



Article

What Can Students' Bibliographies Tell Us? Evidence Based Information Skills Teaching for Engineering Students

Fei Yu

Liaison Librarian

Dorothy Hill Physical Sciences and Engineering Library

University of Queensland

St. Lucia, Queensland, Australia

E-mail: f.yu@library.uq.edu.au

Jan Sullivan

Liaison Librarian

Dorothy Hill Physical Sciences and Engineering Library

University of Queensland

St. Lucia, Queensland, Australia

E-mail: j.sullivan@library.uq.edu.au

Leith Woodall

Liaison Librarian

Dorothy Hill Physical Sciences and Engineering Library

University of Queensland

St. Lucia, Queensland, Australia

E-mail: l.woodall@library.uq.edu.au

Received: 20 April 2006

Accepted: 16 May 2006

© 2006 Yu, Sullivan, and Woodall. This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/2.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Abstract

Objective - This project sought to identify students' strengths and weaknesses in locating, retrieving, and citing information in order to deliver information skills workshops more effectively.

Methods - Bibliographies submitted from first-year engineering and second- and fourth-year chemical engineering students' project reports were analysed for the number of items cited, the variety of items cited, and the correct use of citation style. The topics of the project reports were also reviewed to see the relationships between the topics and the items cited.

Results - The results show that upper level students cited more items in total than did lower level students in their bibliographies. Second- and fourth-year engineering students cited more books and journal articles than first-year students cited. Web sites were used extensively by all three groups of students, and for some first-year students these were the most frequently used sources. Students from all three groups had difficulties with citation style.

Conclusion - There was a clear difference in citation frequency between upper and lower level engineering students. Different strategies of information skills instruction are needed for different levels of students. Librarians and department faculty members need to include good quality Internet resources in their teaching and to change the emphasis from finding information to finding, interpreting, and citing accurately.

Introduction

One of the core duties of academic librarians is to help university students develop information skills. In designing their training programs, librarians are faced with making practical decisions about the content and delivery of the training. Eldredge claimed "evidence-based librarianship offers a decision-making framework" (290). This study used the principles of evidence based librarianship in its expectation of finding evidence from students' bibliographies to help teaching librarians develop improved information skills classes for engineering students.

The Dorothy Hill Physical Sciences and Engineering Library at the University of Queensland offers many tailored information skills workshops to students at various levels of study and in different disciplines in the Faculty of Engineering, Physical Sciences and Architecture. Tailored workshops were presented to project design students in first-year engineering and second-year and fourth-year chemical engineering programs. The

primary goal of the workshops was to develop the students' ability to locate and retrieve the information needed for their projects. Time was also spent teaching citation techniques to be used in their project reports.

Although general use of Internet search engines was not usually encouraged, it is acknowledged as an important source for certain types of information. Anecdotal evidence suggests that students tend to use the Internet to find information, rather than using scholarly databases for journal articles or searching library catalogues for books. However, no study has examined the information sources used by engineering students for their design projects, or determined what differences exist between first-year students and upper level students.

Another increasing concern among librarians, as well as teaching academics, is that students have very little knowledge of or skill in citing the information correctly. Again, few studies have examined this topic. The question was whether instruction librarians should spend more time in training students how to cite information.

Because the university is taking an increasingly hard line on plagiarism, students need to be aware of the necessity of acknowledging other people's work and ideas by citing them in the bibliographies of their research work.

This study was designed to find evidence showing students' strengths and weaknesses in locating, retrieving, and citing information, and the study also sought to explore the implications for future improvements in information skills teaching.

Literature Review

In order to help design information skills programs, academic librarians have used a range of research methods to identify the information sources used by students in their assignments. These techniques include survey questionnaires, pre-testing and post-testing, focus groups, and interviews.

Majid and Tan used a questionnaire-based survey in their research and determined that although books are students' preferred source of information, Internet search engines such as Google and lecture notes were the next favourite sources. Use of computer databases and electronic journals was surprisingly low (318). Palmer and Tucker conducted an evaluation of the information skills literacy program at Deakin University (Geelong, Victoria, Australia) using a combination of pre- and post-tests with questionnaires. They concluded that the majority of first-year engineering and technology students were familiar with basic types of information sources such as books, journals, and Internet websites. Palmer and Tucker used evaluation questionnaires to obtain students' feedback on improving information literacy skills activities. Students recommended that more time "be directed to developing the concepts of complex reference types, such as chapters in

books, papers in conference proceedings, and other forms of academic monographs with multiple authors" (28).

Tenopir's study found that engineers read fewer journal articles than scientists or medical researchers (157). Another study found that engineers rely heavily on interpersonal communication with colleagues and social networks (Fidel and Green 564). Similar information using behaviour may be reflected in engineering students' bibliographies for their writing assignments, however little literature has been identified on this topic.

Citation analysis is another technique used in research studies. It is widely used in areas such as library collection policy development, knowledge base structure analysis, and academic research assessment. However, it has had limited use in relation to design and evaluation of information skills programs in engineering. One study used citation analysis to identify the information sources biology honours students used for assignments (Kraus 175). Citation analysis has also been used to examine the accuracy of students' citations of information sources in their assignments. In testing an online tutorial tool to track students' referencing errors, Kendall found many students experience difficulties with citing and referencing bibliographic sources (131). When referencing both books and e-documents, first-year students made more errors than postgraduates (62% for books vs. 44%, 85% for e-documents vs. 80%). The errors included missing place of publication, missing publisher details, missing date of publication, incorrect format for author's name, incorrect location of title in citation, and incorrect format for title (Kendall).

In summary, a range of techniques such as questionnaires and pre- and post-tests have been used in information skills research studies. Only a few studies have been found

where citation analysis was used to find evidence of how students use information sources and the problems students have when citing the references in their assignments. Few studies have analysed undergraduate engineering students' bibliographies to see what information sources they use and how they cite the sources.

The current study was designed to analyse undergraduate engineering students' bibliographies to confirm the findings from previous research using techniques other than citation analysis and to help determine the components of information skills teaching and training.

The Aim of the Study

The ultimate purpose of this study is to use evidence found in research to plan, prepare, and systematically design appropriate information skills training for different levels of engineering students. In order to achieve this purpose, we looked to see if there was a relationship between the research topic and the type of information sources used. Past experience has shown that for some topics, students tend to use one source of information more than others. However, no research has confirmed or refuted this observation from anecdotal evidence.

The librarian instructors involved in this research examined the bibliographies to see if the items were correctly cited following a known citation format. The librarian instructors regarded the ability to compile a comprehensive and correctly cited bibliography as a skill that all university students should acquire.

Methodology

In this study, the bibliographies of design project reports from first-year engineering

students and second- and fourth-year chemical engineering students were analysed. In total, 134 first-year, 15 second-year and 8 fourth-year bibliographies were collected and analysed. (Third-year chemical engineering students were not required to do project reports.) The authors examined each bibliography and tallied the cited references. The results were entered in an Excel spreadsheet to identify:

- the number of items cited in each bibliography and the total number cited for each class;
- the number of information sources used and the relationship between project titles and information sources used; and
- the correct use of citation style (e.g., Harvard or Vancouver).

For information sources used, the authors examined the variety of sources and the total number of items used from each source. To determine the correct use of citation style, the authors examined the layout of the bibliography and evaluated the accuracy of citation format, including the presence of appropriate parts of the citations, consistency of citation style, capitalisation, italics, and punctuation.

Statistical analysis involved the use of a two tailed t-test to show the degree of significance in a comparison of the three groups to see if there were any patterns, both in terms of using information sources and in citing them.

Results

The research identified three categories of results: the total number of items cited; the number of information sources used, and the relationship between project titles and the type of information sources used.

Bibliography Items	First-Year (<i>n</i> =134)	Second-Year (<i>n</i> =15)	Fourth-Year (<i>n</i> =8)
Total number of items	2356	312	615
Average (mean) number of items in each bibliography	17.6	20.8	76.9

Table 1: Number of Items in First-Year, Second-Year and Fourth-Year Student Bibliographies

Total number of items cited

There was a clear pattern that higher year students cited more items in total than lower year students with first years citing an average number of 17.6 items per bibliography and fourth year students citing an average of 77.1 (Table 1).

A detailed examination of the references showed that 4 first-year bibliographies contained less than 5 items; 84 contained between 5 and 20 references; 38 contained between 21 and 40 references; 8 contained between 41 and 60 items; and there were none containing more than 60 items. In contrast, there were no fourth-year students with less than 5 items in their bibliographies, and there were 4 with more than 60 items (Table 2).

Number of information sources used

Five types of information sources were examined: Web sites, journal articles, books, personal communications and lecture notes, and other specialised information such as standards, patents, and theses. References to each type of source were tabulated for each class, and percentages were calculated. A one-tailed t-test was also calculated to document the significant differences between the three groups of students' bibliographies in terms of the sources used by each group.

As students progress in years, they tend to rely less on Web sites as information sources (Table 3). Use of books shows a reverse trend: first-year students use books less than students in upper level classes. None of the three groups showed an obvious preference in the use of journal articles.

	First-Year (<i>n</i> =134)	Second-Year (<i>n</i> =15)	Fourth-Year (<i>n</i> =8)
	1 - 4	4	0
Total number of items in each bibliography	5 - 20	84	1
	21 - 40	38	1
	41 - 60	8	2
	60 -	0	4

Table 2: Detailed Breakdown of Items in First-Year, Second-Year and Fourth-Year Student Bibliographies

Information Sources	First-Year (n=134)		Second-Year (n=15)		Fourth-Year (n=8)	
	#	%	#	%	#	%
	Web sites	1582	67.1	173	55.5	141
Books	536	22.7	102	32.7	363	58.8
Journals	194	8.2	22	7.1	71	11.5
Personal communications and lecture notes	14	0.6	4	1.3	2	0.3
Other specialized information (e.g., patents, CDs, theses, standards)	30	1.3	11	3.5	38	6.2
Total	2356		312		615	

Table 3: Analysis of Information Sources Used in First-Year, Second-Year and Fourth-Year Students' Bibliographies

A two-tailed t-test showed there were significant differences between three of the student groups with regard to the number of books used as resources for the project bibliographies:

- first-year and second-year students
- first-year and fourth-year students

- second-year and fourth-year students

There was also a significant difference between second- and fourth-year and between first- and fourth-year student groups in relation to the total number of items cited in the project bibliographies (Table 4).

Information Sources	First-Year	Second-Year	Fourth-Year	Significance
Web sites	11.8	11.5	17.6	
Books	4.0	6.8	45.5	a, b, c
Journals	1.4	0.3	8.9	
Personal communication and lecture notes	0.1	0.29	0.25	
Other specialized information (e.g., patents, CDs, theses, standards)	0.2	0.7	4.5	
Total	17.6	20.8	77.5	b, c

a = significant difference between first- and second-year $P < 0.05$

b = significant difference between second- and fourth-year $P < 0.05$

c = significant difference between first- and fourth-year $P < 0.05$

Table 4: Mean Number of Items Cited in First-Year, Second-Year and Fourth-Year Student Bibliographies

Project	1 (n=19)	2 (n=23)	3 (n=17)	4 (n=18)	5 (n=22)	6 (n=11)	7 (n=16)	8 (n=6)
Total no. of items	120	470	379	460	360	246	195	92
Web sites	27.5	59.8	80.2	77.6	70.0	77.2	50.3	50.0
Journals, newspapers	4.2	10.4	7.7	8.0	10.0	3.3	8.2	4.3
Books	67.5	29.1	2.9	13.3	18.9	14.6	37.9	42.4
Personal communication and lecture notes	0	0	0.3	0.7	0	2.0	2.6	0
Other specialized information (e.g., patents, CDs, theses, standards)	0.8	0.9	2.1	0	0	2.4	1.0	3.3

Table 5: Relationship Between Project Topics and First-Year Students' Bibliographies

Note: Numbers below grey line are per cents (%)

First-year students did not use many textbooks. Second-year students used encyclopaedias and handbooks extensively, and most of them cited the three core encyclopaedias recommended by the lecturer.

Relationship between project titles and the type of information sources used

The relationship between project titles and information sources was examined for the first-year students, because the project topics for that class dealt with a wide range of engineering issues. For example, Project 1 involved detailed mechanical design processes in a very specific field, whereas Project 3 required students to consider many social, economic, and financial issues while

evaluating solutions to traffic problems. The authors assumed, therefore, that different types of information sources would be used for different projects. The students received few recommendations for information resources from their lecturers.

Results shown in Table 5 confirm that students used fewer Web sites for Project 1 (27.5% of the total items in their bibliographies), compared to students completing Project 3 (80.2% of the total items in their bibliographies). Project 1 students used more books (67.5%) than students completing Project 3 (2.9%). Project 1 students used more books than any other group.

Citation	Analysis	First-Year (n=134)		Second-Year (n=15)		Fourth-Year (n=8)	
		#	%	#	%	#	%
Layout of bibliography	List not divided by reference type	118	88.1	14	93.3	7	87.5
	List in alphabetic order	82	61.2	N/A	N/A	N/A	N/A
	List not numbered or bulleted	104	77.6	N/A	N/A	N/A	N/A
Accuracy of citation	Presence of appropriate parts of citation	109	81.3	13	86.7	5	62.5
	Consistent use of a citation style	107	79.9	14	93.3	6	75
	Capitalisation	22	16.4	N/A	N/A	N/A	N/A
	Italics	80	59.7	N/A	N/A	N/A	N/A
	Punctuation	87	64.9	N/A	N/A	N/A	N/A

Table 6: Citation Style Analysis of First-Year, Second-Year and Fourth-Year Students' Bibliographies
Note: N/A - students in second- and fourth-year did not receive a recommended style, so these analyses were not always relevant.

Correct use of citation style

There was no apparent evidence that second- and fourth-year students performed better than first-year students in terms of bibliography layout or accuracy of citations (Table 6). The fourth-year students had the lowest percentage scores on the assessment of their use of appropriate parts of citations.

Discussion and Implications

Analysis of the bibliographies showed students in all years were able to find a variety of relevant information. They were not so successful in citing the information.

The analysis showed second-year and fourth-year students tended to use Web sites less and books and journal articles more than first-year students. Both second- and fourth-year students used core chemical engineering materials, such as encyclopaedias handbooks, and prescribed textbooks, because their project topics were all on process design in chemical engineering. This corresponds with the findings of Majid and Tan who found that books and the Internet are undergraduate students' favourite sources (318). It also supports Tenopir's findings that engineers read fewer journal articles (157).

First-year students, on the other hand, have not yet specialised in a particular subject area, and their project topics are more general. The purpose of the students' research projects was to give them an opportunity to learn about the engineering profession. There were few required readings from lecturers. Since these students had recently graduated from high school and were not aware of the core resources for university courses, it is likely that they turned to the Internet for information. However, there were a few projects for which the lecturers thought Web sites provided the best sources for information. In these cases, the focus of information skills teaching could be about ways to evaluate Internet information, how to cite the information in the text, and how to reference information in the bibliography.

The comparison between types of information sources used by students showed that all year levels tend to use 'basic reference types' - such as books, journal articles, and the Internet - more than specialised information sources such as standards, theses, and patents. This supports Palmer and Tucker's findings that students are familiar with basic types of information sources such as books, journals, and Internet Web sites, but they are not familiar with more complex resources. As suggested by Palmer and Tucker, our information skills teaching should focus more on those complex reference types for upper level students.

We observed that some students, especially first-year students, could not differentiate between a journal and a journal article, and they did not understand why they needed journal articles. This knowledge will help us redesign our information skills workshops for first-year students, to include more explanation of the content and value of books, journal articles, and Web sites.

There was clear evidence that all year groups had problems in citing information accurately. This was consistent with Kendall's findings (131). One common citation error among all year groups' bibliographies in this study was inconsistency in listing author names. There were missing parts in author names and in some instances surname and first name were not in the right order. Students at all year levels also had difficulties citing personal communications and specialised documents. It seemed that they had trouble deciding what information should be included in the citation and what could be omitted.

Many first-year students received low marks for the accuracy of their citations (Table 6). Only 3% achieved full marks for citation accuracy, while 44% achieved full marks in citation layout. The central problem we observed from the fourth-year students' project bibliographies was inconsistency. The fourth-year design project report consisted of three volumes, and each volume was authored by a different student from the group. Each submitted a list of references which often followed different citation styles. Inconsistency within a bibliography included different layout, different citation styles, and sometimes repeated references.

In order to address the citation accuracy problems mentioned above, exercises to help students recognise different parts of a citation and to familiarise them with different citation styles should be designed and included in information skills workshops. Librarians also need to work with students to better understand the dynamics of student groups and in finding the person in their group best suited to having overall responsibility for producing the bibliography.

The most important finding of this study is that citing information was clearly a weakness for all student groups in this project. At all year levels, more time should be spent on teaching students how to cite information accurately. The importance of correctly citing information should be explained and stressed in all information skills training.

Academic staff also expressed concern that the in-text citations at all year levels did not always match the bibliographies. This aspect needs to be examined more closely. Future information skills training may need to incorporate in-text citing for students at all levels.

The findings indicate that systematic planning of information skills teaching and training should be conducted, and learning outcomes need to be revisited for all levels of students. With first-year students, we need to concentrate on the basics and build on this progressively in later years. For example, with the first-year students we should emphasise finding, interpreting, and citing books, journal articles, and Web sites. For second-year students, the emphasis would be on chapters of books and encyclopaedias. Personal communications and specialised publications such as conference papers, patents, and standards would be covered in the fourth-year. In later years, to help produce the bibliography in the correct citation style, reference management software such as EndNote could also be introduced.

Conclusion

This study showed that there was a clear difference in citation frequency between upper and lower level engineering students. Upper level students cited more total items in their bibliographies than did first-year students. Regarding the variety of items cited, second- and fourth-year engineering

students cited more books and journal articles than first-year students, but websites were still used extensively by students in all years. Some evidence showed that for a few first-year design project topics, students used more Internet sources than other sources of information. Librarians and department faculty members need to select good quality Internet resources to include in information skills teaching and training. Students in each group had difficulties citing personal communication and other specialised information sources. They also had various problems in consistency of citation style and inclusion of parts of citations such as author names. These findings indicate that different strategies in information skills teaching and training are needed. The emphasis needs to change from merely finding information to finding, interpreting, and citing it accurately. Systematic planning is needed to gradually build on students' information skills portfolios.

Acknowledgement

A version of this paper was presented at the 3rd International Evidence Based Librarianship Conference held in Brisbane, Australia (October 2005). See: <http://conferences.alia.org.au/eb12005/Yu.pDf>

Works Cited

Eldredge, Jonathan D. "Evidence-Based Librarianship: An Overview." Bulletin of the Medical Library Association 88.4 (2000): 289-302. 28 May 2006 <<http://www.pubmedcentral.gov/article/render.fcgi?tool=pubmed&pubmedid=11055296>>.

Fidel, Raya, and Maurice Green. "The Many Faces of Accessibility: Engineers' Perception of Information Sources."

Information Processing & Management
40.3 (2004): 563-81.

Kendall, Margaret. "Tackling Student Referencing Errors through an Online Tutorial." Aslib Proceedings: New Information Perspectives 57.2 (2005): 131-45.

Kraus, Joseph R. "Citation Patterns of Advanced Undergraduate Students in Biology, 2000-2002." Science and Technology Libraries 22.3/4 (2002): 161-79.

Majid, Shaheen, and Ai Tee Tan. "Usage of Information Resources by Computer Engineering Students: A Case Study of

Nanyang Technological University, Singapore." Online Information Review 26.5 (2002): 318-25.

Palmer, Stuart, and Barry Tucker. "Planning, Delivery and Evaluation of Information Literacy Training for Engineering and Technology Students." Australian Academic and Research Libraries 35.1 (2004): 16-35. 28 May 2006
<<http://alia.org.au/publishing/aarl/35.1/full.text/palmer.tucker.html>>.

Tenopir, Carol, and Donald W. King. Communication Patterns of Engineers. Hoboken, NJ: IEEE Press; Wiley Interscience, 2004.