**Innovative Approaches to Information Literacy Instruction for Engineering Undergraduates at Drexel University**

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## Introduction

As information professionals, engineering librarians have the primary responsibilities of providing access to engineering information resources and giving instruction in how to use these resources.  In the case of undergraduate engineering students, this extends to building their information literacy skills, an important component in helping them become lifelong learners.  This paper describes a major educational initiative we, the Drexel University engineering librarians, participated in during the 2005-2006 academic year: the Freshman Engineering Design Sequence.  In each of the two terms for this program, we endeavored to employ active learning techniques and to embrace relevant technologies to provide an improved educational experience for our students.

## The Freshman Engineering Design Sequence

The Freshman Engineering Design course offered at Drexel University focuses on the design process and its applications in engineering.  Lectures expose students to the various engineering disciplines and to the current research and special projects that are occurring in each engineering department.  Students also work in groups to complete a year-long design project, which requires research using a variety of both print and electronic information resources.  The entire freshman engineering class (approximately 700 students) takes this course each year.  Research, clear thinking, exploration of alternatives, and revision form the core competencies taught in this class, and are common to both good engineering design and good writing.

The Freshman Design Sequence of 2005-2006 included a sequence of classes focusing on English composition and writing in the humanities (Humanities 107-108). Each design group (usually five students) went through this sequence together; this allowed us to deliver information skills instruction as part of the Humanities 107 sequence while focusing explicitly on each group's information needs as pertaining to their design project in the Engineering 101 sequence.

The Engineering 101 sequence exposes students to the foundations of the various engineering disciplines, as well as introducing them to the process of engineering design.  The major coursework for this sequence is a group design project which spans two of the three terms in the freshman year.  While these first-year engineering students tend to lack the technical skills and knowledge to produce a working product, the design sequence provides valuable experience with working in a group, developing an idea, researching alternatives, and exploring design methodologies.

The Humanities 107 sequence focused on English composition, technical writing, and research skills.  Students were exposed to a wide variety of materials from the humanities, such as novels, nonfiction essays, poetry, films, and plays – both written and performed.  This sequence provided a natural setting to introduce core information literacy skills, such as defining an information need, locating and evaluating information

resources, and properly using and citing these resources in written papers and reports. While the engineering content of the freshman design projects was taught in the Engineering 101 sequence, the Humanities 107 faculty provided essential guidance on the construction of their final report, and eventually evaluated these reports with regard to the written content and proper use of citations.

The success of the individual group instruction on research has resulted in its continued inclusion in a newly revised engineering curriculum. While no longer integrated with humanities, the design project continues to have the same goals. Library skills are now covered in the Engineering Design class and in the peer tutoring sessions. We must note that after the end of the 2005-2006 academic year (the period covered in this paper) the Drexel University Engineering Department instituted significant changes to tDEC (the Drexel Engineering Curriculum) and the Freshman Design Sequence. (http://www.tdec.drexel.edu/ has an up-to-date description of undergraduate engineering education at Drexel University). Information literacy instruction remains integral to the Freshman Design Sequence in the new format. The English faculty with whom we worked on the hybrid pilot are now designing a new general curriculum that incorporates much of what we developed for engineering students. The goal is to introduce students to research skills for professionals regardless of their profession.

**Lifelong Learning**
One of the goals of higher education is to prepare students to be Lifelong Learners; to be curious and independent, and to take greater responsibility for their own learning (Trezza 1993, ABET 2000). In their Information Literacy Competency Standards for Higher Education (2000), the Association of College Research and Libraries (ACRL) states: "Information literacy forms the basis for lifelong learning. It is common to all disciplines, and to all levels of education. It enables learners to master content and extend their investigations, become more self-directed, and assume greater control over their own learning." As academic librarians, we seek to be active partners with faculty in developing students' information literacy skills as they become Lifelong Learners.

**Information Literacy**
Information literacy can be defined as "the ability to locate, retrieve, evaluate, and use relevant resources to address an information need" (ACRL 2000). A student's process of seeing information generally begins with a perceived information need; that is, the student not only lacks the relevant information to address the problem at hand, but they also know that they lack this information. This is the point at which a student begins to search for information. For engineering undergraduates, the needed information is often foundational: specialized handbooks and encyclopedias that give an introductory overview of engineering topics. However, students are highly predisposed to search for information through sources that have worked for them in the past, usually Google and other resources on the free web. Unfortunately, the detailed engineering information they need tends to not be available on the web from sources that are both free and reliable. This information is, however, available through the University Libraries. Our challenge in building information literacy in engineering students is to acquaint the students with the array of library resources available to them and to help them intelligently navigate the

systems (usually online databases and electronic book collections) that contain the information.  So, in that sense, how do we motivate our engineering students to become independent and lifelong learners?  In their progressive life situations, students will have different information needs and they will need to use appropriate sources to meet these needs.  How do we prepare them for future information challenges based on their present information needs?  What are the roles of libraries and information professionals in assisting students to become independent learners?

**Learning Styles**
There are several challenges inherent in teaching information literacy.  A primary challenge is that not all students learn in the same way.  They have different learning styles and are possibly at different stages of their cognitive development.  This requires a multitude of approaches in teaching information skills (Burge and Snow 2000).  Fleming and Mills (1992a, 1992b) identify four basic types of learners: Visual Learners who prefer images, including charts and diagrams; Aural/Auditory Learners who prefer "heard" information, including lectures, conversations, and online chats; Read/Write Learners who prefer text as both input (reading) and output (writing); and Kinesthetic Learners who prefer to learn by doing and by relating subjects to concrete examples.  Since information literacy is a core skill that is important for all students, we aim to provide instruction that reaches all types of learners.

**Active Learning**
The Greenwood Dictionary of Education defines Active Learning as "The process of having students engage in some activity that forces them to reflect upon ideas and how they are using those ideas. […] The attainment of knowledge by participating or contributing.  The process of keeping students mentally, and often physically, active in their learning through activities that involve them in gathering information, thinking, and problem solving" (Collins and O'Brien 2003).  At this point, there is a significant body of evidence from all fields that Active Learning is an extremely valuable technique that can improve students' educational experience (Michael 2006).  When students are active participants in their instruction, they will retain more information and form more meaningful connections between concepts.

Too often, information literacy instruction is presented as a set of procedures for locating a hypothetical resource in the library.  However, students are not interested in finding some resource randomly chosen as an example; they want to find a resource that they perceive as being important and useful.

**Statement of Hypothesis**
We believe that students are more likely to learn new skills and concepts when they perceive them to be relevant to their lives or their studies. By combining varied instruction techniques aimed at different learning styles, with a strong active learning component delivered at the student's point of need – when they have a concrete, perceived information need – information literacy instruction can be improved so that students retain more and develop lifelong learning skills.

**Prior Information Literacy Instruction Methodology**

In previous years, students were exposed to information skills instruction through a lecture delivered by an engineering librarian to each section of the Humanities 107 class. This basic model is still being used in the freshman composition class taken by non-engineers, English 101. While this model did expose students to valuable research skills, students tend to be somewhat disconnected from the material and retain only a small part of what they learn. In addition, the Humanities 107 sequence has moved to a hybrid class model; combining online and face-to-face instruction techniques. Because this model reduces the amount of time class sections meet in person, instructors are less likely to devote an entire class meeting to instruction from a librarian.

**Our New Methodology**

We realized, however, that the adoption of a hybrid class model gave us an opportunity to deliver library instruction in a new (and hopefully improved) way. Students were assigned to take an online tutorial on information seeking skills, replacing the in-class lecture from a librarian. At the conclusion of the tutorial a brief quiz, requiring the active use of library resources, was administered. After students were exposed to fundamental concepts online, they were required to meet as a design group with an engineering librarian for a personalized consultation regarding their research process.

**The Online Tutorial**

The tutorial was designed by the library and was delivered through the same WebCT online course management system that was used for the rest of the class's online content. The tutorial consisted of five sections, each followed by a brief quiz: Finding Books, Finding Journals, Searching Databases, Finding Patents, and Citing References. The quizzes took advantage of some built in functionality of WebCT. In each section students were presented with two multiple-choice questions drawn from a pool of ten. If students wished to take the quiz again (usually to improve their score), they were allowed to do so; another two questions were randomly selected.

By using WebCT, we were able to integrate the tutorial with a graded quiz which reinforced key concepts while forcing students to gain hand-on experience using library resources. This combination of written tutorial with an active information seeking exercise engages both those students who learn by reading as well as those who learn by doing.

The Finding Books section introduced the library's online catalog and how to locate books within the library. It then discussed a variety of reference sources that are especially valuable to new engineering students: subject specific handbooks, dictionaries, and encyclopedias. This section's quiz asked students to find the call number for a specific title, retrieve a piece of data (the molecular weight of benzene, e.g.) from a reference book, and evaluate which reference works would be the most useful in a given situation.

The Finding Journals section discussed the distinction between a scholarly, peer-reviewed journal and a popular magazine. It then worked through the process of

deciphering an article's citation and locating the full-text of the article in a library database. This section's quiz asked students to determine if a publication was scholarly or not, to identify databases with full-text access to specific journals, and to find the full-text of an article from a citation. In an effort to further encourage their active participation, students were also directed to find the worst, driest, most boring journal article title they could and to post it to the class discussion board.

The Searching Databases section introduced the concept of databases as information resources and presented examples of databases, both bibliographic (ProQuest Research Library) and not (Facebook.com). Students were then led through two searches for scholarly articles on specific topics in the ProQuest database. The first topic was drawn from the social sciences and many relevant articles were found; the second search related to engineering, which was outside the scope of the database. Elsevier's Engineering Village was then presented as an example of a bibliographic database relevant to the engineering literature. The second search was repeated, with significantly more useful results. The quiz for this section required students to identify an appropriate online database for specific information need, use Engineering Village's thesaurus feature to identify relevant controlled vocabulary terms for given search concepts, and to locate papers on a specific topic in various bibliographic databases. Since this section formed the bulk of the tutorial, the quiz for this section consisted of three questions drawn from a pool of fifteen instead of the usual two from a pool of ten.

The Finding Patents section provided some background on patents in general and then introduced students to searching in the US Patent and Trademark Office's website (uspto.gov). Some issues related to retrieving useful copies of a patent's full-text were also discussed. The quiz for this section required the students to utilize the USPTO website and find specific patents. As an additional active learning exercise, the tutorial also asked students to spend some time exploring patents and to post the strangest patent they could find on the course's WebCT discussion board.

Finally, the Citing References section provided links to pre-existing library tutorials on various citation styles and avoiding plagiarism. However, the bulk of this section consisted of an introduction to RefWorks, a web-based bibliographic management system that the library offers to patrons. Design groups were also encouraged to set up RefWorks accounts during their consultations with a librarian; we have found RefWorks to be a very valuable tool for organizing research and creating bibliographies. No quiz was administered for this concluding section.

Our student population comes from a wide variety of backgrounds and has had varying levels of library instruction prior to attending college. To accommodate this, the tutorial was designed so that students with well-developed library skills could quickly skim through the presented information, while students who needed more instruction (or who were new to the Anglo-American style of library services) could spend more time exploring specific topics.

Also, the Humanities 107 faculty was gracious enough to add the engineering librarians to the online course shell as instructors, allowing us to take advantage of other features of WebCT to reach out to students. For example, we were able to actively participate in class discussion boards, answering questions about the research process and offering advice on using specific library resources. We found this to be very useful for reaching those students who learn best through conversation. However, the most beneficial aspect of delivering basic library instruction online instead of through lectures is that it freed up the engineering librarians' time to provide individual face-to-face consultations to each design group.

**Design Group Consultations**
Groups were required to make an appointment with one of the engineering librarians to discuss the research they were doing for their design project. During these consultations, the librarians demonstrated relevant information resources such as the Ei Compindex and Inspec databases (accessed through Engineering Village), the USPTO patent search website, RefWorks, conference proceedings, and technical reports and other "grey literature". These consultations offered an opportunity for dialogue with each design group, addressing issues and information needs specific to each project.

The students were active participants in these sessions, guiding the librarians as they searched for information of use to the group. Because the consultations were directly tied to the students' actual information needs, the students tended to be very engaged in these sessions and were very receptive to the information being presented. Also, because the students had already been exposed to the basics of library research by the online tutorial, the librarians were able to quickly move into more complex material. Since introductory topics such as using the library catalog or searching a general database had already been covered, students were in a much better position to absorb advanced information. And finally, the consultations gave the students an opportunity to get to know and become comfortable with the librarians. Students were encouraged to come back to the library as their project progressed and to contact the librarians with any information needs that may arise later in the year. Judging by the large number of students who did come back for more assistance, this was a very successful piece of outreach.

The importance of these consultations to our instruction methodology can not be overstated. However, successful consultations were only possible because we utilized instructional technology to deliver the first level of library instruction. Without the online tutorial and quiz, students would not have been prepared for advanced material discussed during the consultations and the engineering librarians would have had to devote their time to teaching classes, not meeting with design groups.

These sessions also provided a forum for the engineering librarians to alert students to a few continuously updated web pages maintained by the library: Engineering Reference Assistance (http://www.library.drexel.edu/services/refengineer.html) and The Fundamentals of Engineering Research Guide (http://www.library.drexel.edu/resources/guides/engineeringfundamentals.html). These

pages allow the engineering librarians to keep students informed of the latest developments that may aid their research.

**Results**

Based on the feedback we received from the freshman engineering students and the Humanities faculty, we believe that our instruction initiative was a success. In an end-of-year survey, 75% of the students responded that the online tutorial was helpful to their project, and 72% responded that their group's personal consultation was similarly helpful. Beyond these numbers, the responses to the "additional comments" section of the survey are informative:

> "[The librarian] was extremely helpful and provided my team with a multitude of instructional websites that helped us a lot when researching our project."

> "The entire Library instruction was very helpful for me because I never took advantage of the library in high school or at other colleges that I had attended classes at. For those reasons, I do not know how to effectively use the library and its resources. This helped me tremendously."

> "[The librarian] was helpful in obtaining information for our survey of literature. He better explained the purpose of that portion of the proposal to us and showed us the tools that we had available through the library. The [online tutorial] has given me knowledge regarding the services provided by our library that has extended into the work I have to do for my other classes."

> "I like how it was done this year. Like it was mentioned how students would all learn it in a classroom, I think it would've been boring and less interesting this way. The way it was done this year is better because it was in small groups and it was more one on one with the librarian. Stick with the way it was done this year."

The Humanities faculty was also pleased with the results of the information skills instruction. They noted a general improvement over previous years' classes in the quality of research and sources cited. Fewer students relied only on Google and the free web and more investigated patents, technical reports, and the scholarly literature.

A telling anecdote occurred on an occasion when not all the members of a design team showed up for their scheduled consultation (due to the difficulty of finding a time when five students and a librarian were all free, this was not unusual). After a few minutes, one of the team members stepped out of the consultation to call the missing student and tell him that this was actually incredibly useful and to come to the library immediately. Dr. Valerie Arms, the Director of the Freshman Design program, commented "I love that a group called someone else to attend. We plan to find ways to keep this consultation idea no matter what our students are majoring in."

## Conclusions
Lifelong learning requires students to explore learning experiences from a variety of perspectives using a variety of techniques such as speaking, listening, reading, writing, and reflecting. Addressing various learning styles through active learning strategies motivates students to explore a variety of approaches to acquire information seeking skills. These skills contribute to lifelong learning since students become independent information seekers who can adapt to any situation and are able to transfer their learning to any future demand for research. Students in the Freshman Engineering Design program have shown great strides in becoming expert information seekers. Recognizing different learning styles, actively engaging students, and collaborating with faculty members are all valuable techniques that can help information professionals build students' lifelong learning.

## References
Accreditation Board for Engineering and Technology, *Criteria for Accrediting Engineering Programs*, 2000 (ABET, Inc.: Baltimore, Maryland).

Association of College and Research Libraries, Information literacy competency standards for higher education: The final version, approved January 2000. *College & Research Libraries News*, 2000, **61**(3), 207-215.

Burge, E. and Snow, J., Candles, corks and contracts: essential relationships between learners and librarians. *The New Review of Libraries and Life Long Learning*, 2000, **1**, 25-34.

Collins, J.W., and O'Brien, N.P. (Eds) *The Greenwood Dictionary of Education*, 2003 (Greenwood: Westport, Connecticut).

Fleming, N. and Mills, C., Helping students understand how they learn. *The Teaching Professor*, 1992a, **7**, 4.

Fleming, N. and Mills, C., Not another inventory, rather a catalyst for reflection. *To Improve the Academy,* 1992b, **2**, 137-149.

Michael, J., Where's the evidence that active learning works?. Advances in Physiology Education, 2006, **30**, 159-167.

Trezza, A., Innovative delivery systems for education in an informative age. *Lifelong Learning: An Imperative in Today's Society*, 1993, p. 61.