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Hands-on Learning for Freshman Engineering Students

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Formal library orientation sessions for freshman engineering students have been offered for more than seven years by librarians in the Engineering and Physical Sciences Library (EPSL), University of Maryland. Approximately 800 students per year attend these sessions. The sessions are conducted in the library and are required by all students enrolled in ENES 100 (Introduction to Engineering Design). In the spring of 2001 the orientation sessions were reformatted based on comments contained in short surveys completed by students at the end of each session. The format was changed from completely lecture-based to a more interactive session entitled "EPSL Expedition." In addition, during this same semester, librarians volunteered to rewrite and update the chapter on "Library Research Skills" for the course textbook, *Introduction to Engineering Design* by James W. Dally. This paper will attempt to answer the following question: Do freshman engineering students learn and retain more information through an "interactive" orientation session than they do from a "lecture" based session?

Background and Selective Literature Review

Engineers In the Workplace

In his paper on industry expectations, Rodrigues (2001) talks about the information literacy expectations of engineers in the corporate world, and the shortcomings of engineers in this area. Because engineers in the corporate world are expected to find specific data, and also be able to locate and create patents and other intellectual property, graduating engineering students benefit greatly from a basic knowledge of how an engineering library is organized, as well as a familiarity with general and specific reference books. They should also have a working knowledge of the nature and usefulness of a wide range of technical journals, and be able to search relevant online sources provided through the university library. Engineers should know about the design and content of technical databases, as well as non-technical resources that provide information about competitors, suppliers, products, and management techniques. The reality seems to be that many engineers do not take advantage of the information resources available to them. It is believed that competency in bibliographic research will not only increase the engineer's confidence level, but will allow them more time to apply the knowledge when and where it counts. Solid library research skills and competency are especially important for accessing engineering library resources, which are "virtually always superior to that of the corporate world where library service may be limited or non-existent." These skills are even more important for engineers who work in

corporations without a corporate library.

Engineers as Students

Freshman engineering students are typically required to work on projects with a group of fellow students. These students normally require a great deal of information when they begin their projects, and will continue to have information needs as they progress. This is similar to expectations they will face in the workplace. According to Ackerson and Young (1994), engineering students are among the least likely of students enrolled in the science and technical disciplines to know about and use the literature in their field. Since this behavior appears to be characteristic of the engineering profession as a whole, it is even more important to teach information literacy skills from the freshman year of college. "A steep increase in the volume of information produced in the science and technical fields, along with its evolution into electronic format, means that teaching existing knowledge is becoming less important than teaching effective information-gathering skills-skills that will enable engineers to cope with the ever-changing knowledge landscape." Since engineering students typically value accessibility over quality when choosing information sources, it seems even more important to teach them how to critically evaluate material.

Engineering Faculty

Leckie & Fullerton (2001) report that while faculty have reported that some or all of their freshman level courses require library research, many science and engineering graduates are able to avoid the library until late in their educational experience, and many manage to avoid the library completely. According to Bracke & Critz (2001), even though faculty believe it is important for their students to be information literate, they generally do not see it as their responsibility to teach it. 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. This leaves librarians with the challenging task of finding ways to introduce these skills in an effective manner.

Implications

The literature tells us that although engineering students are expected to have information literacy skills when they graduate, many are lacking in this area. It is clear that faculty place great emphasis on information literacy and research skills for their students. However, if they are not using class time to teach these skills, then it is up to librarians to provide the tools and skills these students need. While teaching information skills to engineering students can be challenging, it is rewarding to everyone involved when they learn and retain the knowledge that is given to them. Student input into the process is extremely important in learning what works and what doesn't. Clearly, engineering students need to be able to find critical information from databases, technical journals, handbooks, and product catalogs. They need to be able to search patent databases, and know how to apply for patents themselves. They also need to know how to critically evaluate information they find. According to Bracke & Critz (2001), library instruction for engineering students needs to be "specific, context-based and highly relevant to their current information needs." It is also important to teach students in a manner which will allow for the greatest retention of the material, and this is key to the success of library instruction for engineering students.

History of Library Orientation at the Engineering and Physical Sciences Library at the University of Maryland

The ENES 100 class (Introduction to Engineering Design) at the University of Maryland (UM) in College Park is a first-year required course offered by the A. James Clark School of Engineering. This is a project-based course, which introduces students to process skills associated with engineering design. The course features small sections (maximum of 36 students each) led by a faculty member and assisted by an undergraduate fellow. In this course, students work to design and build a product using computer software for word processing, spreadsheets, CAD, and communication skills.

In the fall semester of 1992, the EPSL librarians, in consultation with the faculty, began offering library orientation sessions to freshman engineering students through their ENES 100 course. While only a few sections of this course took advantage of the orientations, by 1995, all sections (between 13 and 24 per semester) were participating. The sessions were one hour in length, and were given during regularly scheduled class times.

The arrangement at the time was to split up each section into three groups of 10-13 students each. Each of these three groups would be revolved among three workstations or dedicated terminals spending around 20 minutes at each. The three "mini" sessions consisted of introductions to the library catalog, databases, and patent searching.

There were some problems with this format. First, the sessions took place in a public area of the library and were thus subject to distractions. Second, it was difficult to have each student in a position to see the computer monitor clearly.

These problems were addressed in 1999 through the creation of a small instruction room, which would accommodate about 20 students, in the library. With the aid of a computer and a projector, each section could be split into two groups and the instruction could be given privately with the technology available to project the computer images onto a large screen. Each half of the class received one hour of lecture in this room. Within this hour, the lecturer demonstrated key web-based resources: catalog, databases, patents, and technical reports. The demonstrations were tailored around the topic of the projects that the students were assigned. Some examples of projects are working windmills, hand powered water pumps, and the desalination process. Students completed an evaluation at the end of each library session. Students consistently requested a "hands on" portion of the session be added. They wanted to actually do the work, instead of listening to a lecture.

In the spring semester of 2001 the ENES 100 library instruction was transformed completely. First, a laptop utilizing a wireless LAN and a projector was used for the informational instruction session to the students. As a result, the sessions were moved to a nearby corner of the library's main floor, in an individual study area, where current periodicals are shelved. In this semi-private area, study tables and carrels were replaced with 30-40 chairs. This allowed room for an entire class, which meant we no longer needed to divide the session between two groups. Second, the class became "hands on" after a brief orientation. Concurrently, another innovative library instruction course was underway in the main library on campus. This course, known as the "Library Safari," was created by a group of librarians, headed by Trudi Hahn and Margaret Cunningham of the UM Libraries' User Education Services Department. These two hour "Library Safari" sessions were intended to familiarize students with the library on a basic level. A small group of librarians customized the "Library Safari" format and content to meet the needs of the ENES 100 students, and named the class the "EPSL Expedition." The activities in the "Expedition" would give the students "hands-on" practice for finding books, journal articles, patents, and technical reports. The students would also get practice in finding information from engineering handbooks and product catalogs. After a 15-20 minute introduction from a librarian, the students would break up into groups of four to five, and answer questions from a packet that required them to use various printed and web resources. The entire session would last from 1 1/2 to 2 hours. A librarian would be available to them if they needed help. At the end of the "Expedition," the students turned in their results, which were graded by the professors, and completed an evaluation form.

Methodology

In the fall semester of 2000, the ENES 100 students were given a survey to complete. Five hundred surveys were sent to faculty members who were asked to distribute them to students then return them to the library. The survey was given at least two months after the ENES 100 library orientation and had four parts. First, the students were asked about their research and computer habits. Second, they were asked about the ENES 100 library orientation, and their perception of the information they learned. Third, the students were asked to identify sources that are most frequently used to find books, journal articles, and patents, and to name the resource that had been most useful to them for their project. Finally, the survey asked students to comment on the orientation itself. The same survey was given two years later, in the fall semester of 2002, one and a half years after the orientation session had been changed from lecture-based to "hands on." In 2000, there was a return rate of 33%, with 165 of the surveys returned. In 2002, there was a return rate of 54%, with 268 of the surveys returned. There were some interesting differences in the survey results. Not only did the students seem to find the orientation more useful, but they also were better able to match appropriate resources to the information need.

Findings

The students were asked about their Internet and e-mail usage, library catalog and database searching, frequency of library visits and conducting research from home. The survey is shown in appendix A.

In this first section, no large differences were found in the data between 2000 and 2002 (see figure 1). The number

of students coming into the library at least once a week decreased slightly, while those doing research from home at least once a week increased slightly. Not surprisingly, at least 90% of students are consistently using their computers daily to check e-mail and "surf the web." Those students using library databases at least once a week increased from 12% in 2000 to 29% in 2002, over a 100% increase (use data from first two columns).

	Almost every day		**Every Week**		**Once or twice a month**		**Once or twice a semester**	
	2000	2002	2000	2002	2000	2002	2000	2002
I read my e-mail	93%	90%	6%	8%	.6%	1%	.6%	.4%
I surf the web	80%	89%	13%	10%	6%	1%	.6%	0%
I use VICTOR or VICTORWeb (catalog)	3%	1%	11%	15%	40%	40%	45%	44%
I use library databases	3%	1%	9%	28%	40%	49%	48%	21%
I come to the library	11%	10%	20%	18%	31%	48%	39%	24%
I do research from home	26%	12%	32%	52%	22%	22%	19%	14%

Figure 1

In the second part of the survey, students were asked: 1) if they found the class useful for their assignments, 2) whether they learned anything new in the class, and 3) if they used what they learned for their assignments. In the fall of 2002, students generally found the class more useful. Also, more students reported learning something new, and more students reported that they used what they learned for their course assignments. The increase was 9-10% overall in the "I definitely agree" category (See figure 2).

	I disagree.		**I agree somewhat.**		**I definitely agree.**	
	2000	2002	2000	2002	2000	2002
I found the class useful for my assignments.	17%	10%	65%	62%	18%	28%
I learned something new in the class.	12%	7%	43%	38%	45%	56%
I used what I learned for my assignments.	27%	14%	49%	53%	24%	33%

Figure 2

In the third section of the survey, the students were asked to match an information need to a resource. Even though the perceptions only moderately indicated that they learned something new, the data show that they more consistently matched the most appropriate resource to the information need in 2002. The resources are listed as books, patents, and journal articles on the survey. They are given a list of possible places to find these resources, and asked to match the resource to the item (see Figure 3). The students were also asked what resource they used the most for their projects.

The resource that I use most frequently to find books is:	Amazon
The resource that I use most frequently to find patents is:	Applied Science & Technology Abstracts
The resource that I use most frequently to find journal articles is:	Compendex
The resource that I found most useful for my water pump project was:	NTIS
	USPTO Databases
	VICTOR

	VICTORWeb Other *(please specify)*

Figure 3

For books, the "correct" answer would be the library catalog (VICTOR or VICTORWeb). For patents, a "correct" answer would be USPTO Databases. For journal articles any of the databases would be considered correct (Applied Science & Technology Abstracts, Compendex, NTIS).

We found a significantly higher rate of "correct" answers in the fall 2002 survey, especially in the area of patents and journal articles. For books, in the 2000 survey, 47% of the students chose the library catalog. In 2002, 56% of the students chose the catalog. For patents, in the 2000 survey, 12% of the students chose an appropriate patent resource, while 34% chose an appropriate resource in 2002. For journal articles, in 2000, 16% chose an appropriate resource for finding articles. In 2002, 43% chose an appropriate resource. When asked what resource they found most useful, answers included all of those listed on the survey. However, in the 2002 survey, students mentioned a few other resources, including "Home Depot" (See figure 4).

*The resource that I found **most useful** for my water pump project was:*	
2000	2002
7% Article database	18% Article database
23% Library Catalog	18% Library Catalog
11% Internet (general)	11% Internet (general)
2% Patents	3% Patents
2% Technical reports (NTIS)	3% Technical reports (NTIS)
	9% Textbook
	1% Other people (professor, TA, peers)
	1% Home Depot

Figure 4

Comments

All ENES 100 students are given the opportunity to make comments by filling out an evaluation form at the end of each instruction session. In general, the comments made on these forms, for all years, have been more positive than the comments made on the two "end of semester" surveys. A large number of the 2000 "end of semester" surveys mentioned the desire for a "hands on" or an interactive orientation session. Some students specifically requested that they be able to follow along on their own computer, or do computer exercises themselves. They frequently mentioned that they did not like the "lecture-based" format. They rarely mentioned the content of the course in any specific manner. The 2002 survey had its share of negative comments about the length of the session (which had increased to two hours). However, the responses were more critical of the content presented rather than of the session itself. For instance, they mentioned actual resources that were used, such as databases and patents. A few students asked that the session be even more customized towards their class project. Still, some students requested that the class be more "hands on," leading us to believe they would like the lecture portion cut out completely.

Conclusions

The answer to the central question: Do freshman engineering students learn and retain more information through an "interactive" orientation session than they do from a "lecture" based session? is "yes." A significant trend in the data shows students are learning more through "hands on" instruction than they did through lectures only. In the section of the survey where students match the appropriate resource to the information need, the number of correct answers was significantly higher in 2002, with the percentage of correct answers almost triple for some of the resources. Overall, the use of the "expedition" format seems to have increased the students' attitudes toward the

library, the librarians, and the instruction session. However, some problems still remain, including some students' attitudes that they do not need the instruction. Also, some students resent that they are required to attend. Another problem is the heavy emphasis on textbook learning in freshman and sophomore engineering classes. "Use it or lose it" becomes a problem when students aren't required to use what they learn until later on in their academic career. What does the future hold for us? We will continue to evaluate the students' comments and to accommodate their needs. We will continue to refine the exercises and look for even more effective ways to teach information literacy to these students. One key will be to enlighten the students about the use of key library supplied/supported web resources and not only those that are commercial web-based search engines, as a matter of convenience.

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Appendix A:
ENES 100 Library Instruction Evaluation

Your answers on this evaluation will help the Engineering & Physical Sciences Library (EPSL) to improve library services. Thank you in advance for your participation! ☺

First, tell the librarians a little about yourself. How often do you do the following? Mark the ***one*** answer that best represents you.

	Almost every day.	Every Week.	Once or twice a month.	Once or twice a semester.
I read my e-mail	☐	☐	☐	☐
I surf the Web	☐	☐	☐	☐
I use VICTOR or VICTORWeb	☐	☐	☐	☐
I use library databases	☐	☐	☐	☐
I come to the library	☐	☐	☐	☐
I do research from home	☐	☐	☐	☐

Now, give EPSL staff your impressions of the library instruction that you received as part of ENES 100. Check the ***one*** answer-box that most closely resembles your opinion.

	I disagree.	I agree somewhat.	I definitely agree.	Not applicable.
I found the class useful for my assignments.	☐	☐	☐	☐
I learned something new in the class.	☐	☐	☐	☐
I used what I learned for my assignments.	☐	☐	☐	☐

Your answers below will help EPSL determine how effective librarians were at teaching during your library instruction class and at the information desk throughout the semester. Choose the *one* best answer for each question from the list of choices on the right.

The resource that I use most frequently to find **books** is: The resource that I use most frequently to find **patents** is: The resource that I use most frequently to find **journal articles** is: The resource that I found **most useful** for my water pump project was:	• Amazon • Applied Science & Technology Abstracts • Compendex • NTIS • USPTO Databases • VICTOR • VICTORWeb • Other (*please specify*)

- OVER -

What did you like most about the library, its staff and the instruction you received?

What did you like least about the library, its staff and the instruction you received?

How would you improve the instruction and our services in the future?

Are there any additional comments you would like to share with us?

Thank you very much for your help! ☺

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