

Action research for generic skill development: an integrated curriculum approach to develop information literacy, critical analysis and English expression of engineering students (utilizing triangulated assessment)

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***Abstract:** This paper concerns the extent of engineering students' generic skills in searching and retrieving the professional published literature and their ability to read, conceptualize and write a simple literature review. Students with a range of written English ability, including English as a Foreign Language (EFL) and English as a Second Language (ESL) are the subjects reported in this paper.*

Provoked by a paper presented at AaeE 2001 in Brisbane (Airey, 2001) an academic staff member and a librarian formed a partnership to undertake an action research project. One goal was to extend students' information literacy capabilities in a piece of integrated assessment. A further objective was to integrate generic skill development while researching a topic on sustainability. The action research project was embedded in the Mechanical Engineering unit, Energy and the Environment.

Students conducted a literature review. They were required to give a coherent account of issues raised, to describe the links and correlations, ambiguities and weaknesses of current knowledge contained in their selection of literature. Students were also asked to give their own opinions and predications of the technology studied.

A triangulated, moderated, assessment system comprising academic, librarian, and peer marker was employed. Statistical correlations between the three components were undertaken. Our findings support one of two possible scenarios: either a sizeable proportion of the student cohort had low critical analysis skills, or socio-cultural barriers to honest peer assessment came into play.

***Keywords:** Integrating generic skills, Information literacy, Written English ability, Peer assessment.*

Introduction

There is tension striking the balance between measuring *hard* technical engineering knowledge acquired and working to develop students' *soft* generic skills. We term this tension the “crowded curriculum” dilemma.

In this paper we discuss our experience attempting to integrate some generic skills into an engineering unit.

There is an impression amongst many students that information obtained from the World Wide Web is sufficient for a literature review. Serious implications follow for the quality of life-long learning key to Engineers Australia (IEAust) graduate attribute requirements.

With a background awareness of these issues a teaching partnership between academic and librarian arose and resulted in the work described in this paper. The circumstances of the development of the partnership are relevant to understanding the issues of the “crowded curriculum” and generic skills development are briefly described here: the librarian has had significant experience in administering the undergraduate, postgraduate and research aspects of the engineering collection at QUT. An important part of this work involves teaching/disseminating basic and advanced skills of information retrieval and literacy to staff and students through individual consultation, workshops and seminars. It had become obvious through the course of this work that there was minimal time in the curriculum for these skills to be transferred. However, through many individual consultations it was apparent that students frequently needed these skills in tasks such as undergraduate projects. One difficulty in teaching these skills in seminars presented to students was that they were taught somewhat removed from the engineering context. The academic had been teaching the course Energy and the Environment for two years and had found that there was a plethora of information available in this area in both the Web and the refereed literature. Students had great difficulty in appropriately accessing and processing this information while taking a critical approach. One compounding factor was that energy and sustainability issues are strongly influenced by the background and/or agenda of the author. On issues such as Greenhouse, fossil fuel reserves, emerging alternative energy technologies and sustainability issues even the experts do not agree. Students needed help to manage tasks associated with the Energy and Environment course.

Thus the academic and librarian were trying to achieve similar goals and it was felt that by syndicating teaching information retrieval and literacy in the context of an actual course would enhance the objectives of both parties and provide benefit to students. A creative tension existed between the academic and librarian's skills and approaches, shared/different values and their difference in emphasis.

The Faculty of Built Environment and Engineering at QUT has been motivated by the Institution of Engineers statement on generic attributes of Graduate Engineers. Our action research project sought to enhance students' generic skills namely, researching information, thinking critically about information, English expression, coaching for improved performance.

We believe our work can fairly be described as *action research*, as it fits most of the accepted working definitions. (Altrichter, Kemmis, McTaggart, & Zuber-Skerritt, 1991, p. 8). We began our project with the premise that our students' generic skills in the areas detailed above

were wanting. We set out to measure skill levels while at the same time; we sought to improve the skills we were trying to measure.

This paper poses questions about integrating generic skills into a crowded engineering curriculum. We look at engineering student information seeking behaviours and the issue of various levels of written English language ability in a diverse student cohort. We discuss the labour required to administer this type of assessment and the value and reliability of peer assessment.

In this exercise we wanted to integrate generic skill enhancement with the acquisition of technical knowledge. The intent was for students to learn in a self-directed manner through discovering the history, developments, limitations and possibilities of energy technologies. We wanted students to read the published state-of-the art. The learning goals embodied in the set task were:

- For students to learn about sustainable energy systems, by means of researching the published literature and writing a review;
- For students to learn about sustainable energy systems by peer marking one other's review;
- Reflect on some of the contentious areas in environmental / energy policy;
- Develop critical thinking skills both by researching their topic, and by offering a critique of one other;
- Develop and enhance students' information retrieval skills;
- Develop and enhance students' writing and citing skills;
- Promote the use of peer-reviewed scholarly literature;
- Develop students' coaching skills, that is, skills developed as a peer marker.

The paper commences with a description of the course, assessment and student cohort details. This is followed by a description of the assessment

Student Cohort and Assignment / Assessment Details

Our two cohorts (one undergraduate, the other postgraduate) included different proportions of overseas students with native English, English as a foreign language (EFL), English as a second language (ESL) or non-English speaking background (NESB) as shown in Table 1.

	EFL ESL NESB	Native English Speaker	Total
MMB451 Undergrad	7	20	27
MEN175 Postgrad	22	2	24

Table 1: Student cohort language background

	Singapore	Thailand	Indonesia	Europe and Other	Australia	Total
MMB451 Undergrad	5	0	0	0	22	27
MEN175 Postgrad	2	11	2	5	4	24

Table 2: Student cohort – origin

Table 2 shows that our students' country of origin varied, with south-east Asian countries predominating. The overseas students in the undergraduate cohort get credit for half of the BEng. degree for holding an approved overseas diploma qualification.

As one of four pieces of assessment in a thirteen week semester, mechanical engineering students studying Energy and Environment were set the task of conducting a brief literature review. We suggested they research one topic from a selected range of thirty environmentally sustainable energy technologies. It was also possible for students to negotiate a topic of their own interest. Later in the semester each student got to mark one other's paper. Then the academic and the librarian's marks were correlated and moderated to give a final mark.

Students were asked to review the published literature to evaluate the practicality, viability and sustainability of various technologies and to predict future trends. We stipulated students review at least five pieces of literature, encouraging them to keep searching until they had a coherent selection of papers.

We encouraged the development of critical thinking skills by asking student reviewers to distil the essence of an author's argument. Students were asked to identify unifying threads or determine opposing points of view from a number of writers on the same topic. We asked students to distinguish between empirical fact and writers' opinions. We were also trying to test students' ability to conceptualise a topic/problem.

Students were encouraged to analyse the literature, and to construct their arguments using the *debatable statement / debatable position* device. A debatable statement is one that can be proved wrong by reasoned argument. This concept is commonly taught in many writing and rhetoric courses e.g., (Colorado State University. Writing Center, 2003), (Hoffmann, 2003)

Peer assessment was included in the assessment procedure. Markers were rewarded with a mark (up to five percent of total assessment) for their effort. We felt the skills student might enhance by marking are somewhat akin to those *coaching* skills necessary for management and supervision. Therefore peer marking could have some valid claim to build generic skills in our graduates.

Assessment Results

Our experience with the peer marking exercise mirrored that of the results of the lecturer's earlier experiment with peer marking "Students ... found it quite difficult to make a critical assessment of the papers they were marking." (Brown, 2001, p. 347) This also accords with Airey who writes "It is evident that most students are reluctant to say that their work, or that

of their peers is anything less than good, and that on average the students tend to overestimate the quality of their assignments. (Airey, 2001, p. 406)

In common with other researchers, e.g., (Airey, 2001, p. 407) our experience is that a peer marking exercise does not save lecturer effort. In fact, it requires a good deal of effort to administer and moderate.

The standard of written English expression overall was poor. This is matter of concern as these students were only one year away from graduation. Not surprisingly EFL/ESL students did less well.

Inadequate skills in English expression (spelling, grammar, syntax, and vocabulary) were not confined however to EFL/ESL students. Few of the native English speakers distinguished themselves with this piece of assessment.

Whilst there were a good number (about three quarters) of competent examinations of the technology, few (about one fifth) of the students produced a report that was particularly easy, or a pleasure to read. Feedback given to students when they received their mark included pointers, such as:

- Consider your reader;
- Proof read;
- Check spelling;
- Write with brevity and clarity;
- Avoid overly long sentences;
- Avoid flowery prose;
- Understand passive vs. active voice (as a rhetorical device);
- Correctly reference literature;
- Consider acquiring useful writing tools for your professional library e.g., dictionaries, thesauri, guides to modern English usage, and rhetorical style guides.

Perhaps our most important piece of advice was to urge students (as nearly fully-fledged professionals), to read more. In order to be a competent professional writer, one must *read* good writing. We suspect that (in general) engineering students read and interpret texts a good deal less than other students.

(Orr, 2002, p. 42) points to the contradiction that while English is predominant in practice of engineering, most of the world's engineers are not native speakers of English. Orr believes that the engineering profession needs a reliable instrument for measuring competence in engineering English. He goes on to propose the application of Douglas' "Language for Specific Purposes Test". (Douglas, 2000)

Overseas students are partly motivated to choose Australia because this is an English speaking country. Perhaps our engineering curricula have paid too little attention to the quality of English expression required of our students? Australian universities may need to guard against the lowering of written English language achievement criteria as a mechanism to cope with significant EFL/ESL populations. Should we set objective tests in English competence before we allow our students to graduate as engineers?

The primary focus of this unit is *hard* technical knowledge. We are perhaps uncertain of the true writing capability of students as we had relatively few marks available to give sufficient incentive. Fifteen percent of the total unit marks were allocated to the literature review. Ten for the review, and five for their marking effort. Any trade-offs in this attempt to integrate technical and generic, we term the “crowded curriculum” dilemma.

Students exhibit a clear preference to cite Web-based sources. Despite being explicitly instructed not to use public domain Web sites, a few students persisted in only citing Web sites. This accords with the findings of Philip Davis’ longitudinal studies (Davis, 2003) that show a clear reluctance of microeconomics undergraduates to cite *other* than Web documents. One of our undergraduates wanted to know why we insisted on scholarly literature when he was *sure* he would not have access to such literature, as a graduate practising engineer. His perception was most working engineers are information poor, practising on the wrong side of the digital divide. It was felt that this reflected a poorly developed concept of the work of a professional engineer and it is a concern that such concepts persist into the latter years of an engineering degree.

The fact that most of our subscribed, peer-reviewed scholarly literature is available through a Web browser (via seamless IP authenticated access) does tend to blur the distinction. Information literacy education needs to equip students with skills to distinguish between edited, reviewed, scholarly writing and the public domain, unfiltered opinions and trade literature found on the Web.

Students had a poor conception of how to correctly cite literature in the text, and in their bibliography. Of twenty-seven papers, only three students cited literature without flaw or blemish.

Observations on Marking

Figure 1 shows the correlation between the librarian and the lecturer's mark for the undergraduate cohort. Native English speakers and long term Australian residents (full symbols) are distinguished from EFL/ESL speakers (outline symbols). In general the marks for the EFL/ESL students were lower than that for the native speakers, though the EFL/ESL group is small and may not be completely representative. It can be observed that there is a strong correlation ($R^2 = 0.9726$) between the lecturer's and librarian's marks for the EFL/ESL literature reviews. Presumably this indicates that both markers could more easily distinguish features in the literature reviews for which they could award marks. Two such features would clearly be English expression and evidence of a critical approach. Correlation between the lecturer's and librarian's mark for the Native English speakers is lower ($R^2 = 0.7494$) than that for the EFL/ESL students, though still significant.

When a general comparison of the lecturer's and librarian's marks is made by comparing the position and slope of the trendline it can be observed that the for the Native English speakers the librarian gave a lower mark on average than the lecturer. After discussion this was found to be because the lecturer recognized the technical content of the literature reviews where as the librarian generally found all Native English reviews were deficient in English expression. For the EFL/ESL students the same trend can be observed, though the sample is small. The lower EFL/ESL marks are particularly noticeable as being given lower marks by the librarian than the lecturer. In these items the English expression was particularly poor yet there was still a basic level of technical content.

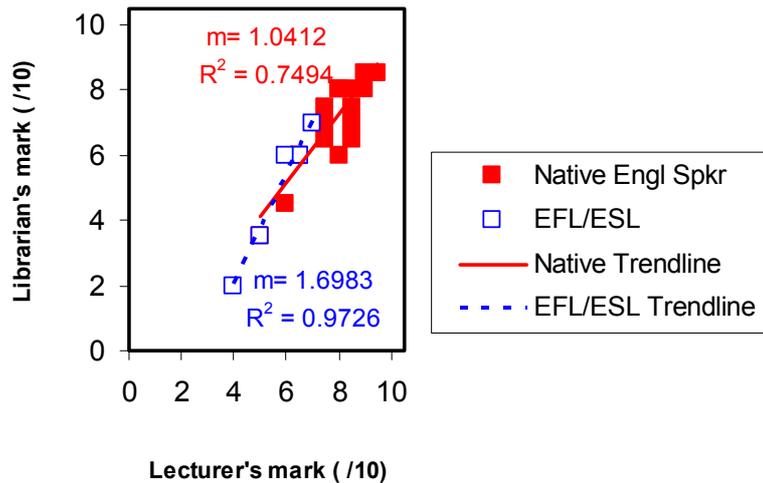


Figure 1: Correlation between librarian and lecturer's mark

Figure 2 shows the correlation between the mark given to a literature review by a peer marker and the average of the lecturer's and librarian's mark. The EFL/ESL literature reviews were generally marked by native English speakers. For the EFL/ESL students there is a strong correlation ($R^2 = 0.8244$) between the teaching team mark and the peer mark. As in Figure 1, this indicates that there were features in the work that made it possible to discriminate marks. The most obvious factors are clear English expression and critical approach. The technical content of both groups was similar. By the position and gradient of both trendlines it can also be observed that the mark awarded by the peer markers was higher on average than that of the teaching team average.

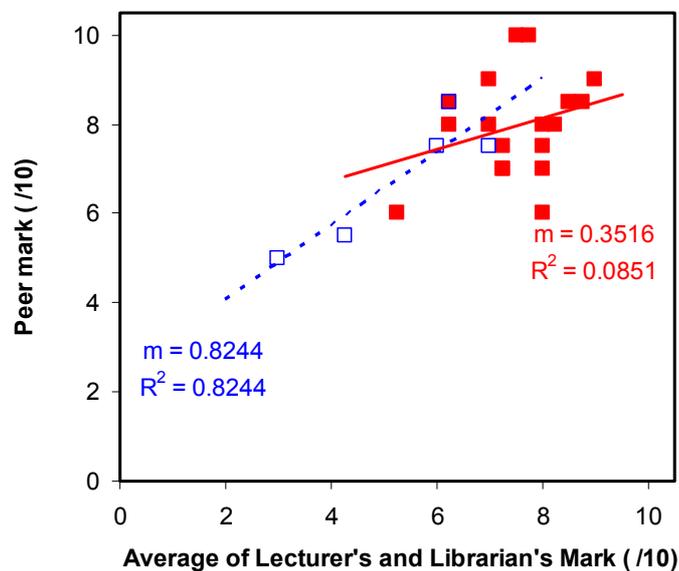


Figure 2: Correlation between peer mark and average of lecturer's and librarian's mark. (symbols as for Figure 1).

Figure 3 shows the correlation between the peer mark and the lecturer's mark for a cohort of postgraduate students. Though the correlation for the native English speakers is strong, the sample is so small that we can say little regarding the trend. For the EFL/ESL students, the

correlation is close to zero ($R^2 = 0.0004$) indicating either or both lack of critical ability is assessing peers work and/or reluctance to criticize another's work. The gradient of the EFL/ESL trendline is close to zero ($m=0.0241$) with an average close to 8. Most EFL/ESL students adopted the universal mark of about 8/10 for the literature review they marked even though this would reduce the mark they received for their marking effort. We note that the names of peer markers were released to the writers of the literature review.

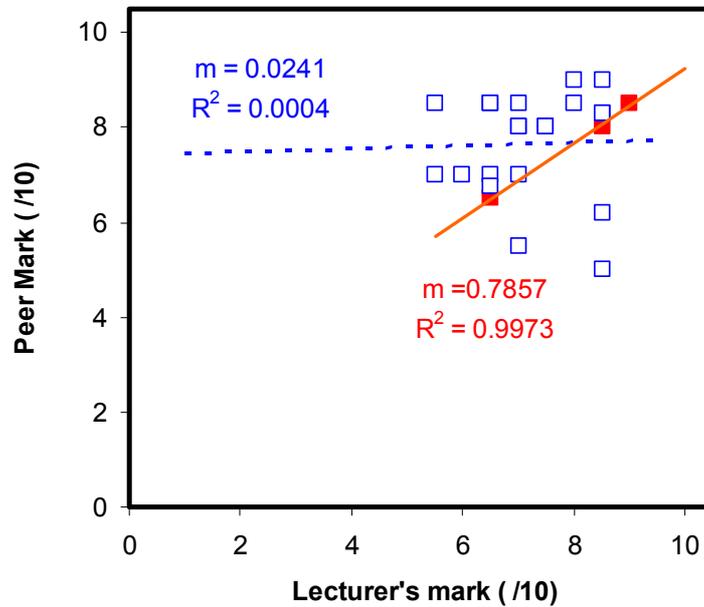


Figure 3: Correlation between peer mark vs. lecturer's mark. (symbols as for Figure 1).

Conclusion

Whilst the majority of students wrote good reviews in the sense they understood the technology, their English expression and writing skills were found wanting. Because of this the academic and librarian had to moderate their respective marks to arrive at a consensus mark. We think the *creative tension* in moderating a student marks was instrumental in finding the right balance between students' technical knowledge acquisition and their generic capability improvement.

Significant differences in students' ability to undertake critical evaluation of literature and their peers' work were found to be related to their background and English ability. It may be desirable in the future to specifically target this group to help them develop these skills.

As an action research project we have implemented changes as a result of the findings of the present study which will have ongoing evaluation. The major development is an online teaching resource which has been created to guide students. We have removed student choice in citing styles having stipulated an Author-Year style (and given examples of citing most literature categories). Our online teaching site has links to exemplar review publications in energy and engineering. As an ongoing piece of action research, 2003 students have the benefit of reading our marker's feedback to the 2002 cohort before they undertook their literature review. Evaluation of these measures will be the subject of future papers.

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