived situations was reorganized according to the occurrence sequence, similarly a series of situations were gathered in a process called questioning/learning. Those ISU situations were then used as a framework to identify information behavior associated with each situation.

1) This study focuses on the need of exploring the situations of the physicists when they seek and use information. An attempt is made to identify critical ISU situations perceived by physicists in the course of completing their research to present their doctorate theses.
2) It emphasizes the need of identifying the different types of problematic situations that the individual faces in critical moments and of studying the specific strategies (or help) used to bridge the cognitive gap. This study tries to identify informative behavior and strategies used by physicists to fill the gap that appears in the different situations.

4. Information Seeking and Use Situations

The data gathered shows that physicists experiment seven different critical ISU situations to complete their research.

4.1. Research Initiating Situation

It is the situation where physicists know they have taken on the responsibility of initiating a doctorate and have to do a research that will end up in a thesis, they count on a director that guides them throughout the process. In this stage they ask themselves the following questions: “Is this going to be a basic or applied research?” “How is it going to be carried out in any of the two cases?”

4.2. Questioning and learning process

Process characterized by the repetition of the situation gap/use/help also represented in the theory stress/coping (Wilson, 1997, 39-50) in progress, starting with the subject selection going on to assuming, rejecting, confirming and finalizing ideas. Further explanation of each situation within a process is discussed below.

4.2.a. Subject selection situation.

It is the first barrier to deal with. In this situation physicists have to define a subject for their research project. They usually have two or more subjects to choose from. Subjects may be related to the dissertation written for their University degree, i.e. subjects from a previous research. Or subjects that the directors suggest according to the research lines that they intend to develop; sometimes doctorate students have the option and sometimes they don’t. The average time for definite selection takes between 4 months and 2 years, according to the interviewees. Some researchers follow parallel subjects for some time until they finally decide which will be the selected subject. Others start with a subject and change if they don’t make progress. This stage involves the reading of articles provided by the director, followed by consulting the

network of quotations that they can make from the initial article. In this situation they have the following questions in mind: “Will I continue with a subject from the seminar?” “Will I start a new subject?” “How can I decide on one of the two subjects?” “What is the subject that I’ll really be able to solve?” “Have I selected the right subject?”

4.2.b. Ideas Assuming Situation.

In this situation physicists work on the selected subject. Here information seeking on the subject occurs again. In this stage they make a thorough search to check the current state of the subject and to find out if anybody else is working on it. In the case of those who work with very new subjects, the directors already have the existing bibliography. They consult that and don’t make any thorough seeking.

In this stage it is noted the use of bibliography databases and of complete text; in general, they access to databases found on the Internet for free as *Uncover*, Los Alamos or bases temporarily available, such as commercial companies demos (*Web of Science* or PROLA, *Physical Review On Line Archive)*, this situation was repeated in the answer of several interviewees because it coincided with the demonstration given by the Institute of Scientific Information in 1998. Many of them also use the *Current Contents* acquired by the Periodicals and Newspapers Library of the Physics Department.

In all situations occurs the browsing of scholarly journals such as the series *Physical Review*, when it arrives to the Library or Department (the groups usually have personal subscriptions). The questions they have in mind in this situation include: “Will I find relevant information?” “Will the journal that I need be available?” “Will I be able to find the quoted articles?”

4.2.c. Ideas Confirming Situation.

In this situation Physicists have elaborated an idea about their thesis subject and they move forward in this sense. They make experiments, measurements and bibliographical research or anything they need, such as programs, calculations, etc. depending on the experimental o theoretical orientation. According to the results they make a hypothesis and try to prove it once and again to finish the work. In the experimental case in particular, the thesis subject may be modified according to the experiment results. They may have assumed several possible ideas that need confirmation, whether it is carried out or not, due to time and resource restrictions.

In this situation the questions are structured: “What causes the problem?” “How come I am stuck here?” “Is this the right specification level to carry out the trial?”

4.2.d. Ideas Rejecting Situation

In this situation, Physicists may face conflicting ideas or may lack the required information to confirm their ideas. They encounter a difficult problem to solve which prevents them from carrying on with the research, a problem that takes them quite long to solve. The Physicists feel 'problematic', 'hazy', 'frustrated', and 'very tired'.

For some technical reason and/or lack of necessary equipment in the country the technical trials cannot be performed. Sometimes they have to resort to agreements to make measurements with the appropriate apparatus, for example, abroad. In other cases theoretical information is needed to support the experimental part that has to be produced.

The questions (or gaps) that they have in mind at this point change the previous structured questions to other open or unstructured: “Why can’t I solve the problem?” “Is there any other way of going through it?” “Doesn’t this information confirm my expectations and the previous information that I have gathered?” “Why don’t I have the information that I expected to get?” “What’s going wrong?”

4.2.e. Ideas Finalizing Situation

In this situation the physicists try to seek formal consensus with their directors and support it with the accepted and/or published articles on the subject to finalize their confirmed ideas. Specific information sources are used as in the whole ISU process to finalize ideas.

The article production takes them to a peer-review process where international specialists analyze and evaluate the work. With the approval comes the research validation.

The questions they have in mind involve: “Does my director agree with my ideas and the assumed solutions?” “Is there any critical information that I have overlooked and should take into account?”

Concrete instances of help declared by the physicists may be identified within the 4 situations: working in teams, seeking bibliography, obtaining journal articles and getting in personal contact with the director, visiting professors in congresses, etc.

4.3. Passing on Ideas Partially (Articles) and Totally (Thesis) Situation

In this situation two stages are present, the first is the article production that takes form when the research moves forward; those articles represent the partial communications of the research. After having produced between 1 and 6

articles, the Physicists write their thesis and submit their work to an evaluation committee. In this stage total communication with the academic community occurs, through the thesis presentation and defense before a committee of specialists. From the gathered data it is noted that the physicists move on to this situation when they want to:

(a) present findings to get feedback from the group (in the cases where they work in groups and give talks on the thesis progress, 4 cases over 9 interviewees);

(b) pass on knowledge to the scientific community through articles published in international journals;

(c) inform the scientific community of the progress of their work in the presentation of works to congresses.

When they are in this situation, some of their questions involve: "How should I write the article?" "What should I include in my presentation?"

4. 4. Moving among ISU Situations

Having identified the ISU situations, it is important to point out that, according to the data gathered, the Physicists follow some sequence order to move from one ISU situation to another. For example the first situation, *research initiating,* with respect to the questioning/learning process always keeps that order. It was noted that Physicists can move from 3 situations (*confirming, rejecting and finalizing ideas*) to the *passing on ideas situation*. The *subject selection* shows the barriers to cross, in the subjects that are very new sometimes there is a lack of theoretical support, that is the reason why the *research initiating* is more difficult. In the moment of *passing on ideas* the satisfaction is greater too. The risk/reward theory (Wilson, 1997: 39-50) can be applied here, the newer the subject is the more risk and reward in the passing on information.

To complete a doctoral thesis, the physicists may move within a questioning and learning process among the five situations in different routes from one to the other. They may move backwards to some particular situations repeatedly. The process of moving from one ISU situation to another, without taking into account the route taken, helps the physicists to develop a better framework to answer the questions they have in mind and thus complete their research successfully. Moreover, the ISU process in the academic career doesn't stop when the ideas are passed on to others. In fact the information transmitted to others creates new information needs and problems, and physicists will have to develop new research in a post doctorate to then change the role and start directing the students and help them with their thesis, besides developing their own research project. They will continue defining their situation and will apply the best strategy to cope with each situation. The ISU is a continuous process that never ends in the academic career.

5. Relations between ISU situations and informative behavior

According to the data gathered, when the physicists perceive that they are in each of the ISU situations, they apply different information abilities and strategies to answer the questions that they have in mind (bibliography seeking, articles, consulting experts or the director, suggestions form the research group). A distinctive set of information behavior was found (including physical, cognitive and affective behavior) associated with different situations. Some important examples are shown below to illustrate the relation between ISU situations and informative behavior (in terms of choice of information sources, information relevance judgment criteria used, information organization strategies, information presentation strategies, physicists feelings and the definition they give to information).

5.1. Use of information sources and choice of sources in different situations

Physicists use bibliography very often. The interviewees showed a similar behavior in the choice of information sources in each of the identified ISU situations. The use of specific information sources such as journals, free database on the Internet (*Uncover* or Los Alamos *pre-prints*, etc.) appear in the situations of: *subject selection, confirming ideas, checking ideas*. In the latter, physicists tend to choose information sources that are convenient, easily accessible and on their desks. Their persistence in using preferential sources is extremely high; checking daily the Los Alamos *pre-prints* database, browsing the *Physical Review Letters*, searching in the PROLA are routine and systematic tasks incorporated to their informative behavior. What changes is the approach to information sources, this may be thorough in the *subject selection and ideas assuming situations* within the questioning/learning process and of permanent update in the *confirming, rejecting and finalizing ideas situations.*

Physicists also use other individuals (experts) with whom they interact on a face-to-face basis during their ISU process, for example the director or other people they meet when they attend congresses or when visiting professors go to their University.

Information from those sources becomes critical when physicists move forward in the questioning/learning process covering the four situations (*subject selection, confirming, rejecting and finalizing ideas*). Physicists are very independent users when seeking and using information; this characteristic gives a direction to the organization of library services since researchers skip all mediation that they don't consider nimble; therefore the library must facilitate the necessary tools when they need them, ensure the subscription to journals and expensive database and the quick access to the primary document. That is what physicists value, otherwise the library appears to them as an obstacle. And when they are in the *subject selection situation* they won't doubt in a detour to using alternative

sources. In the *confirming and rejecting ideas situations*, physicists increasingly use specific (international periodical publications) and authoritative sources, and primary data generated by experiments, as well as consulting their bosses and experts.

5.2. Information relevance judgment criteria in different situations

In the *research initiating and subject selection situations*, physicists apply stringent criteria to judge the information relevance. They pick up or accept information provided by their directors to build an idea of the problem they are working on. In the *ideas assuming situation*, the relevance judgment criteria remain and physicists decide more carefully if the information they gather is relevant to the development of their ideas or not. In the *confirming and rejecting ideas situations*, physicists mention that they compare logically the data gathered against: (1) data obtained in the research process; (2) director suggestions; (3) information gathered from other sources to confirm the validity of their assumed ideas. In the *ideas finalizing situation* the relevance judgment is relaxed, when physicists mention that they need to confirm their ideas through the publication of articles.

5.3. Choice of information organization strategies in different situations

In most situations, physicists pointed out that they organize the experiment information in software programs. However, in the *confirming and rejecting ideas situation* physical ways of organizing information (e.g. jotting notes, making photocopies, printing articles) were deemed essential to record important evidence for later use.

5.4. Choice of information presentation strategies in different situations

In most of the identified situations, when physicists need to gather information, they present their questions to the information sources (e.g. directors, members of the research group) aiming at getting relevant answers. In *Ideas finalizing situation*, physicists present their ideas with an aim to get feedback and consensus from their director, experts and doctorate students from the research group in the case of teamwork. In the *Passing on ideas situation*, physicists take on the role of communicating new knowledge and findings through different channels, formats and supports which vary according to the purpose of the presentation and the different ISU situations; for example group meetings to communicate the progress in informal chats; different kinds of presentations in *passing on ideas situation,* in congresses through papers or posters. Finally, the thesis defense where the information is presented in an exam before a thesis committee with the thesis itself as support. At last the formal communication through the publication of articles in journals.

5.5. Changing feelings in different situations

In the *Research Initiating situation* and in the *Subject selection*, the physicists express feelings of doubt, fear and confusion. In the case of experimental studies, this feeling continues through the *Research initiating* stage, since some of them must wait for 2 years for the preparation of a laboratory, for example, to produce the first results. In the *subject selection situation* those who feel comfortable with the subject and make quite fast progress, feel well. In the *Ideas assuming and confirming situation*, they have stronger feelings and they are more worried because they expect to confirm the assumed ideas. Their feelings, however, are more negative in the *ideas rejecting situation*, where they feel pressure and frustration. The physicists overcome these feelings coping with the situation as a learning experience, being able to solve problems is a typical situation in a Doctorate, it is part of their training. In the *Ideas finalizing and Passing on ideas situations*, they express mixed feeling, on one hand they feel well, more relaxed because their work is almost over and their ideas are in agreement and shared by others; but on the other hand they show feelings of frustration because the context is not suitable for continuing with the academic career in the country. In general terms they have less intense feelings in each situation, except in the *Ideas rejecting situation*, where they continue feeling frustrated when their ideas are rejected in the first case, since this might mean a delay in the progress of their work. In the *Passing on ideas situation* when one of their articles is accepted by a scholarly Physics journal such as the *Physical Review Letters*, then the feeling of satisfaction for the accomplished work is really high.

5.6. Changing perception of information in different situations

It is interesting to note that the way in which the Physicists define information changes as they move on the dynamic ISU process. In the *Research initiating and subject selection*, information is journal articles, descriptions and director's comments. In the *Ideas assuming situation*, information is referred to as raw data that can be transformed and applied. This is clear in the experimental studies that get measurements and material to reach conclusions or get work models. For theorists is different because they have to find parameters in more abstract subjects. In *Ideas confirming and rejecting situations,* information is evidence, testing results, facts, confirmation obtained from articles, reasons for explanation and clarification. In *Ideas finalizing situation*, information is feedback, agreement and consensus from director, co-director and experts. And in *Passing on ideas situation*, information becomes universal and capital knowledge, information with value to the scientists of the world. The changing meaning of information as perceived by the physicists shows information is a stimulus that creates a change at the own level (degree) of certainty. (Krikelas, 1983: 5-20). As all the pieces of the research are assembled, the value of truth, objectivity is acquired, which will become universal knowledge on the subject once it is passed on.

6. Conclusions

It can be asserted that the phases in the research process determine the characteristics of the ISU process. These determine the distinctive features of the situations identified in this study, which are combined and influenced by one another in a dynamic and recursive way. On the other hand, since the research process itself is subject to socioeconomic conditions for its fulfillment, transitively the information seeking process is too.

The following conclusions arise from the relations between the ISU situations and the information behavior:

- ✓ In the use of information sources users obviously prefer to consult all the material from their desks and only resort to the library in the cases when they have to seek a particular article. It is important to point out that there is a general tendency to skip the librarian. He is perceived as an interface to obtaining the material. This is a perception observed in physicists, since none of the interviewees has consulted the librarians during their ISU process.
- ✓ In the choice of information sources, Krikelas theory (1983, 19: 5-20) is confirmed as regards the preference of some sources over others. The physicists interviewed have developed a hierarchy of preferences of the information resources that they consult, and they exercise it permanently.
- ✓ The physicists use stringent information relevance criteria in all ISU situations.
- ✓ As regards the choice of information organization strategies, this information behavior was shown in the systematization of information within this community. In 1991, a physicist in Los Alamos was the one who started the *pre-prints* database, permanently consulted by the community. (Ginsparg, 1997: 43-58).
- ✓ Information presentation strategies vary according to the situation from informal chats to the publication of an article in the case of partial communication, to the thesis in the total communication.
- ✓ Feelings vary in the different situations from frustration to satisfaction, according to the opposites rejections/approvals and delays/progresses in the research process. This shows that the passage between opposites is a part of the learning process.

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