INFORMATION SKILLS TRAINING FOR ENGINEERS

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Introduction

The 1996 review of engineering education in Australia "Changing the Culture: Engineering Education into the Future" [1] in discussing the changing focus of engineering education, states that "the focus of engineering education will be on creating lifelong learners, from early education, through undergraduate education to continuing professional education, and from generalist to technical specialist." This report also advocates that "students will be more responsible for their learning. The highly structured and prescriptive nature of traditional undergraduate courses in engineering will be replaced by programs affording greater freedom of choice." Project-based, problem-based or inquiry-based education encourages the shift in ownership of the education process from staff to students, from teacher to learner. Dependence on reading lists, one or two text books, lecture notes and the pearls of wisdom coming from the teacher do not allow students to take responsibility for their own learning, rather, it restricts their ability to be independent seekers of information and knowledge and to be able to solve problems on their own in a creative and independent way.

Engineering education, like the rest of higher education, needs to prepare students for a changing world where "teaching existing knowledge is becoming less important than teaching effective information-gathering skills" [2]. Smerdon [3] discusses the critical importance of lifelong learning for engineers who need to upgrade their careers continuously. Engineers need to acquire the skills and habits that will enable them to update their knowledge and skills on an on-going basis when they commence their undergraduate education.

The volume of information available to engineers is increasing rapidly, particularly in electronic format. Engineering students are generally highly computer-literate. Computer literacy and information literacy are not however synonymous, even though information skills training normally encourages computer skills acquisition. One of the myths widespread use of the Internet has fostered in recent years, is that all the information students need is available on the Web. Even if this were true, students still need to learn how to use the Web efficiently, critically and productively as the Web contains raw data. They also need to learn what they are NOT going to find on the Web and both the direct and indirect costs of locating and retrieving useful and relevant information efficiently.

Most contemporary engineering courses only attend to the development of information skills as an afterthought (e.g., an add-on library skills seminar) not as integral to the education process. The goal of learning information skills is more than learning how to

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use libraries. Without the subject area connection, generic lessons on how to use a range of information sources are inappropriate, as any attempt to teach library and information skills in isolation is perceived by students as irrelevant. Course-integrated information skills training or a cognitive approach that focuses on helping students develop appropriate, relevant and individualised research strategy [4,5] is the ideal way for students to learn how to conduct research on a topic, and how to locate, find, use, analyse and evaluate information, regardless of its format or source.

This paper focuses on three different programs dealing with information skills training for engineering students. The programs are:

- Interactive webbook for first year engineering students;
- Information skills training for final year mining and minerals processing students;
- Integration of information skills training into chemical engineering curriculum.

The goals and objectives for the programs are based on the same overall aim which is: *"to produce graduates who have the capacity to locate, retrieve, analyse and use information from the available contemporary resources, using the most efficient methodology".*

Webbook

First year engineering students used an interactive webbook to acquire information skills to help them search information sources for the projects which they are required to undertake as part of the subject *Introduction to Professional Engineering* during the first semester. The subject was based on a project in which students worked in groups of five or six under the guidance of a tutor, to conduct an investigation and report their findings. Each group worked on one of five topics. The project topics in 1997 were:

- University of Queensland - City transportation links;
- Smart solution to the Gold Coast - Brisbane rush hour traffic;
- Design of a portable solar cooker for camping and bushwalking;
- System design aspects for total recycling of all materials in a car;
- Whey to go? - Disposal of whey in dairy products.

The major aims of the subject were to provide students with experience in working effectively in teams, managing a project, managing time and using the tools of professional engineering, including written, oral and graphical communication and using technical information sources. The role of the library was to provide information skills training to support the project. Specific goals for the 1997 program were to facilitate the teaching and learning of information competence by using the World Wide Web and to assess the impact of the information skills component by examining the final reports submitted by the students. To achieve the first goal, a Web-based workbook, the webbook was developed to replace the print workbooks used in previous years.

The information skills component of the subject was taught by the use of print-based workbooks in the previous two years. The workbooks designed to help students understand and learn about information sources in the area of their project topics were distributed to all first year engineering students at the beginning of first semester . The

workbooks included a set of exercises which the students were expected to complete and hand to the library staff. The exercises were marked by the librarians and the results were integrated into the overall marks for the subject.

Towards the end of 1996, the Dean of Engineering who coordinates the subject, made funds available to the Physical Sciences and Engineering Library to enhance the information skills component. This was a wonderful opportunity to explore use of interactive media. The funds were used to increase the hours of two part-time librarians and to pay a multimedia designer to create the webbooks. At the same time, plans were underway to establish a training room / electronic access facility with 16 Pentium computers in the library.

The reasons why we decided to move from print-based workbooks to the webbook were:
- The Web provides flexibility as to where, when and how students learn and how often they review their learning;
- Improved learning outcomes [6];
- It offers many more options to access a variety of information sources, for example direct links to the Library's catalogue, networked databases such as Applied Science and Technology Index, full-text documents, patents, company web pages, etc.;
- Students learn how to use the Internet to do their research in a more efficient way (not all students knew how to use the Internet prior to coming to the University);
- It is newer technology, and "cool", "exciting" for most first year students;
- The webbook exercises provide immediate feedback to the students;
- The Web provides consistent and standardised marking of the exercises;
- Computer based assessment is efficient saving the manual marking of 500 assignments by librarians.

A project team consisting of subject librarians, a multimedia/web expert from the Information Technology Department and an instructional designer from Tertiary Education Development Institute planned the program by:
- Examining the advantages and disadvantages of using the Web to achieve the educational objectives defined above;
- Exploring the students' diversity of learning styles;
- Examining the infrastructure requirements to make sure over 500 students had access to workstations with Internet access;
- Discussing the project topics and resource requirements with the academic staff who were project coordinators;
- Locating both traditional and electronic resources relevant to each project topic;
- Producing the contents, a script and a story board which was then converted to Web pages by the multimedia designer;
- Asking academic staff, tutors and other librarians to test the webbook and the exercises prior to making the webbooks available to the students.

The exercises were made available on the Web for the students to enter their answers. All answers were marked automatically. A database of all possible answers was created. Students were able to go back to check their answers. They were obviously able to do much of the work at home or wherever they had access to an Internet terminal. The students, in groups of twenty, were introduced to the webbooks during a one hour seminar they attended in the Library. These sessions helped those who were not familiar with the Internet to start using it. They were encouraged to come to the Library's new electronic access facility anytime to practice their Internet skills and to use the information sources presented to them in the webbooks to do research for their projects. All sources listed in the webbooks were carefully chosen by librarians to make sure they were relevant to each of the project topics. Hypertext capabilities allowed the students to access the glossary and links to other Web pages as well as the Library's Web catalogue and networked databases.

It was important to liaise with the lecturers who coordinated each of the projects to explain the concept and ask for their input as well as to ensure that the information skills component was truly integrated into the subject. Each of the project coordinators agreed to send the tutors to one of the seminars the students attended, so that the tutors were aware of what the students were expected to undertake. The final project reports were examined by the library staff to see the impact of the information skills training in terms of the quality of the bibliography, references and sources. The webbook exercises constituted 6% of the assessment and the final project report and the bibliography constituted 4% of the assessment.

The students completed a simple questionnaire to evaluate usefulness of the webbook, the exercises and the initial seminar. The results indicated that over 70% thought they were useful. They wrote comments about the whole program. Most of them commented that the use of the Internet and the relevant information sources for their projects were valuable learning experiences. The most common comments to the question "*how could the webbook be improved?"* was *"easier ways of recording answers"* and *"harder or more in-depth questions"*. Feedback was sought from the academic staff at the end of the program on the impact of the information skills training on students' overall performance and reports. All librarians involved in the program provided critical evaluation as well.

Plans are underway for 1998 to make improvements not only to the webbooks, but to the whole Web site by adding a discussion list for students to communicate with each other and with tutors and academic staff and making more use of the electronic noticeboard as well as enhancing the exercises. Comments and input from the students, the lecturers and the librarians will be incorporated when making the changes. The 1997 webbooks can be found at **http://www.library.uq.edu.au/9e105/.**

Information skills training for mining and minerals processing engineering students
All final year engineering students are required to prepare a thesis on a subject approved by the Head of Department. The thesis is designed to develop personal creative abilities and to demonstrate ability to carry out independent research. The library was approached by the Head of Mining, Minerals and Materials Engineering Department to collaborate in

designing an information skills training program for final year mining and minerals processing engineering students as part of their thesis subject. It was agreed to make the information skills component compulsory and to assign 10% of the thesis mark to assess students' learning. The program and the information skills exercise designed after consultations with various academic staff used the Big Six Skills approach developed by Eisenberg and Berkowitz [7] which includes task definition, information seeking strategies, location and access, use of information, synthesis and evaluation.

The training was carried out over three weeks and included 5 hours of instruction by library staff. Folders containing handouts specially prepared for the program were given to all students. The training included:

- Week 1: Introduction to research skills: different types of information resources relevant to mining and mineral processing, efficient strategies to do research, services available to final year students both at the University of Queensland and beyond, such as document delivery. This part of the program in the form of a one hour presentation by a librarian and the subject coordinator emphasised the importance of information skills for professional engineers and use of critical judgement in evaluating information received from a variety of sources.
- Week 2: students divided into groups of 20 spent two hours in the Library's computer facility, learning how to use databases relevant to the subject, standards, patents and product and trade information. The databases covered included: IMMAGE from the Institute of Mining and Metallurgy, GeoRef, Compendex, Current Contents, Oshrom (Occupational safety and health information). All of these databases are networked which gave all students ability to have hands-on practice as well as access from home or departmental facilities. The topic chosen by the subject coordinator for training and demonstration was "shaft sinking in soft ground".
- Week 3: Groups of 20 students spent the final two hours learning about referencing, citing, personal reference databases, in particular Biobase, a shareware program, and effective writing skills. This session was presented jointly by the librarians and an academic staff.

Mining engineering students were given an exercise at the last seminar which required them to build a personal reference database, using Biobase, to enter the results of a literature survey on "Water and mud inrushes into mines". The assignment due three weeks after the last seminar was marked according to a list of criteria designed to assess their ability to search a variety of resources. The minerals processing students were required to present intermediate progress reports instead of completing the exercise set for mining engineering students. The students were required to demonstrate their ability to search relevant information sources by compiling an up-to-date list of references relevant to the thesis topic and include critical analysis of each reference in the progress reports. Once again, they were assessed on the basis of their demonstrated research skills.

All students were asked to complete an evaluation form at the end of the last seminar. The purpose of the evaluation was to assess the effectiveness of the training and gather input from students to improve the program the following year. All students thought what

they learnt during the seminars would help them for their thesis. Some of the comments students made about the training were:

- *Has given me a good insight of how to search for valid information;*
- *I had no idea about the information / sources available before these seminars;*
- *These skills should be taught to first year students rather than receiving them in fourth year;*
- *Didn't know about the databases. Know now how to access them & so will use them;*
- *I have no doubt I will continue to use some of the sources later in my career;*
- *The information I learnt will help me especially for obtaining research information when I am in the industry.*

The main issues identified by respondents were:

- Appreciation of the usefulness of the skills learnt for retrieving specialist information;
- Appreciation of the usefulness of the skills and knowledge acquired for use after graduation during an engineering career;
- Information skills would have been more useful if introduced in 2nd or 1st year;
- Databases were regarded as the most useful component of the training;
- Biobase was regarded as the next most useful component of the program;
- Internet training was regarded as the least useful component of the program.

Planning has already begun to design the information skills training program for 1998. The practice of joint planning and presentation of the program by librarians and academic staff as well as assessment of information skills will continue in 1998. Expansion of the program into second and third year courses will also be considered.

Integration of information skills training into Chemical Engineering curriculum
One of the significant outcomes of the work library staff achieved as a result of successful integration of information skills programs described above has been to show these programs as examples of possibilities to other engineering departments. The Chemical Engineering Department while reviewing its curriculum in the second half of 1997 invited the Library to be a member of the Curriculum Review Committee with a view to assisting them with the integration of information skills into the entire curriculum. Members of the Review Committee were already convinced about the ineffective nature of ad hoc information skills programs (the add-on library classes) which are usually offered as an afterthought, not as integral to the education process. The need to produce a program integrating information skills at all levels of the curriculum so that the graduates left with a set of information skills was recognised at the beginning of the planning process. One academic member of the Committee and two librarians formed a working party to produce a list of attitudes, skills and competencies for the graduates in order to ensure the subjects offered included projects and assignments which took these attitudes, skills and competencies into account. The following is a list of attitudes proposed [8]:

- Graduates will value the need to learn after graduating and the need to be information literate;
- Graduates will recognise that the pace of change in information handling will mean that they will have to continue to develop their information skills during their careers;

- Graduates will have a critical attitude towards information. They should always ask themselves how reliable the information is;
- Graduates will have an ethical attitude towards the use of information. This includes:
  - attributing sources
  - respecting confidentiality
  - copyright and intellectual property.

Some of the academic staff who will be teaching the new curriculum will need to update their own information skills to ensure they are able to set the projects and assignments which require the students to locate, use and evaluate a variety of information sources and synthesise and present what they found. Librarians will be involved to make sure training of academic staff takes place via active liaison and training programs especially designed for them.

Conclusion

Continuous support of the information skills programs by the faculty, course coordinators and policy makers was of paramount importance. Without such support, any information skills program is bound to be ineffective. Political support at decision making level is more significant than financial support, at least initially. Programs described above would not have succeeded without the encouragement of various academics, heads of departments, the Dean and the University Librarian.

Librarian involvement in teaching and learning activities, such as curriculum review processes and university-wide committees as well as participation in workshops and seminars on pedagogic issues along with academic staff is important to create links with academic staff and to make personal contacts. There are similarities between the design of information skills programs and other subjects in engineering or science . Library staff were able to discuss the relevance and significance of information skills for students at both undergraduate and postgraduate levels at appropriate committee meetings and workshops in the context of teaching and learning across the university or the faculty, by emphasising the need to produce graduates for an increasingly complex, competitive, socially sensitive and interdependent world. The fact that several academic staff were open about lack of their own information skills gave librarians opportunities to organise special workshops for academic staff. These initiatives facilitated acceptance of information skills programs for undergraduate students as part of the subjects they study.

As the examples discussed above show, information skills training for engineers as part of the curriculum is of great significance. Libraries have been offering the so called add-on library classes for a long time. They are usually organised at the request of a friendly academic who gives up one hour of class time so that the students learn how to use the catalogue, indexes and abstracts, and maybe how to cite references. These library classes are often ineffective because they are not seen by the students as part of their overall education, they are often taught out of context, not in relation to a project or an assignment and students can not see the relevance of learning how to use the catalogue or indexes and abstracts. The role libraries and librarians have to play by working in collaboration with academic staff to promote and inculcate lifelong learning and acquisition of skills to locate, retrieve, evaluate and use information regardless of format

or source, has become more important than ever in order to produce graduates who can cope successfully in a work environment where technical knowledge of engineers becomes obsolete in a short time.

Acknowledgments

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