Information Access Instruction (IAI[4]): Design Principles

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This article proposes four design principles—The User, Active Learning, Conceptual Model of Teaching, and Modularity—as a conceptual framework of an Information Access Instruction (IAI[4]). These principles, when put in practice as specific guidelines, seamlessly link information sources together, regardless of their implementation medium, information structure, or interface style. Examples are drawn from a section of a four-unit elective undergraduate course taught in the Department of Library and Information Science, University of California at Los Angeles.

Learning to use and teach increasingly complex information sources and systems presents numerous challenges both to learners and educators. When the learner is a college student in a large research academic setting, it is crucial to teach the student how to access local and distributed information sources regardless of their format and structure.

UCLA's Department of Library and Information Science (LIS) has developed an elective four-unit undergraduate course, *Information Sources and Libraries*, LIS 110. The forty-hour course is offered during each of three academic quarters with two sections per quarter. Two forty-five-minute classes meet two times a week for ten weeks. The course is currently being taught by three instructors with about thirty-five students per section. There is no prerequisite for enrolling in the course other than general college requirements. This means that students bring to the class different academic and cultural backgrounds, different experiences and attitudes toward libraries, and different levels of technical competence in the use of information technologies.

Since its inception in 1970s, the LIS 110 material (e.g., syllabi, assignments, lecture notes) has been shaped by varied instructional viewpoints, experiences, technologies and administrative contexts. During the early era the course emphasized the use of printed bibliographic sources, card catalogs, and corresponding filing techniques. At that time online searching of multidatabase retrieval systems was reserved for graduate library students who would be doing online searching, typically on Texas Instrument terminals at 300 bauds. During the middle era the material was still organized around printed bibliographic sources, but instruction shifted away from card catalogs and filing techniques toward searching online public access catalogs, OPACs. Most recently, I have covered both electronic (e.g., OPACs, databases on CD-ROMs, information accessible through Internet/gophers) and printed sources regardless of their format (e.g.,

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reference books, audiovisual sources, manuscripts, government documents).

Is there a way that librarians can integrate information sources regardless of their medium (e.g., printed, electronic, distributed, and multimedia) into a single information access instruction program? Is there a metaphor that can aid us in teaching information structures regardless of the implementation medium (e.g., Wilson's printed *Art Index* and its online and CD-ROM products)? How conceptually different are, for example, printed Wilson's indexes from their electronic versions with regard to general makeup and structure of their files and records, display features, ease of use, time necessary to locate a relevant citation, or learning curve? We need a conceptual framework that would be user-sensitive, information-rich, and sufficiently flexible in order to assist designers of bibliographic instruction (BI) programs to integrate sources regardless of their implementation medium and information structure. Such a framework would provide both uniformity with regard to teaching style and flexibility to include/exclude emerging or obsolete information technologies and sources as appropriate. The proposed framework, based on four design principles, supports these requirements. It also applies to varying lengths of instructional units. In order to educate a population of self-sustained researchers, we need to consider the entire information space rather than arbitrary sources that happen to be conveniently accessible at a given time and place. After a brief review of BI literature, I will describe four design principles that are applied in my section of LIS 110, and report some of the preliminary results.

PRIOR WORK

The reviewed literature for this paper suggests two main forms of training end-users: (1) software search aid programs, and (2) bibliographic instruction programs.

Software Search Aid Programs

Known as front-ends, gateways, intermediary systems, and computer-assisted instruction (CAI), *software search aid programs* are designed to assist the online searcher in many different ways. Some offer simplified, and often compromised, views of native systems or virtual interfaces to several related systems; others, to a limited extent, provide special features in response to characteristics of a certain professional user group (e.g., Biosis B-I-T-S, BRS Colleague, GratefulMed, MicroDisclosure). The literature focuses on OPACs, remote online databases, and CAI programs.[1]

As electronic sources grow, it becomes difficult even for the trained intermediaries to maintain their searching skills. Thus, while we can argue that front-end interfaces can be useful to anyone who searches today's numerous databases, we might question their training usefulness especially for end-users, if the front-ends oversimplify native features, inhibit overall process of learning, or hide other potentially useful sources.

Bibliographic Instruction Programs

The reviewed literature reveals a multiplicity of viewpoints with regard to teaching model and structure, confusion as to how we should name BI, and disagreement over the information instruction/consultation versus information delivery debate. Case studies are prevalent. The studies are typically in the pattern BI + X, where X ranges from collection development, interlibrary loan, electronic sources, critical thinking, or a specific population of end-users such as sophomore-level biology majors or the health care community.[2-7] As expected, BI seems to be largely unregulated in terms of library policy and professional training.[8] The reviewed literature is somewhat lacking in the areas of applied BI models and performance evaluation studies. There are exceptions.

The Model Statement of Objectives for Academic Bibliographic Instruction reflects the current trend in library education away from tool-based instruction and toward concept-based instruction; it recognizes the importance of studying user groups to be served and concerns itself with the ways information is defined,

structured, organized, and accessed.[9] The model has been applied at several major academic libraries.

Nancy O'Hanlon describes a "flexible BI model" for developing library research skills based on an analysis of a relevant text, for instance, a term paper.[10] The model builds on the assumption that, to use the library resources effectively, an instructional designer needs to account for *affective*, *cognitive*, and *psychomotor* components of human behavior. O'Hanlon's paper describes ways these three components are integrated in her BI course and suggests various possibilities to incorporate these into computer-assisted instruction-based modules.

Ruth Curtis and Herbert Carson isolate and analyze motivational strategies developed in the ARCS model of motivational design (Attention, Relevance, Confidence, Satisfaction). Unfortunately, no empirical data support the proposed model and evaluate its intuitively sound recipe.[11] While most of the evaluative studies are quantitative, Elizabeth Frick suggests that qualitative approaches may be more appropriate for library user education programs under certain circumstances than quantitative approaches.[12]

DESIGN PRINCIPLES AND THEIR IMPLEMENTATION: A CASE STUDY

This section introduces four design principles of Information Access Instruction (IAI[4]) and describes how these are implemented in my section of LIS 110. These principles are: (1) *The User*; (2) *Active Learning*; (3) *Conceptual Model of Teaching*; and (4) *Modularity*. Design principles are based on the literature in individual differences research, applied cognitive psychology, information seeking, and information retrieval, as well as my own teaching experience.

Design Principle #1: Know The User

If we agree that the main goal of BI is to produce users who can view information as a unique resource and effectively access, evaluate, manage, and communicate information regardless of its structure and medium, then we need first to understand characteristics of the increasingly heterogeneous group of students we intend to educate in these nontrivial tasks.

Background. There is an uneven distribution of research on how different types of searchers (e.g., library-trained intermediaries, information brokers with varied backgrounds, and end-users, including domain specialists, college students, and the general public) use different types of information technologies (e.g., printed, online remote databases, OPACs, Internet sources). For example, we know relatively more about the information-seeking behavior and success/failure rates of college students as searchers of OPACs than we do about how they fare as searchers of unabridged online databases on commercial retrieval systems and native interfaces, or how well they navigate through large Internet spaces. Success rates of professional end-users who search health or legal databases and Internet sources have just begun to emerge.[13–16]

Investigators sought to identify potential predictors on search process and information retrieval performance. The studied variables thought to contribute to performance differences have included academic major, Graduate Record Exam (GRE) quantitative scores, database experience, frequency of use, age, and gender, among other factors.[17–23] A nationwide study of online library catalogs found that people had serious conceptual difficulties, especially with the selection of terms and search modification.[24] These findings, and my own experience, have suggested that, in order to design a BI course that would be user-sensitive, we need to begin with the user.

Implementation in 110. Two types of questionnaires are administered in the beginning of each term in addition to an informal introduction of students to the class.

The students' background characteristics questionnaire (Q1) is designed to gather data on academic major, status (e.g., freshmen, sophomores, juniors, seniors), level of perceived technical competency (e.g., use of computers, frequency of using library catalogs), students' aspira-

tions (e.g., intention to enter graduate and professional schools), past experiences with BI programs, general attitude toward the library, and past and anticipated frequency of writing term papers.

The students' level of information literacy or knowledge content questionnaire (Q2) is organized around three main groups of questions: the extent to which students are aware of tools such as Library of Congress Subject Headings (LCSH) and Library of Congress Classification System (e.g., main purposes and uses in printed indexes and electronic reference sources); students' ability to interpret data elements in bibliographies, indexes, and library catalogs (e.g., to interpret subject headings in different bibliographic settings, holding information about serials, and data elements for different library formats); and students' ability to apply basic search strategy techniques when using OPACs and other reference sources.

Part of students' future scholarly competence is their ability to seek employment opportunities through formal and informal channels, to locate funding sources for potential research activities, and, in general, to have lifelong survival information skills.

Students are told that the questionnaires serve three purposes: to make them comfortable with basic library vocabulary and concepts, to provide a model for subsequent tests, and to customize the content of the course, as much as it is possible, to students' academic orientation and their level of competency.

The answers to the questions pertaining to students' background characteristics (Q1) were examined so that students' capabilities could be incorporated into the design of the course. The answers to the questions in the knowledge content pretest (Q2) were reviewed in the class and returned to students.

Data on students' age, gender, ethnicity, and SAT scores are not gathered. Most students are between eighteen and twenty-two, about equally distributed by gender, increasingly culturally diverse, and have all satisfied general admission college standard tests (e.g., SAT, the Test of English as a Foreign Language [TOEFL]). These data have important implications in designing the content, pace, and structure of the BI course.

Design Principle #2: Apply Active Learning

Active learning, also known as participatory or collaboratory learning, is extensively discussed in the areas of cognitive and education psychology.

Background. In contrast to the stimulus-response paradigm which was adhered to in the early days of cognitive psychology and which emphasizes passive learning and memorization, active learning of real and complex tasks, such as learning to search databases or to use word processors, is driven by the initiatives of the learners, their background knowledge, skills, and experience.[25–30]

Some of the findings from studies on active learning and information seeking influenced a number of guidelines incorporated into the course (e.g., what the goals are; what the precisely measurable achievement outcomes are; what solving-based take-home or in-class assignments are used, and what class discussion covers).

Implementation in 110. Special attention is given to shaping term project topics that students select and subsequently report their search process and research findings to the class. Since students select their own topics, motivational and relevance components are used to guide them throughout the process of preparing a term project, a bibliographic essay. Students receive a three-page handout of specific instructions to aid them in the preparation of the term project. Samples of topics are listed along with examples showing annotated entries for reference sources and topical works.

In addition, a series of eight take-home hands-on assignments are designed to aid the student progressively in the use of basic research tools (e.g.,

concepts of citation and its role in scholarly communication cycle, controlled vocabulary such as LCSH and Medical Subject Headings (MeSH), factual sources (e.g., Internet-based cluster of sources, printed and electronic dictionaries and encyclopedias), and bibliographic sources, including library catalogs and indexing and abstracting services on different media. Students obtain feedback on these assignments from the instructor and may, with appropriate modifications, incorporate them into their term projects.

Part of students' future scholarly competence is their ability to seek employment opportunities through formal and informal channels, to locate funding sources for potential research activities, and, in general, to have lifelong survival information skills (e.g., to know where to look up for health, legal, educational, community-related, business and financial programs, organizations, and experts). Students earn 10 percent of their final grade based on active participation, which involves small-group class projects, discussion in the class based on assigned readings, and presentation of the term project findings to the class.

Design Principle #3: Use Conceptual Model of Teaching

Background. Christine Borgman trained college students on a fifty-record prototype online catalog using two teaching methods: a conceptual method which induces a mental model of the target system, and a procedural method which uses a step-by-step approach typically used to train students to search online databases.[31] The study found that those trained by the conceptual method performed better on complex tasks while the two groups performed equally well on simple tasks. Since most of the required searching tasks in the 110 course are complex, the conceptual method has been adopted whenever possible.

Implementation in 110. The concept of data structure is introduced and illustrated with examples from printed and electronic sources, regardless of their structure or format (e.g., parallel structure of files, records, and data elements in bibliographic Wilson Indexes—both printed and electronic; directories such as the yellow pages and other phone books; and geospatial sources such as *Geographic Information Systems*, GISs). As a result, the concept of a record is defined and shown in many different contexts and display arrangements.

Students learn important concepts of retrieval systems in a simple in-class exercise. They read a two-page journal article and then assign both key words and concept words representing the subject matter of the article. Students also create other data elements for author(s), title, source, and any other descriptive information they would find useful for the purposes of organization and retrieval. The exercise reveals principal library functions of collecting, organizing, and retrieving library documents, and increases the students' level of appreciation for intellectual library activities. It also explains a number of important puzzles: why many government documents may not be searchable by subject words, why we need to search by title words as well as by subject headings, if available, and why the same article may often be represented in a variety of ways in different types of catalogs (e.g., library and trade), indexing and abstracting sources (e.g., with different levels of detail), and bibliographies.

Similarly, the notion of information qualities is introduced early on in the course and applied to narrow down a term paper topic, to modify a student's search on OPACs, or to ask a specific reference question. By limiting the topic of alcohol drinking by any or all of parameters (e.g., time, place, perspective, agent, language, document type, country of publication), the term paper topic is focused to its working title, "Impact of Alcohol Drinking Legislation on Traffic Accidents among Youth in California in the Recent Literature."

Students learn to plan their searching before they "go online." Specifically, they learn where to start, and how to determine first best sources based on types of information they need; students

also learn various search approaches such as known-item search, subject search, specific versus comprehensive search, and factual versus bibliographic search. Since searching, displaying, and printing features are not yet standardized across different databases even on a single system, students learn to use help features and to draw their own comparative charts of database features. In addition, some of the universal system features, such as Boolean and proximity operators, truncation, and ranking capability, are explained in the context of broadening or narrowing one's search (e.g., ORION, MELVYL, VERONICA, WAIS).

Design Principle #4: Use Modularity

Background. The design principle of modularity attempts to deal with an issue of chunking. The concept of chunking has been studied extensively in the areas of cognitive and educational psychology. Herbert A. Simon's article, "How Big Is a Chunk?" examines earlier studies on human memory, extracts estimates of parameters that appear to be crucial to performance in complex tasks, and illustrates how these parameter values predict behavior in a range of laboratory situations.[32] Accordingly, a chunk of any kind of stimulus, including geometrical designs, concrete words, or sentences, is the quantity of five items that short-term memory will hold. The findings from this study and others have consistently indicated that chunking is an efficient learning strategy in helping reduce completion time of performance measures, and that text material presented in chunks significantly improves reading comprehension of good as well as poor readers.[33-34] The chunking idea has been well-studied and confirmed in laboratory experiments and field situations.

Implementation in 110. Chunking concerns itself with some of the related questions just mentioned: what and how much material should we include in a forty-five–minute chunk of time at different levels of BI (e.g., not-for-credit course, abridged two-unit course, four-unit breadth requirement course). Sequencing and linking units together deserve our attention as well. What are the most important concepts or tools we want to convey, so that our students can be self-reliant, confident, and motivated users of information sources and services? How do we rank order the importance of information concepts and sources? How do we deal with issues such as learners' attention span, information overload, feature shock syndrome, and other competing campuswide activities, programs, and attractions.

At the level of interfaces, we need to find a common thread in teaching command-driven, menu-based, direct manipulation, and navigational interfaces without creating an information overload in a given chunk of time.

The related principle of scalability concerns itself with issues of extension and transportability across varied formats and different platforms. With regard to extension, if a ten-hour BI course is to be scaled up to a twenty-hour course, what should we add? Similarly, where should we cut if we have to scale down a course to a four- or five-hour BI unit? Is there a common denominator among varying lengths of instructional units?

In the context of BI instruction, we need to consider problems of compatibility at multiple levels. At the level of interfaces, we need to find a common thread in teaching command-driven, menu-based, direct manipulation, and navigational interfaces without creating an information overload in a given chunk of time. At another level, we need to consider a variety of database protocols, including indexing policies, tools, and special features to go with each database. At the level of teaching information sources, we need to integrate sources coherently and dynamically with local, regional, and virtual significance. By that I mean we must treat both "local significance" sources

(e.g., UCLA libraries, labs, campus backbone network, human networks of free consultants and experts, computing facilities) and virtual digital libraries on the same plane.

Conclusions and Preliminary Findings

I believe that the design principles just presented are sufficiently flexible to be replicable in similar settings, including classroom instruction or informal BI multimodular unit programs. The principles could be also applied to different instructional media, including network-based or computer-assisted instruction. Additional details of my work on which this paper is based can be found in the technical report by Zorana Ercegovac.[35]

Who Are the Students? While 80 percent of my students have remained in the social sciences and humanities, more recently I have seen a shift from predominantly upper-division to lower-division college status. Perhaps students are starting to notice the applicability of the course content to their professional careers and take the course early on "so that they can apply to other courses" rather than just to "fill-in breadth requirements." Most of the students wish to pursue graduate studies and anticipate doing more researching and writing in future. Students' self-reported and perceived level of competence obtained from Q1 is higher than their actual competence as measured by the pretest knowledge content scores from Q2. Students are predominantly self-trained, with little or no library experience from former schools.

How Do Students Fare? Preliminary findings are obtained on the impact of the Information Access Instruction, IAI[4], as measured by three different instruments: a campuswide questionnaire on evaluation of the instruction program that is administered at the end of each quarter, two written tests on knowledge content, and the quality of the term paper, a bibliographic essay. A one-group pretest-posttest design (n = 216) has been used in this preliminary study to provide insights for more controlled studies in the future.

The campuswide questionnaire gathers data on students' views with regard to their subject interest before the course versus after the course; perceptions of the importance of the course relative to other courses they have taken; and written comments on the course.

Two knowledge content posttests that are worth 20 and 30 percent of the final grade are organized around five groups of questions: use of controlled vocabularies and classification schemes in searching and browsing; characteristics of reference sources and literatures from different disciplines for factual and bibliographic information; specific features of online library systems (e.g., OPACs, CD-ROMs); interpretation and specific features of certain indexing and abstracting sources; understanding the nature of information needs and locating the most suitable reference source(s) to meet one's needs.

The term paper, which is worth 40 percent of the final grade, attempts to measure students' cumulative applied mastery of literatures pertinent to the topic of the paper, online searching skills, and general reference sources for factual and bibliographic information. Equally important are the students' attention to accuracy, organization, insight, and good writing style. Finally, students' active participation in in-class assignments and discussions is worth 10 percent of their final grade.

CONCLUSIONS

As the importance of bibliographic instruction becomes more critical, more systematic research is needed to investigate many open questions: the extent to which BI should be presented in different settings, type of format and instructional techniques, standards and evaluation criteria (e.g., prerequisites of students if any, training of BI instructors), to mention just few examples that await attention. We have the opportunity and responsibility to design information access programs that will coherently integrate presentation of varied information tools and sources in an active and rich learning experience.

An annotated presentation program, IAI[4], based on the four design principles, is developed in Microsoft's PowerPoint graphical presentation package. IAI[4] consists of two parts as follows: part 1 is the instructor's presentation program. Each of the ten modules has about thirty color screens and corresponds to two forty-five–minute instructional units. Each screen contains annotations describing the screen, a list of readings, and questions for class discussion. Part 2 is the student's Notebook. It contains copies of screens from the IAI[4] modules with a listing of reference sources and in-class exercises. The program will be tested during the fall term 1994 and the performance results will be reported in the literature.

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