Designing for Collaborative Information Literacy in Engineering Education

DR. LESLEY S. J. FARMER
Advanced Studies in Education and Counseling Department
California State University Long Beach
1250 Bellflower Blvd., Long Beach CA 90840
UNITED STATES OF AMERICA
Lesley.Farmer@csulb.edu http://www.csulb.edu/~lfarmer

Abstract: - The changing informational environment affects higher education, and also emphasizes the need for lifelong education to prepare entering engineers to deal with an uncertain tomorrow. To that end, education should not only pass on existing knowledge but also teach learners how to use tools and processes to create knowledge. Academic librarians focus instructional attention on scholarly research tools and resources for both students and faculty, and work with specific academic departments to offer more specialized or domain-specific training upon need. This paper examines a series of collaborative efforts by university librarians and engineering faculty to incorporate information literacy into their curriculum.

Key-Words: - information literacy, ICT literacy, digital literacy, collaboration, librarians

1 Introduction

The need for critical use of information is more important than ever. The now classic 1991 SCANS report noted information location and manipulation as vital skills for today's employees. In a digital world where the amount of information doubles every two years, adults need to evaluate resources carefully and determine how to use relevant information to solve problems and make wise decisions [1].

Furthermore, it is no longer principally an issue of getting information: it's getting the right information at the right time to do things right and to do the right things. Much of that information is generated and transmitted electronically. Thus, "an effective democracy depends on all citizens participating in the decision-making process. Because so many decisions involve technology issues, all citizens need to be technologically literate" [2].

Moreover, a need exists to increase economic work force capability of the larger community, particularly in the fields of mathematics, science, engineering, and technology. The problem becomes critical as females and under-served populations are under-represented in associated coursework and careers. In short, entering engineers need to be information literate. Especially at this point in time, when people need to be not only critical consumers of information but also effective producers of information, engineering educators should not only pass on existing knowledge but also teach their students how to use tools and processes to solve engineering problems and create knowledge in improve the world around them.

The question becomes: do engineering faculty have the skills to incorporate information literacy explicitly into the curriculum? Fortunately, other academic personnel do exist to aid in this effort: librarians and instructional designers. This paper specifically examines a series of collaborative efforts by university librarians and engineering faculty to incorporate information literacy into their curriculum.

2 Information Literacy and Librarians

Where do information literacy and the library fit into this preparation? Information literacy, as defined by the Association of College and Research Libraries (ACRL), includes "the set of integrated abilities encompassing the reflective discovery of information, the understanding of how information is produced and valued, and the use of information in creating new knowledge and participating ethically in communities of learning" [3]. Librarians have "owned" information literacy since the 1980s, building upon the concept of library skills [4].

Academic librarians tend to focus instructional attention on scholarly research tools and resources for both students and faculty. To that end, university libraries tend to offer standardized workshops for basic research skills, and work with specific academic departments to offer more specialized or domain-specific training upon need. Academic librarians are increasingly developing “stepped” instruction: freshmen overview, basic domain-specific instruction, and graduate student thesis research strategies. Academic librarians provide such instruction principally to ensure that the academic community become effective lifelong learners.

On their part, the academic community often has to be “convinced” of information literacy’s values as it pertains to education as a whole [5]. Academic faculty tend to think of libraries in terms of their resources, which makes sense. The first priority of academic librarians is to support the curriculum and research needs of the faculty.

Therefore, librarians need to collaborate with academic faculty to make them aware of information literacy and to facilitate the provision of information literacy instruction: either to teach processes in tandem with a content-based project, or to teach faculty how to integrate information literacy [6]. In either case, the idea of the structure of information systems should be addressed: most logically by the librarian in terms of resources located through the library, but chemical information system structures would probably be taught by the chemical engineering instructor, for example. The underlying concept of information system structure and organization subsumes these two applications [7].

3 Designing A Information Literacy Engineering Design Course

California State University, Long Beach (CSULB) is an urban campus with one of the most diverse student populations in the nation. About 36,000 students attend to pursue a bachelor’s, master’s or doctorate degree from over three hundred programs. The College of Engineering has six departments, one of which is Computer Engineering and Computer Science (CECS). This department offers a B.S. in Computer Engineering, B.S. in Computer Science, B.S. in Engineering Technology (Technology and Engineering option), an M.S. in Computer Science, and a Certificate in Web and Technology Literacy. Library education is offered through the Educational Technology and Media Leadership program (ETEC), housed in the College of Education. The university library houses over a million volumes, and employs seventeen professional librarians, one of whom serves as the engineering specialist. The collaborative work with CECS had its roots in several initiatives that provided the groundwork for sustainable action.

As CSULB Assessment workshop participants realized that information literacy appeared high in the list of desirable expectations, the library educator and CECS chair started talking about the incorporation of information literacy into the CECS curriculum. The two parties had worked together in the Graduate Council, reviewing programs across the university. The library educator was a credentialed mathematics teacher, had taught computer programming courses, and taught courses for the ETEC program, which had helped her build credibility with the department chair, who was also a woman. The two faculty members discussed the possibility of a general education critical thinking course, which was attractive because it could attract students who might not otherwise take CECS courses; it was also hoped that students who took the course might then pursue a CECS major. At that point in term, the College of Engineering had no such critical thinking course.

The library educator introduced the CECS chair to the Association of College and Research Libraries (ACRL) information literacy framework [8] and the engineering information literacy standards developed by the American Library Association Task Force on Information Literacy for Science and Technology [9]. The standards’ specific performance indicators helped guide the conversation as the duo operationalized those standards in terms of CECS.

They determined that a design process course would address information literacy and also address the needs of CECS students to think critically and conduct research effectively. With that framework, they were able to design several learning activities that would help students learn and practice information literacy skills while gaining computer science and engineering knowledge. Even though both used telecommunications regularly, they found that face-to-face collaboration was more effective because of the back-and-forth conversation.

As a result, the duo codesigned the course CECS 100: Critical Thinking in Digital Information Age. CECS 100 continues to be a successful and useful course, and serves as a required course not only for all CECS majors but also electrical engineering and engineering technology; in addition, it is cited as an appropriate elective for other programs, such as nursing. For fall 2016 twelve sections of the course were offered and filled. Here are a couple of representative syllabi:

http://www.cecs.csulb.edu/~mopkins/cecs100/index.shtml and http://www.cecs.csulb.edu/~pnguyen/cecs100/fa12aft/cecs100fall12aft.html,

4 General Education Information Literacy Standards and Engineering

As chair of the CSULB Library Advisory Committee, the library educator was aware of the drive to incorporate information literacy into undergraduate curriculum. The library spearheaded an information literacy and technology literacy requirement for General Education (GE). The general education requirement of a critical thinking course most easily aligned with information literacy.

The next step was to collaborate with teaching faculty to infuse information literacy skills and knowledge into their curriculum. Information literacy training involved face-to-face sessions and online tutorials. With the help of the CECS department chair, every department chair and program coordinator within the college met to discuss information literacy with the library educator and university librarian. The training session started by having the participants share their preconceptions of information literacy. Then the university librarian shared CSULB library's definition of information literacy was provided, and explained the importance of information literacy. Next the faculty brainstormed the skills that students needed in order to succeed in their programs. The library educator then shared the ABET accreditation standards for university programs in the disciplines of applied science, computing, engineering, and engineering technology, and had the participants map the standards to information literacy [10].

Next, she provided the group with a bibliography of engineering and information literacy curricula, articles, and presentations. The group then reviewed existing or potential learning activities that lent themselves to information literacy. Representative activities included:

- Develop a design brief.
- Find reliable information to solve an engineering problem.
- Locate case studies or best practices in hazardous material and waste management.
- Locate and analyze engineering trade data.
- Conduct a patent search.
- Locate and analyze environment regulations and related court cases.
- Interpret compliance information.
- Research the environmental impacts of an engineering project.
- Test and compare groundwater from several sources.
- Adapt an engineering process discussed in a technical paper.
- Develop toxic material guidesheets.
- Design the perfect waste recycling system.
- Write a white paper or executive summary about an engineering issue.

During the training session, each department identified a required course that students took early in their major, and followed up by including at least one information literacy learning activity in those courses. The science librarian reviewed the training materials, and then assumed the liaison role for the curriculum department.

Fortunately, a couple years later an experienced librarian with a strong engineering background joined CSULB, and became an embedded librarian for the CECS and other engineering departments. She has worked closely with the faculty, developing research guides and online tutorials for their programs (http://csulb.libguides.com/profile.php?uid=19953).

CECS has embraced information literacy, as reflected in the following courses.

- 100. Critical Thinking in the Digital Information Age. Help students develop critical thinking skills using technical software. Main topics include: identifying engineering issues for investigation, developing planning and problem solving strategies, locating pertinent information and examples, critically analyzing these sources, forming and testing hypotheses, synthesizing and organizing results for effective communication, and developing transferable problem solving skills.
- 202. The Digital Information Age. The design and use of common-place digital information systems. Introduction to how information is digitized, secured, compressed and transmitted. Students learn how digital age impacts them and the world they live in.
- 300. Design of Dynamic Web Sites. Dynamic Web design using modern tools. Creation of domains, using hosting services and content management systems. Website portability, usability and accessibility.
- 310. Computer-Based Learning Resources. Explore and learn to use the many existing web-based education tools that focus on teaching technology. Evaluation of resources for age appropriateness and gender preferences.

Students will develop a web-based tool to teach a technical subject of their choice.

- 326. Operating Systems. The structure and functions of operating systems. Interrupt handling, processes and interprocess communication, memory management, resource scheduling, information sharing and protection.
- 346. Microprocessors and Controllers. Intro microprocessor/controller, embedded programming and design. Basic computer organization, representation of information and instruction, addressing techniques, input/output, assembly language programming. Introduction to assemblers, linkage editors and loaders.
- 429./529. Search Engine Technology. Models, algorithms, and evaluation of the retrieval of information from a collection of documents. Document preprocessing. Indexing and searching. Retrieval evaluation. Search engines.
- 448. User Interface Design. Evaluation, design and programming of user interface systems. Fundamentals of human cognition, system characteristics, and the interaction between humans and systems. Usability methods and user/task-centered design. Tools for designing and building user interfaces, with emphasis on rapid applications development.
- 460. System on Chip Design. Complete System on Chip (SOC) design flow from design specification to working SOC. Creation of RTL level modules designed for reuse, integration of Intellectual Property (IP) for RTL and physical level IP, IC verification, creation of self-checking test benches for designs.
- 470. Web Programming and Accessibility. Introduction to World-Wide Web development. Accessibility issues. Web architecture, standards, and programming, emphasizing XML technologies and cascading style sheets. Visual design principles and information architecture. Client-side and server-side programming and protocols. Development for adaptive technologies and mobile devices.
- 478/578. Introduction to Computer Security. Controlling the risk of computer security. Security threats and vulnerabilities in the development and use of computer systems. Tools and controls that can reduce or block these threats. Law, privacy and ethics.

In addition, CECS developed and now offers a minor and a certificate in web and technology literacy, which includes students gaining "an understanding of the system design process and how our digital world works. Students will learn to acquire and evaluate information from the internet and to communicate information via the internet including ethical issues encountered when using the internet. In addition, students learn to create a robust, useable, and accessible Web site. This minor will provide valuable technical skills for a variety of fields.

5 Factors for Success

At this point in time, CECS has institutionalized information literacy into their curriculum. Several courses address the topic at the level of it being included in the course description as well as in content matter and learning activities. Moreover, those courses are offered at each educational level, from first semester freshmen through senior year. In addition, they provide a minor and a certificate in web and technology literacy so that students in other majors can learn and practice these competencies. This success is especially heartening in that the original key players have all moved to different duties. The CECS department chair retired, the library educator is now a department chair herself for Advanced Studies in Education and Counseling, and the university librarian works with communication studies and sociology.

What factors resulted in such sustainable success? The trainings, staffing, and curriculum were analyzed in terms of information literacy instruction and its impact. The findings follow.

- Content knowledgeable leadership who were open to change: learning about information literacy, operationalizing it, developing a commitment to it, and advocating for it
- Library educators with strong information literacy and curriculum development knowledge and experience, as well as computer science teaching experience
- Close transfer of knowledge: the content leader, library educator and engineering librarian understood and trusted each other because of their shared knowledge base
- Long-term professional relationships through college and program level collaboration, university committee work and othr joint activities
- A growing network of connected experts to facilitate transfer of knowledge and experience
- University library commitment to information literacy through subject specialist who taught information literacy, and a library advsisory committee structure that promoted cross-university discussion about information literacy

- University commitment to information literacy, primarily through general education requirements
- CSU system financial commitment to information literacy through grant opportunities.

These contributing factors demonstrate the need for long-term commitment to information literacy and professional collaboration. In addition, past successes were used as stepping stones for future initiatives, which accelerated buy-in and effective action. Other information literacy projects have come and gone, or been only moderately successful; the limiting factors have usually been lack of convenient and efficient technology, lack of incentives, lack of coordination, lack of commitment, lack of leadership, and lack of funding. However, when all the conditions for success are put into place and leveraged, the impact can be impressive.

6 Conclusion

Today's engineers need to be information literate in order to be prepared for their work place success. Because many academic faculty have not been trained in teaching such skills, they do well to collaborate with academic librarians. Together they can select resources and learning activities that optimize physical and intellectual access to engineering information as well as resources that support the use of information to address engineering issues.

References:

[1] United States Department of Labor, *Secretary's Commission on Achieving Necessary Skills (SCANS),* Government Printing Office, 1991.

[2] International Technology Education Association, *Standards for Technology Literacy* (3rd ed.), International Technology Education Association, 2007, p. 11.

[3] Association of College & Research Libraries, *Framework for Information Literacy for Higher Education,* American Library Association, 2015, p. 1.

[4] American Library Association Presidential Committee on Information Literacy, *Final Report*, American Library Association, 1989.

[5] Pinto, M, Assessing Disciplinary Differences in Faculty Perceptions of Information Literacy Competencies, *Aslib Journal of Information Management*, Vol.68, No.2, 2016, pp. 227-247.

[6] Riehle C., & Weiner, S., High-Impact Educational Practices: An Exploration of the Role of Information Literacy, *College & Undergraduate Libraries,* Vol.20, No.2, 2013, pp. 127-43.

[7] Farmer, L. ICT Literacy Integration. In J. Keengwe & P. Bull (Eds.), *Handbook of Research on Transformative Digital Content and Learning Technologies*, pp. 59-80, ICT-Global, 2016.

[8] Association of College and Research Libraries, Framework for Information Literacy for Higher Education, American Library Association, 2015.

[9] American Library Association Task Force on Information Literacy for Science and Technology, Information Literacy Standards for Science and Engineering/Technology, American Library Association, 2017.

[10] ABET, Accreditation policy and procedure manual (APPM), 2016 – 2017, ABET, 2016.