The 5th Intercultural Arts Education Conference: Design Learning

From novice to expert: Information seeking processes of university students and researchers

Liisa Karlsson[a,*], Leena Koivula[a], Inkeri Ruokonen[a], Pia Kajaani[a], Liisa Antikainen[a], Heikki Ruismäki[a]

a University of Helsinki, P.O. Box 9, FI-00014 University of Helsinki, Finland

Abstract

The purpose of this research is to study the information-seeking competencies, practices, and knowledge of university actors. In this observational case study, observers followed the information-seeking processes of eleven Finnish students, researchers, and information specialists[†]. The participants were also personally interviewed. Scientific information seeking proved to be a very complex phenomenon. Three different types of information seekers were found. Most informants had minimum contact with the library, and only a few had knowledge of the value of using librarian competence. The recognition of the centrality of information-seeking studies in university curricula is growing. More faculty-librarian collaboration is needed to attain information seeking and learning outcomes defined within the revised curricula.

Keywords: information-seeking process; university student; doctoral students; researchers; information specialists

1. Introduction

In the information society, information is increasingly available to any person (see, e.g., Aula & Nordhausen, 2006). The Internet search engines will bring substantial opportunities to quickly access scientific information almost everywhere. Information seeking is no longer tied to physical facilities such as library buildings or bookstores. Everyone lives with a flood of information or in a data paradise, depending on the perspective. Provision of information is rarely a problem. Instead, the central issue is

---

* Corresponding author. *Tel.:* +358 9 1911,
E-mail address: liisa.karlsson@helsinki.fi
This article is based on the first study of the project, Searching for Scientific Information, SSI.

how to find relevant and reliable information effectively in every situation. Information retrieval and related skills are important for all scientists.

Study and research need the latest research information. It cannot be based on random and unscientific knowledge, which could circumvent/foil an entire study design and results. Therefore, comprehensive, but exact information criteria and source criticism are particularly strict in scientific information retrieval. Systematically screened, relevant knowledge in science is crucial. It also improves the reliability of research findings. In short, researchers and university students need general, specific and current information (see also, Chu & Law, 2007b).

Studies on academic users' information-searching behaviors can be divided into two research streams (Du & Evans, 2011). The first stream is focused on understanding the micro-level characteristics of users' behavior, for example, information-seeking patterns (Ellis, 1993) and interactions with digital scholarly journals (Nicholas, Huntington, Jamali & Watkinson, 2006). The second stream, which was conducted within the area of library service, focused on examining the impact of macro-level users' information behavior on library information service. For example, Rowlands and Nicholas (2008) conducted research on understanding how students find books and Maybee (2006) how user-centred information literacy instructions can be created. Our research aim is to connect the academic users' viewpoint to that of library services.

2. Previous research

The number of qualitative studies (e.g., Aula & Nordhausen, 2006; McGuinnes, 2006; Morrison, 2007; Haglund & Olsson, 2008; Du & Evans, 2011) concerning students' and researchers' experiences, competence, behaviors and attitudes in information seeking and learning processes is quite small. Many faculties give information learning and seeking studies outside the curriculum, although this instruction would be more effective inside the classroom. McGuinness' (2006) study shows that students acquire information-seeking skills gradually throughout their university education.

Haglund and Olsson (2008) performed an observational study at three universities in Stockholm, Sweden in order to understand the information needs of young university researchers. The results of this study showed that researchers used Google for everything and they had confidence that they could manage on their own; they relied heavily on immediate access to electronic information. The researchers had minimum contact with the library, and only a few had knowledge about the value, usefulness and availability of librarian competence. The study drew the conclusions that librarians should leave the library building and start working in the research environment; library use was considered complicated in comparison with using Google. The study by Du and Evans (2011) with 42 postgraduate students from a wide range of 15 different academic study areas showed that Google and/or Google Scholar were considered as the most popular choices for academic information seekers (82%) and only 18% of the participants started their academic information searching by using library databases.

Chu and Law (2007a) noticed that many students were initially unfamiliar with many of the databases important to them and that the familiarity developed during the year contributed importantly to the development of their information search expertise. The researchers pointed out that much work has to be done to inform and instruct students about these "treasures".

In the Avdic and Eklund (2010) study, the researchers considered the problems that students experience when using a university library reference database. The most significant responses from the students indicated that it took a long time to search, articles in English made the search cumbersome, and they had difficulty finding relevant articles. Obviously, learning how to use reference databases is not a trivial matter. Even though all participating students were mostly positive about their abilities, the results revealed that their information literacy could be much better. According to Chowdhury, Gibb, and Landoni (2011), for instance, uncertainty may prompt users to find information in a vast collection and, at

the same time, they may be excited to discover new information channels and sources; these sources may also provide useful insights for future searches.

In one study Chu and Law (2007b) identify three stages of students' information needs: general, specific and the current. These various stages of information needs were closely linked to the students' research progress, and the study presents the role of different source types at different stages of a student's research. It further shows that many students were initially unfamiliar with many source types important to their research, and the growth of knowledge of many of these sources has contributed to the students' development of information search expertise. Other studies (Chu & Law, 2008; Korobili, Malliari, & Zapounidou, 2011) show that information search training is still essential at the postgraduate and graduate level, and the goal of information search training should be to help all students to become competent.

Ellis et al. (2002) found that: (1) a number of different types of interactions were identified, and (2) the pre-searching interactions between the information seeker and an intermediary aided the information seeker to identify their idea and problem. The researchers found also that (3) most information seekers in this study were at the problem-definition stage or problem-resolution stage following the search process.

3. Research questions and study design

This research is the first part of the research and development project, SSI, concerning searching for scientific information at the university level in Finland. The aim of this first phase is to research the processes of searching for scientific information and determine the different ways of searching for information. In this article, we combine the perspectives of scientific researchers and information specialists because often the two groups are separated: researchers concentrate on their research field, while information specialists focus on research tools with which they are familiar. Both perspectives are important. We focus on researching which scientific information searching paths university students, researchers and information specialists have followed. Our research question is: How do university actors search for research information? We are interested in the information searching processes and the strategies information seekers use. The aim is not to look for differences between students, researchers and information specialists. We focused on what experiences and challenges the seekers face during the search process.

The number of informants in this first phase is small because of the qualitative focus on researching scientific searching processes. Because the research subject is different searching processes, we took informants from different researcher stages: beginners and researchers with much more experience. Furthermore, we included the information specialists that are professionals in information seeking. The participants in this study were ten women and one man from the Faculty of Behavioural Sciences at the University of Helsinki, Finland. Seven of them were university students and five were students who had participated in studies of searching for scientific information; all of them had studied some information technology. Four of the participants were researchers and information specialists and three of them had participated in some studies on searching for scientific information. All students were writing a Master's thesis, which meant that all participants were active in doing their scientific research.

The research data was collected during the summer of 2011. All participants were asked to search for scientific information about the factors of good teaching. The research situations of scientific searching were individual on the computer with an Internet connection. All informants had access to the virtual University library (Nelli, the Helsinki University e-Library) with a broad collection of information sources, data bases and e-journals. One or two observers followed the searching process step by step and recorded the whole search process. The method used was a transcribed think-aloud utterance, and at the end, the observing researcher interviewed the informant about his/her individual search process. In this follow up interview, the researcher focused especially on the problems and problem-solving methods of

the search process. The time given to this scientific search was free and it varied from 16 minutes to 130 minutes; many of the search processes took one hour or less. A researcher repeated on the computer all eleven information-seeking processes and they were compressed to eleven individual search paths. The data was content analyzed and compared qualitatively. The individual search paths are also presented in graphical form. This visualization of the search paths helped researchers to compare the research material and draw conclusions.

4. Results

The informants were a limited number (n=11); therefore, universally applicable conclusions cannot be drawn from the data. Instead, the results are indicative and describe different strategies and general problem sections in scientific information seeking. The informants looked for information along different paths and used 1-14 information sources during their search processes.

These Search paths can be seen in Table 1. The most-used information source was Helka, the Helsinki University Library Collection Database, which was chosen by 7 of 11 informants. The EBSCO databases and Nelli, the Helsinki University e-Library, were often used (6 and 5 of 11, respectively). Only one information seeker used Google and only four used Google Scholar.

So far, our results differ from the study of Du and Evans (2011, 302) where as much as 64% of the Searchers began the information retrieval with Google and 18% with Google Scholar; in other words, altogether 82% of the information seekers used Google Search forms (see also, Haglund & Olsson, 2008). In our study, Google/Google Scholar was used by only 18%, in other words, two people.

Table 1. Expertise levels, statuses and used information sources. (* Informants who have taken a course in information seeking.)

n	Level of expertice	Status	Used information sources
n3*	expert	student	EBSCO > Catalogue of Helsinki University Libraries > SCOPUS
n4*	expert	student	Catalogue of Helsinki University Libraries > Academic Search Complete (EBSCO) > Education Research Complete (EBSCO)
n8*	expert	information specialist	ERIC
n10*	expert	information specialist	ERIC > EBSCO > Union Catalogue of Finnish University Libraries
n6*	survivor	student	Catalogue of Helsinki University Libraries > Google Scholar > EBSCO > Google Scholar
n9	survivor	postgraduate / researcher	Science Direct
n11*	survivor	postgraduate / researcher	Google > Google Scholar > Catalogue of Helsinki University Libraries > Google Scholar > Helsinki University Electronic Library > EBSCO > Tampere University Dissertations Database > Jyväskylä University Dissertations Database > Google Scholar > Catalogue of Helsinki University Libraries > Google > Catalogue of Helsinki University Libraries > Google > Web pages: Institute of Behavioural Sciences / University of Helsinki
n1*	novice	student	Google Scholar > Helsinki University Electronic Library > SAGE
n2	novice	student	Catalogue of Helsinki University Libraries > Catalogue of Aalto University Library > Helsinki University Electronic Library > Google Scholar
n5*	novice	student	Helsinki University Electronic Library > EBSCO > Catalogue of Helsinki University Libraries > SAGE > Education Research Complete (EBSCO)
n7	novice	student	Catalogue of Helsinki University Libraries > Helsinki University Electronic Library > Jyväskylä University Thesis Database > Web Library of the Helsinki Metropolitan Area > Helsinki University Electronic Library > Web pages: Finnish National Board of Education > Ulrichsweb > Reference Database of Finnish Articles > Ulrichsweb

Three types of scientific information applicants were distinguished from the data: novice (n=4), survivor (n=3), and expert (n=4). In the following, these classifications are described in more detail.

4.1. The novice

The novice (e.g., Figure 1) uses a random information seeking style. He or she drifts on trial and error from one web page to another and does not perceive the logic of the information search. This seeker often expresses emotional frustration. The informants described their processes: "I really do not know what I am doing". "How could I know which sources I find are scientific publications and which are novels?" "I have been here once already. Now I can't bear to use this anymore". "Oh ***, I am here again; I circle the whole time . . .", "I am frustrated".

The novice usually uses more different information sources/databases than those in the other groups even though he or she knows only a little about the data bases; a novice may use 4-9 sources/data per person, altogether the informants used 14 different services. All the novices chose to use Nelli, the Helsinki University e-Library information source. However, the actual skills to use Nelli or other possible information sources are missing. The search terms are unsuitable.
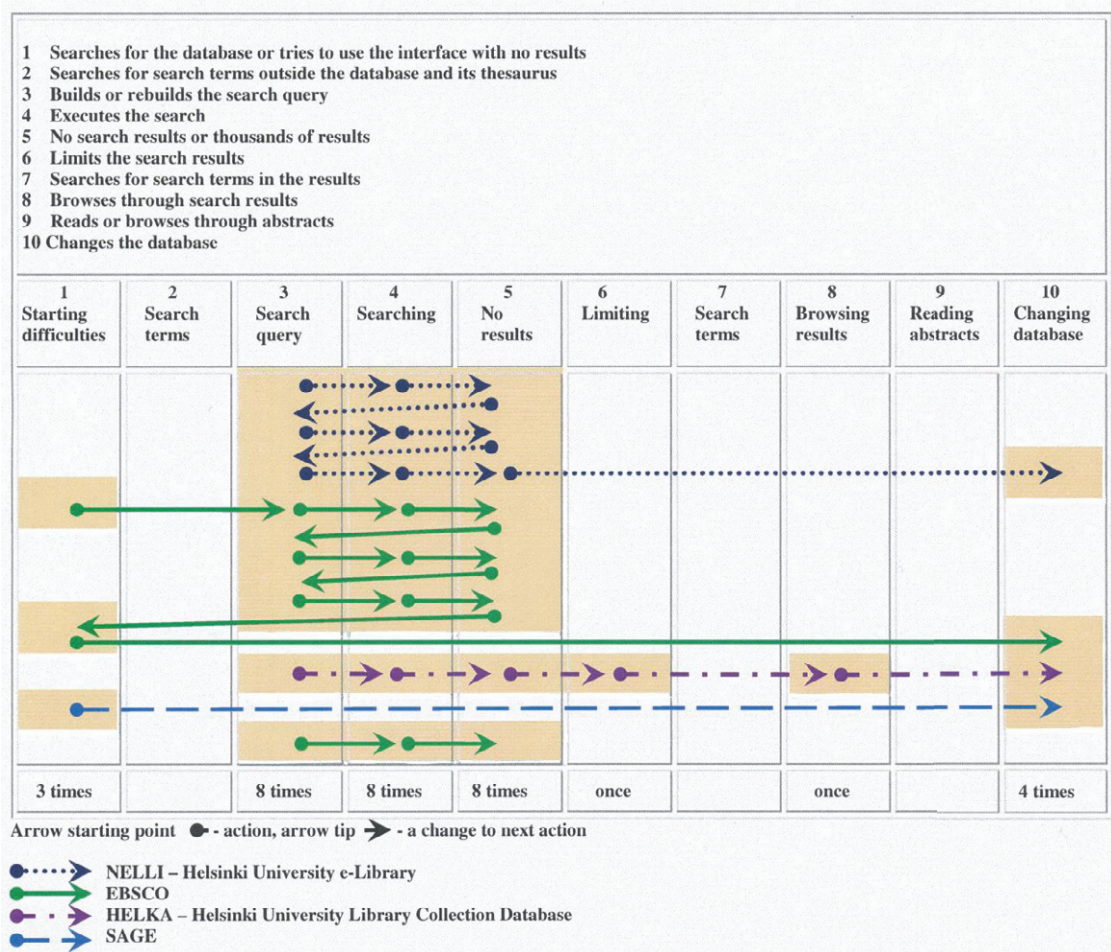

Fig. 1. Path of information retrieval: An example of a novice (n5)

The novice uses words directly from the text of the assignment in the basic form without paying attention to the connotations of words. The novice does not usually think about the essential concepts of the Search topic or what synonyms or parallel concepts might be related to it. There are also shortcomings in forming the search statement. International sources are excluded because the novice uses only Finnish search terms. He/she does not master such search techniques as truncation, the use of search fields, Boolean or phrase searching. However, some of the novices extend their search results by examining the references of publications that have been found.

The novice has an uncritical attitude to the search results. It is difficult for her/him to discern the relevant scientific information. The novice does not examine how the search result answers the task. No one answers the task question, "What are the central factors of good teaching?" The publications that have been found are books in Finnish (7 pieces), articles in books (3 pieces), and domestic articles in trade journals (6 pieces). Peer-reviewed domestic articles were also found (2 pieces), but there were no peer-reviewed international articles found.

4.2. The survivor

For the survivor, it is difficult to form search statements. She/he—like the novice—does not master such search techniques as truncation, the use of search fields, and Boolean or phrase searching. The survivor may also search in the databases with the natural language phrases in the same way as when searching in Google with a search phrase "teacher and good teaching practice". For the survivor, it is difficult to utilize the potential of the database to define the search only by searching the peer-reviewed articles or by searching for articles with the help of keywords. Survivors do not arrange their search results in chronological order. The numbers of the different information sources used by the survivors varied greatly. There were 1, 4 or 14, depending on the informant (three informants used altogether 9 different services).
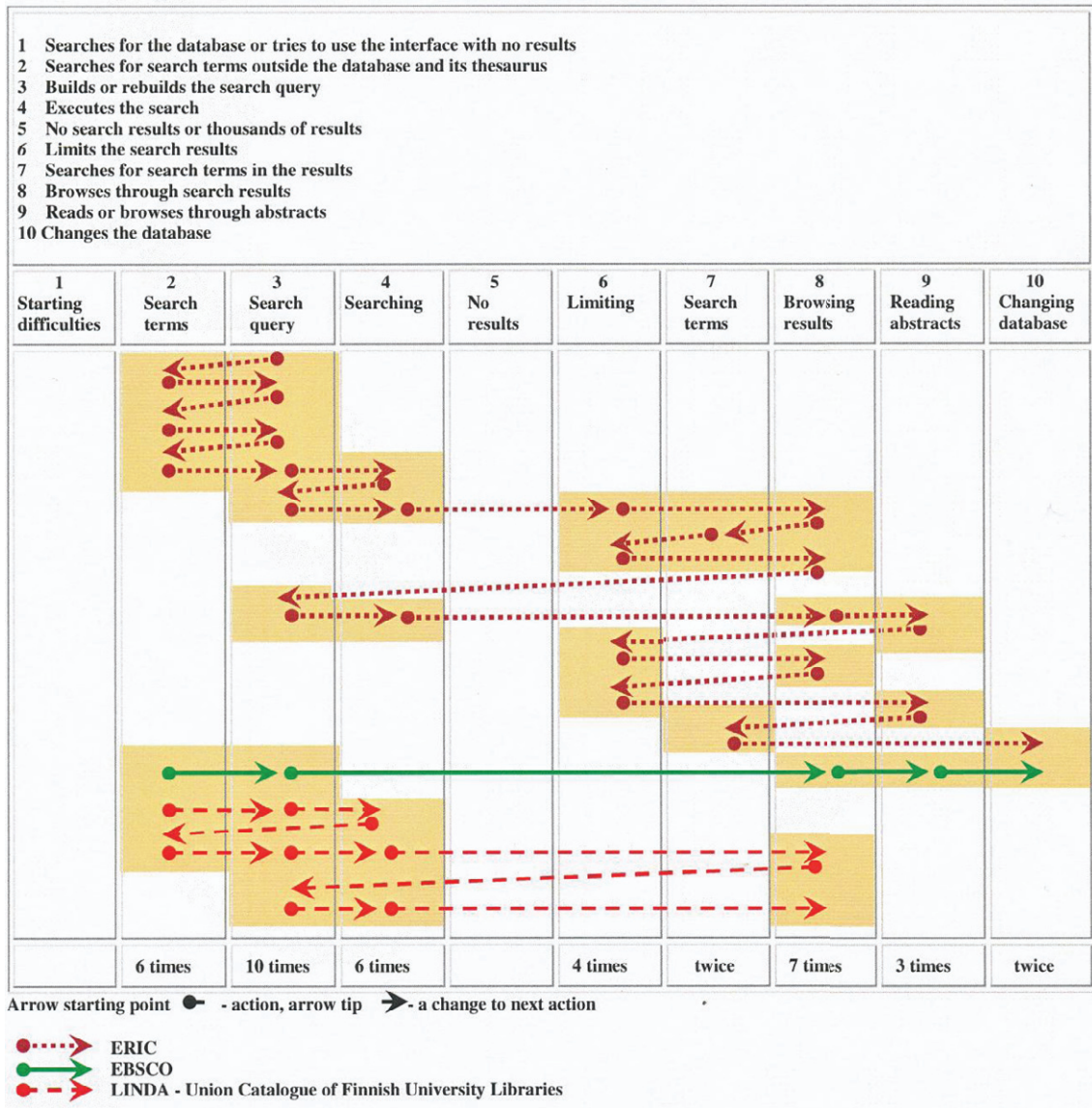
Instead, the survivor has the subject matter and he or she utilizes personal knowledge. He or she uses the researchers' names as search terms and identifies familiar researchers in the search results. Survivors also report that they utilize the knowledge of the social networks of their friends, colleagues and experienced researchers. The informants crystallize their thoughts: "To the researcher, human contacts are important"; and "I use the device poorly; the social network replaces the shortcomings in my technical knowledge". All survivors rethink and edit the search terminology. They extend the terminology with the references of publications that they have found, with abstracts or with keywords. In the search terms, the survivors also use English in addition to the native language and so they find more material that is international. Survivors believe that they should be skilful and independent users in information seeking. At the same time, they often experience that they are weaker than the standard. Unlike the novice, the survivor does not express strong emotions about her/his frustrating information search.

Because of the information search, the survivor finds fewer sources than the novice does because he or she is more critical to the contents of the article. The survivor becomes acquainted with the text; reads the beginning of the found article and glances through the text. Three survivors found altogether four books and one internationally peer-reviewed journal article. One out of three of the survivors produced the collected answer to the information-seeking task.

4.3. The expert

There are two kinds of experts in information seeking (e.g., Figure 2) in the data: the content expert and the veteran expert. Two Master's thesis students are content experts and they have just taken a one-day scientific information-seeking course. The veteran experts are information specialists from the library

and they are experts in general information retrieval. However, the experts have not been "fully trained", even though they had all studied information seeking.

Fig. 2. Path of information retrieval: An example of an expert (n10)

The content expert's search terminology is often static; in other words, he or she only uses a few search terms or phrases, that are not always extended or systematically developed. Usually the expert uses English along with a native language in the information search. However, the veteran expert may be restricted only to English. In addition, the expert expresses that the information seeking is somewhat difficult. The informants will present the matter thus: "This is the problem: too many articles at the same time . . . It is 'searching and shooting' without a system and the understanding of what must be done". "I don't know the right databases".

The veteran expert is characterized by the knowledge of information sources and he uses the databases of the discipline, which are related to the task and subject. The expert masters such search techniques as truncation, the use of search fields, and Boolean or phrase searching. The veteran expert develops search terminology and extends it with the help of keywords that have been found, with the thesaurus, indexes and dictionaries. The expert crystallizes it this way: "When I do not find the keywords on my own, then I try to find some review from a basic lexicon in the subject area to find the essential terms". "I accumulate suitable keywords in a mind map when I am searching". The expert marks off search results and she/he utilizes suitable definitions offered by the database. The number of different information sources used by the experts was lower than the others used. There were three of the sources per person, but one informant made an exception. She used only one information source (four informants used altogether seven different services). The experts found altogether 16 publications: 3 books, 1 Master's thesis, 1 domestic doctoral thesis, and 11 scientifically peer-reviewed international journal articles. Therefore, the latter formed the bulk of the sources that they found. Three of four experts produced the answer to the task (n3, n8, n10).

5. Conclusions

In conclusion, we have discovered that the novice is characterized by random information searching and she/he has only a little knowledge of the information sources and from technique. The search terms are unsuitably chosen and the essential concepts will not often be reflected. There are also shortcomings in the formation of the search phrases. However, the novice may extend her/his search results with the help of the references in the found articles. The novice uses only her/his native language, Finnish. She/he expresses the frustration with the information searching emotionally.

The survivor's obstacles are the shortcomings in the formation of the search statement and problems in evaluation of the search results. The survivor's field of expertise is the knowledge of the subject matter and the utilization of her/his own knowledge and the shared knowledge available from social networks. She/he sometimes spontaneously and dynamically develops the search terminology. Furthermore, the survivor studies a text by skimming. She/he also uses English language terms in the searches.

From the expert group, two groups were distinguished: the content expert and the veteran expert of information searching. The expert also still has something to learn. The search terminology used by the content expert can be static. Instead, the expert in information seeking commands the search technique and develops the search terminology continuously. The expert is characterized by the knowledge of information databases and he or she uses the one that is suitable for the task. The expert becomes acquainted with the search results and is source critical of them. It is noteworthy that the expert uses fewer different databases than the novice or survivor. As the others did, the expert also expressed the difficulties in information retrieval.

Our results differ from the results of Avdic and Eklund (2010) according to which the students mainly regarded their skills as positive. This difference may be caused by the cultural differences in different countries; the ways of expressions are different and/or the demands on themselves and their own skills could differ in different cultures and environments.

We can conclude that searching for scientific information is a challenging process (see also Avdic & Eklund, 2010), which can be seen as an on-going and expanding spiral of learning. We can see this learning spiral or hybrid also as a form of design learning because of the creativity and problem solving in the process. Searching for scientific information continually awakens or evokes new ways and forms of thinking. We use the idea of design as a conversation or interaction. We believe that design is a process in which problems are discussed and solved, where the educational atmosphere is open to new ideas and where design is seen as a generic cultural activity also in searching scientific information.

For the general view of scientific information seeking, we need both the researcher's content-based perspectives and the information specialist's more technical viewpoint. Our aim was to concentrate on the

process of information seeking with the information sources. Therefore, we collected the data at a given time and place with the same instruction. Our study shows that it is only one skill to know how to use the information databases. In addition, a successful information retrieval must encompass the whole research process and scientific contents in the study. This process is analyzed in the following.

The study question is opened by the central concepts of the phenomenon to be examined and by relations between them. To find core concepts will be essential at all stages of the study process. As the entries of the information retrieval, these concepts are needed, but on the other hand, skilful information retrieval also produces new concepts and their parallel terms. Therefore, the process is two-way. Because the English language has increasingly become the international language of study, this language, in addition to the native language, must be known in information searching quite well. Information searching is a demanding skill because the information applicant has to have a command of both her/his own discipline as well as the technical lexicon (cf. Avdic & Eklund, 2010).

Often the present electronic and functional searches for information require knowledge of logic and the use of many kinds of search engines; in other words, the technical expertise of scientific information retrieval through the Internet is essential in information searching today. The technical information is not sufficient because if a researcher does not know how to utilize it suitably or if there is no general overview of the field of information retrieval, the researcher will not know which one to use or how to use the material or the information sources that are found during a search. If the researcher is not in command of the search, random searching using different search engines will generate feelings of frustration and powerlessness, as was the case with the novices in our study.

The acquisition of scientific data and information requires scanning scientific and source criticism. In other words, the relevant information must be found in the search results. Then it is important to command the structure of the scientific text and its study area, the central concepts of the field of study and of the researchers most involved in current research. In the reporting of the study the obtained results are theorized and furthermore, are generalized. They are also in a dialog with the earlier studies. At this stage, information retrieval is again needed. After this, the time for looking for new study challenges begins again. The context—the target, motivation, beliefs, pre-knowledge—is significant for the information seeking process, but it is not the subject of this study.

Therefore, one can state that information retrieval will be connected to the following stages of the study process: finding a relevant study subject, delimiting the subject, and shaping a good question on the core concepts. Then the researcher can focus on the use of programs, scientific "scanning" and source assessment, comparison of different sources with his or her own results, generalizations about the obtained results and theorization before again finding new study challenges. The stages that have been described above do not necessarily follow each other linearly, but they can be simultaneous and multi-directional interactions.

6. Discussion

As we connect the views of academic users to those of library services specialists, we can notice that scientific information seeking appears to be quite demanding and many-sided. Our research data indicates that even the expert in information retrieval has to further develop her/his skills (see also Chu & Law, 2008; Korobili et al., 2011). On the other hand, it shows that the information seeker can also find relevant information with fewer information-seeking skills. The databases will continually develop and new skills will be required to examine them. The new research results facilitate the unifying of databases and the services can be developed to be more user-friendly. Expertise on scientific information retrieval is constantly increasing. It is not static knowledge, which one can gain with the help of one course. Instead, it is dynamic, multiform information and one must constantly accumulate the skills necessary to manipulate it.

This research opens new areas of designing the learning of information seeking processes. According to Seitamaa-Hakkarainen (2011), the design based learning provides a promising learning environment also for expert-student partnerships, which may be useful in developing the learning of information seeking processes. This kind of co-operation between novices and experts should be developed in positive way to courage new seekers to learn more. Positively affective environment on creative problem solving means that good feelings increase the tendency to combine material in new ways and to see relatedness between divergent stimuli (Isen, Daubman & Nowicki, 1987). The cognitive material combined with the positive affective gives better attention, the more complex cognitive context that allows them a greater number and range of interpretations and solutions. This increased awareness of more aspects of more possible ways of problem solving is essential in information seeking (Dreisbach & Goschke, 2004).

To get the general view requires both the user point of view and the information specialist's perspective (see Avdic & Eklund, 2010). It is needed when new scientific databases are developed. Furthermore, these points of view are needed in developing education and guidance in the information retrieval process. The following challenge of the study indeed is to go deeply into the process of developing information seeking in more detail. Future research could study in more detail the contextual background: the effects of motivation, information seekers' beliefs and the targets of the information seeking. It would also be interesting to study the role of instruction in the process of learning information seeking skills (cf. also Chu & Law, 2007a). Furthermore, a quantitative assessment of a wide informant group from which the results have already been found qualitatively could be useful.

Acknowledgements

References

Avdic, A., & Eklund, A. (2010). Searching reference databases: What students experience and what teachers believe that students experience. *Journal of Librarianship and Information Science*, 42(4), 224-235.

Aula, A., & Nordhausen, K. (2006). Modeling successful performance in web searching. *Journal of the American Society for Information Science and Technology*, 57(12), 1678-1693.

Chowdhury, S., Gibb, F., & Landoni, M. (2011). Uncertainty in information seeking and retrieval: A study in an academic environment. *Information Processing & Management*, 47(2), 157-175.

Chu, S.K., & Law, N. (2007a). Development of information search expertise: Postgraduates' knowledge of searching skills. *Portal: Libraries & the Academy*, 7(3), 295-316.

Chu, S.K., & Law, N. (2007b). Development of information search expertise: Research students' knowledge of source types. *Journal of Librarianship and Information Science*, 39(1), 27-40.

Chu, S.K., & Law, N. (2008). The development of information search expertise of research students. *Journal of Librarianship and Information Science*, 40(3), 165-177.

Dreisbach, G., & Goschke, T. (2004). How positive affect modulates cognitive control: Reduced perseveration at the cost of increased distractibility. *Journal of Experimental Psychology: Learning, Memory, and Cognition,* 30(2), 343-353.

Du, J.T., & Evans, N. (2011). Academic users' information searching on research topics: Characteristics of research tasks and search strategies. *Journal of Academic Librarianship*, 37(4), 299-306.

Ellis, D. (1993). Modeling the information-seeking patterns of academic researchers: A grounded theory approach. *The Library Quarterly,* 63(4), 469-486.

Ellis, D., Wilson, T.D., Ford, N., Foster, A., Lam, H.M., Burton, R., & Spink, A. (2002). Information seeking and mediated searching. Part 5. User-intermediary interaction. *Journal of the American Society for Information Science and Technology*, 53(11), 879-882.

Haglund, L., & Olsson, P. (2008). The impact on university libraries of changes in information behavior among academic researchers: A multiple case study. *Journal of Academic Librarianship,* 34(1), 52-59.

Isen, A.M., Daubman, K.A., & Nowicki, G.P. (1987). Positive affect facilitates creative problem solving. *Journal of Personality and Social Psychology*, 52(6), 1122-1131.

Korobili, S., Malliari, A., & Zapounidou, S. (2011). Factors that influence information-seeking behavior: The case of Greek graduate students. *The Journal of Academic Librarianship*, 37(2), 155-165.

Maybee, C. (2006). Undergraduate perceptions of information use: The basis for creating user-centered student information literacy instruction. *The Journal of Academic Librarianship*, 32(1), 79-85.

McGuinness, C. (2006). What faculty thinks: Exploring the barriers to information literacy development in undergraduate education. *The Journal of Academic Librarianship*, 32(6), 573-582.

Morrison, L. (2007). Faculty motivations: An exploratory study of motivational factors of faculty to assist with students' research skills development. *Partnership: The Canadian Journal of Library and Information Practice and Research*, 2(2).

Nicholas, D., Huntington, P., Jamali, H.R., & Watkinson, A. (2006). The information seeking behavior of the users of digital scholarly journals. *Information Processing & Management*, 42(5), 1345-1365.

Rowlands, I., & Nicholas, D. (2008). Understanding information behaviour: How do students and faculty find books? *The Journal of Academic Librarianship,* 34(1), 3-15.

Seitamaa-Hakkarainen, P. (2011). Design based learning in crafts education: Authentic problems and materialization of design thinking. In H. Ruismäki, & I. Ruokonen (Eds.), *Design learning and well-being: 4th International Journal of Intercultural Arts Education* . Department of Teacher Education. Research Report 331. University of Helsinki (pp. 3-14). Helsinki: Unigrafia.