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Managing information for capstone engineering projects

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BACKGROUND

Engineering students have strong technical skills but may not have had the opportunity to develop research skills during their course. Information retrieval skills are scaffolded throughout the engineering program, but it is not until the capstone project year that students are confronted with the challenge of finding and collecting relevant references and citing these in a consistent and appropriate referencing style. This study investigates capstone students' perceptions about their own referencing skills. The results will inform future approaches to teaching information literacy skills to capstone students in mechanical engineering.

PURPOSE

This study explores the research question: how does class use of bibliographic software and mode of instruction affect students' perception of their ability to access, manage, and integrate information into written research reports?

DESIGN/METHOD

Collaboration between a senior engineering lecturer and a liaison librarian resulted in a new teaching practice. In the early weeks of the semester during a large lecture information sources and access to databases were demonstrated. This was followed by small hands-on computer based tutorials introducing students to library databases and integrated bibliographic software. Seventy-four students from mechanical engineering were surveyed before the start, and at the end of the small group training sessions. The change in students' perceptions regarding their ability to manage information was measured by analysing four Likert type survey questions, including two free-form responses.

RESULTS

Analysis of the data yielded a positive response by students to small group training for enhancing their database retrieval and integrative bibliographic software skills. Qualitative results indicated that the students' confidence in creating in-text citations and references would be increased; the quality of students' reference list would be improved; and consequently an increase in their tendency to use the software.

CONCLUSIONS

This study found that students preferred small group hands-on training to improve their writing and research skills. They indicated that they would prefer exposure to information retrieval and management activities using bibliographic software earlier in their academic career. Furthermore, to successfully enhance information management skills, students preferred scaffolding throughout the course as well as targeted intervention. This was achieved by collaboration between an engineering academic and an engineering faculty librarian.

KEYWORDS

Capstone, information management skills, intervention, collaboration

Introduction

Engineering students have strong technical skills but may not have had the opportunity to develop research skills during their course. Although information retrieval skills are scaffolded throughout the engineering program, at our institution it is not until their final year capstone project - when students are required to produce a comprehensive literature review and a professional research report - that they are confronted with the challenge of finding and collecting relevant references and citing these in a consistent and appropriate referencing style.

Communication skills (incorporating written communication) are recognised as one of the key generic skills highly valued by employees of engineering graduates (Norback, Leeds, & Forehand, 2009). The challenge is to successfully integrate these “soft” skills into an already packed engineering curriculum.

Producing an information-literate student who is knowledgeable about finding, retrieving, analysing and effectively using information is a common goal amongst librarians. Whilst librarians have a common understanding of the term ‘information literacy’ the many contradictory definitions and meanings of the concepts information literacy and digital literacy lead to confusion (Bawden, 2001). For this research we consider Olsen and Coons’ (1989, p.8) definition of information literacy as “understanding the role and power of information, having the ability to locate, retrieve it, and use it in decision making, and having the ability to generate and manipulate it using electronic processes.”

Information literacy is also encapsulated within professional skills sets as in the case of Engineers Australia’s competency standards. In particular competencies 3.4 *Professional use and management of information*, and 3.2 *Effective oral and written communication in professional and lay domains* (Engineers Australia, 2011). Most Australian universities have implemented a set of generic graduate attributes, and at our institution the development of key generic skills allows for the inclusion of other generic skills as defined by external accreditation bodies such as Engineers Australia.

Performing research that results in a well written report in combination with a report presentation is recognised as an important educational tool for enhancing communication skills (Ibeh, 2001) as is the practice at our institution. Ku and Goh (2010) have documented the use of final year engineering research projects in Australia and Europe in which capstone projects are assessed with a literature survey, oral presentation and a written report. Typically capstone students perform an intensive literature review in developing their project proposal (Blicblau, 2004; Krishnan & Kathpalia, 2002; Ku & Goh, 2010). This requires proper documentation of all literature consulted and integrating references into a report utilising an appropriate referencing style in a consistent manner.

Using a linguists’ approach Krishnan and Kathpalia (2002) considered the referencing strategies that engineering students employ to synthesise and cite information from sources in composing their literature review and while citation behaviour is examined in this paper the focus is on students’ perceptions of their skills. Cochrane, Goh, and Ku (2009) investigated the ‘learning hurdles’ engineering students face in conducting and writing their literature reviews and they conclude that systematic embedding and scaffolding throughout programs is required in order for students to develop the necessary academic and research skills. This paper acknowledges that it is necessary to incorporate academic writing and research skills and build upon them throughout the program and it agrees with O'Sullivan and Cochrane (2009) that these professional skills should be addressed in the curriculum.

In terms of scaffolding, this research followed Krishnamurthi’s (2009) approach in implementing several instructional scaffolding techniques to improve students’ writing skills but differs in that it introduced students to a software tool to assist them in organising their information and manipulating references.

Although engineering students receive information literacy training in their first year at our institution, the emphasis shifts in subsequent years to technical skills as required by external accreditation bodies such as Engineers Australia. In our experience, early intervention during first and second year does not automatically translate to the final year project and we argue that to successfully teach engineering students' information management skills (including referencing) requires not only scaffolding but targeted /specific intervention and collaboration between faculty and library.

We introduced students to a bibliographic software tool to assist them in organising their information and manipulating references. EndNote© software has a collection of the 500 most popular bibliographic styles that includes the American Psychological Association (APA) 6th edition. What makes this referencing style particularly attractive is that it does not require any modifications or editing and can be implemented immediately using the EndNote© bibliographic software (Thomson Reuters, 2012).

The literature supports the importance of collaboration between academic staff and library in information literacy endeavours (Hulse, George, & Li, 2009) and in this instance collaboration resulted in a new teaching practice. This involved the demonstration of the use of information sources and databases during a large lecture in the early weeks of the semester. The demonstration was followed by small group hands-on computer based tutorials introducing students to bibliographic software. The change in students' perceptions regarding their ability to manage and reference information using the bibliographic software was measured utilising a survey instrument developed for this research. This approach was selected as it allowed the flexibility to obtain data on a broad range of factors. The next section describes the survey instrument and approach taken to establish how use of bibliographic software and mode of instruction affect students' perceptions of their ability to access, manage, and integrate information into written research reports. Ethics approval was obtained from the university ethics committee, prior to conducting the survey.

Method

The target population for the survey was students enrolled in a final year mechanical engineering unit called Research Methods. They were invited during lectures and tutorials to participate in a paper based survey before the start (phase 1), and at the end (phase 2) of the small group training sessions. Participation was voluntary and students received verbal and written indication of the anonymous nature of the survey. Of the enrolled class of 92 students, 82 per cent completed the survey.

A survey instrument was constructed such that phase 1 questions were on the obverse side of the page and phase 2 was on the reverse side. As the same student completed both sections of the survey it allowed the researchers to pool data for phase 1 and phase 2 and also to pair data. In addition the survey included two open ended free response questions. A copy of the survey instrument after the large group session (phase 1), is shown in Figure 1 and that after the small group session (phase 2) is shown in Figure 2. The survey had an initial question "have you used software to create a list of references at the end of reports?" and a final open ended question "any comments on your experience with referencing at Swinburne University of Technology?".

The survey instrument was a closed questionnaire and comprised of three Likert-scale items which examined perceptions both after participating in large group, lecture format training (phase 1), and after completing small group hands-on training (phase 2). The response to each item was categorised on a scale of SA, A, U, D and SD (matching to a numerical scaling of 5 to 1, where 5 corresponds to strongly agree; 4 to agree; 3 to neutral; 2 to disagree and 1 corresponding to strongly disagree). The basis of the five response-alternatives is centred on the scaling proposal first proposed by Likert (1932) with an underlying assumption of a variable, the value of which represents attitudes and opinions

(Clason & Dormody, 1994). A quantitative methodology based on a survey questionnaire was utilised to collect data. The statistical analysis of the items in the survey used IBM® SPSS® Statistics 19.0 (Field, 2009; IBM, 2012). The survey allowed for two free-form responses which were collated. All comments, for phase 1 and 2 of the survey were sorted into clusters based on similarity for comparison. This cross-sectional anonymous survey, allowed the data to be collected and analysed.

SA=Strongly Agree; A=Agree; U=Undecided; D=Disagree; SD=Strongly Disagree

	SA	A	U	D	SD
(a) Did you find manipulating references difficult?					
(b) Did you feel the quality of your references was appropriate without software management, for example EndNote?					
(c) In previous reports were you confident in creating in-text citations and reference lists without the use of software?					

Figure 1: The Likert section of the survey instrument after the large group session (phase 1),

SA=Strongly Agree; A=Agree; U=Undecided; D=Disagree; SD=Strongly Disagree

	SA	A	U	D	SD
(c) Do you think that EndNote training is useful for manipulating references in a report?					
(b) Do you feel that the quality of your references will improve with the use of software management, for example EndNote?					
(c) Are you more confident in creating in-text citations and a reference list?					

Figure 2: The Likert section of the survey instrument after the small group session (phase 2).

Results and discussion

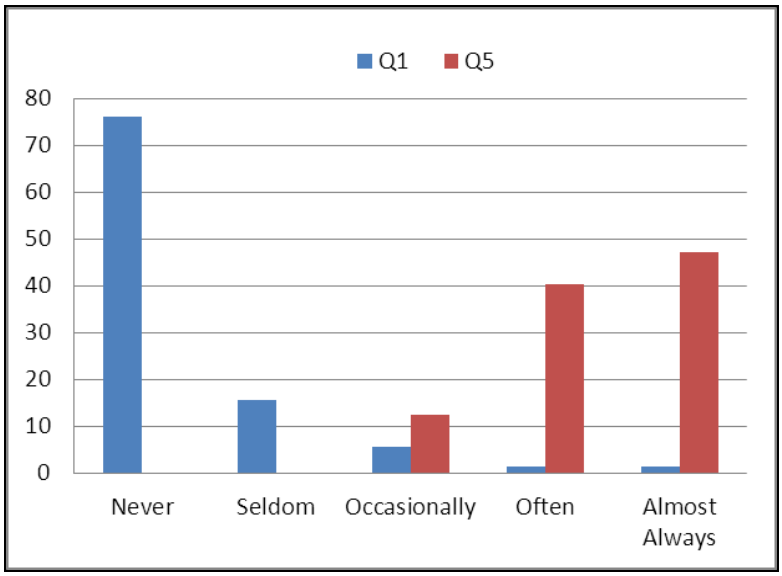
The findings from the analysis of the survey, coupled with qualitative analysis of the free from questions provided a mixture of data which helped evaluate our teaching intervention. The continued implementation of this intervention will help to inform and improve our approach and student learning in the use of bibliographic software.

Student perceptions of referencing skills-frequency responses.

The quantitative data collected presents evidence of the impact on students' perceptions of their ability to manipulate references, improve the quality of their references, and create in-text citations using specialised software. If we correlate these figures in a "before" and "after" approach, they provide us with an understanding into the impact of this type of technology on the student report reference learning experience as shown in Figure 3.

For the question after the large group training session, but before the small group session – *have you used software to create a list of references at the end of a report?* Seventy-four students participated in this survey, 71 answered and 73 per cent of them claimed that they never used software to create a list of references at the end of their academic reports. About 15 per cent used seldom, around 5 per cent used occasionally and approximately 3 per cent used software most of time.

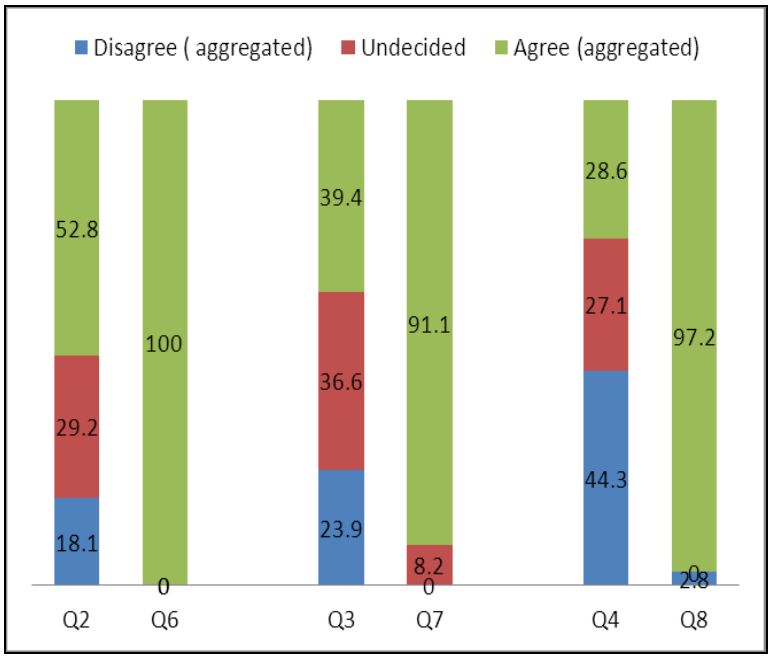
And for the question after the small group training session – *Would you use software to create a reference list?*, of the 72 respondents, about 12 per cent said that they will use occasionally, and the rest would use software most of the time. These responses indicate the positive outcomes of such a training regime.



Q1 have you used software to create a list of references at the end of a report?

Q5 As a result of the Endnote training session would you use software to create a reference list?

Figure 3: Student perceptions of their reference learning experience (phase 1).



Q2 Before this session, did you find manipulating references difficult?
Q6 After attending this training session, do you think that Endnote training is useful for manipulating references in a report?
Q3 Before this session, did you feel the quality of your references was appropriate without software management, eg. Endnote?
Q7 After attending this training session, do you feel that the quality of your references will improve with the use of software management such as Endnote?
Q4 Before this session, were you confident in creating in-text citation and reference lists in previous reports without the use of software?
Q8 After attending this training session, are you more confident in creating in-text citation and a reference list?

Figure 4: Relative student responses to perceptions of using referencing software (phase 2).

When analysing individual responses from before and after training, the relevance of the type of training on learning was a fundamental aspect of this work; this showed a high proportion of positive feedback to the small group, hands-on approach. This was obvious throughout the whole student sample, as shown in Figure 4, which is a representation of the responses. The positive responses and trends in the survey results are consistent with earlier research into the success of using small group training for literature reference information retrieval using the specialised information technology in a classroom environment.

Impact of small group training in referencing software- paired sample responses

A paired samples t-test was conducted to evaluate the impact of the EndNote training program on students' perception of using referencing software. For interpreting the statistical

results, we need to look at the (p) value, which in statistics, means probability and labelled as Sig. (2-tailed). If the (p) value is less than 0.05, we can conclude that there is a significant difference between the two scores (in our case, before and after). In other words, the results showed that the difference we obtained in these two sets of scores were unlikely to occur by chance.

The t-value and degree of freedom (df or the number inside the brackets after t) help researchers and statisticians to find the effect of size in our interpretation. The large effect will show a substantial difference. In all situations in our study, the effect of size is large (based on t- value and df) and there is a substantial difference.

The outcomes of the analysis were as follows:

- There was a statistically significant change in students' perception to use bibliographic software such as EndNote after attending the training session (before M=1.37, SD=0.78 and after M= 4.35, SD= 0.70, t(70)= -9.655, p<0.005). The mean increase was 2.98 with the 95% confidence interval ranging from -3.22 to -2.74.
  This indicates the increased likelihood that students will use the software to gather and manipulate references. This result is not surprising given their lack of confidence in creating in-text citations and reference lists.
- There was a statistically significant change in students' opinions about the difficulty of manipulating references after attending the EndNote training session (before M=3.39, SD=0.88 and after M= 4.57, SD= 0.49, t(70)= -9.655, p<0.005). The mean increase was 1.18 with the 95% confidence interval ranging from -1.42 to -0.93.
  This reflects students' opinions that the software training was useful and that the software will assist them in making the referencing process less complicated. These results are consistent with the notion that engineering students find referencing a challenging task to perform.
- There was a statistically significant change in students' opinions about the quality of the reference lists after attending the EndNote training session (before M=3.17, SD=0.81 and after M= 4.41, SD= 0.64, t(70)= -9.376, p<0.005). The mean increase was 1.24 with the 95% confidence interval ranging from -1.50 to -0.97.
  This suggests that students believe that the quality of their referencing will improve by using the bibliographic software.
- There was a statistically significant change in students' confidence in creating in-text citations and reference list by using software after attending the EndNote training session (before M=2.82, SD=0.96 and after M= 4.32, SD= 0.0.53, t(68)= -11.85, p<0.005). The mean increase was 1.5 with the 95% confidence interval ranging from -1.75 to -1.24.
  The results are encouraging as it implies students' increased confidence in creating in-text citations and reference lists after the training session.

The paired sample responses of small group training in referencing software, confirmed that the targeted intervention was successful. It exposed students to an information management tool, which they perceived would facilitate referencing. It is pleasing to note students' increased confidence in their referencing skills as a result of the training.

Qualitative data – open ended question responses

In addition to the closed questionnaire quantitative data, students were provided with the opportunity to complete two open-ended questions one before and one after the training session. The comments were grouped into "similar" context and they complemented the

interpretation of the numerical results. For example, a number of students indicated that they have had very little demand for referencing skills with comments such as:

'limited requirement for referencing until now (little or no essays completed', and
'haven't had to do a whole lot before'.

These comments support our argument that targeted intervention is required at the point of need i.e. the start of the final year project. Further evidence of the impact of small group computer based teaching was also noted in the student comments:

'first time actually learnt something practical efficiently',
'well run class', and
'the training was quick and easy to follow'.

From the perspective of students' increased confidence in referencing, the comments support the introduction of the bibliographic software tool:

'a very brilliant software that allows an easy way of referencing', and
'very useful program that will greatly help with referencing'.

Limitations and future research

- Our sample only considered one cohort of students, final year mechanical engineering students and their perceptions and not all undergraduate engineering students. It would be useful to examine engineering students' perceptions longitudinally and investigate if their beliefs change over the span of their education.
- The findings indicate students' self-assessment of the training's influence but it did not ascertain their depth of understanding.
- Some natural research extensions of these findings include connecting the findings with student assessment data in order to evaluate the impact on student learning.
- Based on these findings future teaching intervention will incorporate small group hands-on training in the use of bibliographic software at the beginning of the final year project. In addition, training in the application of this software will be developed in conjunction with librarians and engineering academics to elicit the integration of engineering communication skills in literature and information retrieval areas required for report writing within the engineering community.

Conclusions

This study found that students greatly benefitted from small group hands-on training to improve their writing and research activities. They indicated that they would prefer exposure to information retrieval and management skills using bibliographic software earlier in their engineering program. Furthermore, to successfully enhance information management skills, student preferred scaffolding of implementation of bibliographic software use throughout their course together with targeted intervention for specific applications. This was achieved by collaboration between an engineering academic and an engineering faculty librarian.

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