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The citation behaviour of Civil Engineering students

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Abstract

The *New Review* project investigated how to improve students' information searching skills and the resulting reference lists through a new approach to teaching the literature review. This paper reports on one element of this study, which analysed reference lists from 47 final-year projects written by Civil & Building Engineering undergraduate students (BEng and MSc). It finds a strong positive correlation between the literature review mark and overall mark for each project, as well as a slightly weaker correlation between the number of references cited and the mark received. An analysis of the number, age, and type of references cited is performed in addition to an investigation into the quality of the bibliographic citations themselves. Finally, this paper makes recommendations as to how Information Literacy (IL) teaching relating to the literature review may be improved.

Keywords

Literature review; citation analysis; undergraduate students; postgraduate students; learning support; civil engineering; building engineering.

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1. Introduction

Citation behaviour is an important aspect of Information Literacy because it represents the culmination of the information seeking and handling process and provides an indicator of the success (or otherwise) of that process. The Centre for Education in the Built Environment (CEBE) funded a project called "NEW Review", which aimed to improve students' information searching skills and resulting citation behaviour through a new approach to teaching the literature review. A survey of staff in the Civil and Building Department at Loughborough University showed that 50% thought their students' final year projects' reference lists were either poor or very poor. To help ascertain where some of the problems might lie, and to ascertain a benchmark against which to measure the success of the project, an analysis was performed on the literature cited by some past final-year projects. Two undergraduate degree programmes: a three-four year Construction Engineering Management (Bachelors) and a four-five year undergraduate MEng Civil Engineering (Master's) that submitted in 2008 were chosen. The aim was to build a profile of the references being cited and the corresponding marks received and to see where the strengths and weaknesses lay. After implementing a new teaching approach based around some of the findings from this research, a repeat exercise is planned for future final-year projects with a view to measuring the impact of the new teaching methods.

2. Literature Review

The citing characteristics of students have been studied in some detail. Research has covered the citing behaviour of undergraduates, taught postgraduates and PhD students across different disciplines and sometimes with a view to see if these characteristics have changed over time. In some cases, this has been incidental to the main aim of the research, which may have been related to collection management in libraries rather than understanding the citation behaviour of

students. Other studies have varied in their coverage by examining the accuracy of the references cited, their number and composition in terms of the type of resources cited, their frequency and their currency, providing some analysis, usually by questionnaire, to assess the motivations underpinning citation behaviour. However, there have been no studies to date which focus on the citation practices of Civil Engineering undergraduates, and most of the literature deals with information search behaviour rather than trying to improve the teaching of the literature review.

2.1   Types and age of material cited

Williams and Fletcher (2006), in an effort to guide library collection development at their university, examined the bibliographies of Master's' theses from their engineering department, some of whom were civil engineering students. From 9,340 citations found in 250 theses, the authors found that the civil engineering students cited the least percentage of journal articles (26%) but, together with aerospace students, cited the highest percentage of books at 22%. Similarly, Gao, Yu and Webster (2007) used PhD and Master's students' theses from 1988, 1996 and 2004 to help inform collection development. Noticeably, over the three sample periods, there was an increase in the number of journals being cited from 33% in 1998 to 45% in 2004 with a commensurate drop from 54% to 34% of books being cited in the same period. To their surprise, sources found on the Internet were limited to just 2% of the total items cited in 2004.

In two articles, using similar methodologies, Oppenheim and Smith (2001) and Clarke and Oppenheim (2006) looked at the citation behaviour of undergraduate and Master's students respectively. Twenty undergraduate Information Science students' final year projects were selected from 1997-2000 to establish if there had been an increase in the volume of use of the Internet as a source material over the period. Oppenheim and Smith (2001) found the majority of sources cited by these students were from books and journals, but when viewed over the three year period, they found an increasing use of the Internet and of books at the expense of journal citations. In contrast to this, Clarke and Oppenheim (2006) found from postgraduate dissertations that the majority of citations were from journals and that this was steadily increasing, along with citations to web based material. This time 120 dissertations were selected in six lots of 20 from 1998 to 2003. Again, the majority of the citations were from books and journals with journals gradually taking precedence. The nursing students studied by Gannon-Leary et al. (2006) made less use of books (27% of the total sources cited), but a greater use of journals (37%) than did the students in Oppenheim and Smith's study (2001). These nursing students also consulted a range of web-based resources, which were shown to be reputable information sources. Hovde (2000), in a not dissimilar exercise, examined the bibliographies of 109 English first year student papers. Books, perhaps not surprisingly, were cited the most frequently at 47.69% followed by journals at 42.1%. This study, however, showed that students did not have access to the Internet through their library, hence electronic resources were absent from their bibliographies.

Uçak and Al (2009) examined the different citation practices from a range of disciplines, one of which included several engineering subjects, as well as subjects from the social sciences, the humanities, pure science and the arts and humanities. The authors analysed the bibliographies of 391 Master's and PhD theses, recording a range of their bibliographic features including their type, currency and language. The results were characteristic of the particular disciplines with a heavy reliance on books in the arts and humanities and the social sciences, and a greater reliance on journals in the 'harder sciences'. The engineering results showed that 60.3% of the citations were from journals and 25.7% from books, although civil and building engineering were not included in the sample. Web-based resources were only evident at a very low level. This is not surprising since the sample of theses were taken from 1967-2007, although it was not clear in the research what proportion was taken from each of the decades covered in the sample. In Williams and Fletcher's study (2006), there was a tendency to cite fairly recent material with 50% of the material cited appearing within the last eight years and 80% within the last 15 years. Gao, Yu and Webster (2007) found a similar pattern in the currency of items cited where 50% of journal articles cited over the period were just less than 6 years old. In line with the work of Oppenheim and Smith (2001),

Gannon-Leary et al., (2006) found that the majority of citations made by nursing undergraduates, in a particular assignment, were to material less than five years old.

2.2   Student level

Not surprisingly Gao, Yu and Webster (2007) found that PhD students cited far more sources on average than Master's students. In combining Master's and PhD students in his research Eckel (2009) sought to tease out the different citation behaviours of students who had completed their work over the period 2002-2006 and a number of the Master's level students were from a civil and building programme. The results suggested that there was a progressive basis in the use of more scholarly sources of information by PhD students whereas Master's students were more likely to draw their information sources from a wider source of materials. Eckel (2009) also found that the use of generic web sites were ranked as the fourth most common source by both Master's and PhD students, a finding echoed by the work of Williams and Fletcher (2006).

Taking a sample of first- and second-year junior and senior students' research papers, Carlson (2006) analysed citation data from 583 bibliographies from work submitted by students in 2002, in an attempt to show how students' citation behaviour differed when related to discipline, year of study and course level. Results from the analysis showed that the number of books cited by students was fairly constant throughout this period at about half of the material cited. There was, however, a significant difference in the rate at which journals were cited by first year students compared to the the citation rates of journals by students in other years which rose progressively to 23%. Almost the reverse was true for those students citing websites, with first year students citing websites the most frequently at 23%. Of these students, the ones in foundation seminars were the most frequent citers of websites. In common with other studies, Carlson (2006) found characteristic disciplinary preferences where students in humanities subjects cited books more than any other source.

3. Methodology

Final-year projects from the entire cohort of 24 MEng Civil Engineering (Civil) students, and 23 BSc Construction Engineering Management (CEM) students were selected for this study. Both groups of students are set a research project in their final year of study on a topic of their choosing. The MEng project module is a 400-hour module worth 40 credits. The BSc module is a 300-hour module worth 30 credits. Apart from the different number of credits, the projects' requirements and assessments are very similar and both groups are given a full project briefing by academic staff and are offered the same information literacy sessions by library staff. At the beginning of this study, the title page, mark sheets, and reference lists of all projects were photocopied. One Civil project and three CEM projects were found to be unusable as it was unclear whether the lists supplied were actual references, or just a general bibliography. Data from the remaining projects was entered into two Excel spreadsheets in the following categories:

- Name
- Project title
- Literature review marks & comments (from supervisor and moderator)
- Overall agreed project mark
- Number of references
- Age of references
- Material resource type (book, journal, etc)
- Print or electronic resource
- Domain of URLs cited
- Citation accuracy

4. Results

4.1 Literature review marks

To ascertain an average literature review mark for analysis purposes, the mean of the marks given by the supervisor and moderator were taken. This was necessary because, while a final overall mark was agreed by the two markers, a final literature review mark was not. Thus, although the figure was somewhat artificial, it was considered to be the best indicator available. The combined results for the two programmes are given in Table 1.

Table 1: Literature Review and overall marks

Range	Literature Review marks			Overall marks		
	Lowest	Highest	Mean	Lowest	Highest	Mean
	10	18.5	13.96	44	70	54.98

The results for the literature review and the overall marks from the two programmes were combined into a single data set and a scatter graph plotted to show the relationship between the two (see Figure 1, below).

Figure 1: Combined literature review mark compared to the overall project mark.
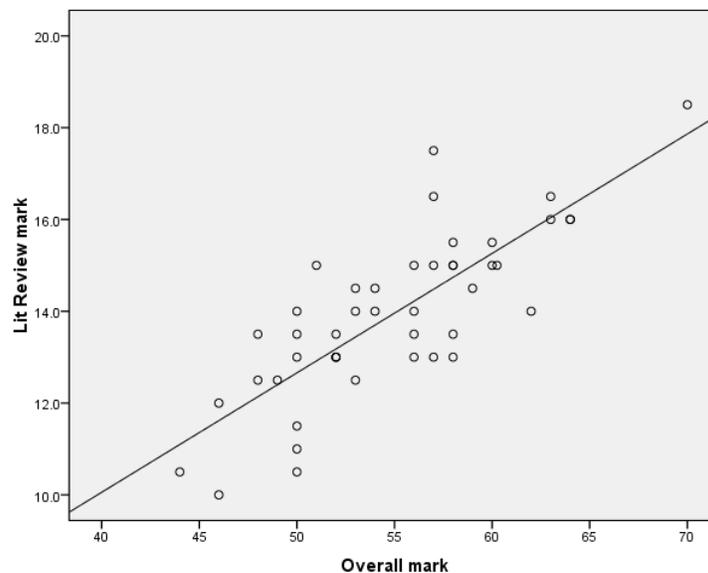
Figure 1 shows there is a general relationship between the average literature review mark and the overall mark received. This could be interpreted in a number of ways. Perhaps the better students do better literature reviews, or the better the literature review, the better the resulting research (and therefore mark). The level of correlation between literature review mark and overall mark was tested using a one-tailed Pearson r test for the combined data, which gave a correlation of 0.799 significant at the 0.01 level.

4.2 Number of references

The range of references cited by students from both programmes is given below in Table 2.

Table 2: Range of references cited

|	Lowest	Highest	Mean
CEM	17	137	45.2
Civil	18	60	31.5

The combined number of references cited from each programme was plotted against their average literature review mark to see if there was any relationship between the two. The result is given in Figure 2.

Figure 2: Combined literature review mark with number of references
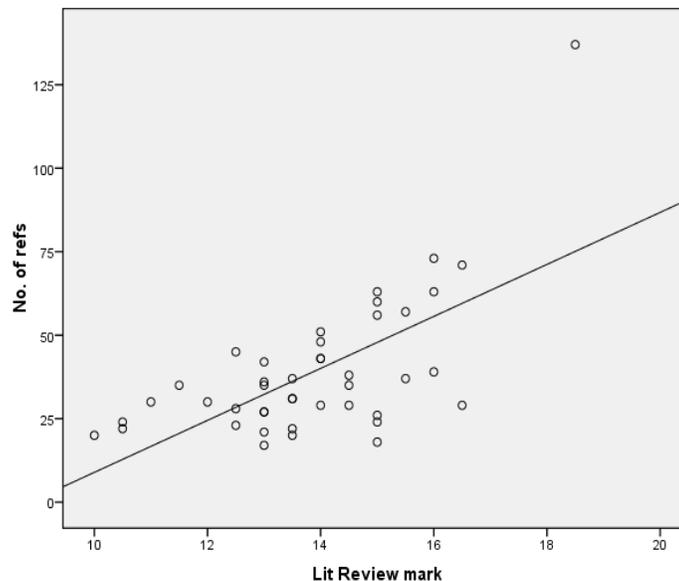
The line of best fit suggests a correlation between the literature review mark given and the number of references cited. The inference being that the more references cited, the better the mark, although there are, of course, visible exceptions to this theory. This result was tested again by using a one-tailed Pearson r test for the combined data, which gave a correlation of 0.647 significant at the 0.01 level. These results, however, need to be treated with a little caution since the distribution of the number of references is rather scattered.

4.3 Age of references

The dates of the references were put into seven categories: no date given; earlier than 1980, 1980s, 1990s, 2000-2005, then subsequent years: 2006, and 2007. There were no references from 2008. The results from both analyses are illustrated below in Figure 3.

Figure 3: Civil and CEM - Date of references cited
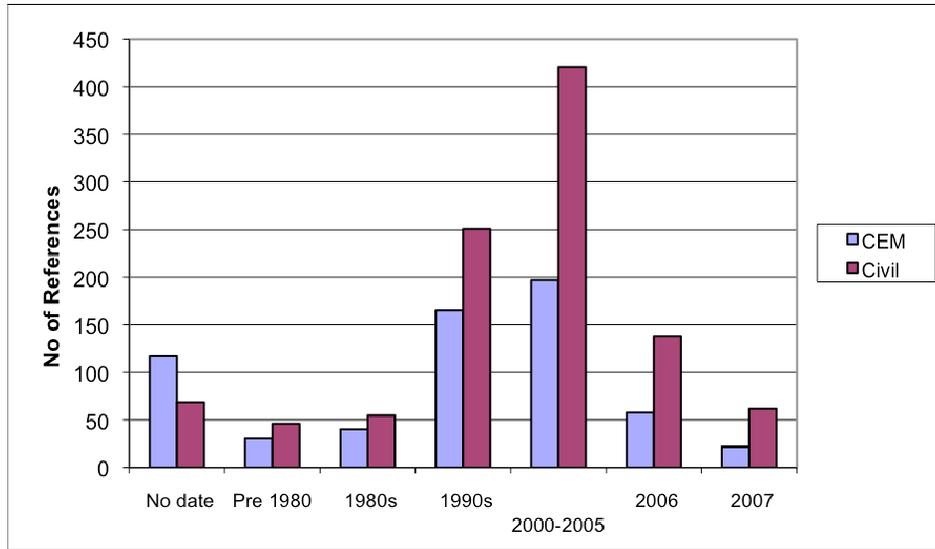
Figure 4: Age of references cited by percentage
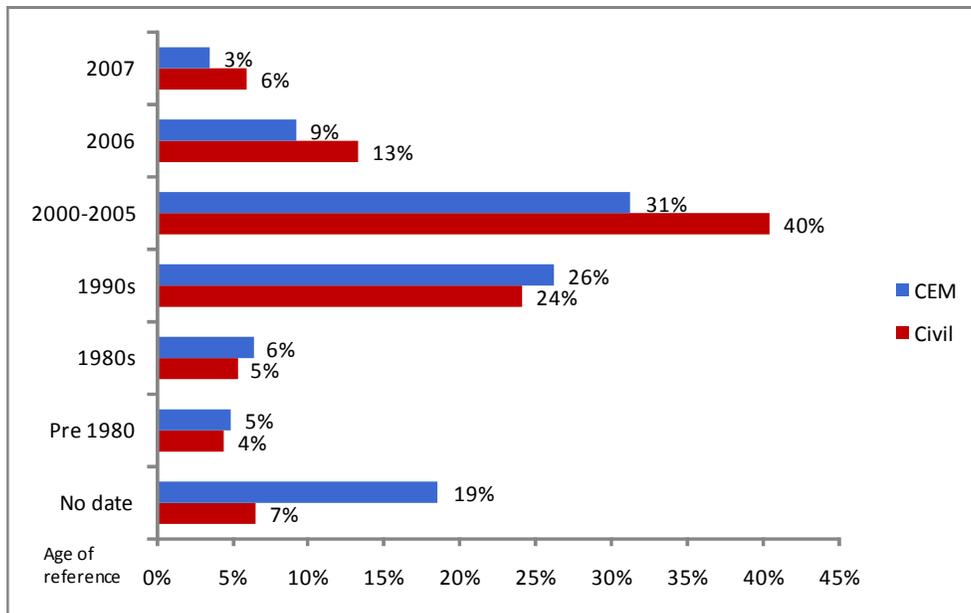
Both graphs show a peak in the number of references cited between 2000 and 2005 – 5-9 years before the research projects were completed. When the results are viewed by percentage, as in Figure 4, it shows how the two programmes differ in the age of the citations, with 59% of the Master's students (Civil) and 43% of the Bachelors students using references dated post 2000. A cross-tabulation between the peak age of references cited by each student, with the literature review mark received, was performed. There were no significant trends other than the students for whom "no date" was given for the majority of their references, were all in the bottom four literature review marks for their cohort. This may have been an indicator of poor citation practice rather than a large number of sources for which no date was available.

4.4 Types of material cited

Each source referenced by the projects was classified according to a material type as given in the Table 3 below.

Table 3: Types of materials cited by both programmes

	Civil	Civil %	CEM	CEM %	Total	Total %
Book	192	18.4	267	42.3	459	27.5
Journal	304	29.2	111	17.6	415	24.8
Web site	162	15.6	121	19.2	283	16.9
Report	198	19.0	48	7.6	246	14.7
Conference	79	7.6	24	3.8	103	6.2
Standard	61	5.9	7	1.1	68	4.1
Guideline/Regulation	20	1.9	36	5.7	56	3.3
Thesis	9	0.9	1	0.2	10	0.6
Manual	3	0.3	6	1.0	9	0.5
Newspaper	2	0.2	7	1.1	9	0.5
Lecture notes/slides	7	0.7	0	0.0	7	0.4
Correspondence	3	0.3	3	0.5	6	0.4
Case study	1	0.1	0	0.0	1	0.1
TOTAL	1,041		631		1,672	

It can be seen that overall there were more references to books (459 or 27.5% of the total) than any other form of literature, although journals were not far behind (415 or 24.8%). Indeed, for the Civil group, journals were the most highly-cited source by quite a significant margin (29.2% of their total references, compared with 18.4% to books).

4.5 Print vs. electronic sources

The material classification above referred only to type. Thus an e-journal and a printed journal would both be classified together as a "journal". Further analysis was conducted on the data and this showed that the majority of the sources were cited in their print form, as shown in Table 4.

Table 4: Printed vs. electronic sources cited

	Print	Electronic
Civil	753	288
CEM	461	170
Total	1,214	458

Just under than three-quarters of all sources cited were printed. It may be, of course, that some students cited the printed article even though they used the electronic version. There are a number of possible reasons for this, the students might have assumed that citing printed sources would win them more academic credit, or they didn't know how to cite electronic sources, or perhaps it was simply easier to cite in the printed format.

4.6 Citation accuracy

An analysis of the accuracy of the citations provided in the reference lists was also conducted based on the assessment of four aspects:

- Completeness: were *most* of the references in the list complete enough to enable someone to successfully locate the source?
- Adherence to a style: did the references attempt to conform to a known citation style (e.g. a version of Harvard or Numerical)?
- No major flaws: was the reference list free from major flaws (e.g., listing a website under "w" for "www"; omitting page references for journals; or place of publication for books. This aspect is discussed further in section 4.8).
- Consistency: having chosen a format, did all references for that material type follow the same format?

Reference lists were given a "1" if correct or a "0" if flawed depending on how they rated against the above categories and a total score given out of 4. Notes were made on any weaknesses in the citation lists, to see where the main problems lay.

Table 5: Civil citation accuracy scores

Complete	To a style	No major flaws	Consistent
18	19	14	17
78.3%	82.6%	60.9%	73.9%

Out of 23 Civil projects: 12 (52%) met all four aspects of accuracy; three received 3 out of 4; and eight got 2 marks or less out of 4. It can be seen from Table 6 (above) that the majority, 19 (83%), attempted to use a known citation style, while for 18 projects (78%), the majority of their references were complete and for 17 (73%) consistent, with 14 having no major flaws. This did, however leave 9 projects (39%) with major flaws described by the categories listed in Table 8.

Table 6: CEM citation accuracy scores

Complete	To a style	No major flaws	Consistent
13	12	3	10
56.5%	52.2%	13.0%	43.5%

For citation analysis purposes, all 23 CEM projects were examined - this included the three projects where it wasn't clear whether the citations were listed as bibliographies or references. A minority (2 or 8%) were correct, meeting all four aspects of accuracy. Four (17%) received 3 out of 4, but the majority (17 or 73%) got 2 marks or less. Only 56% of the lists had cited the majority of their references with sufficient accuracy for a third party to locate the source. A similar percentage (52%) had attempted to use a known citation style, and only 43% were consistent in their application of their style. A very small number (3 projects – 13%) had no major flaws.

4.7 Citation weaknesses

Table 8 shows the number of projects by programme and their particular citation weaknesses which fell into 9 main categories.

Table 7: Citation weaknesses

	Civil	CEM	Total
Poor web page citation	4	8	12
Omitted place of publication (books)	5	6	11
Grouping by type	2	6	8
Omitted publisher (books)	3	3	6
Poor terminology	0	3	3
Poor legislation citation	1	2	3
Omitted page numbers (article)	1	2	3
Omitted year	1	1	2
Omitted volume/part (article)	0	1	1

Citing web pages correctly seemed to be the main issue for both groups of students. Citations ranged from a listing of URLs (including www.google.co.uk under "W"), to omitting parts of the reference – "date accessed" being the most commonly omission. In the case of references to books, omitting the place of publication was also common, although in some cases including unnecessary information also occurred, such as the full postal address. Omitting the publisher completely was also evident. One-quarter of CEM students grouped their references according to type: "books", "journals", "websites" etc., which was neither helpful to the reader, nor based on any referencing style. Three CEM students displayed a lack of information literacy by referring to journals as "magazines", book chapters as "journal articles", and misusing "op.cit" and "ibid". Citations to legal material proved difficult in three cases, and omitting page, year and volume/part information from all material types also occurred.

5. Discussion

5.1   Comparing the two groups

The comparison between the standard of the literature reviews and their referencing from the two programmes was a little difficult as one programme consisted of undergraduate students who were studying to obtain a Master's degree over a four to five year period, and the other programme consisted of Bachelor degree students who were studying over a three to four year period. However, the same information literacy training, in terms of how to find and cite material correctly, was available to both groups and the disparity between the data from these two groups of students was perhaps greater than was expected. We have seen that such disparities are evident in the literature in terms of the level of citation and its accuracy. In Carlson's (2006) study, first year students cited on average less than their seniors (7.78 compared to 10.11). A comparison of undergraduates' citation behaviour by Oppenheim and Smith (2001) and Master's students by Clarke and Oppenheim (2006) showed on average a difference in the mean rate of citation in favour of Master's students. Although the comparison was between two pieces of work which were of different lengths, the results showed that the mean citation rate for the Master's' students was 60.2 and for undergraduates it was 34.9 citations per project. The difference between the mean citation rates for Civil and CEM programmes was 13.7, with the Civil students having a mean citation rate of 45.2 and CEM students having a mean of 31.5. This compares to a mean of 42 citations from civil and building Master's' theses examined by Eckel (2009) and of 40.44 from 18

civil Master's' theses examined by Williams and Fletcher (2006). The mean differences in rates of citation for this research (13.7), and in the literature generally, tends to show that the higher the level of study, the greater the number of sources that a student will cite, while it is recognised that there may be differences in the respective length of the work. . Thus, there is a clear opportunity for designing interventions that would help narrow the gap between the two programmes examined here.

The analysis of citation accuracy is perhaps less well-covered at student level than the analysis of the frequency of the sources that they cite. However, Clarke & Oppenheim (2006) examined the citation accuracy of 310 references to journal articles found in 20 Master's bibliographies. The authors found that 77 of the article citations had errors (24.9%) split between a number of error types with almost 50% of them relating to the format of authors names or errors in pagination. In conclusion, Clarke & Oppenheim (2006) found that of the 20 bibliographies only three (15%) were error-free. By comparison, the 52% of 'error-free' Civil students' bibliographies looks above average, while the fact that only 8% of CEM projects were error-free is a cause for concern. Comparisons are not straightforward though, given the precise criteria by which errors were judged to have occurred.

5.2   Literature review mark

There was a correlation between the mark obtained for the literature review and the overall mark that the students received for their final-year project. This suggests that, the higher the mark gained for the literature review, the higher the overall mark. There was also a correlation between the number of references cited and the mean literature review mark, although, as stressed by this paper, this correlation is a little weaker. While causality cannot be conclusively shown for these two results, it is useful evidence to have to encourage students to read and cite widely in order to have a greater chance of gaining a higher overall mark.

5.3   Currency of reading

In most cases, students in this study had cited fairly recent references (2000-2005). This seems to agree with findings by Gannon-Leary et al. (2006), which showed that, for nursing undergraduates, even though these students belong to a very different discipline, the peak age of references was 7 to 9 years earlier than their students' coursework completion date. Interestingly, Oppenheim and Smith (2001) found the majority of references cited by undergraduate Library and Information Studies (LIS) students in their study were 0-5 years old. In a later study Clark and Oppenheim (2006) found that of the 7223 references cited by LIS postgraduates, 55.7% were to items between 0-4 years old and a further 16.1% of these were 5-9 years old. Whilst it could be argued that LIS is quite a different subject area to Civil Engineering, which may explain these differences, 11.8% of citations in Clark and Oppenheim's study were not dated, a not dissimilar figure to the 9% of undated references supplied by the Master's students in this study.

Studies that provide a more appropriate disciplinary comparison include the work by Williams and Fletcher (2006) who found that 50% of the material being cited by Master's' civil engineering students was on average less than 6 years old and 80% of the material had been published within 14 years. Similarly, Kushkowski et al.(2003), who examined Master's and PhD theses completed during 1973-1992, found that half of the engineering citations they examined were seven or less years old. Generally across the research where the citations of engineering students are examined, either graduate or undergraduate, a fairly consistent profile of student citing behaviour emerges with a good proportion of references being about 6-9 years old.

However, in this current study, there were 72 citations of sources from 1980s and earlier material amongst the Civil Group and 101 citations dated 1980s and earlier by the CEM group. Indeed one of the moderators commented on the currency of one student's references asking "Why so many

old 1960s [and] 1970s texts?". With this in mind, any new approach to teaching the literature review should encourage students to think about the currency of the material they cite as part of more holistic strategies they need to adopt to evaluate information sources.

5.4   Types of materials cited

It is encouraging to see such a broad range of sources read and cited as part of students' final year projects. This underlines the importance, not only of teaching access to the secondary literature (books and journals), but to primary sources as well (standards, legislation, etc.). It also highlights the importance of teaching students how to cite such materials as part of the information literacy practices that one would expect at this level of academic work. These results tie in with the findings from the literature. Books and journals are consistently the two most popular sources that students cite. Oppenheim and Smith (2001) and Clarke and Oppenheim (2006), both noted a consistent use of these two sources forming the majority of citations, although actual percentages did vary notably in favour of journals, particularly for students who were at an advanced level of their academic studies. This result is confirmed by Carlson (2006) who found a gradual increase in the percentage use of journal papers and a gradual reduction in the number of websites cited by students' nearing completion of their undergraduate studies. Oppenheim and Smith (2001 p.303) have noted though that "it has been suggested that the 'harder' the science, the greater the proportion of citations to journal literature". This point is based on Price's observation (1998, cited in Oppenheim and Smith, 2001, p. 303) that "at least '80% of the citations in a scientific literature should be to journal literature". Whilst the Civil group in this study did not hit the 80% target, it may explain why the students examined were heavier users of the journal literature than their CEM counterparts, whose projects had more of a Social Science/Management thrust.

This research also found that websites were the third most popular source overall (16.9%) and were second only to books for the CEM cohort, but came fourth after the report literature for the Civil group. In their study, Oppenheim and Smith (2001) found that citations to websites increased year on year between 1997 and 1999, to a high of 17.2% of the total citations in 1999. As their analysis was performed 10 years earlier than the current study, the figure of 16.9% citations to web sites by Civil students seems quite low. Similarly, other recent studies have produced surprisingly low numbers of citations to web sites. For example, Gannon-Leary et al. (2006) noted that 12% of total citations by nursing students were to web sites, while Clarke and Oppenheim (2006) showed that postgraduate students' use of electronic formats generally increased at the expense of printed formats, although there were some fluctuations in level of use over the period of their study. By contrast, a study by Kraus & Fisher (2000) illustrated that a mere 1% of citations by biology students in 2000 were from web sources. It is interesting to note in the current study that the long tail of other sources cited, namely standards, regulations (including legislation), theses, manuals, newspapers, lecture notes, correspondence and case studies, accounts for 10% of the total citations.

5.5   Citation practice

It is in the area of citation practice that some of the biggest concerns resulted from this research. The analysis we undertook was subjective in that it relied on the researchers' opinions as to whether the citations met the criteria being analysed. However, the discovery of over 80% of reference lists in the CEM cohort and 40% of the Civil group with major flaws, is clearly an issue. Similarly, the fact that 117 of CEM students' references offered no date, and that the three projects where the majority of references provided no date received some of the lowest marks for their literature review, cannot be ignored. These findings strongly point towards the need for further IL training and support in this area. For example, the Civil & Building Department currently has no Departmental Citation Standard. It may be that the introduction of such a guide as part of the Departmental Handbook would improve referencing amongst students. This Guide could also focus on citing non-standard items such as legislation and web sites, which this study has highlighted as an area of particular weakness. The introduction of assessed referencing teaching

at an early stage in the students' academic careers, particularly through the use of RefWorks personal bibliographic software package, would also help.

6. Conclusion

The results from the research on the two programmes, Civil and CEM, showed a general agreement with the literature. Where disciplinary comparisons were possible, the rate of citation, the type and currency of citations were broadly similar. In this study where comparisons were made between programmes, students who were studying for an MEng cited more journal articles, more recent material and fewer web sources than their Bachelor degree counterparts. Despite the original assumptions that students would cite web-based sources very frequently in their work, the data showed that web based citations were less pronounced than expected, although for CEM students, web resources were the third most-frequently cited source.

The results strongly suggest there is scope to continue and expand a process of information literacy education aimed at improving the citation practice for students with particular emphasis on:

- Improving citation accuracy through example and standardisation at departmental level
- Narrow the gap in the frequency (upwards) of items cited between undergraduate and Master's students
- Explain the necessity, as an aid to increase the credibility of their research, to cite and examine current research where appropriate
- Improve students' ability to assess the quality of the sources they cite, particularly if material is taken from general websites
- Encourage the evaluation of sources and citation of an appropriate range of materials
- Set broad guidelines on the number and composition of citations that are necessary to constitute a credible literature review
- Emphasise that the authority, currency and balanced composition of references cited is likely to lead to a better literature review and overall project.

These strategies will inform the new approach to teaching the literature review by library and academic staff, the success of which, it is hoped, will be assessed by performing citation analyses on the literature reviews of future students.

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