Meeting the Communication Skill Needs of Employers with Professional Portfolios

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CONTEXT

Engineering graduates need to meet the high expectations of the profession for strong communication skills. Many institutions use stand-alone communication skills courses to meet these education needs, though students can find them unconnected to their degree, leading to dissatisfaction and poor learning. Improvement of writing skills through an across-the-curriculum approach, is very difficult to co-ordinate, assess and document for employment or accreditation purposes. This paper considers a Portfolio approach to teaching communication skills at the University of Canterbury.

PURPOSE OR GOAL

Our new Portfolio program is motivated by employers' comments on engineering graduates' weak communication, especially writing, skills, and the need to demonstrate learning of communication skills for accreditation. Because students rate their abilities in communication skills highly in our exit surveys, the new programme intends to resolve the disconnect between students and employers.

APPROACH

Students are required to revise and polish six of their course outputs to a professional standard, and then present them as a 'Portfolio' of work for a 0 credit course. Passing this course is a prerequisite to entry to the compulsory fourth-year course in Professional Engineering Development, which requires a high communication standard. To support students in this process, we have developed a 90-page Communications Portfolio Guide that sets out our expectations and provides guidance. An array of workshops and tutorials are used in place of lectures and assignments. These are conducted by a mix of post-graduate students, Learning Skills Centre staff, and academic/professional engineers. Assessment is done with a clear Marking Guide employed by post-graduate students and moderated by a senior tutor and the academic co-ordinator for communications skills development. Additionally, the Portfolio program has benefitted from extensive engagement by a practising engineer who has spoken with students, provided professional samples, and also checked our pass/fail bar.

ACTUAL OR ANTICIPATED OUTCOMES

The first full implementation was in 2013. That year, over 40 students out of 170 failed to meet our passing standard. Roughly half of the 40 failed because of sentence-level grammar issues (e.g., comma splices), while the other half failed because of inadequate attention to our presentation/formatting requirements. We are challenged by a significant number of students who are not motivated to improve their communication skills, and also challenged by a student culture unaccustomed to revision and resubmission of work to reach a professional standard. All 2013 failing students met the standard in 2014 after supplemental work.

CONCLUSIONS/RECOMMENDATIONS/SUMMARY

Students are succeeding in meeting professional writing standards. The predominance of small errors and multiple resubmissions have led us to increase the emphasis on error-checking. The program has the full support of employers and academic staff. We believe that meeting communication goals relies on clear links between employers' needs, and effective curricular design to develop students' communication skills.

KEYWORDS

Writing, curriculum development, portfolio assessment.

Introduction

Engineering graduates need to meet the high expectations the profession has for strong writing abilities and other communication skills (e.g., oral presentations, and drawings). Though similar to the communication skills required by scientists and technologists, engineers are expected to master significantly different communication skills than other university students (Sageev & Romanowski, 2001; Gorman et al., 2001; Reave, 2004; Passow, 2012). For example, engineering students need to learn how to write succinctly and objectively with a passive voice (Walker, 2000). This and other changes in writing processes can mean that students may need to unlearn some of the skills they acquired before entering an engineering degree program.

Engineering students need to master writer-, genre-, and reader-oriented composition, though not necessarily to equal levels or at the same time (Paretti, 2008). In Years 2 and 3 (of a 4-year curriculum), engineering students need to master 'genre-oriented composition'. This requires that they demonstrate the ability to match the expectations for diverse, yet specific, writing types: cover letters, laboratory reports, design reports, engineering drawings, and oral presentations. In Years 3 and 4, engineering students, to varying degrees, need to focus more on 'reader-oriented composition' that recognises and addresses the distinctions resulting from the variety of readers they will have. In Year 4 and in professional practice, the emphasis shifts more to 'writer-oriented composition'. At this stage writing becomes linked to reflective practice as part of the step that engineering students take towards the life-long learning required of professionals (Schon, 1983, 1990).

Although the process of developing writing skills is applicable to all engineering degrees, it could be argued that the challenges are greater for civil/environmental engineering educators who teach writing. These graduates need to write not only for other engineers, but also for clients and affected citizens. This diversity of audiences complicates the process of teaching writing to engineers. Development of communication skills is central to the education of civil and environmental engineers. Although this paper describes an approach implemented for civil and natural resources engineering students, much of the analysis can be applied to other degree programs.

Employers commonly identify communication (particularly, writing) skills as the greatest weakness of our engineering graduates, similar to observations made of other graduates (Sageev & Romanowski, 2001; Ostheimer & White, 2007). A typical comment from an academic in the department reads:

> *In my opinion most [of our students]... are absolutely terrible writers probably because we have encouraged those students who are good in math and sciences to come into engineering rather than those students who are good in maths, science and English. No matter how much we emphasise that writing is important, it is not until they get out to work that they get a shock when the employers tell them how terrible they are. They simply don't believe us.*

Our Advisory Board (comprising employer representative from industry) highlighted poor writing skills as the greatest weakness of our department's graduates, while also recognising that this problem is severe with engineering graduates they hire from other universities. Increasingly, engineering firms organise in-house courses for new graduates on engineering writing. A two-day course run in Wellington by BrightStar in 2010 on 'Report Writing for Technical Professionals' cost NZ $2,000, indicating high market demand for improving writing by the broader technical professional sector. Anecdotal evidence indicates that civil and environmental engineers are becoming less prominent participants in aspects of multi-disciplinary engineering projects where communications skills are critical, to include bidding documents, permit/consent applications, and financial project assessments. Various national and international accreditors for engineering qualifications have identified a need for

curricular innovations to address communication skills development (Felder & Brent, 2003; Pappas et al., 2004; Becker, 2006; Passow, 2012). The message university engineering educators receive is very clear: improvements must happen or the value of our graduates will suffer greatly.

On the other hand, in our exit surveys students rate their communication skills as one of their educational strengths. Our graduates were asked how well they believe their education prepared them for each of the attributes of our engineering graduate profile. For graduates of 2007 and 2008, 'communication and writing' scored 4.0 (on a scale of 5), which was the third highest of 10 attributes, outscoring 'Ability to understand and apply engineering sciences (3.6)' among other attributes. Our students either do not believe that engineers need to be good writers, or are convinced that their writing skills are already adequate. It is relatively easy to address an education problem when students admit that they have gaps in their education. It is a much more difficult matter to improve teaching and learning when students do not see that their current education is deficient (Dannels et al., 2003). This disconnect between employers and recent graduates justifies our bold new initiatives.

Some background context is needed regarding our specific situation. We have roughly 5% international students, 30% women, and some of the brighter students in the country. The Years 2 and 3 curricula allow for no electives, and in Year 4 students have two required courses along with five options to complete their program of study. Excepting the students who fail courses, most students are taught as a cohort through Years 2, 3 and 4. This means that we can and do exert significant co-ordination between courses to balance workload and ensure consistent treatment of various topics. We have not received comments regarding any changes in our approach to teaching communication skills from past national accreditation boards. We have relied on various communication skills being taught in one or another required course. These particulars need to be noted because they can make it difficult to extrapolate our experiences to other engineering programmes.

Rather than have a specific communications competency in the final year, we have chosen to have ours at the end of Year 3. Our two compulsory courses in Year 4 ('Project' and 'Professional Engineering Development') require stronger communication skills of our students. O'Sullivan and Cochrane (2002) comment on the strong key role that communication skills have in our project course. To promote success in these Year 4 courses, writing skill improvements in Years 2 and 3 were urgently needed. Rather than fail students in Year 4 courses on the basis of weak communication skills, our department agreed that a pre-requisite level of communication skills would need to be attained before entry into these required courses. Further advancement in communication skills is expected in those Year 4 courses, and these advances are assessed against higher standards.

Other engineers have highlighted the difficulty in applying the literature on teaching of writing skills to university engineering education. For example, Robinson and Blair (1995) note that, "… much of … [the literature is] conflicting and not all of it relevant to the writing requirements of [engineering] disciplines." Much past work on teaching writing to engineers (e.g., Beaufort, 2007) seems to come from the viewpoint that simple adaptations of methods used in the arts, humanities, and social sciences will be sufficient to allow engineers to reach communication goals. Others suggest that writing across the curriculum approaches are adequate for such purposes (Boyd and Hasset, 2000). Our assessment is that a distinctive approach is needed: one that focuses on the specific communication tasks faced by practising engineers, and one tightly linked to employers' expectations.

Methods of teaching writing skills that focus instruction on the requirements of different specific types of writing are often called genre-oriented approaches (Walker, 1999). Although critics dismiss these approaches as taking a cookbook or template-driven approach to

teaching writing, they have the distinct advantage of being goal focused, which helps in convincing reluctant engineering students to put in the effort to improve. Universities as diverse as M.I.T. (Paradis and Zimmerman, 2002) and Curtin University in Australia (Grellier and Goerke, 2010) have developed Writing Style Guides with a clear dependence on a genre-based approach to teaching communication skills. Grellier and Goerke (2010) go so far as say that the way engineers use unique document types for specific purposes is like using specific tools for specific mechanical tasks. Contextual learning, and hence genre-oriented teaching of writing, is particularly important for engineering students because they are characteristically practical-oriented learners.

Too many engineering students arrive at university convinced that either they cannot write or do not need to write. Engineering education needs to move beyond classing students as 'bad' writers, and instead treat them more as 'uninitiated' writers (Fernsten and Reda, 2011). Genre-oriented approaches help to emphasise that learning writing is acquiring a set of (transferable) skills.

Recent research in engineering education has emphasised the importance of involving industry in education (e.g., Lamancusa et al., 2008). A tight link between improved teaching of writing and addressing employers' expectations aligns with calls for more professional links for engineering students (Donnell et al., 2011). This call is both strong and multi-national (ASCE, 2004; King (Aust.), 2008; Royal Academy of Engineering (UK), 2007a, 2007b; U.S. National Academy of Sciences, 2004).

Departmental Stocktake

Goals

The Department considered the graduate profile (as set by our accrediting body, IPENZ) and the abilities of incoming students in establishing year-based communication goals for graduates. Because of our decision to assess Portfolios based on communication skills developed in Years 2 and 3, we focused on those needed at the end of Year 3. These are shown in Table 1.

Analysis of grammar errors

In order to better understand the skills of current students, a number of assignments were examined by a co-author with extensive experience of advising students on ways to improve their writing. The analysis indicated that grammar issues were much more serious than subjective issues such as structure or overall logic or clarity (though there were issues with these as well). Knowing that it would be impractical to teach all the applicable grammar rules to such a wide range of students, a count was made to see which errors were most common. The most common errors were:

- Spelling mistakes (including capitalisation and apostrophe use)
- Run-on sentences (two independent clauses run together)
- Comma splice (two independent clauses joined by a comma)
- Sentence fragments (phrases or dependent clauses treated as sentences)

Combined, these errors were over 50% of the total grammar issues; perhaps unsurprisingly, they also coincide with 4 of the 20 most common errors in undergraduate writing in A.A. Lunsford and K.J. Lunsford's (2009) broad-based USA study. These four dominated over other issues such as: mis-use of articles, confusions over 'which'/'that', delayed verbs causing reading difficulty, mis-use of capitalisation, apostrophe errors, errors of subject/verb agreement, mis-use of verb tense, mis-use of pronouns, inconsistent use of the singular/plural, and mis-use of colons and semi-colons.

Table 1: Communication skills expected of students after Year 3.

Skill
Manage large sets of raw data and use graphical display
Extract concepts from variety of reading materials
Locate reference resources
Extend laboratory reports to an appreciation of implications and research potential
Develop support for arguments in an engineering context
Write an engineering report for a non-engineer client
Write effective instructions and diagrams in an engineering context
Use word-based answers to calc. problems with well documented calcs. in appendices
Deliver a short yet structured oral presentation
Read engineering practice documents (design codes, standards)

Diagnosis of deficiencies

Our former across-the-curriculum approach to teaching communication skills had a number of deficiencies, which were highlighted by the examination of student work. These were:

- Students were partly assessed on communication skills in each course, but never so much that it was a key determinant for the final grade; as a result, an improvement in weak communication skills had not been demanded.
- Faculty gave students inconsistent messages about the expectations for each type of report (e.g., laboratory report vs. assignment); this limited the impact of the instruction that was carried out independently in each course.
- There was no co-ordination between courses regarding communication skills assessment or standards, and hence no logical progression for students.
- There were few or no questions related to communication skills in examinations; this reinforced the student perception that good writing was less important than solid quantitative skills.
- We increasingly used group reports at higher levels, which made it more difficult to demonstrate or assess individual competence at essential communication skills.
- Students were not shown the relationship between communication exercises in their coursework and the communication expectations after they graduate and are in practice.

A Portfolio Approach

Two predominant approaches to teaching communication skills to university engineering students exist. One approach relies on formal communication courses. The other method could be called an ‘across-the-curriculum’ approach, where communication skills are advanced in a systematic way by introduction into courses throughout the curriculum. Innovations and improvements in across-the-curriculum approaches are acknowledged (Waggenspack, et al., 2013).

Because the majority of our engineering students are taught as a cohort, with most students taking the same courses at the same time through Years 1-3, it is theoretically possible to provide effective co-ordination with this latter approach. However, there had been no clear way to assess communication outcomes and ensure attainment of our goals prior to Year 4.

Our Department’s faculty considered the option of a separate communications course, but was very reluctant to move in that direction. The perception is that such courses do not effectively link communication skill development to engineering practice requirements

because (1) the courses are generally taught by non-engineers, and (2) the courses develop negative stigmas (partly because of academic staff impressions or the generic writing examples used). In addition, our diverse student intake means that a small number of very strong students need minimal assistance to meet near-professional writing standards.

We see our Portfolio approach as a middle, 'third way'. Architects and Fine Arts students often have 'Portfolio Assessment' of their work to support their overall educational development. During these Portfolio assessments the students are asked to provide samples of their best work and an overall assessment is made. We believe a Portfolio approach for assessment of communication skills would give co-ordination while reinforcing that this is improving students' value to employers. In addition, portfolio approaches have demonstrated parallel benefits in engineering curricula (Williams, 2002; Johnson, 2006; Dysthe, Engelsen, & Lima, 2007; Eliot & Turns, 2011).

Currently, the six items in the communications Portfolio are:

1. Sketch (from Year 2 Timber Design course)
2. Laboratory report (from various Year 2 courses)
3. Reasoning report (a qualitative assessment of effects from Year 2 Environmental Engineering or Transport course)
4. Client report (from Year 3 Design course)
5. Calculation-rich report (from Year 3 Structural Analysis or Modelling courses)
6. Oral presentation (from an independent or course-dependent assessment)

The Portfolio is formalised as a 0-credit, pass/fail course that is a pre-requisite for required Year 4 courses.

Portfolio Programme Components

Lectures, Workshop, Tutorials

Direct support for students preparing their portfolios comes in the form of two hours of lectures, a one-on-one tutorial session in groups of 15 students, two hours per week of office hours by the teaching assistant co-ordinator, and a computer lab with tutors. All of these are optional for students. The intention with the lectures and workshops is to give students general advice that will help them to develop skills for their portfolio and, consequently, for all course submissions. All teaching materials are readily available for students through an electronic course assistance website.

Involvement from engineering practice

We advertised locally for a 'Writing Mentor' from the engineering community. Our choice proved to be an experienced consulting engineer who in recent years has given lectures to incoming employees on writing. His assistance has proven very valuable. We have organised for him to give a one-hour lecture to our Year 2 students on the importance of good writing in civil and natural resources engineering graduates. His advice includes the following reasons why students should improve their writing:

- Nearly all the technical specialists and managers in engineering organisations are good writers.
- Senior engineers have to interact with other professionals such as lawyers and planners who are good writers.
- When editing and revision time is reduced, the organisation's costs are reduced.
- Communications have legal standing when disputes arise.
- As a good writer, you will receive better grades while a student and, because your supervisors will be impressed, you will receive faster promotion when employed.
- If you want to be paid at professional salaries, then your writing has to be at a professional standard.

- Improvement in writing skill indicates a positive attitude towards continuous learning. It is an on-going journey. Enjoy the challenge!

Our Writing Mentor arranged for students to receive copies of reports similar in style or intent to the Portfolio items. The Writing Mentor provided copies of reasoning reports, client reports, calculation-intensive reports, and engineering sketches. The Portfolio co-ordinator analysed these professional reports and highlighted to students the similarities and differences to corresponding student report types.

Finally, our Writing Mentor has helped us when assessing the pass/fail bar for Portfolio. This became invaluable when the high initial failure rate (discussed below) made us question whether we had set the bar too high.

Assessment

Assessment has been organised around the six submissions mentioned above. All six submissions must be at Portfolio standard. Significant presentation flaws (e.g., no figure captions or poorly formatted headings) result in a failure. In addition, five 'fatal' flaws lead to failure. The maximum number allowed per each assignment is—

- Spelling mistakes (4)
- Comma splices and run-on sentences (3)
- Sentence fragments (2)
- Faulty parallelism (2)

The last one, although not one of the most common errors in student writing, has been included because of the common use of lists in engineering report writing, and because it draws students' attention to differing grammatical forms.

In addition, to pass Portfolio an overall assessment of the student's communication skills must merit at least 5 out of 10. This overall assessment was needed to identify students who avoided the errors above, but who nonetheless either make large numbers of other sentence-level grammar errors, or who exhibit major style concerns. Either of these problems would decrease their ability to pass our required Year 4 courses. The Portfolio co-ordinator has taken advice from our Writing Mentor and other faculty to develop a qualitative ranking method to use for the overall assessment.

All students are given written feedback by tutors. The Department has a Marking Guide to aid tutors, and this has been provided to students along with the marking sheets. The markers have been a mixture of engineering and arts postgraduate students. A significant amount of oversight by faculty is needed in the grading of portfolios. Maintaining consistency is a key concern, particularly in determining the pass/fail line.

Students who do not pass on their initial assessment have an opportunity to resubmit. If they still do not meet the standard, they receive a fail for the course. The students who fail have an opportunity to have their grade changed by attending special help sessions and submitting a new item that is assessed as up to standard. The Portfolio course is not an assessment of their communication skills at graduation. Students who pass Portfolio must still demonstrate competence at the Bachelors level in their communications-intensive, Year 4 courses.

Communications Portfolio Guide

After developing a number of individual guidance documents for various specific purposes, we decided to compile them into a printed book. The book format has the advantage of being definitive and easily referred to by faculty and students alike. A series of on-line, continuously updated documents ran the risk of confusion by students over which version or document should be consulted and when updates had been posted.

Our guide is roughly 90 A4 pages. It has been spiral bound to make it easier for students to use while at their computer workspace. In addition to specific advice directed at the Portfolio requirements (covering the Department's agreed presentation standards and key aspects of effective, accurate, and error-free writing), the Guide also contains advice on writing the different types of assignments, including laboratory reports, client reports, calculation-rich reports, and engineering sketches. Additionally, it has a chapter on short professional communications that gives advice on how to take meeting minutes, compose emails, and how to meet professionals and faculty in their offices. The Guide even includes advice on responding to short-answer and essay questions that students might find on examinations. The Guide uses a large number of student-relevant examples and makes frequent reference to the expectations of the engineering profession.

For our department, which already prided itself on the way individual academics would teach communication skills within their courses, it has been a serious exercise to develop one Guide that everyone would adhere to and use. Because students no longer need to adjust their writing for individual academics, it has become useful for them to develop report templates in Word that they can use for multiple courses. Developed through the goodwill and dedication of numerous academics, and we hope this Guide will be used for a few years before its inevitable revision. We have already identified that additional chapters should be added on peer reviews, posters, and conference/journal papers.

Outcomes and Modifications

The programme has been phased in over a number of years. 2013 was the first year of full implementation. Only 9 students out of 170 passed Portfolio without need for a resubmission. Another 17 had passed 5 out of 6 items, while 25 had passed 4 out of 6, and these students seemed able to complete relatively easily. That still left 119 falling far short of professional standards. The pass rates for the sketch and oral presentation were much higher than for the four written items. In the end 50 students failed and were given an opportunity to receive a change of grade through extra tuition and resubmission. Eventually all of these students passed in early 2014.

One difficulty encountered was that a large number of students put in a minimal effort prior to submission when they knew that they would have a chance to resubmit. In the most extreme case, only 23% of students passed their laboratory report in 2012, and of those who failed and resubmitted in August, only 21% passed. However, for the last resubmission in November 2013, 76% of those who had not yet passed did pass. The respective values for the reasoning report, over the three submissions were 44%, 32%, and 70%.

To address this matter, in 2015 we intend to require payment to the Department of $100 for each resubmission, which will address costs associated with additional marking. The resubmission process is an important part of replicating professional practice, but it has led to our markers becoming an error-finding service.

Many of the failures were because of small errors in grammar or presentation signalling a lack of attention to detail and poor proofreading skills. Of the 36 students who failed because of grammar or presentation issues (instead of oral presentation or misunderstanding the requirements), 21 had more grammar than presentation issues while 15 had more presentation than grammar issues, and six failed only because of presentation issues. In 2012, a similar pattern was seen with those same students halfway through their Portfolio requirements: roughly 40% did not meet standard because of inattention to detail.

To address this matter, we have developed a method for students to correct their presentation issues without requiring a resubmission. We have also provided tutorials in error-checking.

Because of the optional nature of the course support, and because it is a 0 credit course, a large number of students seemed to fail because of a lack of dedication and focus. To address this issue, we intend to allow fewer resubmissions prior to students taking required extra tuition and extra assessment items.

Somewhat surprisingly, after removing failures for the reasons above, we found few students with serious writing difficulties. The overall communication score in 2013 was 6.7/10, with a pass mark of 5/10.. Students with English as a second language did not fail the Portfolio at a significantly higher rate than native English speakers.

It should be noted that 70% of the students passed Portfolio, and the average communications skill level of Year 3 students in 2013 was higher than in previous years. Professional engineers who mark Year 3 reports in our design course noted an improvement in report writing skills in 2013 over past years. Angela Bielefeldt, a visitor with interest in improving communication education and who taught our students, noted that our Year 3 students' report writing skills seem to be at a significantly higher level than her students at the University of Colorado. Thus, in spite of some poor results in 2013, there have been accomplishments.

One student who failed the 2013 assessment, but passed the reassessment after tuition and a new submission, provided the following unsolicited email related to our Portfolio:

> *I have found the portfolio a very laborious task but at the end of it I am glad I was made to do it. It has greatly improved my report writing and general English. I can remember being told at school that I didn't need to take English as engineers don't need to be proficient at writing! The three day course I completed in the April holidays proved to be a refresher course and confidence booster for my ability to write precisely and accurately. I understand Civil and Natural Resource Engineers are the only disciplines to undertake portfolio requirements and this shows when comparing written work to our contemporaries from other disciplines. Overall the portfolio assessment has improved my writing skills ten-fold and I would like to thank you for that.*

Conclusions

The key questions we still face are:

- Where to set the pass/fail bar for Portfolios?
- How to improve students' proofreading skills?
- How to build on the Portfolio platform in Year 4 courses?
- How to get an academic staff member to agree to lead the programme when everyone will point out that person's communication errors? ☺

A question we have resigned to leave unanswered (for now at least) is: how much better educated are our students because of the introduction of Portfolios? We do not have strong data on the performance of students before the curriculum changes, and we have such a serious situation with respect to weak writing skills that we cannot justify retaining a control group who do not go through the Portfolio process. Although far less than ideal, we will need to rely on the feedback we receive from employers and a comparison with students in other engineering degrees who do not have a Portfolio requirement.

After three years of hard effort, the Department remains resolved that the Portfolio approach will work for us. Its key advantages are:

- It mimics professional practice, increasing student buy-in
- It develops students' (currently weak) skills in revising their work by focusing on specific items
- It accommodates a widely varying ability of incoming students
- It retains communication skill development in many engineering courses
- It allows for co-ordination and quality assurance
- It provides students with outputs that they can show prospective employers.

The Portfolio approach has excellent potential for departments looking for another way to teach communication skills. Although some aspects have been specifically tailored for our situation, most of it could be readily transferred to other engineering degrees.

Some of our important lessons bear emphasis. The buy-in of academics is critical, as for any approach to improving communication skills, but especially in curricula already constrained by mandatory course requirements and program accreditation criteria. The gap is very wide between employers' views of students' communication skills and students' perceptions of their skills, which means that it is especially challenging to get students to take seriously the need for improvement. We have found the links to employers critical throughout the development of the Portfolio. As with any major effort at curriculum change, the portfolio development has required significant effort, which is particularly difficult because (as a 0-credit course) the new course provides no new funding. The Portfolio programme has led to its share of unforeseen indirect effects that have needed careful management. In spite of these issues, the Department believes the Portfolio approach will provide a step change improvement in student communication skills.

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