

Meeting the Demands of the Workplace: Science Students and Written Skills

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Over the last 15 years, surveys in a range of English-speaking countries, from North America and the United Kingdom, to New Zealand and Australia, have consistently shown that employers rank oral and written communication skills as highly as or more highly than any technical or quantitative skills. However, in New Zealand there has been very little research into determining exactly what is meant by the “written communication skills” employers state they desire. A further issue in this research to date has been a lack of differentiation between employers—no study has specifically targeted the requirements of employers of science graduates. This article reports the findings of ongoing research into the expectations of science students and of employers of science graduates, and centers around several key questions:

- What do New Zealand employers of science graduates specifically want in terms of their new hires’ writing skills?
- How can information gained from employers of science graduates be used to motivate science students to take seriously the need to develop their writing skills?
- How can writing programs be evaluated and developed to help science students acquire communication skills that are important for their future learning and for their employment and promotion prospects?

Findings are compared with the findings of the 2004 National Commission on Writing’s survey of American businesses.

KEY WORDS: written skills; science education; college; workplace.

INTRODUCTION

As college instructors working with undergraduate science students, we strive to equip our students with skills that will aid their future learning, their intellectual and social development, and also their pursuit of employment and promotion. Over the last 15 years, surveys in New Zealand and Australia have consistently shown that employers rank oral and written communication skills as highly

as or more highly than any professional or technical skills (Higher Education Council, 1992; Australian Association of Graduate Employers, 1993; Victoria University, 1996; Andrews, 1995; Reid, 1997). The workplace’s urgent need for employees with strong written skills is also regularly reported in the New Zealand’s popular press (see for example Hart, 2004; Bland, 2005). A range of studies from North America and the United Kingdom have demonstrated that this demand for graduates with excellent written skills is not confined to New Zealand but is a global concern (see for example Jones, 1994; Jiang *et al*, 1994; Merrick, 1997; Treadwell and Treadwell 1999), and applies to students in all disciplines, from accounting to social work (Park, 1994; Forte and Mathews, 1994; Tanner and Cudd, 1999). The EnterTech Project, a North American

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educational effort, has been built around the demand for “soft skills” including communication skills coming from the high-tech industry (Nelson *et al.*, 2001); a 2002 Wall Street Journal/Harris Interactive survey revealed communication and interpersonal skills were ranked at the top of a list of 24 attributes sought by American corporate recruiters (Alsop, 2002). In 2004, the United States College Board’s National Commission on Writing issued a widely-publicized report indicating both how highly employers prize writing skills and how much the lack of those skills may cost both companies and workers themselves. Intensified employer demand, in combination with the speed of technological development and the increasing commercialization of the field of science, has meant that science students at college level must acquire stronger written communication skills than ever before, to be competitive on a global job market.

However, in New Zealand there has until now been very little research that has focused specifically on the needs of employers of science graduates. It is possible that these employers have needs which are specific to their industry and do not match the profile of the “generic” employer. Furthermore, no research to date has investigated exactly what is meant by the “written communication skills” employers state they desire. Neither have students’ (and, in particular, science students’) assumptions about the communication skills required of them in the workforce been examined. Consequently, we cannot accurately know whether those universities which teach communication skills to their science students are meeting the requirements and concerns of employers, nor do we know how accurately science students judge their own need to meet those requirements and concerns. This paper reports on ongoing research being undertaken at Massey University, New Zealand, centered around the following key questions:

- What do employers of science graduates specifically want in terms of their new hires’ writing skills?
- How can information gained from employers be used to motivate science students to take seriously the need to develop their writing skills?
- How can science-specific writing programs be evaluated and developed to help science students acquire communication skills that are important for their future learning and for their employment and promotion prospects?

Massey University is unique amongst New Zealand universities in requiring that all science majors pass a communication course. The English Department teaches communication and writing classes that serve students majoring in science, applied science, technology, engineering, and several other scientific majors. While located within an English department, the classes are designed and taught by faculty with qualifications and experience in writing across the curriculum, with a specific focus on science writing. Students majoring in science or technology are required to enroll in and pass one of these communication classes as part of their degree, but coalface experience reveals that these students often express resistance to the idea of “having to take English” and are dismissive of the usefulness of class content to their real-life career aspirations.

In 2004, a long-term project was initiated at Massey, undertaking to survey science students, the faculty who teach science students, and the employers who eventually hire science graduates, in order to find out what these different stakeholder groups perceive as specifically important attributes under the broad heading “communication skills.” These data can be used to make recommendations to improve science writing courses at Massey University and elsewhere, and to refine methods and principles of assessment for those engaged in teaching science writing.

METHODOLOGY

In 2004, questionnaires were filled in by approximately 300 science students and 40 science academic faculty members, and mailed to 50 New Zealand employers of science graduates. These comprehensive questionnaires identified specific attributes of written communication, oral communication, and interpersonal communication, and asked respondents to value the importance of each attribute on a 7-point scale, and also to rank the relative importance of each attribute. A rich and complex data set was generated; this article focuses on the data collected from employers concerning writing skills and draws comparisons with the responses of students where these responses highlight important similarities or discrepancies (for a list of the written communication attributes identified by the Massey University questionnaire see Table I). Objectives were to clarify the exact nature of employers’ expectations, to ascertain whether students accurately comprehended what their future employers wanted, and to identify

Table I. Massey University Communication Skills Survey Written Skills Questions

<i>For employers:</i> The purpose of this section is to identify more clearly the written communication skills that you consider important when looking to employ someone with a Bachelors or Masters degree in science. Please rate, on a scale of 1-7 (where 1 is not at all important and 7 is essential), the importance of the following skills:	<i>For students:</i> The purpose of this section is to identify more clearly the written communication skills that you think will be important for success in your future employment. Please rate, on a scale of 1-7 (where 1 is not at all important and 7 is essential), how important you think the following skills will be when you are engaged in your career:
1. The ability to spell correctly	<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7
2. The ability to use correct punctuation	<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7
3. The ability to use correct grammar	<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7
4. The ability to express ideas clearly in writing	<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7
5. The ability to write in business format (for a non-scientific/non-academic audience)	<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7
6. The ability to write a scientific report (for a scientific/academic audience)	<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7
7. The ability to write persuasively	<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7
8. The ability to convey information accurately	<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7
9. The ability to write in styles appropriate to different readers (clients, employees, government agencies)	<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7
10. The ability to write logically	<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7
11. The ability to collect relevant information from a variety of sources	<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7
12. The ability to condense material from a variety of sources and convey it clearly	<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7
13. The ability to use a professional writing style	<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7
14. The ability to write clear instructions	<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7
15. The ability to write a scientific/academic paper (for publication)	<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7

and analyze significant discrepancies in expectations, in order to develop and improve the teaching of communication skills in science undergraduate programs.

Of the 50 questionnaires mailed to employers, 23 were returned. The 46% response rate, achieved with no follow-up action or reminders, compares very positively with the response rate from the 2004 National Commission on Writing's survey, in which the initial response rate was just 17%.⁴ A range

⁴After the lackluster initial response rate, intense follow-up efforts including repeat phone calls produced an eventual response rate of 53%, which the Commission called "very robust."

of businesses were represented in those who responded to the survey: 52.38% worked for a national organization; 33.33% for an international organization; 9.52% for a small business employing less than 25 people; and 4.76% for regional organizations. The kind of industries represented also varied widely, including general business firms, agribusiness firms, research institutes, and a variety of others including financial and consulting organizations. Fifteen of the 23 respondents reported hiring employees with an undergraduate degree in science or applied science within the last 3 years; seven of the remaining eight reported hiring students with

postgraduate qualifications in science. The Massey University questionnaire invited interested respondents to volunteer for a follow-up telephone interview, and six did so, a participation rate of 26.1% of respondents. These six employers were then contacted and a semi-structured interview conducted with each one. These interviews provided rich data on the requirements of science employers in New Zealand.

At the same time initial analysis of the results of the Massey University employer survey began, the College Board's National Commission on Writing released the results of a survey of North American employers, investigating employers' requirements concerning written communication skills in university graduates (for a list of the College Board's survey questions on writing skills, see Table II.). While the American study is larger in scale, the significant similarities in objectives and findings enable a number of pertinent comparisons to be drawn between the United States and the Massey University studies, allowing conclusions to be drawn on a multi-national basis. It is important, however, to first note the several differences in the scope and design of the American project. The Commission did not focus on employers of science graduates: it mailed surveys only to Business Roundtable members, surveying businesses in six sectors: mining, construction, manufacturing, transportation and utilities, services, and finance, insurance, and real estate, which means that some areas of science were excluded. While New Zealand has its own Business Roundtable, questionnaires were mailed not exclusively to Roundtable members but rather to companies that had previously hired or directed recruitment efforts at Massey University science students. Also, the American survey did not include small businesses, whereas the Massey University study did (the average number of employees of the American responding firms was over 58,000; in New Zealand, few if any firms have workforces this large). The Massey University study included questions on oral communication and interpersonal skills not covered by the US survey; conversely, the US survey included several specific written skills questions that were not included in the Massey University study, including questions on the writing of memos, Power-Point presentations, and e-mails. The Commission's survey also differentiated between the kind of skills needed by salaried and "hourly" or nonprofessional workers, a distinction that was not made in our study.

RESULTS OF THE MASSEY UNIVERSITY STUDY

At the broadest level, results accorded with expectations raised by previous research. One hundred percent of responding science employers agreed that good communication skills were in the top five qualities they sought in new hires. A slightly lower number, 95.24%, agreed that good interpersonal skills were in their top five desired employee traits. Somewhat less expectedly, results from the science student questionnaire revealed students' agreement with employers' assessments. Despite the appearance of classroom resistance, 97.6% of surveyed students agreed that communication skills were among the five most important attributes for employment in science, and 98.7% stated the same for interpersonal skills. This clearly disproves the assumption that the reason behind student resistance to or disengagement in communication classes is the students' lack of appreciation of the importance of these skills to their future careers. Massey University's science students are aware of the requirements of the workplace, possibly due to the popular media's publicizing of the issue, and they do recognize their need for written, oral, and interpersonal skills in order to succeed in the job market. For this initial measurement, then, the study reveals an unexpected attitude amongst science students, and a striking degree of unanimity between two key stakeholder groups.

Significantly, however, New Zealand employers of science graduates did not find students exhibiting the written skills they required in their employment. About 61.9% of the New Zealand employers surveyed stated that they found the desired level of written communication skills in science graduates only 'occasionally' or 'sometimes.' One employer stated this very bluntly: "we have no expectation they'll come equipped with the skills say to write a proposal instead of an assignment." Similar dissatisfaction was reported by the Commission's study: a majority of employers reported that one-third of workers do not meet the writing requirements of their positions. United States employers, like the employers surveyed in New Zealand, were forthright about the weaknesses they perceived, one stating, "The skills of new college graduates are deplorable—across the board; spelling, grammar, sentence structure . . ." (National Commission, 14).

Additionally, New Zealand students accorded less importance to writing skills across the board than

Table II. Business Roundtable & National Writing Commission Questionnaire

1. Do you take writing (e.g., of technical reports, memos, annual reports, external communications) into consideration when hiring new employees? *(Please check the box in front of the most appropriate response.)*
 - A. Professional ₁ Almost never ₂ Occasionally ₃ Frequently ₄ Almost always
 - B. Hourly ₁ Almost never ₂ Occasionally ₃ Frequently ₄ Almost always

2. How many employees have some responsibility for writing (either explicit or implicit) in their position descriptions?
 - A. Professional ₁ A few ₂ About 1/3rd ₃ About 2/3rds ₄ Almost all
 - B. Hourly ₁ A few ₂ About 1/3rd ₃ About 2/3rds ₄ Almost all

3. When a job either explicitly or implicitly requires writing skills, how do you usually assess a job applicant's writing ability? *(Please check all that apply.)*

_A Writing sample provided by job applicant _D Impressions based on letter/written application
 _B Writing test taking during the job interview _E Other (_____)
 _C Review of coursework on resume

4. When you are hiring new employees, how often are samples of written materials or presentations required of the applicant?
 - A. Professional ₁ Almost never ₂ Occasionally ₃ Frequently ₄ Almost always
 - B. Hourly ₁ Almost never ₂ Occasionally ₃ Frequently ₄ Almost always

5. If a job applicant's letter or other written materials were poorly composed (i.e., grammatically incorrect or hard to understand) would that count against the applicant in hiring?

₁ Almost never ₂ Occasionally ₃ Frequently ₄ Almost always

6. Listed below are several forms of communication that are common in American companies. Please indicate how frequently each form is used in your company by circling the appropriate number.

	Almost never	Occasionally	Frequently	Almost always
A. E-mail correspondence.....	1	2	3	4
B. Other memoranda and correspondence	1	2	3	4
C. Oral Presentations with slides/visuals (e.g., PowerPoint)	1	2	3	4
D. Oral Presentations without visuals.....	1	2	3	4
E. Formal reports.....	1	2	3	4
F. Technical reports.....	1	2	3	4

7. Effective written communication can have a number of different characteristics. In your company, how important are each of these characteristics?

	Not at all important	Not very important	Important	Extremely important
A. Accuracy	1	2	3	4
B. Clarity	1	2	3	4
C. Conciseness	1	2	3	4
D. Scientific precision.....	1	2	3	4
E. Visual appeal.....	1	2	3	4
F. Spelling, punctuation and grammar	1	2	3	4
G. Other (please specify).....	1	2	3	4

8. In your company's current workforce, approximately how many employees have those skills?

₁ A few ₂ About 1/3rd ₃ About 2/3rds ₄ Almost all

9. Approximately how many new employees have the writing skills that your company most values?

₁ A few ₂ About 1/3rd ₃ About 2/3rds ₄ Almost all

Table II. Continued

10. Does your company take effective writing skills into account when making promotion decisions?								
A. Professional	<input type="checkbox"/>	1 Almost never	<input type="checkbox"/>	2 Occasionally	<input type="checkbox"/>	3 Frequently	<input type="checkbox"/>	4 Almost always
B. Hourly	<input type="checkbox"/>	1 Almost never	<input type="checkbox"/>	2 Occasionally	<input type="checkbox"/>	3 Frequently	<input type="checkbox"/>	4 Almost always
11. If an employee possesses outstanding technical but poor writing skills, does your company provide writing training?								
A. Professional	<input type="checkbox"/>	1 Almost never	<input type="checkbox"/>	2 Occasionally	<input type="checkbox"/>	3 Frequently	<input type="checkbox"/>	4 Almost always
B. Hourly	<input type="checkbox"/>	1 Almost never	<input type="checkbox"/>	2 Occasionally	<input type="checkbox"/>	3 Frequently	<input type="checkbox"/>	4 Almost always
12. If your company provides writing training, what is your estimate of the annual cost per trained employee?								
Annual estimate per trained employee: <input type="text"/>								

did New Zealand employers. In only one category, “the ability to condense information,” did employers and students assign an attribute the same value; in every other category students valued the written skill lower than employers. This finding calls into question the unanimity previously observed: it may be that science students think written skills are important, but not sufficiently important to work on.

A number of employers highlighted as a specific area of dissatisfaction the difference between the academic writing science students were accustomed to produce for college instructors and the ‘real-world’ scientific and business writing that businesses needed their employees to be able to deliver. This conforms to previous studies’ identification of “audience awareness” skills as an essential component of effective writing (Jones, 1994; Freedman and Adam, 1996; National Commission, 2004). New Zealand respondents consistently emphasized employees’ need to be able to adapt their writing for different situations and end-users, adjusting style, vocabulary, and format to meet differing expectations and differing needs. When asked in a follow-up interview what the employer would choose to tell New Zealand university science students, one respondent stated: “Put yourself in the shoes of the audience you want to reach. Communication is very audience specific and there are lots of audiences out there.”

There seems to be clear agreement, crossing national lines, that the demand for strong written skills is growing, not decreasing, with developing technologies; with science’s increasing adoption of business modes of operation; and with the ever-intensifying focus on the bottom line. Employers agree that workers who can write clearly can well save their employers money and time: “Writing skills are fundamental in business. It’s increasingly important to be

able to convey content in a tight, logical, direct manner, particularly in a fast-paced technological environment” (National Commission, 8). Respondents to the Massey University questionnaire were invited to suggest any written communication skills that they considered essential which were not covered by the listed attributes, and the suggestions revealed a concern with writing efficiency. Concision, succinctness, and the ability to write to deadlines were all identified. One respondent placed particular stress on the ability to write efficiently under time constraints, emphasizing the need of prospective employees to be aware that “if you’re writing for a busy general manager or minister, [you must] get to the nuts and bolts very succinctly.”

HIGHLIGHTS OF THE MASSEY UNIVERSITY STUDY

Fifteen specific attributes were identified under the umbrella of written communication skills, and respondents were asked to rate the importance of each on a 7-point scale on which 7 indicated “*essential*” and 1 indicated “*not important*” (see Table I). While skill in the individually listed areas of punctuation, spelling, and grammar was not rated in the top seven attributes by either employers or students, employers nonetheless valued each of these foundational skills distinctly more highly than did the students (see Figure 1). One employer wrote in to his questionnaire, “I don’t think there is a ‘least’ important” skill, and general employer agreement with this sentiment is revealed in the consistently high values employers accorded to all 16 individual skills: out of a maximum possible 7.0, the lowest ranked skill was accorded a value of 5.1. A noticeable disparity that appeared in the respective values assigned a specific skill by

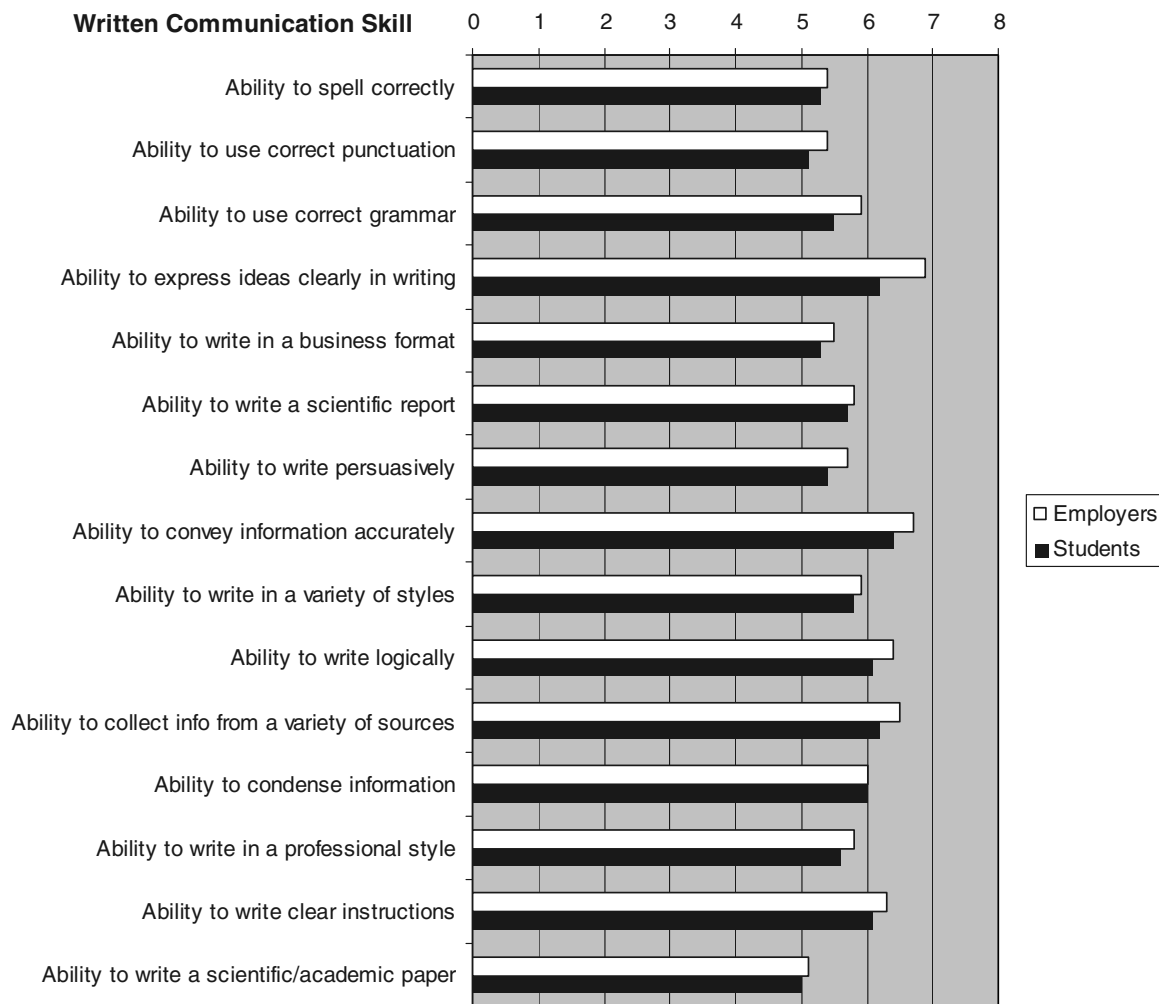


Fig. 1. Relative values of specific written skills identified by employers and students.

employers and students appeared with “the ability to use correct grammar.” Employers gave grammatical correctness a value of 5.9 compared with the students’ assigned value of 5.5. This disparity may reflect students’ greater willingness to rely on word-processing tools such as grammar checks, and in the follow-up interviews employers were specifically questioned about their perception of the usefulness of the various software tools. Employers uniformly expressed reservations about reliance on spelling and grammar checks. However, one respondent was a keen exponent of a particular software tool, developed for the Australian civil service, which identifies percentage of passive sentences used in a document. He stated that he runs through it all his own presentations, and he has personally conducted

an in-house training session for his staff on the importance of primarily using the active voice.

Both spelling and punctuation were accorded a value of 5.4 by employers. Both questionnaire data and information gathered from follow-up interviews firmly underscored New Zealand science employers’ demand for these foundational or basic writing skills of punctuation, spelling, and grammar on the part of employees. One described reading badly spelled, ungrammatical documents as giving him “a bad feeling. It doesn’t instill confidence. It’s symbolic. One takes symbols of quality of writing seriously.” Another emphasized the professionalism that can be conveyed—or undermined—by the grammatical correctness of documents: “It’s about giving you credibility. . . critical. [It’s about] giving your work credibility by

presenting it to the highest standard possible.” The Commission’s study grouped “spelling, punctuation, and grammar” skills together as one rankable attribute, but results clearly showed that United State employers, too, see these foundational or basic skills as highly valuable professionally: 58.7% of respondents viewed “spelling, punctuation, and grammar” as “extremely important” and a further 36.5% as “important.”

The Massey University study found near total agreement on the central importance of “the ability to express ideas clearly in writing”: valued at an average of 6.9, this skill was the clear first-rank choice of employers. Interestingly, while students gave this skill a relatively high score of 6.2, they ranked this attribute second, behind “the ability to present information accurately” (for relative rankings of the five most highly ranked skills, see Table III). Students may be indicating a significant misunderstanding here: even if the information presented in a document is *accurate*, this does not mean the information is *clear*, or well-communicated, and therefore it may not meet the needs of the audience, client, or employer; it may not even be intelligible. Employers valued accuracy highly too, but ranked it second, behind clarity. This data reinforces employers’ desire, confirmed by both oral and written feedback to the questionnaire, for a worker in a science-related industry to ascertain the needs of the audience, and adapt the presentation of information to meet those specific needs clearly, accurately, and in timely fashion.

The Massey University study also sought to identify those specific writing tasks in which employers wanted their workers to be proficient. While employers ranked the *general* skill of clear writing extremely highly, they accorded the *specific* skill of report-writing (for a nonspecialist audience) a markedly lower value, 5.8. This was very similar to the value accorded this attribute by students: 5.7.

Table III. Comparative Rankings of the Top Five Written Communication Skills Identified by Employers and Students

Written communication skill	Employers	Students
Ability to express ideas clearly in writing	1	2
Ability to convey information accurately	2	1
Ability to collect info from a variety of sources	3	3
Ability to write logically	4	4
Ability to write clear instructions	5	5

In part, the lower value accorded report writing by employers can be explained by the diversity of respondents and by the differing needs of the industries represented and of different positions within those industries. However, this lower evaluation does raise an interesting question for educators: a report is a manageable and teachable piece of assessment, useful for college instructors, but arguably may be of less usefulness to potential employers.

However, before dismissing the value of the formal report as a taught assessment, it is important to note that the questionnaire also revealed that employers highly value the ability to collect information from a variety of sources (valued at 6.5), and the ability to condense information from a variety of sources and convey it clearly (valued at 6.0). These skills are both significantly developed in students by the particular tasks involved in researching and structuring a report. Interestingly, students also recognized the value of these two sets of skills, giving them values almost identical to those of employers (6.2 and 6.0, respectively.) Thus, there is a strong argument to be made that even if the production of a formal report is not required in every workplace, the array of skills developed by report writing renders it a tool of ongoing value in college science education. Nevertheless, this finding has implications for the types of reports required by educators, who may also need to consider the literature review as a form of assessment.

The Commission’s study interrogated report-writing skill differently. It asked employers to identify what kinds of writing they expect from employees: 62% reported requiring formal reports “frequently” or “almost always.” Because of the differing ways the two surveys present this question, it is hard to compare the Commission’s findings regarding report-writing with the New Zealand responses, other than to draw the general conclusion that employers in both nations highly value the skills necessary for the production of a written report. The communication tool most often used and/or required in American workplaces, the Commission found, is e-mail.

Other specific results concerning written communication from the Massey University questionnaire are shown in Figure 1.

COSTS OF POOR WRITTEN SKILLS

If, in New Zealand as in the United States, employers are finding desired written communication

skills in new graduate employees only infrequently, what steps are they taking to remedy this situation? What do these steps cost them? The follow-up interviews conducted in the Massey study asked employers about the kinds of mentoring and training in writing tasks provided in their organizations. All respondents reported some kind of mandatory or optional training and/or feedback systems on employee writing. This varied considerably, from managerial review of any document going to an external audience, to peer-review sessions of potential publications, which are regularly scheduled at research institutes. The study found a general, and concerning, expectation on the part of New Zealand employers of science graduates that new employees will arrive needing help improving their writing. As one employer reported of new science graduates, "many don't have much in their kitbag."

The Massey University study did not inquire directly into the specific costs incurred by the remedial writing training employees need. However, the costs and benefits of teaching employees basic English skills have recently been debated in New Zealand's leading newspaper (Bland, 2005); the article reports on an employee-literacy initiative at a plastics manufacturing firm in Auckland. Recent reports of British and North American estimates of the business costs of poor written communication have been alarming. Research undertaken by Britain's Royal Mail suggests spelling and grammar mistakes alone cost British businesses over £700 million a year (Royal Mail, 2003). The estimated costs of poor employee writing featured extremely prominently in report of the Commission's findings in the United States: the annual private-sector costs for providing writing training to employees who needed it was calculated at US\$3.1 billion annually. It seems incontrovertible, then, that employers and college instructors share a common goal: for students to graduate to employment with greater competence and flexibility in written communication.

Seeking to elicit more information about the diversity of written skills required in the workplace, the Massey University study's follow-up interviews asked employers what they would choose to tell science students about the need for written communication skills in science careers. Such aspects as demonstrating flexibility, writing in plain language, and explaining complex procedures or operations clearly to a lay audience, were all mentioned.

CONCLUSIONS AND FUTURE STEPS

Writing should by no means be regarded merely as a 'vocational skill,' and the authors do not recommend that college curricula should be solely shaped by the exigencies of the workplace. It seems inarguable, however, that if science students are to be adequately prepared for rewarding and remunerative work within the science industry, with the opportunity to advance themselves on their chosen career path, colleges should thoughtfully develop programs tailored to improve these students' written skills, based at least partly on the requirements of industry, rather than the expectations of college communication instructors who often have been educated from a nonscientific background. In addition, college science writing programs must take seriously employers' concerns about students' lack of ability to 'translate' academic writing skills into practical every-day skills of use in the workplace. What are the specific issues highlighted by this study?

First, the Massey University study shows that science students definitely do perceive the importance of communication skills to their career prospects, although the importance they accord to it is still significantly lower than that accorded by employers. This raises an important question: if students do strongly agree that communication skills will be valuable to them in their future employment, what then are the reasons behind their resistance to communication classes? One reason may be that students perceive a disconnect between class content and actual job requirements. The findings of our study should prove significantly useful in communicating to science students what written skills employers in their field do specifically demand. Further research into student resistance has already begun, with a new survey and in-depth interviews aiming to assess the range of students' reasons for disengaging from writing classes. This further study should enable the researchers to continue improving the content delivery of written communication skill classes and more fully engaging students, developing a science writing curriculum that is both relevant and popular.

Our study shows that the concerns of employers of science students conform to previous, more generic, studies and confirms employers' demand for strong written communication skills in the college graduates they hire. The majority of employers surveyed feel that science graduates do not usually have an appropriate level of writing skill for entry into the

workplace. Clearly, more effort and commitment on the part of colleges is needed to develop students' writing skills, perhaps by integrating these skills into the broader curriculum—it seems that a single class at freshman level may not be sufficient to bring students' skills to a level required by employers.

Employer demand for the foundational writing skills of punctuation, spelling, and grammar, coupled with the general employer perception that graduating students do not always have a reliable grounding in these skills, means all college programs must seriously consider their role in the teaching of these skills. Finding an effective and time-efficient way of doing so will be essential.

The results of the Massey study pose interesting challenges for curriculum development. Scaffolding towards a large piece of writing, the scientific report, is a keystone of the current writing programs; however, employers state that report-writing is not a highly valued skill. Nonetheless, researching and constructing a formal report helps students develop a number of writing skills employers highly prize. It may be possible to retain and adapt this particular writing assignment to increase its relevance to the requirements of the workplace, and to ensure that it requires advanced skills in reviewing and integrating the literature, skills which were clearly prioritized by employers surveyed.

Although this was not investigated in the initial questionnaire, the follow-up interviews showed that employees' use and misuse of electronic communication tools, particularly e-mail, was identified by a number of New Zealand employers as an area of particular concern, which is in line with the findings of the United States National Commission on Writing. As the Massey University study continues, it may be useful to modify the questionnaire to collect more e-mail-specific data. A new or expanded teaching module within science writing courses in electronic communication skills and ethics may be indicated.

Study findings encourage consideration of how college instructors can refine delivery of existing course content to present science students with the real-life application that employers demand. Possible ideas may include collaboration with the private sector: guest speakers from well-known employers might be invited to directly address specific workplace needs, or to reinforce the importance of learning foundational skills.

Finally, it should be noted that the performance expectations and specific skill requirements will vary

with employer and also with position, and thus generalizations about the specific demands for written skills should be made cautiously. Nonetheless, the data from this study and those it builds on confirm the vital importance for science students of a communication curriculum that teaches foundational skills of spelling, grammar and punctuation, audience analysis, and clarity, concision, and accuracy in written communication.

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