INFORMATION LITERACY SKILLS OF ENGINEERING STUDENTS

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ABSTRACT

Information literacy is one of the critical digital-age literacies for higher education. Students need to be information literate to cope with the challenges in further studies and future profession. Assessment of students' information skills is important to determine how information literate they are. This study describes the results of an information skills assessment and has identified the skills that need improvement. It has also identified the type and format of resources students most frequently use in course assignments.

The respondents in the study were diploma-level engineering students who had undergone at least three semesters at a Malaysian college. Data were collected using a survey instrument adapted from Mittermeyer and triangulated using a citation analysis of student bibliographies in an essay assignment. The results of this study show that the respondents seriously lacked the necessary knowledge and skills to evaluate internet information, to identify the most efficient search strategy, to use scholarly resources, and to use information ethically. Most scholarly resources used were books in print format, while most non-scholarly resources referred to were in electronic format. This study implies the importance of information literacy assessment as the first step in improving students' information skills. It also indicates the need to encourage students to use more scholarly electronic resources in their coursework. It is suggested that a larger sample of students be used in order to be more representative of the engineering student population. An intervention program should also be introduced to improve students' information literacy skills.

Keywords: *Assessment; Information literacy skills; Engineering students; Citation analysis*

1. INTRODUCTION

Engineering is a field that is fast developing as a result of scientific and technological advancement. The growth of digital information, the focus on lifelong learning, and the demand for highly skilled workers have highlighted the need for information-related competencies. Thus, engineering students need to be equipped with strong information literacy skills to succeed in their academic and future professional endeavours.

American Library Association [1] defines an information literate person as one who is able to recognize when information is needed, and to locate, evaluate and use the needed information effectively. UNESCO includes information literacy skills as part of the wide-ranging information and communication technology (ICT) literacy skills [2]. A student who possesses ICT literacy skills should be able to recognize information needs and use information and communication technology (ICT) features and applications to access, retrieve, store, manage, integrate, evaluate, create and communicate information effectively. In addition, he or she should also understand the ethical and legal use of information.

The Ministry of Higher Education (MOHE) of Malaysia is committed to produce ICT and information literate graduates as part of the country's human capital development plan. The National Higher Education Action Plan 2007 – 2010 stresses the importance of ICT in two of the seven strategic thrusts. The second strategic thrust: Improving the Quality of Teaching and Learning emphasizes the effective use of ICT in content delivery and the acquisition of 21st-century skills. The importance of ICT skills in human capital development through self-directed learning using the electronic media, the Internet and e-learnig is highlighted in the sixth strategic thrust: Enculturation of Lifelong Learning [3].

1.1.Information Literacy Education

Historically, information literacy education was initiated by academic librarians who used several approaches to develop information literacy among students. Common pedagogical approaches include stand-alone courses, computer-assisted tutorials, and course-integrated instruction [4]. Stand-alone courses can be in the form of compulsory orientation information skills module for first-year students, optional information skills courses for final-year students undertaking a research project, and compulsory credit-based courses. These courses are often conducted by librarians. Researchers such as Webber and Johnston advocate the teaching of information literacy as an independent discipline [5].

Computer-assisted courses such as interactive Web-based tutorials, virtual tours and OPAC tutorials are often used as a training package to develop information skills in distance learning programmes. These courses encourage the self-learning principle for individuals and specific user groups.
Rafste and Town are among many authors who have used course-integrated instruction [6], [7]. An example of a subject specific guide is an information retrieval guide for medicine developed by Leicester University Library [8]. Such course-integrated information literacy programmes often use the problem-based learning approach [9].

1.2.Information Skills Assessment

Educators such as Laurillard, stress the importance of assessment in an academic curriculum because students learn what assessment assesses [10]. Summative assessments are performed for a variety of reasons such as to judge a learner's ability and readiness to proceed, graduate and for selection purposes. Formative assessments are used to give feedbacks on performance to improve learning. Diagnostic assessments identify students' existing skills and learning difficulties. This information can guide course coordinators and academic advisors in designing an appropriate intervention programme.
Assessment methods should match the purpose of assessment while taking into account the crucial issues of reliability, validity and feasibility. Different types of information literacy assessments include one-off multiple choice tests, essay assignments, direct observations of students actually performing an information search, group projects, and portfolio assessment of information searching skills. Standardized information literacy surveys are usually developed by a collaboration of researchers. An example of such surveys is iSkills, which was developed through the collaboration between the Educational Testing Service (ETS) and several universities in the United States [11].
Each of these assessment methods has its strengths and weaknesses. The iSkills test provides a comprehensive simulated computer-based test of information literacy on three dimensions of ICT literacy: cognitive proficiency, technical proficiency and social or ethical understanding. However, the whole test takes several hours to complete. On the other hand, multiple choice questions are less time-consuming and easier to mark, can test a wide range of knowledge quickly, and is highly reliable, but does not have high validity to indicate the learner's actual information skills in solving real life problems [12]. An example of a multiple-choice test is the one developed by Mittermeyer, based on the ACRL standards for information literacy [13]. This test is used in this study as the instrument to determine whether students have the information skills to search for information. The description of the test is given in the following section.

1.3.Information Skills Test

An important step in information literacy development is to obtain data on students' abilities. These data will indicate areas of improvement and the most appropriate training and services required. Data for this study were obtained using the test adapted from Mittermeyer. The test consists of 20 multiple-choice questions related to information research process, which consists of five major steps, namely: 1) Defining which information is required, 2) Identifying the main concepts in the research, 3) Developing a search strategy, 4) Performing the search, and 5) Using the search results. Each of these steps requires information literacy skills to make the information search successful. Based on the *Information Literacy Competency Standards For Higher Education* published by the Association of College and Research Libraries and the International Federation of Library Associations guidelines on information literacy, the information research skills are grouped into five major themes [14], [15], [16].
The five themes used in the test are: 1) Concept Identification, 2) Search Strategy, 3) Document Types, 4) Search Tools, and 5) Use of Results. Each of these themes has several information skills associated with it. These skills become the variables in the study. There are 20 variables, and each variable is represented by one multiple-choice question. The test was administered to 3000 incoming first-year students to Quebec universities in 2003.

1.4.Citation Analysis

Citation analysis is often done to document the type of resources students use and to quantify their information-seeking behaviour. Hovde recommends using research paper bibliographies as a non-invasive and time-saving assessment tool to study students' utilization of library resources [17]. Scholarly resources include books, dissertations, theses, peer-reviewed journal articles, conference proceedings, research and government reports. Non-scholarly resources comprise handbooks, articles from newspaper, magazines, bulletins, newsletters, brochures and web sites. The format of resources is classified as either print or electronic.
The objectives of this study are two-fold, namely (a) to determine which specific information literacy skills students need to improve on, (b) to identify the type and format of resources students most frequently use in course assignments.

2. METHODOLOGY

The random sample for the study consisted of second and third-year engineering students at the diploma level in a college. These students were chosen for the belief that they must have already acquired the necessary information skills after undergoing at least three semesters of study. During the first week of study at the college, these students were required to attend an inductive library talk and participated in a two-hour library tour. However, some students have also voluntarily attended library ICT skills courses during their study programme to enhance their information skills.

Students were informed that the test was on voluntary basis. Seventy take-home test papers were distributed, of which forty-nine were returned. The test items were modified to make them specifically relevant to local engineering students. Content validity of the questionnaire was evaluated by a Malaysian information literacy specialist with more than twenty years working experience in the field. In the questionnaire, information literacy skills are categorized into the five broad themes mentioned in Section 1.3. Each theme consists of several specific information skill questions. Data obtained in this study were analyzed according to these themes.

For citation analysis, second and third-year student essays on current issues in mechanical engineering were selected. Students worked in a group of three or four to encourage sharing of ideas and resources. They were required to include a bibliography of the resources used. The type of resources was then classified as either scholarly or non-scholarly by the instructor. The format of resources was also analyzed.

3. RESULTS AND DISCUSSION

Based on the questionnaire responses, the percentage of students who correctly answered every question in each information literacy theme was analyzed descriptively using SPSS. Citation analysis of the type, number, and format of resources used in student essays were tabulated.

3.1.Area 1: Concept Identification

Figure 1 shows the percentage of students who correctly answered questions 4, 8, and 13, which relate to concept identification. For question 4, only 18.4% of the respondents selected the best answer, which includes the three main concepts in the topic. 61.2% of the respondents included the non-significant term effect, which reduces the number of search results obtained.

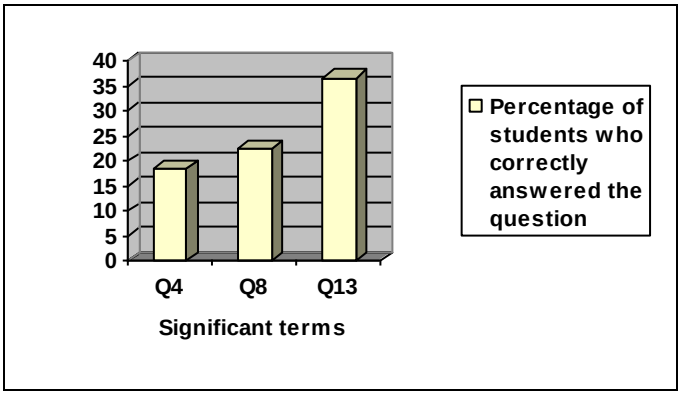

Figure 1. Result for concept identification

For question 8, most respondents do not appear to be able to distinguish between significant and non-significant terms by including restrictive terms such as impact and depletion.

Over a third of the respondents (36.7%) selected the best answer to question 13. They seem to be able to recognize words with similar meaning. Protective measures and measures to decrease damage have the same meaning. However, most respondents (48.9%) do not seem to be able to distance themselves from the original terms in the topic.

The responses to questions 4, 8 and 13 show a common misconception that the more terms used in a search will yield the best search results. Respondents need to know not to make the search too narrow, and yet include the significant terms in a search.

3.2.Area 2: Search Strategy

Figure 2 shows the percentage of students who correctly answered questions 2, 9, 11, 12, and 16, which relate to search strategy. For question 2, 36.9% of respondents appear to recognize the problem of using terms, which do not correspond with the ones employed and preferred by the OPAC system. However, some of these respondents might have arrived at the answer by eliminating options, which are very unlikely to be true.

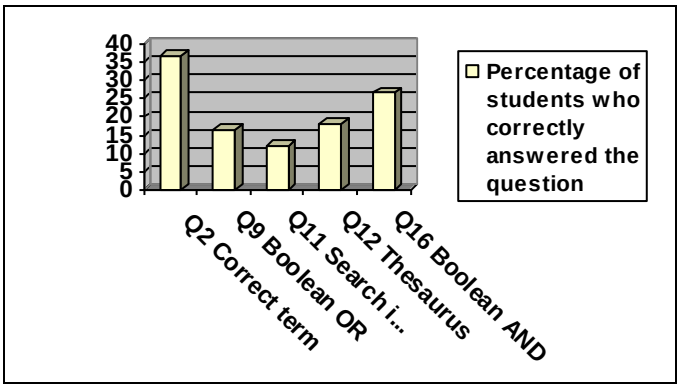

Figure 2. Result for search strategy

Only 16.3% of respondents chose the correct Boolean operator OR for question 9 to get more search results. This shows that the basic concept of OR in searching is not well understood.

Only 12.2% responded correctly by choosing C for question 11. Most respondents (77.6%) selected A or D, which indicates that they are not be able to use the correct search index by failing to differentiate between an author, a title and the subject of search.

Most respondents (81.8%) do not know the use of a thesaurus in searching for preferred terms for a particular database. Using controlled vocabulary is an important search strategy when using databases.

Only 26.5% of respondents know the function of Boolean operator AND to restrict the number of search results.

Responses to questions 2, 9, 11, 12, and 16 show that most respondents lack the strategy to perform searching efficiently by not knowing which Boolean operators to use, not being aware of the use of a database thesaurus and not knowing which search index to use in an OPAC system.

3.3.Area 3: Document Types

Figure 3 shows the percentage of students who correctly answered questions 3, 15, and 20 relating to document type. Only 26.5% of the respondents know the usefulness of encyclopaedias in providing an overview or summary of a topic.

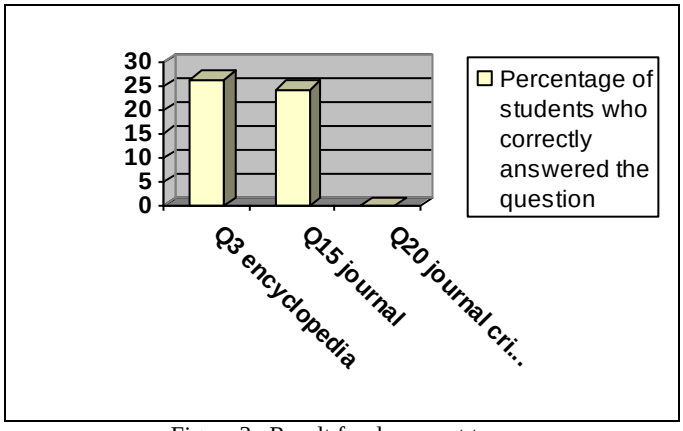

Figure 3. Result for document type

Only about a quarter of the respondents (24.5%) recognize that a journal is the best document type to obtain the latest information on a subject. Quite a high percentage cited Google for E as a way to get new information. These respondents are probably not aware of the varying quality and reliability of information found on the internet as compared to journals.

None of the respondents selected all the characteristics of a scholarly journal. 30.6% of respondents are not able to identify any of the characteristics of a journal. Most respondents know the characteristics partially.

The responses to questions 3, 15, and 20 indicate that most respondents lack the knowledge in identifying the criteria of different document types, and subsequently cannot select the most appropriate document type to use for different types of information.

3.4.Area 4: Search Tools

Figure 4 shows the percentage of students who correctly answered questions 1, 6, 7 and 14 relating to search tools. Only 8.2% of the respondents know that the most efficient search tool to find journal articles is a database. A

majority (75.5%) of respondents chose Google, which can provide links to some journals but requires more time to explore the web to get the articles.

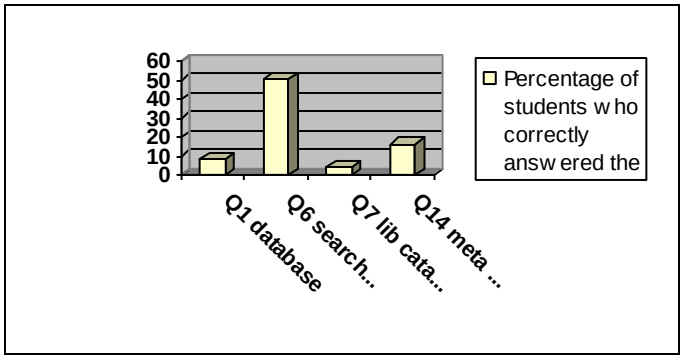

Figure 4. Result for search tools

About half (51%) of the respondents recognize that a search engine cannot locate books in the library. A very low percentage (4.1%) know that a library catalogue cannot access an article by author or article title, but only by the journal title. Not being able to use the search indexes correctly leads to waste of time in searching.

Most students gave incorrect answers or did not know what a Meta search engine does (83.7%). This lack of knowledge about internet search engines can cause inefficiency in locating information. Most students only know partially what information can be found using the library catalogue.

Responses to questions 1, 6 and 14 show that while most respondents tend to use an Internet search engine even to search for journal articles; they seem to be unaware of what a meta search engine can do. A low score for question 7 shows their lack of knowledge on how to use the search index in an OPAC system or a library catalogue.

3.5.Area 5: Use of Results

Figure 5 shows the percentage of students who correctly answered questions 5, 10, 18, and 19 pertaining to the use of information obtained. Most respondents (85.7%) cannot interpret a citation or recognize the corresponding document type. This lack of knowledge hinders efficient searching because the respondents will not be able to gauge the relevance and currency of a reference, and subsequently unable to select the best way to search for information.

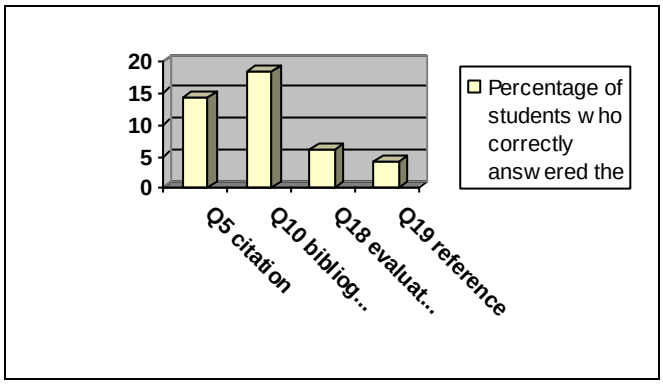

Figure 5. Result for use of information

About (81.6%) do not seem to know what a bibliography is, and subsequently will not be able to use it to find relevant documents. A very small percentage of respondents (6.1%) know the criteria to evaluate an Internet site despite it becoming the most popular search medium today.

Only 4.1% of respondents know when to include a reference to an article they cite, thus may commit plagiarism without them realizing it.

The responses for questions 5, 10, 18, and 19 show that most respondents seriously lack the knowledge for making a sound evaluation of internet information, using information ethically, or using a citation to search for more information on a topic.

The summary of the results for the specific information literacy knowledge areas surveyed in this study is presented in Table 1.

Table 1. Information literacy skills addressed by the questionnaire and the results obtained.

Broad information literacy skill area	Specific knowledge of the skills addressed in this area by the questionnaire	No	% of correct answers
Concept identification	Identifying the main concepts in a topic by using key words.	4	18.4
	Differentiating between significant and non-significant terms.	8	22.4
	Using words with similar meaning to describe a concept.	13	36.7
Search strategy	Using Boolean operator AND function.	16	26.5
	Using Boolean operator OR function.	9	16.3
	Using the correct search indexes.	11	12.2
	Using a thesaurus to get the preferred vocabulary for a particular database.	12	6.3
Document types	Knowing when to refer to an encyclopaedia.	3	26.5
	Knowing when to refer to a journal.	15	24.5
	Knowing the criteria of a scholarly journal.	20	0
Search tools	Knowing when to use a database.	1	8.2
	Knowing when to use a search engine such as Google.	6	51
	Knowing when to use a library catalogue.	17	10.2
	Knowing when to use a meta search engine such as Copernic.	14	16.3
Use of results	Knowing what a bibliography is.	10	18.4
	Recognizing the type of document that corresponds to a bibliographic reference.	5	14.3
	Knowing the criteria used in evaluating the quality of a web site.	18	6.1
	Knowing when to include a reference to avoid plagiarism.	19	4.1

Even though the sample size of respondents is small and does not represent all engineering students, the study results reveal a serious lack of knowledge in all the main areas of information literacy. This is evident in the percentage of correct answers being less than 50% in all but one specific skill of information literacy.

The percentage of correct answers is especially low (less than 10%) with respect to:

- knowing that a thesaurus should be used to get the most appropriate terminology in a particular database.
- knowing the criteria of a scholarly journal
- knowing the criteria used in evaluating the quality of a web site.
- knowing when to include a reference to avoid plagiarism.

Most respondents seem to be most familiar with using a search engine such as Google to find information. This is not surprising as they are part of today's digital natives. However, they seem to lack the search skills required for academic research, and seriously need to be aware of the ethics in using information.

3.6.Citation Analysis

Nineteen group essay assignments were examined to triangulate the test score data. The citations from the bibliography were checked to determine whether the resources were scholarly or non-scholarly. The status of journals and conference proceedings, whether scholarly or non-scholarly were checked using Ulrichweb, an online version of Ulrich's International Periodicals Directory. Table 2 shows the type and format of the resources used. Each website is checked to determine the nature of content, which could be either scholarly or non-scholarly.

Table 2. Type and format of resources

Type	**Format**		**Total**
	Print	Electronic	
Scholarly			
Journal	9	0	9
Conference proceedings	3	4	7
Book	12	2	14
Government documents	2	0	2
Other (thesis, dissertation)	0	0	0
Total	26	6	32
Non-scholarly			
Websites (blogs)	0	27	27
Report	5	0	5
Handbook	3	0	3
Other (magazine, newsletter)	0	0	0
Total	8	27	35

The percentage of scholarly resources is 48%, slightly lower than non-scholarly resources. Most of the scholarly resources used are books in print format, followed by journals and conference proceedings. For scholarly resources, the print format is used more often (81%), while for non-scholarly resources, the electronic format is more commonly utilized (77%). These results agree with the major findings from test scores which indicate lack of students' skills to search for and use electronic scholarly resources.

4. CONCLUSION

This study identifies the information literacy skills that students need to improve on. These include identifying the most efficient search strategy, evaluating internet information and websites, as well as using information ethically. Students' usage of electronic scholarly resources in their course assignments is very minimal. Examination of the bibliographies shows that most students are not aware of the proper format of citation.

This study has several important implications. Firstly, the poor test results should initiate a probe into the causes so as to identify appropriate actions by all concerned. It may be a consequence of the lack of awareness among students on the importance of developing good information skills. Students should be encouraged to use more scholarly resources in both print and electronic format. Another important implication of this study is that it is crucial to assess students' information literacy skills as a proactive action to evaluate and improve the effectiveness of an information literacy programme. Constant assessment and constructive efforts should lead to a more integrated curriculum and collaboration between academicians and information literacy specialists to produce a well-designed programme and ultimately information literate engineers.

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Are information literacy skills tested in your state? Teaching information literacy skills has never been more important. But it's easier said than done. As teacher-librarians, how do we teach those critical, all-important information literacy skills in ways that capture and hold student interest? Definition. Let's start with a clear understanding of what "information literacy" means.Â Redefining Literacy for the 21st Century by Warlick shows you the rationale for developing information literate students and using technology. The Super3â„¢: Information Skills for Young Learners by Eisenberg & Robinson helps the very youngest learners get started researching. Today's students must develop information and media literacy skills in order to function in society. Traditional library training focused on students' information literacy skills and included instruction in utilizing advanced database features and searching relevant materials. However, some students still have difficulty locating resources following library training in database search techniques (Blummer et al., 2012).Â Developing information literate students is the key role of the teacher librarian in todayâ€™s schools. It is an educational as opposed to an administrative role, and the increasing use of digital resources by students in the school and at home means that information literacy skills are now a vital part of a studentâ€™s repertoire of learning skills. Keywords: engineering students, mastery learning instruction, motivation, writing skills, zone of proximity development. Writing skill is one of the most significant skills in learning English as a second and foreign language. It is a fundamental language element that helps students improve their language competence, literacy, and develop cognitive skills (Behizadeh & Engelhard, 2011; Bacha, 2002). Mesfin (2013) also asserts that writing is a very crucial skill for improving learners' thinking and efficiency in the academic world. Particularly, engineering and technology students need Engineering skills that employers look for in candidates for employment, examples of each type of skill, and how to show employers you have them.Â Because engineers operate in a variety of industries, some hard skills are vital only to specific industries. That being said, each hard skill below is important in most engineering work. Engineers are creators in everything from biology to computer programming.