Re-Envisioning Instruction for the Electronic Environment of a 21st Century Science-Engineering Library

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SUMMARY. Library services have changed dramatically in recent years due to the rapid developments in both information technology and electronic resources. The behavior and expectations of users have changed as well. Users expect to find full-text information online that is retrievable with a minimum of effort. The information literacy movement is influencing the approaches of many instruction librarians, but this influence is often realized in generic materials geared to reach the greatest number of students, materials that do not suit the specific needs of science and engineering library customers. Librarians must re-envision instruction for an environment where a "one size fits all" approach is not appropriate. *[Article copies available for a fee from The Haworth Document Delivery Service: 1-800-HAWORTH. E-mail address: <getinfo@haworth pressinc.com> Website: <http://www.HaworthPress.com> © 2001 by The Haworth Press, Inc. All rights reserved.]*

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INTRODUCTION

Library services have changed dramatically in recent years due to the rapid developments in both information technology and electronic resources. The behavior and expectations of undergraduate users have changed as well. These users expect to find full-text information online that is retrievable with a minimum of effort. Increasingly, libraries are focused on information literacy instruction as a means of preparing users to navigate and evaluate electronic resources effectively. Information literacy instruction often is delivered during lower-level undergraduate courses and is concentrated on teaching similarities among resources in order to reach the broadest number of students. However, through the course of their academic careers science and engineering undergraduates develop unique information needs that are not always well met through a generalized approach to teaching information literacy. In this essay, the authors discuss how science and engineering librarians should re-envision instruction in order to provide a more individualized system of instruction that accounts for these students' status as modern undergraduates and science and engineering majors.

SCIENCE AND ENGINEERING UNDERGRADUATE STUDENTS

Many of today's traditional undergraduate students (the eighteen through twenty-something group) have grown up with computers integrated into everyday and academic life. Computer use among incoming freshmen is at an all-time high (Kellogg 2001). Moreover, these students are motivated by and focused on the outcomes of their education. For example, the 2000 Freshman Survey by UCLA's Higher Education Research Institute indicated that over eighty percent of incoming freshmen plan on obtaining a graduate degree. Seventy percent cited the desire to make more money as a motivation to attend college, and over seventy-one percent cited the need to get profession-specific training or to be able to get a better job as a reason. In contrast, when considering what objectives are essential, less than forty percent cite influencing social values while sixteen percent cite the desire to make a theoretical contribution to science. Only eighteen percent cite becoming involved in cleaning up the environment or influencing the political structure as very important objectives. In short, students' emphasis appears to be more self-focused and goal-oriented rather than outwardly focused, or focused on a quest for knowledge (Kellogg 2001).

In addition to what is known about today's undergraduates, there are some differences in academic activities and expectations for students in science and engineering disciplines that sets them apart from their peers. Course work in these majors tends to emphasize active hands-on participation in their learning experiences (e.g., project and lab-oriented assignments) for both individual and collaborative efforts. Hativa and Birenbaum indicate that students in engineering curricula are often required to use self-regulated learning approaches: "They are required to perform original and inventive individual projects and to frequently solve difficult problems on their own and generally to put more work and thinking effort into their assignments than education students" (Hativa and Birenbaum 2000).

Science and engineering majors also need to learn how to navigate within the increasingly complex electronic information environment. They must become proficient in basic information skills, which include: an understanding of the structure of information within the library's domain as well as outside it; the mechanics of information retrieval for varying information formats; and the evaluative competency needed to select the appropriate resources and options for a particular information need.

Of these information skills, evaluative competency is, perhaps, one of the most crucial and yet most complex skills for students to acquire. Students need to be able to distinguish between Web pages created by authors who may or may not be knowledgeable on a subject, and databases licensed by libraries, which are frequently the electronic counterpart to the reputable indexes libraries have relied upon for years. Users of Web search engines may encounter great difficulty, possibly unwittingly, in retrieving accurate information. A 1999 study of the AltaVista search engine indicate that only 27.2% of pages returned contained correct, or mostly correct, answers to the authors' questions, while incorrect or mostly incorrect information was found in 8.8% of returned pages (Connell and Tipple 1999). Faculty have accepted Web pages as a part of students' research, but frequently take steps to insure that students seek non-Web resources as well. These faculty report that often students display a lack of ability to evaluate resources, regardless of format (Herring 2001). Teaching of evaluative skills is essential and must extend to all types of resources, but is not the only necessary focus of information literacy instruction for science and engineering majors.

Science and engineering students need to master complex subject-specific resources that often require a sophisticated and diverse set of search skills. Competency is crucial to success in their chosen academic endeav-

ors and will be applicable in their professional careers (Leckie and Fullerton 1999). The American Chemical Society's Committee on Professional Training stipulates that one primary objective of laboratory instruction is to give students "the self-confidence and competence to . . . plan and execute experiments through the use of the literature" (American Chemical Society 1999). Information literacy instruction for these students should, therefore, be specific, context-based, and highly relevant to their current information needs. Moreover, instruction efforts should address the desire expressed by science and engineering students to fulfill their information needs in the most convenient, comfortable, and time-saving manner possible (Brown 1999) by providing guidance on "shortcuts," quick tips, and alternatives to standard searching mechanics whenever possible.

In addition to the unique characteristics of these students, the expectations and philosophies of their faculty add an additional layer of complexity to teaching information literacy. Research has shown that while most faculty in these disciplines believe undergraduate students should be taught information literacy skills, the majority do not believe it is necessary to include information literacy in their classes (Hativa and Birenbaum 2000). Other faculty do not see it as their responsibility at all, claiming that undergraduates should already possess such skills (Leckie and Fullerton 1999). Additionally, science and engineering courses are often centered on standard textbooks for the first two, and sometimes even three, years of the undergraduate curriculum. Lower-division undergraduate science and engineering courses often do not rely on external library resources for coursework. Despite these factors, the students are still expected to have information literacy skills even though class time is not always provided to acquire these skills (Leckie and Fullerton 1999). This creates a situation in which undergraduate science and engineering students may not receive any information literacy training unless they receive it in general education or elective courses.

DELIVERY OF INSTRUCTION OUTSIDE THE CLASSROOM

Knowing that science and engineering undergraduates have needs for information literacy, librarians face the challenging task of finding ways to introduce information-seeking skills. As noted previously, course-integrated classroom opportunities are not always available–or even the preferred option for instruction. Many libraries have begun to explore online tutorials to reach these students, but little is yet known about their effec-

tiveness for specific populations of students. Advancements in technology and the constantly improving Web skills of librarians allow tutorials to grow more complex and, to a degree, interactive. Unfortunately, most librarians lack the time, money, programming skills, and artistic flair necessary to make cutting edge Web tutorials. Tutorials are still primitive in comparison to the average video or Web game that is as common and ordinary to the undergraduate student as a microwave oven.

Furthermore, there has been little research assessing whether students can and will learn through online tutorials, or if they will use them without prompting from an instructor. Recent studies have confirmed what most instruction librarians already know: online tutorials cannot, and should not, be substituted for librarian interaction with students. Simply stated, "web-based library tutorials are best used in connection with academic classes rather than in isolation" (Dewald 1999). Additionally, many library tutorials are accessed in an artificial environment and are generic in nature, teaching catalog searching, basic search strategies, and other information literacy skills outside the student's learning context. Tutorials are frequently designed to send the user back and forth between the tutorial and the resource, rather than mimicking a more natural search process. Teaching out of context in an artificial environment may make it difficult, if not impossible, for students to acquire transferable skills.

Although online tutorials may have utility when face-to-face contact is not possible, or for those who prefer this type of instruction, instruction delivered in person is almost always optimal. An excellent face-to-face instruction opportunity is through a reference desk interaction. Ackerson states that "linking reference service (a reactive transaction) more closely with library instruction (a proactive transaction) can strengthen both activities and support more effective and consistent interaction . . . " (Ackerson 1996). In this setting, teaching traditional in-depth searching skills may be challenging due to the brevity of the interaction, especially when the goal is to teach transferable skills. It is important, however, to recognize these interactions as teachable moments in which information literacy skills may be taught immediately and within the context of a student's work.

Library patrons, undergraduates in particular, commonly come to the desk with skills and experience in using the Web. In fact, the 1998 UCLA Higher Education Research Institute Freshman Survey indicated that 82.9% of freshmen had used the Web for research or homework, a number that has surely risen in the succeeding years (Sax 1998). More often than not this means undergraduates have some experience with serendipitous searching, where results, whether correct or not, are found seem-

ingly through chance. Although this method can seem random compared to focused Boolean searching, in actuality serendipitous searching is more targeted than it may appear. On the Web, and in free and licensed databases, links are rarely random. Links on Web pages often point to pages on related topics. Likewise, library databases (e.g., INSPEC or Science Citation Index) in which displayed records include hyperlinks often point to related information such as other articles by an author, other articles on a subject, or articles citing the article. A savvy user can utilize this structure to quickly navigate to potentially relevant information.

Knowing that many users have experience with serendipitous searching presents an opportunity to teach searching skills without relying exclusively on Boolean logic or crafting elaborate search strategies. Librarians can highlight and explain the value of special features available in Web-based databases, such as clickable subject headings or descriptors, thereby involving the user in the search immediately and building upon existing skills.

These special features appear more and more often in databases and can be a great aid in getting to specific information quickly. The National Library of Medicine's *Entrez* is a prime example of interconnectivity for serendipitous searching. With *Entrez*, users can search and retrieve data from eight databases produced by the National Center for Biotechnology Information. These linked databases allow users to pursue pertinent information as they encounter it. In another example, citation indexes (e.g., Science Citation Index), especially in hyperlinked format, lend themselves to serendipitous searching by providing links for cited authors, cited publications, or full-text within an individual record. Moreover, the linking of electronic resources through programs such as CrossRef provide mechanisms for chance encounters, by lending the "browsing of the stacks" feel to the electronic universe. In fact, CrossRef describes linking as enabling "readers to gain access to logically related articles with one or two clicks–an objective widely accepted among researchers as a natural and necessary part of scientific and scholarly publishing in the digital age." These special features are highly targeted tools that can reinforce serendipitous searching skills and lead users to specific, needed information quickly.

RE-ENVISIONING CLASSROOM INSTRUCTION

The ACRL Information Literacy Competency Standards for Higher Education prescribe the formulation of relevant searches as a fundamental concept of information literacy (*Information Literacy Competency*

Standards for Higher Education 2000). These standards encourage teaching keyword and Boolean search techniques so that the user can transfer these skills regardless of the resource. This technique largely reflects a traditional and "library-centric" approach, but is not always an intuitive way for users to search, and commonly ignores the refinements of many electronic resources to clarify needs and facilitate searching. In other words, the attempt to teach generic tools that reach across all electronic resources may downplay unique features in resources, such as the "more like this" option, that are particularly relevant to users. Unfortunately, information literacy instruction at the undergraduate level may never get past the simplistic notion of database "sameness."

This general approach, recommended by ACRL, is quite successful for research meant only to "dip one's toe" into the scientific literature, but is not sufficient for upper-division undergraduates faced with projects or assignments in their majors requiring far more comprehensive study. Fjallbrant and Levy explain that "subject-specific information literacy has additional dimensions and is closely related to the pattern of information flow within that discipline" (Fjallbrant and Levy 1999). As science and engineering students advance, they need to recognize both the many channels available for information in their disciplines and the many different searching mechanisms within these channels. Subject-specific information competency requires facility with a myriad of both print and electronic resources (e.g., handbooks and indexes) that provide comprehensive access to the literature needed for advanced study or research in science and engineering.

While electronic resources are very convenient for users, print resources must not be forgotten in subject-specific instruction. A recent Harvard survey reveals that the highest percentage of library resources used across disciplines are in print format. While they did not rate as highly as electronic on convenience, they were rated as superior in providing information needed by students, usefulness of material, reliability, and availability of assistance (Waters 2001).

Along with the continued need for print resources, specialized electronic resources continue to grow in importance. Powerful, sophisticated electronic resources (e.g., INSPEC, BIOSIS, SciFinder, and METADEX) provide unprecedented multiple-point access to a vast array of information. Yet, differences in citation/abstracting levels, lack of consistent search interfaces and results displays, and resource-unique controlled vocabulary often necessitate individualized training for effective use. According to Kutner, this lack of standardization "creates confusion for users when a wisely conducted search in one database is not inter-

preted the same way in another database" (Kutner 2000). This exemplifies a weakness of information literacy instruction that stresses similarities between resources yet fails to address the complexities of specialized electronic resources.

In order to gain the confidence and ability to successfully navigate information searches, students need both to see and to try the unique "bells & whistles" available, preferably at the time in their information pursuit when these options add value to their quest. Given the pragmatic nature of science and engineering students, timing of this resource-specific instruction to an assignment in hand is far more effective than "just-in-case" instruction that touts general search skills without a context in which to use them.

CONCLUSION

In order to impart the information literacy skills that will benefit students as science and engineering undergraduates and as they encounter information needs throughout their careers, librarians must remain aware of several issues:

- Science and engineering students differ from their peers in their academic activities and in the expectations of their instructors.
- Science and engineering undergraduates have unique curricular needs that will require specialized and targeted instruction.
- Online tutorials have not been adequately assessed as a educational tool for this population.
- The reference desk provides an immediate and valuable opportunity for context-specific information literacy instruction that builds upon serendipitous searching skills.
- Classroom information literacy instruction for this population needs to go beyond basic instruction emphasizing similarities among resources to instruction that emphasizes more complex understanding and subject-specific resources in all formats.

As the vision of a digital library environment continues to evolve, both successful comprehensive searching and serendipitous discovery of information should become more commonplace. Edelson and Gordin's *supportive scientific visualization environment* aims to provide adaptive advances in interface and activities design, organization and selection of materials, and functional documentation to support non-expert users as

they build the requisite information skills in a scientific or technical discipline (Edelson and Gordin 1996). The current crop of electronic databases continues to evolve as well, with the continued development of such value-added, user-supportive features as alternative search strategy suggestions; sophisticated, accurate exclusion of unwanted information; and more refined cross linking to other search and/or results platforms. These digital enhancements, many of which are already being utilized, will continue to evolve and provide improved user support. They will not, however, negate the need for context-specific, hands-on, personalized instruction that can facilitate optimal user employment of these resources. Perhaps the science fiction vision of fully interactive, intelligent computers and information systems–combined with holographic librarians who inquire as to the "nature of your information emergency"–will be the reality of the future, and will allow for truly self-sufficient users. The reality in 2001, however, is that science and engineering undergraduates still benefit from some degree of human intervention. By demonstrating to undergraduates that databases and other information resources are valuable, usable tools, librarians will have taken an important step in making students information literate for life.

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