

# Children's Information-Seeking Behavior: a Laboratory versus an Operational Research Environment

Andrew Large ([large@gslis.lan.mcgill.ca](mailto:large@gslis.lan.mcgill.ca)) & Jamshid Beheshti ([beheshti@gslis.lan.mcgill.ca](mailto:beheshti@gslis.lan.mcgill.ca))  
Graduate School of Library & Information Studies  
McGill University  
Montreal, Quebec H3A 1Y1, Canada

## **Abstract**

This paper explores the issues involved in conducting research into the information-seeking behavior of young users in an educational context, and in particular discusses the relative merits of an experimental (in vitro) research environment compared with an operational (in vivo) environment. Research papers typically concentrate on the results generated by the adopted methodology, and more rarely reveal the methodological problems that may have been encountered in generating these results. Growing numbers of research studies have explored the information-seeking behavior of children when confronted with online or CD-ROM databases, OPACs or the World Wide Web. The majority of such studies, however, have been conducted under laboratory conditions using an experimental methodology. In contrast, operational conditions enable the information-seeking behavior of young users to be assessed in a real classroom setting and over an extended period of time. The information seeking is not task-based so much as goal-based - its goal is to acquire information that is relevant to a specific class assignment. Many research papers may in practice adopt a methodology that exploits to some extent both laboratory and operational conditions. Nevertheless, the distinction between the two is real, and the tension between controllability and realism must be resolved by information retrieval researchers.

## **I. Introduction**

One of many ongoing debates within library and information science (LIS) has been the nature, quantity and quality of its research. The focus of the first library science programs was on training professional librarians, and with the exception of a few schools, most notably at the University of Chicago, research was slow to emerge as a preoccupation. Assessments of LIS research quantity and quality have not always been positive. Connaway and Powell (1999) warn of "disturbing signs that LIS research is not receiving the attention that it warrants." Cronin and Crawford (1999) conclude from a citation analysis of the publications from the deans of the 20 most highly rated LIS graduate programs in North America that "only a couple of individuals...seem able to combine the expectation of scholarly recognition with the exercise of administrative functions." Busha and Harter (1980) considered that "a large proportion of librarianship's research has been uneven in quality and demonstrably weak in methodology." At least one observer has ascribed LIS research failings in online information retrieval to methodological shortcomings. Fidel (1987) argues that the experimental methodology adopted by many researchers has produced unexplained results that on occasion contradict common sense.

Researchers must choose between an experimental research methodology, where an attempt is made to introduce the environmental controls found in a science laboratory, and an operational methodology which seeks to observe and/or measure actions in a naturalistic environment.

Researchers must also make a second level of choice - between quantitative and qualitative methodologies. This paper considers the pros and cons of these choices in relation to one research environment: investigations of information retrieval by children. In particular, it draws upon the experience of the authors gathered over two three-year research projects dealing with information retrieval by grade-six primary school students.

## **II. Research Methodologies**

### **1. The Experimental Research Methodology**

Much of the research conducted with information retrieval systems and their users has adopted a so-called experimental, or “laboratory” methodology. Using this methodology, research problems are formed in the shape of testable hypotheses. The researchers strive to ensure as much control as possible over their environment and to minimize interference from external factors by employing the metaphor of the scientific laboratory. They identify a series of variables, and seek to measure the relationships between these variables. Data are collected systematically for subsequent analysis, often using statistical techniques such as sampling and significance testing. Such a research design is often termed “scientific” because it resembles the kind of controlled experiments employed in scientific research (Hannabuss, 1995). Indeed, it may employ an experimental group alongside a controlled group, an approach typical of scientific experiments. Results typically are presented as statistical measures from which the initial hypotheses can be proven or disproved.

An experiment to identify the characteristics that make a successful information seeker, for example, might hypothesize that the more frequent searcher is the more effective searcher. In such a simple experiment, the researchers are interested in one independent variable: searcher experience. This variable, at its simplest form, may be defined in terms of four categories of users: professional searchers with an in-depth domain subject knowledge, professional searchers without any subject knowledge, novice searchers with an in-depth domain subject knowledge, and novice searchers without any subject knowledge (Meadow, Marchionini and Cherry, 1994). The experiment would measure the impact of this independent variable on one dependent variable - the different search output retrieved by these four groups. All other possible variables would be controlled. For example, all four groups would seek to answer the same information queries using the same database and the same search software.

Such a research methodology hopes to establish statistically valid causal links (using standard and conventional statistical significance tests) that are relevant to the initial hypothesis. In the above example it may confirm that search output improves as level of experience increases. The findings can be expressed (at least in an ideal world) universally and unequivocally. Furthermore, the use of a controlled laboratory environment should make the experiment repeatable, so future researchers can confirm the hypothesis should they so wish. As Goldhar (1972) summarizes the experimental approach, it “is the most generally applicable and successful on the average and in the long run.”

Much of the research concerning information retrieval over the past forty years since the Cranfield Research Projects has been experimental in nature. The original methodology used in the Cranfield project is still used today in the TREC projects. Recently, however, questions have been raised about the appropriateness and reliability of using experimental methodology in measuring the effectiveness of interactive information retrieval (Borlund & Ingwersen, 1997). This methodology does pose a

number of problems, including:

- Might other variables that have not been controlled affect the experimental outcomes - the searchers' educational level, language skills, perseverance, and other user characteristics too numerous to measure for most studies?
- Will the searchers behave "normally" under experimental and hence simulated conditions?
- How will the relevance of any retrieved records be assessed when the queries are simulated rather than genuine (from the perspective of the searchers' own information needs)?

## **2. The "Operational" Research Methodology**

Not all research situations lend themselves to an experimental design, particularly if the variables are difficult to measure. In contrast, operational research emphasizes the real environment rather than a controlled laboratory environment. It views the world from the actor's point of view, and sees human behavior from the actor's own frame of reference (Hannabuss, 1995). It has also been called naturalistic research, because it involves an in-depth study of people and situations and events (Mellon, 1990). Experiences are viewed from the perspective of those involved. In the last decade or so, research into information retrieval issues undertaken in an operational environment has assumed considerable importance as an alternative to experimental research under laboratory conditions.

In the context of information retrieval, such an operational research methodology would examine ways in which individual information seekers *interact* with the information retrieval system rather than using the system as a black-box "into which one feeds a question and from which one gets an answer" (Robertson & Beaulieu, 1997). Its actual methods include documentary study, interviews and participant observation. Typically, large amounts of data are gathered using such techniques, and a major challenge is to impose some kind of order on them, by identifying recurring and important themes that can be organized into coherent structures.

Such an operational research project might involve the observation of a group of information seekers over a period of time, backed up with pre- and post- interviews. The seekers would be looking for information that they actually need for their own purposes (rather than undertaking an experimental task), and they would be free to follow their own inclinations. The researchers might then investigate the way in which any information retrieved is incorporated into the seekers' own work.

Such a qualitative approach does not have to manipulate a series of variables that may in practice be difficult to identify and/or define unambiguously. It does not impose an artificial laboratory environment on the actors. It can therefore gather observations on how people actually function, with minimal distortion from the research team. Unfortunately, it also has a downside. The researchers must now cope with the idiosyncracies of a real workplace, library or classroom. They may be forced to make compromises in their research design in order to accommodate the real actors that are playing the scenes.

## **3. Quantitative vs Qualitative Methodologies**

The quantitative methodology formulates research problems in the form of testable hypotheses, attempts to identify and measure relationships between variables, and strives to minimize researcher interference (Hannabus, 1995). Data are collected systematically and typically are analyzed using

statistical techniques like sampling and significance testing. Such an approach is especially suitable when data can be assigned to unambiguous categories and where correlations, causal relationships and group differences are critical to understanding the phenomena under investigation.

By no means all situations lend themselves to a quantitative methodology. This is especially the case when the variables are difficult to isolate or to measure. In contrast, qualitative research places an emphasis on the context in which phenomena are being studied. The qualitative methodology is less easily defined than the quantitative one (Fidel, 1993). Wallace and Van Fleet (1998) point to the different meanings that can be assigned to qualitative research, and comment that an author may have to describe a qualitative methodology in much more detail than a quantitative one to editors and referees. Glazier (1992) reminds us that “non-qualitative methodologies have traditionally been thought of as better able to collect value-free data that are meaningful and verifiable”, but Fidel (1993) believes that qualitative analysis offers the best method for exploring human behavior. Powell (1999) believes that qualitative research methods in LIS “are clearly enjoying an increased popularity.”

It is tempting to equate the experimental research environment with the employment of quantitative methodology and the operational research environment with qualitative methodology. Hannabus (1995), for example, equates an experimental design with a quantitative methodology, while Sutton (1993) believes that researchers adopting a qualitative methodology “are particularly careful not to undermine the validity of observations by isolating them from the environment that gives them meaning”, thereby linking a qualitative stance with the operational environment. But such a rigid association in fact is misleading. Although it is perhaps more common to find quantitative techniques in experimental research and qualitative techniques in operational research, this need not be the case. Fidel (1993) argues, for example, that the qualitative methodology is every bit as “scientific” as the quantitative. Furthermore, both techniques are quite often applied in a research project regardless of whether that project has adopted an experimental or an operational approach. As Glazier (1992) argues, quantitative and qualitative methodologies are not only compatible but in many cases they should be inextricably mixed in the research process. Fidel (1993) goes further; although she believes that qualitative research is essentially different from quantitative research (and in some respects they are opposites), she also says that quantitative research always includes a basic qualitative component, and a qualitative study can use quantitative techniques. In the IR environment, the interaction between the two types of data analysis may be more systematic than casual usage. While the qualitative analysis may be used at the beginning and at the end of the IR research, when questions and documents are assessed and users’ preferences are measured, quantitative analysis may cover the input and the output measures. Hence, the “qualitative aspects are confined to the two ends of the process of assessment” (Robertson & Hancock-Beaulieu, 1992).

### **III. An Experiment-Based Project**

In the early 1990s the authors were involved in a three-year research project to investigate the educational potential of multimedia information sources for primary school students (specifically, grade-six students). As a part of this project, in the first year they also enquired into the information retrieval skills of the subjects (Large, Beheshti, Breuleux and Renaud, 1994). This research employed an experimental approach. A sample of 48 students was randomly assigned to five equally sized groups (except that each group should have the same number of boys and girls). One group was required to undertake four searches on a printed encyclopedia, and the other group to undertake the same searches on the CD-ROM equivalent. All students were given a short preliminary training

session on using both tools. The same two research assistants were used throughout the project to ensure uniformity of approach. The students were taken from their class for two separate search sessions, at each of which they tackled two of the search questions. A detailed log of retrieval activity was maintained by the research assistants. The three independent variables were:

- print encyclopedia versus CD-ROM encyclopedia
- complexity of search request (as measured by the number of individual concepts comprising the request)
- gender

There were also two dependent variables:

- retrieval time
- number of search steps

The resulting data were analyzed using quantitative techniques: an analysis of variance test, and the Kruskal-Wallis non-parametric test. Qualitative analysis was not used at all in this project.

Such an experimental approach offered a number of advantages. These can be grouped into two main categories. First, a highly controlled environment was established in which to investigate retrieval. The students themselves had been randomly selected and then randomly assigned to groups, taking account only of one independent variable: gender. All the students were presented with an identical database, search queries and searching environment. They were monitored throughout the experiment by research assistants and a complete data record of their searches was logged. Second, and equally important, the researchers were free to set the experimental parameters with little "interference" from other groups such as teachers and parents. For example, there was no requirement to select an information source that related to the school's grade-six curriculum. Indeed, the researchers deliberately wanted to choose a source with which the students were totally unfamiliar, so that prior knowledge would not interfere with the experiment. Furthermore, the students could be drawn from several schools (hence broadening the sample) because there was no need to take account of any differences in the grade-six curriculum followed by the various schools - the researchers and not the teachers established the experimental task.

Despite such advantages, a number of drawbacks also were encountered as a consequence of opting for an experimental approach. The artificial and simulated nature of the experiment, removed as it was from everyday classroom activity, potentially may have adversely affected student motivation. The searches were not related to any class projects and nor were they situated in any broader context. The teachers were not present when the searching took place, and in accordance with the anonymity required by ethical considerations, the individual performances of the children were known only to the researchers. In such a situation the students had no real incentive to take the experiment seriously. In fact, as far as could be observed by the research assistants, most if not all students did take the test searches seriously. Indeed, a few showed signs of anxiety and stress much as if their work was being assessed for school purposes. Of course, this in itself could be said to introduce an artificial element, as information searches typically would not be associated with a stressful, monitored (by the researchers) environment. It may be that primary school children are used to following instructions, the rationale for which is neither explained to them nor, if it is, appreciated by them. Certainly, the researchers would have been more concerned about motivation and commitment had the students been older - in middle high school rather than primary school.

A second criticism of the experimental methodology also flows from the need to exert a control over the environment. None of the students had used the CD-ROM chosen for the experiment, and indeed

they had not previously used any CD-ROM-based information source (the experiment took place in early 1991). This was an important consideration, as differences in student searching expertise could be discounted for the CD-ROM (although all students had searched printed encyclopedias). Since all students were given an identical pre-experiment training session, it could be assumed that searching expertise could be discounted as a variable. The drawback, however, was an inability within this research to observe any improvements in searching techniques as a result of growing familiarity, and a question mark surrounding the usefulness of measuring search performance over two sessions only. Robertson (1996) has made a similar comment in relation to the OKAPI OPAC experimental research: "we should be looking at users over a longer time period than just one session on a system."

A third area of concern, frequently encountered in quantitative analysis within an experimental context, is the level of variability within rather than between groups. In other words, the independent variables that were controlled caused in many instances a smaller effect on the dependent variables than did other, unidentified and non-controlled, variables among the students. No amount of data manipulation in the quantitative analysis could negate this reality. Other independent variables could have been selected, most obviously being some measure of academic ability. Unfortunately, it is not easy to obtain from the school or school board information about the academic performance of individual students, even if it can be agreed that such information would provide a reliable and precise measure. Furthermore, the addition of one or more new variables would reduce the size of each group, and this in turn would affect the level of significance produced by the quantitative analysis of the resulting data. The total number of subjects involved in the experiment could be increased to take account of the need for more groups, but this creates additional logistical and financial problems.

#### **IV. An Operational-Based Project**

The second research project conducted by the authors in the late 1990s opted for an operational rather than an experimental approach. The objective was to investigate once again information retrieval by grade-six students and using CD-ROM encyclopedias. More specifically, the intention was to identify interface characteristics that facilitated rather than impeded retrieval (Large, Beheshti and Breuleux, 1998).

The subjects comprised all the grade-six students (53 children from two classes) from one primary school. No sampling was done to establish the group. Indeed, because the children were to undertake the retrieval as part of an assessed, extended school project it would have been unfair (and unacceptable to the School) to include some students but exclude others). In this operational setting the students were to find information for an actual class project. Three information sources on CD-ROM were selected on the basis of their relevance to a class project about to be undertaken and the different interface characteristics that they exemplified. The students were provided with a short training session on use of the CD-ROMs and were then free to use them, in groups of three, as the teachers determined over the course of the project (four weeks). A sample of the searches was directly captured on videotape (seven hours) and a microphone recorded the students' conversations. The final group written assignments were photocopied (but without the teachers' marks or comments), the oral presentations were audiotaped and the three-dimensional models built by the groups photographed. The students were also pre-tested for knowledge on the project topic and asked to complete a post-project questionnaire. The data collected by these various methods were analyzed

using qualitative techniques.

This operational setting offered several important advantages over an experimental setting. The students now had a motive to undertake the searches - the retrieved information would be incorporated into an assessed class project. The searches were not performed in a controlled time period, but took place over a prolonged time period, enabling any learning tendency to be observed. In fact, the students could continue to search until they decided that they had retrieved all the information they needed. Search performance was judged not only by reviewing the taped sessions, but also in terms of the written and oral presentations, and the models. The students were able to interact both within their groups and between groups just as they do in many other aspects of their school work.

At the same time, the operational setting undoubtedly presented the researchers with problems. The initial obstacle was gaining approval for the research from the school board. Approval from the board had proven relatively straightforward in the case of the experimental research, which was much less intrusive in the classroom.

Selection of the class project proved a slow process. Unlike in an experimental setting, this selection could not be undertaken by the researchers alone as it had to be an integral part of the grade-six curriculum. This curriculum in fact is quite general in its specifications, and this did not cause major problems. Two other factors, however, did very much influence the selection of the school project. Very few schools in the Montreal area teach only in English; they either teach entirely in French, or follow a French immersion program. In the particular school involved in the research, the students are taught half the day in English and the other half in French. All science subjects are taught in French, and therefore the researchers' initial preference for a science-based class project (scientific topics had been chosen in the earlier experimental research) had to be abandoned. Second, the class project had to be acceptable to the two class teachers. Although the researchers discussed at length project selection with the teachers, the latter had the final say (a history topic was chosen). The project selection also limited the research to one school. Initially it had been intended to use several schools, but it proved impossible to get a number of teachers from several schools to agree upon one common class project. Finally, the actual CD-ROM titles could only be chosen once the project had been selected. Given that the titles had to represent different interface models as well as have relevant subject content for the project, this could have created a major selection problem.

The teachers, not the researchers, also "managed" the project. That is to say, the teachers both at the outset of the project and throughout it gave the students the necessary instructions, including the objectives of the exercise, suggestions on search terms, the kind of model that should be built, and so on. In some instances the researchers would have preferred less guidance to have been provided.

The research had to cope with the idiosyncracies of the class timetable - school holidays, trips and so on interrupted the regular spacing of search sessions. This made project planning difficult; for example, the final interviews with the students had to be canceled for lack of time - the school year had come to an end! Work had to be undertaken in groups because this was the teachers' normal practice; this made it impossible to draw any conclusions based on individual student performance. Furthermore, students (or groups of students) could not be isolated one from another as in an experimental setting. As a consequence, individual students would pass on the benefits of their knowledge about the CD-ROM interfaces and contents to other students. This may be a laudable

example of class cohesion and shared learning, but it also influenced searching in ways that could not easily be monitored by the research assistants, who were only present during timetabled search sessions and who in any case could not prevent or even discourage such information exchange.

Finally, the operational research proved more expensive to conduct than the experimental research, even though it took place in only one school rather than the four schools used in the experimental procedure. The operational research placed much heavier demands upon research assistants' time in the school, and the qualitative analysis was more time consuming than quantitative analysis.

## **V. Conclusions**

As Westbrook (1994) argues, the research problem should determine the research approach and the methods employed. Research into children's use of information retrieval systems has opted more for experimental approaches (see, for example, Marchionini, 1989; Borgman, Hirsh, Walter and Gallagher, 1995) than operational approaches (see, for example, Solomon, 1993). The experimental approach allows individual search attributes to be investigated and avoids the confounding elements that a real classroom can so easily impose.

It is less effective, however, at providing a broader picture of an information system's role in the classroom. Operational research does provide a longitudinal and naturalistic view of the students at work, but must cope with a series of factors that inevitably limit the researchers ability to control their research environment. Quantitative analysis provides sharp numerical measures of search performance, but fails to provide as satisfactory an insight into the searching behavior of the subjects. Qualitative analysis can provide a wealth of data on searching habits, but the extrapolation of the results to other operational environments is more difficult to justify. As Fidel (1993) argues, it is best used for exploring human behavior in circumstances where little is known about the individual phenomena related to that behavior.

There are now some examples of information retrieval research employing both experimental and operational methodologies to test and evaluate new systems and interfaces (see, for example Robertson, 1997; Beheshti, Large, Bialek, 1996). In assessing the information-seeking behavior of children, or any category of users, research should not be confined to utilizing one type of methodology to decide whether one system is better than another. The complexity of the interaction between the user and the system should be measured with equally complex methodology, which in many situations would mean using experimental and operational methods of assessment. In addition, qualitative and quantitative tools would be needed to collect data for model building, which ultimately would provide the researchers with theoretical and conceptual framework to design and develop better systems for information retrieval.

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## References

- Beheshti, Jamshid, Large, Valerie, & Bialek, Mary. (1996). PACE: A Browsable Graphical Interface. *Information Technology and Libraries* 15 (4), 231-240.
- Borgman, Christine L., Hirsh, Sandra G., Walter, Virginia A., and Gallagher, Andrea L. (1995). Children's search behavior on browsing and keyword online catalogs: the Science Library Catalog Project. *Journal of the American Society for Information Science* 46 (9), 663-684.
- Borlund, Pia, & Ingwersen, Peter. (1997). The Development of a method for the evaluation of interactive information retrieval systems. *Journal of Documentation* 53(3), 225-250.
- Busha, Charles A.. & Harter, Stephen P. (1980). *Research Methods in Librarianship: Techniques and Interpretations*. New York: Academic Press.
- Connaway, Lynn Silipigni & Powell, Ronald R. (1999). Introduction: research matters. *Library and Information Science Research* 21 (1), 3-6.
- Cooper, Marianne (1990). Perspectives on qualitative research with quantitative implications: studies in information management. *Journal of Education for Library and Information Science* 31 (2), 105-112.
- Cronin, Blaise & Crawford, Holly (1999). Do deans publish what they preach? *Journal of the American Society for Information Science* 50 (5), 471- 474.
- Fidel, Raya (1987). What is missing in research about online searching behavior? *Canadian Journal of Information Science* 12 (3/4), 54-61.
- Fidel, Raya (1993). Qualitative methods in information retrieval research. *Library and Information Science Research* 15 (3), 219-247.
- Glazier, Jack D. (1992). Qualitative and non-qualitative research methodologies: thesis, antithesis, or synthesis. In J.D. Glazier and R.R. Powell, eds. *Qualitative Research in Information Management*. Englewood: Libraries Unlimited.
- Goldhar, Herbert (1972). *An Introduction to Scientific Research in Librarianship*. Urbana: University of Illinois.
- Hannabuss, Stuart (1995). Approaches to research. *Aslib Proceedings* 47 (1), 3-11.
- Large, Andrew, Beheshti, Jamshid and Breuleux, Alain (1998). Information seeking in a multimedia environment by primary school students. *Library and Information Science Research* 20 (4), 343-376.
- Large, Andrew; Beheshti, Jamshid, Breuleux, Alain & Renaud, A. (1994). A comparison of information retrieval from print and CD-ROM versions of an encyclopedia by elementary school children. *Information Processing and Management* 30 (4), 499-513.

- Marchionini, Gary (1989). Information seeking strategies of novices using a full-text electronic encyclopedia. *Journal of the American Society for information Science* 40 (1), 54-66.
- Meadow, C.T., Marchionini, G., & Cherry, J.M. (1994). Speculations on the measurement and use of user characteristics in information retrieval experimentation. *Canadian Journal of Information and Library Science* 19(4), 1-22.
- Mellon, C. 1990. *Naturalistic Inquiry for Library Science: Methods and Applications for Research, Evaluation and Teaching*. Westport, CON: Greenwood Press.
- Powell, Ronald R. (1999). Recent trends in research: a methodological essay. *Library and Information Science Research* 21 (1), 91-119.
- Robertson, Steve (1996). Final comments.  
[Http://: web.soi.city.ac.uk/research/cisr/ser/ucla/node24.html](http://web.soi.city.ac.uk/research/cisr/ser/ucla/node24.html)
- Robertson, S.E. (1997). Overview of the OKAPI projects. *Journal of Documentation* 53(1), 3-7.
- Robertson, S.E. & Beaulieu, M. (1997). Research and evaluation in information retrieval. *Journal of Documentation* 53(1), 51-57.
- Robertson, S.E. & Hancock-Beaulieu, M. (1992). On the evaluation of IR systems. *Information Processing & Management* 28(4), 457-466.
- Solomon, Paul (1993). Children's information retrieval behavior: a case analysis of an OPAC. *Journal of the American Society for Information Science* 44 (5), 245-264.
- Sutton, Brett (1993). The rationale for qualitative research: a review of principles and theoretical foundations. *Library Quarterly* 63 (4), 411-430.
- Wallace, Danny P. & Van Fleet, Connie (1998). Qualitative research and the editorial tradition: a mixed metaphor. *Library Trends* 46 (4), 752-769.
- Westbrook, Lynn (1994). Qualitative research methods: a review of major stages, data analysis techniques and quality controls. *Library and Information Science Research* 16 (3), 241- 254.