The Science Library Catalog: A Springboard for Information Literacy

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The world of electronic information is increasingly important, and opening that world to children is a critical part of the library media specialist's job. That task would be much easier, of course, if electronic information resources were more "child-friendly."

A number of researchers in our field are tackling design issues related to children's use of these resources, and the creators of the Science Library Catalog (SLC) are pioneers in this effort. Led by Christine Borgman, this research team has been designing successive versions of the SLC and using them as a platform for longitudinal research for almost a decade. In this column, the team summarizes its experiences to date.

The column outlines the cognitive theories that have informed the SLC's ongoing design; describes the catalog itself; explains the continuing research effort based on the SLC; and discusses the research results-emphasizing the findings that are most relevant to school library media specialists as they seek to develop children's information skills. References to others' work-including Paul Solomon's fall 1994 "Current Research" column-suggest the expanding research base that is beginning to establish design criteria for electronic information resources for children.

The most progressive voices in the school library media community are currently urging the teaching of the higher-order thinking skills involved with information literacy in elementary and secondary schools.(1) Carol Kuhlthau's process approach is one model for helping students approach library research critically and analytically.(2) Michael -Eisenberg and Robert Berkowitz's Big Six Skills model is another.(3) The clear implication of all such approaches to library and information skills instruction is that school library media specialists should spend less time on such mundane matters as catalog skills and more time on overarching ones, such as search strategies and techniques for evaluating information. Yet in reality school library media specialists, particularly those in elementary schools, spend a great deal of time helping children learn the basics of catalog navigation. Whether school library media specialists are teaching formal units on information retrieval or helping children find materials on an informal, one-to-one basis, they often are aware of children's frustration with this basic library finding tool. It is difficult to imagine going on to higher-order research skills if one cannot even locate a desired book or subject in the catalog.

Children’s Difficulties Using Library Catalogs

Most of the difficulties that children have using library catalogs are related to their still-developing cognitive abilities and their still-limited knowledge bases. Children are often unable to formulate appropriate search terms because of their smaller vocabularies and their imperfect command of subject domains.(4) Children are further hampered in this effort by their still-evolving memory functions. Cognitive psychologists report that recognition memory develops before recall memory and that the human brain uses associative pegs and webs to retrieve or recall specific memories from storage. In general, children have not yet developed the associative pegs and webs that will enable them to retrieve a wide variety of terms from their memory banks; they are, however, able to recognize familiar words, objects, and ideas when they see them.(5) Of course, recall memory requires more cognitive effort than recognition memory for adults as well as children, and both recall and recognition are important factors in information retrieval for all ages. The point here is that children’s memory functions are less developed than they will be as the children mature.

Even when children are successful in formulating appropriate search terms, they might have difficulty applying these terms in a particular information retrieval system. Leslie Edmonds, Paula Moore, and Kathleen M. Balcom discovered, for example, how conventions for alphabetizing entries can impede children’s abilities to use traditional card catalogs.(6) Both keyboarding and spelling errors can result in search failures in electronic catalogs.(7) Given the array of barriers facing children when they approach any library catalog, it is not surprising that school library media specialists must devote so much attention to helping children overcome their difficulties.

The Science Library Catalog

This team of researchers at UCLA’s Department of Library and Information Science has long been intrigued with the idea that library catalogs could be developed that would make information retrieval easier for children. If library catalogs were designed to accommodate children’s cognitive skills and information-seeking behavior, many of the obstacles discussed above might be alleviated. The Science Library Catalog (SLC) Project is an effort to build and test a prototype information retrieval system that is consistent with established principles of interface design and human/computer interaction, taking into account the special developmental circumstances of children. The project has dual objectives: to design a prototype of an effective, child-friendly retrieval system for library catalog information and to enable researchers to learn more about the information-seeking behavior of children using such a catalog.

An overview of the SLC itself demonstrates how its design attempts to facilitate children’s successful searching. The SLC interface is based on the graphical metaphor of library bookshelves. A well-established device in computer interface design, graphical metaphors are intended to convey conceptual models of systems that conform to the intended users’ mental model of those systems. When the child begins a search in the SLC, he or she sees a computer screen with a picture of a bookshelf with ten shelves. The fifth and sixth shelves, corresponding to the Dewey 500s and 600s, are labeled “Science” and “People Using Science.” When the child

clicks on one of these shelves, the screen cascades to the right, displaying the subcategories immediately below this level of the Dewey hierarchy (see figure 1 [*SLMQ* 24, no. 2 (Winter 1996): 106]). The child can continue to click on shelves until a desired subject at the bottom level of a hierarchy is reached.

The first four versions of the SLC, on which the research results reported here are based, were intended as browsing catalogs.(8) Browsing search behavior was the focus of the research because this mode relies on recognition memory rather than recall memory. A browsing mode also allows a child to explore the database without having a specific objective as well as to search for a particular desired item. All navigation through these first four versions of the SLC database (as well as in the current version) is accomplished by clicking on a mouse. When a child reaches the lowest level of the hierarchy in a subject category, all he or she has to do is click on the bookshelf for a list of books on that subject. These are displayed on a "notebook" (see figure 2 [*SLMQ* 24, no. 2 (Winter 1996): 106]), continuing the metaphor established with the library bookshelves.

When the child clicks on a book title, the standard MARC catalog data appears-not in the traditional card catalog format or the typical format of an electronic catalog but on a picture of a book, opened to its title page (see figure 3 [*SLMQ* 24, no. 2 (Winter 1996): 106]). A mouse click turns to the verso of the title page for more catalog data and the descriptive information from the notes field. Turning back to the title page, the child clicks on a map button located on the book pocket on the inside cover. This reveals a map of the library, showing the child exactly where the book is located.

At any time during this process, the child is able to move back to an earlier stage of his or her search or to start a new search. The system allows the child to define the beginning and end of every search. There is never an "error" message; the system never tells the child that no books are available. The final stage of actually locating the book on a map of the library seems to provide closure for many children, who sometimes trot immediately to a shelf to confirm that the book, or its cousins, is really there.

The Science Library Catalog Research

Studies on these four versions of the SLC were conducted over a four-year period at three research sites: the UCLA University Elementary School (UES); the Open School (a Los Angeles Unified School District magnet school); and the Central Library of the Los Angeles Public Library (LAPL). Taken together, the three sites serve a wide range of children; the 131 young people who participated in the studies thus represented a broad array of children's needs, abilities, and skills.

UES is a laboratory school at UCLA with excellent computer and library resources. To create version 1 of the SLC, the research team loaded 1,150 MARC records representing the UES holdings in the Dewey 500s and 600s; 1,500 records were loaded to create version 3. The Open School, a participant in the Apple Vivarium project, is well-stocked with Macintosh computers. Its library media center is very small, however, and staffed on an informal basis by parent

volunteers. To create version 2, the researchers loaded 250 non-MARC, minimally cataloged records from the Open School's holdings.

The students at both schools reflect the ethnic diversity of California children. These are schools of choice for the parents who send their children to them, however, and they might draw from a better educated and more affluent segment of the population than is found in a "typical" public school in Southern California. In contrast, the Children's Literature Department of the LAPL's Central Library draws its primary clientele from the economically disadvantaged inner-city communities surrounding it. The schools in its immediate area serve student populations that are 90 percent Latino, 8 percent African-American, and 2 percent Anglo. The computer and library resources at these schools are extremely limited. The public library, however, has an extensive collection of materials for children; version 4 of the SLC was created with 8,200 MARC records of the library's 500s and 600s.

Each of these versions of the SLC was implemented in HyperCard on Macintosh Classic and Macintosh SE computers, which were the most commonly used computers in schools at the time the research began. Each version was tested in a round of experiments at one of the research sites. In an iterative design process, the system was modified according to findings from each successive study. The final two experiments, on versions 3 and 4, also tested students' searching behavior on the OPAC system installed at the respective sites. Table 1 summarizes the four experiments.

Table 1.

Summary of Science Library Catalog Experiments

Experiment	SLC Version and Other OPAC	Location	Records in Database	Subjects
1—1989	1	University Elementary School	1,150	34
2—1990	2	Open School	250	32
3—1991	3 and Orion	University Elementary School	1,500	33
4—1993	4 and LePac	Los Angeles Public Library	8,200	34

The studies focused on children aged nine to twelve, an age range that encompasses searching behavior at both the concrete-operational and formal-operational Piagetian stages of development.(9) By age nine, most children are able to read well enough to be able to navigate

with reasonable competence in a database of children's science titles. For each experiment, the sample of thirty-two to thirty-four children was drawn randomly from the pool available and balanced by age and gender. At the school sites, children were taken from their classrooms to the library media center by a researcher. At the Central Library, the children were selected from classes that were visiting the library from a neighboring school.

Each child was instructed to play with the SLC for a few minutes to get familiar and comfortable with it. After two or three minutes of warm-up, the child was assigned search topics. In experiments 1 and 2, children searched for six topics in the SLC; in experiments 3 and 4, they searched for four topics in the SLC and four topics in the OPAC. The search questions were drawn from the typical science curriculum for the fourth through sixth grades and reflected a balance of science (Dewey 500) and technology (Dewey 600) topics. In experiment 4, one topic in each set was determined by the child, who responded to a probe within a science or technology area: "how to cook something you like" or "an animal you like."

The children were instructed to tell the researcher each time they found a book that matched the search question. The child's judgment that a match had been made defined a successful search; children were not required to find specific targeted books. Children were also told that they could abandon a search at any time. After the search session, the researcher asked a few questions designed to elicit relative satisfaction with the program or programs that the child had used. Experiment 3 also included focus groups conducted with the children to gather additional qualitative data.

Research Findings

The research questions focused on learning more about how children search automated library catalogs: Are there differences between children's searching performance with a hierarchical, browsing interface and with a more conventional keyword, Boolean retrieval system? Do age, gender, and computer experience affect children's ability to search effectively? Finally, what are children's preferences in library catalogs? The following discussion outlines some of the findings in four specific areas.

Browsing Modes and Keyword Systems

Children are able to use both browsing modes and keyword systems in automated library catalogs. The children in the studies searched both kinds of systems persistently and successfully, finding matches for a median of 5 of 6 topics in experiments 1 and 2; a median of 3 of 4 on both Orion and the SLC in experiment 3; and medians of 2 of 4 on LePac and 2.5 of 4 on SLC in experiment 4.

In general, the children were able to use the hierarchical, browsing, recognition-based SLC effectively with no training or adult intervention. Some different results from one version of SLC to the next, however, are worth noting. In versions 1 and 2, the rates of successful searches and the search times were nearly identical. In version 3, the search times increased and the rate of successful searches did not improve. This version included new navigational features that allowed the children to browse laterally through the database, simulating the familiar experience

of browsing along the bookshelves in a library. These features proved to be more confusing than helpful: Children tended to get lost in the database, perhaps because the hierarchical metaphor was confused. Consequently, these lateral navigational features were removed for version 4.

Version 4 involved a much larger database and an increase from four to six levels in the searching hierarchy. Some levels of this hierarchy had originally held clusters of records as large as two hundred titles, an unwieldy number for browsing. These records were reclustered according to keywords in titles and subject headings, which somewhat confounded the hierarchy.(10) In spite of this, children found almost the same number of topics in version 4 (a median of 2.5 out of 4) as they did in version 3 (a median of 3 out of 4).

In the first two versions of the SLC, children abandoned only 22.0 percent and 18.2 percent, respectively, of the six assigned searches. In version 3, with the problematical navigational features, they had more difficulty, abandoning 30.3 percent of four searches. In version 4, with the much larger database, they had the most difficulty of all, abandoning 39.1 percent of four searches. These differences in persistence, as well as the differences in overall performance noted above, appear to be related to design characteristics of the various versions of the catalog. Comparisons among the experiments must be interpreted cautiously, however, as each experiment involved different versions of the software, different children, different research sites, different databases, and different search topics.

Although the research focus on browsing behavior was intended to structure the search task itself, finding a book about a particular topic probably did not, in fact, encourage browsing. Most children simply stopped with the first book record they thought matched their task, although some kept looking to find the book that looked best and others actually went to the shelves to retrieve physical books. In subsequent research, more open-ended, “story problem” tasks have been used to encourage more extended browsing.

Experiment 4 included some open-ended search questions and provided some preliminary evidence that children can use the browsing mode effectively. Asked to find “an animal you like,” the children were successful in the SLC. Four children, however, abandoned the search on the keyword catalog-hindered by entering misspelled words, the names of obscure animals, or the names of animals in Spanish rather than in English. When asked to find a book about “how to cook something you like,” children were again more successful browsing in the SLC. Many had difficulty formulating appropriate searches in the keyword catalog, using terms like “meat loaf” or “tamales” that are too specific for this system.

In general, the children were more successful on the keyword, Boolean retrieval systems than expected, exhibiting success rates and search times that were comparable with the corresponding versions of the SLC. The children’s task in these experiments, however, included some advantages that are not present in most searching situations. For example, children were given searchable terms for which matches existed in the database; the children were not required to construct search strategies or to remember appropriate terms. Assuming that they could spell the words, the children were thus able to find keyword matches, regardless of whether they understood their searches. Some of the children in experiment 3 had had prior experience on the

keyword system. In addition, training and a reference sheet were provided for the keyword catalogs but not for the SLC.

Topics and Children's Searching Effectiveness

Search topics affect children's searching effectiveness. Search topics used in the studies were related to the elementary science curriculum, balancing science and technology topics. The only topics that were consistently easy for children to find were concrete subjects that were easy to spell: "chemistry" and "farming," for example. This result is consistent with Paul Solomon's findings on children's use of an OPAC in a school library media center.(11) Other topics in the SLC study were consistently difficult: "weather," "tyrannosaurus," "how rubber bands are made," "fire trucks," "[human] feet," "bridges," and "veterinarians." Of these, "tyrannosaurus" and "veterinarians" were included specifically because they are difficult to spell. The other difficulties that children encountered with these topics seemed to be related to problems of domain knowledge and vocabulary development. **In general, children were more successful finding topics in the Dewey 500s than in the Dewey 600s.** This might be due in part to the greater emphasis placed on science in the elementary curriculum, leading children to be more familiar with the subject domain represented by science topics than by technology ones. It is also possible that the structure of the Dewey Decimal System is less clear or less "logical" in the 600s. For example, fewer than half the children were able to find "fire trucks" or "fire fighting" in the SLC, in spite of the fact that children are very familiar with this topic. Located under "engineering" and then under "building for city services," the topic was effectively buried for most of the children. "Bridges" was also difficult for them to find in the SLC, where it was located in the "engineering" classification: 55.6 percent of the children abandoned this search in experiment 4. "Bridges" was also difficult to find in the keyword system, where the children had trouble spelling the word: 64.3 percent of them abandoned this search.

Other Factors about Children's Searching Effectiveness

Age, gender, and computer experience have minimal effect on children's ability to use the Science Library Catalog, while age may be a factor in keyword systems. Age, gender, and computer experience did not appear to affect search results with the SLC. Only minor differences were found on these factors, and they were inconsistent across experiments. While children in experiment 4 had less computer experience than those in the earlier experiments, it is difficult to separate computer experience from such other factors as database size and structure in analyzing their less successful search results. Age was a factor in performance on one of the keyword catalogs: Older children were more successful and faster in their searches on this system than younger ones.

Preferences in Library Catalogs

Children show some differences in their preferences for library catalogs. The children claimed to like all four versions of the SLC as well as both keyword OPACs. Both interviews and the separate focus groups in experiment 3, however, showed that younger children preferred the SLC to the keyword system: They liked its graphics and its non-reliance on spelling and keyboard skills. Older children in experiment 3, echoing the preferences of more skilled adult

searchers, preferred the fast, direct access they had learned to exploit on the keyword system. To accommodate the children's preference for alternative access modes, the current version of the SLC (version 5) embeds keyword access in the browsing hierarchy, incorporating a spelling-correction system.(12) It should be pointed out, however, that focus group data also showed that children would rather not use any library catalog: They prefer to go directly to the shelves to find books. If that doesn't work, they will ask a friend or a librarian. They turn to a catalog only if all other strategies fail.

Implications

Traditional command-driven library catalogs tend to be unforgiving, opaque systems. In spite of this, even young children can learn to use them with some degree of success, particularly for frequently consulted terms.(13) The research reported here demonstrates that children can also get matches in keyword systems, particularly when the databases are large and the search terms are provided. However, the enhanced browsing capacity of the SLC appears more likely than command-based systems to generate evolutionary search strategies and the kind of discovery learning inherent in the contemporary elementary curriculum.

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