

Establishing a Benchmark for Effective Intervention: First-Year Engineering Students' Writing and Their Perceptions Thereof

Tyler Evans-Tokaryk¹, Muaaz Bhamjee² and Zach Simpson³

¹Academic Development Centre, University of Johannesburg. ²Department of Mechanical Engineering Science, Faculty of Engineering and the Built Environment, University of Johannesburg. ³Faculty of Engineering and the Built Environment, University of Johannesburg

¹tyleret@uj.ac.za; ²muaazb@uj.ac.za; ³zsimpson@uj.ac.za

Significant numbers of students entering post-secondary institutions in South Africa do not possess the critical writing abilities they need to succeed. This, coupled with engineering students' apparent dislike for writing, poses a significant challenge for engineering instructors in the area of academic writing instruction. The aim of this study was to undertake a baseline assessment of a first-year cohort of engineering degree students' writing abilities as well as their sense of self-efficacy in academic writing. This study emerged from the need to understand where writing interventions may be most beneficial and how such interventions can harness students' existing resources. Two types of data were collected for the study. A survey instrument was designed to assess students' sense of self-efficacy in writing as well as their perceptions of the importance of writing skills. The students were given a baseline writing task which was evaluated according to a research instrument designed to assess a sample of higher, middle, and lower order concerns in the writing. A close textual analysis of selections of students' writing was also conducted. Students did not perform nearly as well on the writing task as they expected they would. The results from this study indicate that while the student-participants have a high sense of self-efficacy as writers, their beliefs about their writing skills (formed before university) do not match the expectations of their instructors. This suggests that the context in which students formed their sense of self-efficacy as writers is very different from university; the sources of their self-efficacy may not be particularly relevant for the kind of writing they are doing as engineering students. A positive observation from the study is that the students perceive that communication skills are as important as technical skills to their success in their studies and beyond. The student-participants' confidence in their abilities as writers and their perception of the

importance of communications skills are resources that can be leveraged to develop activities aimed at student writing development. The results also indicate that writing development initiatives should focus on developing students' explicit knowledge of the conventions of engineering writing, and the need to link writing processes and practices with the processes and practices by which engineering knowledge is constructed.

Introduction

Recent scholarship demonstrates that significant numbers of students entering post-secondary institutions in South Africa do not possess the critical writing abilities they need to succeed (Archer, 2010a; Council on Higher Education, 2013; Slonimsky & Shalem, 2006; Van Dyck, 2005). South African literature pertaining to development of academic literacies offers much by way of strategies for use in addressing this challenge (Boughey, 2007; Jacobs, 2007; Van Dyck, 2005). However, such literature seldom pertains specifically to the engineering fields, and even more rarely begins from the perspective of students' current writing abilities, sense of self-efficacy, and opinions as to the importance of writing in their academic lives.

Anecdotally, engineering students often dislike writing and select programmes in engineering at least in part because they hope that writing will play a marginal role in their academic life. Such beliefs have, historically, been reinforced by engineering curricula that have been 'lighter' on writing and 'heavier' on technical content. At the higher education institution at which this study was undertaken, efforts have been made to address this by building writing-intensive modes of instruction and assessment into the curriculum. This is not only because effective written communication

abilities are important for students' future careers (Crawley et al., 2007; Sulcas & English, 2010), but also because writing is an important vehicle for enquiry and learning about technical content (Kalman, 2008; Richardson, 2000).

This paper reports on a study aimed at undertaking a baseline assessment of students' writing abilities as well as their sense of self-efficacy in academic writing. This two-pronged approach emerged from the need to understand not only where writing interventions may be most beneficial, but also how such interventions can harness students' existing resources. The primary research question that informed this study, therefore, was: To what degree do engineering students' sense of self-efficacy and related beliefs about writing correlate to their actual ability?

To address this question, two types of data were collected. First, a survey instrument was designed which asked respondents about their sense of self-efficacy as writers and their perception of the importance of writing. The survey contained a number of task-specific questions and was analysed using descriptive statistics. Second, the first-year cohort of engineering degree students was given a baseline writing task. This writing task was evaluated by a team including the researchers as well as a Faculty-appointed writing tutor. The evaluation was done according to a research instrument designed to assess a sample of higher, middle, and lower order concerns in the writing. A close textual analysis of samples of students' writing was also conducted.

Student Writing Development and Self-efficacy

There is increasing international recognition of the need for communicative competence in virtually all fields of industry (Sulcas & English, 2010). Numerous studies have demonstrated the important premium that employers place on graduates' ability to write well (Crawley et al, 2007, provide a useful summary of such studies in the context of the engineering profession). However, few students enter into the university experience having mastered academic writing practices (Paxton, 2007). Paxton's (2007) notion of interim literacy is useful in understanding where students are in their development as writers when they enter engineering programmes. 'Interim literacy' refers to the fact that students are in transition from the literacy practices of the school and home to those of the university. Such a notion reminds researchers and educators alike that the development of academic literacy practices does not occur in a simple, straight-forward manner (Paxton, 2007), but

rather requires multiple, focused opportunities for developing new practices. It also emphasises the need for mediation of academic writing practices within higher education, including engineering programmes.

Students do not, of course, enter into the university experience as blank slates: they bring with them a variety of resources. The New Literacy Studies literature (Gee, 2000, provides a useful introduction and overview of this literature) shows that different social institutions privilege different literacy practices and that, because some social institutions are more powerful than others, so too are some literacy practices more powerful than others (Barton & Hamilton, 2000). Often, the resources that students bring are not recognised by institutions of higher education and, as a result, academic literacy practices have come to serve a gate-keeping function within higher education (Lillis, 2001). The work of Archer (2009; 2010b; 2012) shows how the recognition of multimodal student meaning-making resources (i.e., modes other than academic writing) can positively impact on student success in university curricula. This paper builds on Archer's argument that multimodal pedagogies allow students to bring different forms of cultural capital (Bourdieu, 1991) into the classroom, and suggests that such an approach also improves students' sense of self-efficacy more generally. Given the gate-keeping function currently served by academic writing, the current research argues for a curricular approach that begins with an improved understanding of students' self-efficacy and beliefs about the mode of academic writing specifically.

Since the publication of Bandura's work on self-efficacy more than thirty years ago (Bandura, 1977), education researchers have been demonstrating the impact that students' beliefs about their own abilities have on their academic success. Some scholarship has focused both on post-secondary students' "perceived capability to perform various reading and writing activities" and their expectations "regarding the value of these activities in attaining various outcomes" (Zimmerman, 2000, p. 84). More recently, research has confirmed that students' self-efficacy influences their agency, especially with regards to writing tasks at the post-secondary level. Jones (2008) observes that individuals with a high sense of self-efficacy have confidence in their ability to perform a skill or complete a task. He further suggests that they are more likely to take on challenges, set goals and identify strategies for meeting them, self-regulate, and work hard. Recent research also suggests that self-efficacy includes metacognitive skills such as the ability to identify and obtain assistance when it is needed (Williams & Takaku, 2011; Stewart, Seifert, &

Rolheiser, 2015). A more confident student, then, may have more interest in a writing task, invest more effort, get support from a writing centre or instructor, and have greater perseverance when revising and editing a draft (Pajares, 2003). These behaviours can have as significant an impact on students' performance as their technical writing skills.

In their review of research on the impact of self-efficacy in academic settings, Usher and Pajares (2008, p. 752) identify four sources of self-efficacy for students. First and foremost is so-called mastery experience — the students' interpretation of the result of their own work. If students interpret an outcome as a success, their self-efficacy is raised; if they interpret it as a failure, their self-efficacy is lowered. The second source of self-efficacy is the vicarious experience students have when observing others. In other words, students will measure themselves by comparing their results and actions with those of their peers. A third source of self-efficacy beliefs is the feedback students get from others (peers and instructors); some feedback can empower, while some can weaken. Finally, the physical experiences (such as pleasure or anxiety) students have when completing academic tasks can influence their sense of self-efficacy. It seems clear that instructors can have a significant impact on each of these factors.

There is considerable evidence that self-efficacy is a strong predictor of behavioural (including academic) outcomes (Graham & Weiner, 1996; Jones, 2008; Pajares, 2003; Prat-Sala & Redford, 2012). Indeed, in his review of research focusing on the relationship between self-efficacy and student writing, Pajares concludes that "students' confidence in their writing capabilities influence their writing motivation as well as various writing outcomes in school" (2003, p. 141). In the same paper, Pajares reports on studies of college undergraduate writing which found "effect sizes for writing self-efficacy in multiple regression models [that] ranged from .32 to .42" (p. 144). In other words, there is typically a strong correlation between self-efficacy and writing outcomes. There is also evidence that students with better writing skills are less impacted by self-efficacy while those with weaker writing skills are more impacted by self-efficacy (Stewart, Seifert, & Rolheiser, 2015).

Following the principles set forth by Bandura (1997), Pajares (2003) offers some basic guidelines for assessing writing self-efficacy, some of which are particularly relevant here and are further elaborated in the Methodology section below. Researchers should ask

students to rate their belief in their ability to perform a specific task that they will perform in the very near future. In other words, the efficacy instrument (e.g., a survey) should be administered immediately before students perform the task with which the survey results will be compared.

Self-efficacy is, then, an important aspect of writing studies. In order to create interventions that will help students develop the academic literacies required, it is necessary to understand not only students' strengths and weaknesses as writers but also their own perceptions of themselves as writers, the confidence they have in their writing abilities. It is only with a clear baseline understanding of students' abilities and their perceptions of those abilities that effective development strategies can be conceptualized, created, and deployed. The remainder of this paper reports on a research project aimed at collecting and analysing baseline data that will help make such intervention possible.

Methodology

Working with students in a large (400+) first-year engineering class at a South African university, the researchers deployed the following instruments: 1) a survey that focused primarily on students' perceptions of themselves as writers and attitudes towards writing; and 2) a baseline assessment of students' writing abilities.

The survey instrument was administered using SurveyMonkey (a commercial product that guarantees the respondents' anonymity and encrypts the data). Students who were enrolled in the course in the third week of classes received an email invitation to complete the survey through Blackboard, the university's Learning Management System. The third week was chosen as it was hoped that, by this time, most possible student registration problems would have been resolved. The email included a brief description of the proposed research and a link to the survey. The survey asked three different sets of questions: 1) demographics; 2) writing skills and abilities, particularly as related to an upcoming writing assignment; 3) perceptions of the importance of writing skills in different domains (including, but not limited to the engineering program). These questions were developed using existing methodologies for assessing writing self-efficacy for post-secondary students (McCarthy, Meier & Rinderer, 1985; Shell, Murphy & Bruning, 1989; Lavelle, 1993; Shell, Colvin & Bruning, 1995; Pajares & Valiante, 1999; Schmidt & Alexander,

2012). In total, 78 students (out of approximately 400) completed the survey, representing a response rate of roughly 20%.

Thereafter, a writing assessment was undertaken which required students to write a short, in-class essay during the fourth week of class. This essay was on a topic relevant to the students' field of study, namely, the technological process, which had been covered by the lecturer in the week prior to the writing task. No instruction was given beforehand on the academic writing process, and students were given no direction beyond what was included on the assignment task sheet. Students were allowed a maximum of thirty minutes to complete the task. While the writing assessment was not formally incentivized with course marks, students were advised that it would be graded and that their completion of the task would constitute part of their participation mark; students were also told that the information gathered from the writing assessment would help determine the content of the "academic literacies" component of the course.

The writing samples were assessed by a team including the course lecturer, writing experts and a writing tutor, all from within the university at which the study was undertaken. The assessment was undertaken using a rubric specially designed for the exercise (i.e., using assessment criteria based on items in the efficacy instrument). Benchmarking was conducted regularly throughout the grading process to ensure each assessor was interpreting the grading criteria in a similar fashion. The academic writing concerns assessed within the rubric include a selection of higher-, middle- and lower-order concerns which the research team identified as broadly constitutive of 'good' academic writing and which were the focus of parts of the efficacy survey instrument. These concerns are indicated in Table 1. The research team also undertook a close textual analysis of a selected sample of students' writing, chosen randomly but representing an array of student writing ability, as indicated by the assessment rubric deployed. The purpose of this analysis was to elucidate upon the concerns evident within the students' writing.

Table 1. Writing concerns evaluated

Higher-order concerns	Understanding of topic	Each criteria coded as follows: 0: Student demonstrates little or none of the required ability 1: Student has some skills but likely needs a significant intervention to achieve required ability 2: Student can achieve required ability with minor intervention 3: Student possesses or exceeds required ability
	Argument	
Middle-order concerns	Coherence and cohesion	
	Paragraphing	
Lower-order concerns	Style and vocabulary	
	Editing	

Findings

Student self-efficacy

Overall, the findings suggest that the first-year cohort of engineering students under study herein have an inflated sense of self-efficacy in that they generally consider themselves to be better writers than the research team's assessment of their actual ability indicates. In other words, the students' self-efficacy does not correlate to their writing outcomes in the expected way. This is evident in the fact that respondents were asked to indicate their ability regarding various aspects of formal academic essay writing. Across all of these aspects, the student-participants indicated a high level of confidence in their ability to perform well. Figure 1 depicts the results obtained for a selection of these concerns: paragraphing, argument, editing, and coherence / cohesion.

The four areas depicted in Figure 1 are selected for particular discussion here because they represent the two areas where the students performed best in the writing task (editing and coherence / cohesion) and the two areas where they performed worst (paragraphing and argument). In all four areas, at least 67% of students expressed at least some agreement with the fact that they would be able to meet expectations regarding these aspects of academic writing. In the case of paragraphing, this figure was as high as 80%. Furthermore, at least 18% expressed strong agreement with these positive statements of readiness and ability. However, as was found upon analysing their performance on the assigned writing task, the student cohort generally performed poorly across all of these areas.

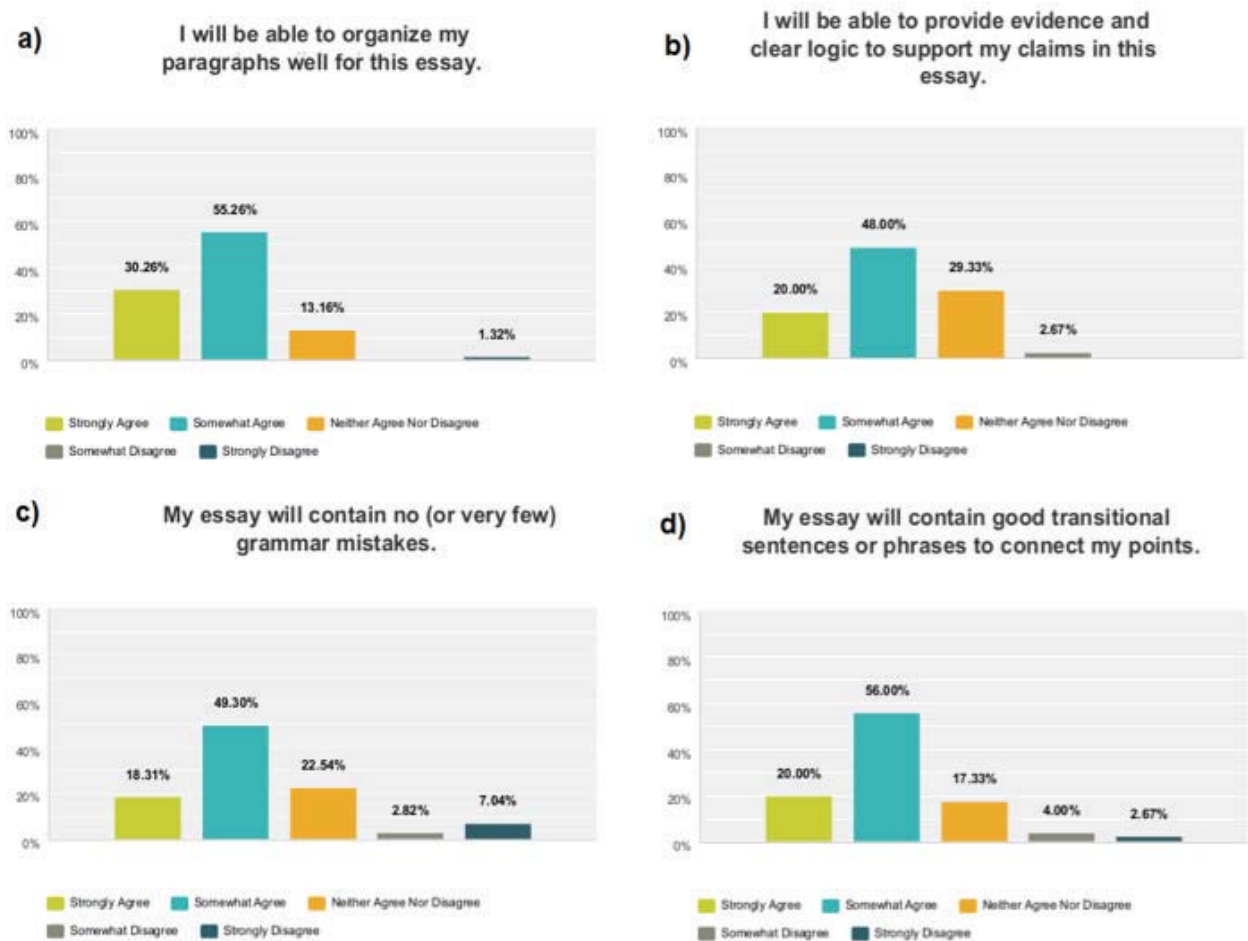


Figure 1. Students' perceptions of self-efficacy related to a) paragraphing, b) argument, c) editing and d) coherence/cohesion.

Student performance

The student-participants' high level of confidence contrasts with the research team's assessment of the students' ability regarding four aspects of formal academic writing. As can be seen in Figure 2, at least half of the students were identified as requiring significant intervention in all four of these aspects of formal academic writing.

With regards to Editing, 60% of students performed very poorly (scoring a 0 or 1) while just over a third (36%) wrote essays that met minimal expectations and could

be improved with a minor intervention (for example, detailed feedback on the assignment or a follow-up workshop). The results are similar for Coherence/ Cohesion where over half (52%) scored a 0 or 1 while just under half demonstrated a need for some minor instruction. The most dramatic results were found in the Paragraphing and Argument areas. A full 71% of student papers had either no paragraphs or very poorly structured paragraphs, while 76% had no argument or a very weak argument. No more than 3% of papers were assessed as already demonstrating the required ability in any of the areas.

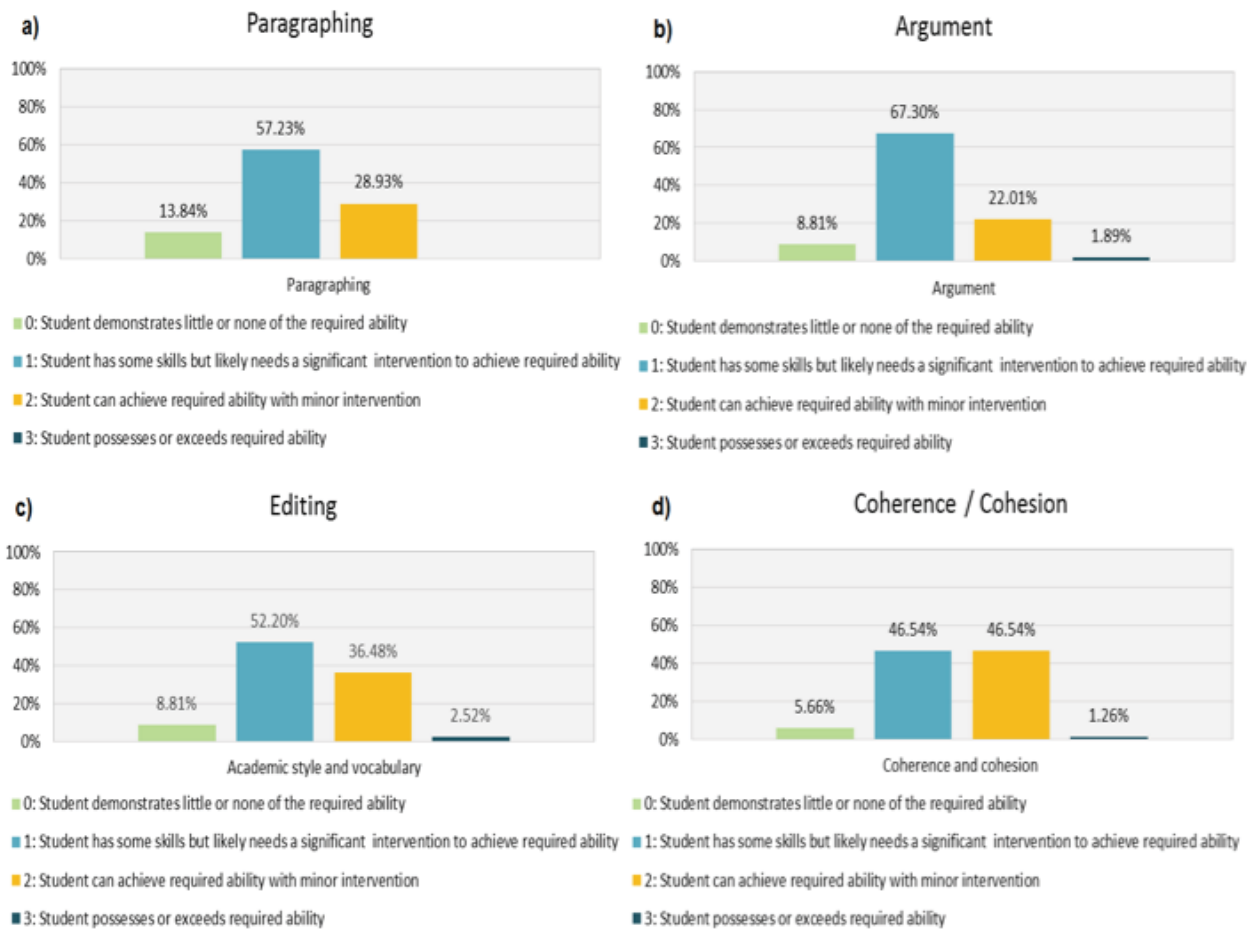


Figure 1. Students' performance related to a) paragraphing, b) argument, c) editing and d) coherence/cohesion.

In order to support the assessments made by the research team, it was necessary to examine a smaller sample of student writing in order to demonstrate where, why and how students were assessed as requiring some writing development in order to meet the requirements of formal academic writing. To this end, the researchers conducted a close textual analysis of a small sample of students' essays. This sample was selected such that they represented a range of student abilities. For reasons of space, only two students' writing are reported on herein. These two students' writing samples are indicative of the kinds of challenges that were found across the student writing. Selected excerpts from the writing are reproduced in Figure 3.

When examining the excerpt provided in 3(a), it is immediately apparent that certain superficial, editing concerns exist. As was mentioned above, editing was one of the areas where students performed best, yet

it often carries greatest sway in assessments of student writing. Of greater concern for the purposes of this paper are the higher-order concerns of coherence / cohesion, paragraphing, and argument. In terms of coherence / cohesion, it is evident in this student's writing that there is a lack of adequate transition between ideas and between claims. For example, in the final sentence of the paragraph, beginning with "Nowadays we have all kinds...", the student raises two separate issues (the impact of existent transportation technologies and the continued need for improvement of such technologies) within a single sentence. The transition from one idea to the next is not signalled, either through the use of linking devices, or through the demarcation of text via sentence construction or paragraph construction. More generally, there is no single, clearly-stated main idea with supporting evidence in the paragraph. This is typical of all papers that received a grade of 1 or 0 (over 50% of the class).

- a) The need kept on increasing to such an extent that the Scientists and engineers had to come up with a solution which could solve people's problems of transportation then the oldest engine came to built using steam only. The scientists then started to do their research on how to build engines which are better economic and fuel efficient. Nowadays we have kinds of automobiles and aircrafts due to the emerging technological innovations it keeps on changing its shape and there is always room for development and modification to further meet the needs of the people as the demand increases then scientists must come up with more better ideas for the engineers to broader their implementation of those ideas.
- b) Engineering has brought a lot of changes in this world, since science has started lot of things are upgraded with time increasing. Engineers are creators, inventors and renovators.
- Without electricity life was difficult, we have seen the olden days where people were walking distances just to pass a simple message. In olden day it was not easy to start even a fire, it was a process to start cooking, every city was dark at night.
- Now comes the science with its theories and proves, engineers took those theories and laws, and they make something special out of nothing. Everyone can now cook without looking for wood in the forest, we now have stoves, heaters, light bulb, even more. Mind of engineers are awesome, these people are brilliant, they made communication to be simple. With phones you can talk to someone whose ten thousand miles away even more.
- They created fridges, which now we can preserve food for long period of time getting rotten. With kettle you can boil water up to 100 degrees within 5 minutes. Life is simple when we have these appliances, and it's still going to be simple even more if the engineers are increasing in this world.

Figure 3. Student writing samples: a) excerpt of student A's writing from benchmark task and b) excerpt of student B's writing from benchmark task.

The same can also be said of the excerpt in Figure 3(b). The third paragraph of this essay begins with the assertion that engineers apply science so as to "make something special out of nothing". The following sentence provides a further example of the impact of engineering activity: that of heating. Thereafter, the writer speaks to the individual brilliance of engineers before introducing a further example – this time of telecommunications. Although the writer demonstrates significant enthusiasm and commitment to the given topic, s/he neither extrapolates a focused and coherent argument, nor organizes the discussion into a paragraph with a clear main idea. Again, this is a structural feature of well over 50% of the papers.

Comparison of survey and writing assessment results

While most of the survey results clearly indicate that students have a higher sense of self-efficacy as writers

than the writing samples indicate is warranted, some survey data contradict this finding. For example, the survey instrument asked student-participants to indicate what grade they expected to receive both for the essay assignment and for the course as whole. The results of these two questions are provided in Figure 4.

These data demonstrate that although the students had high expectations for both the assignment and for the course as a whole, their expectations regarding the assignment were lower than those regarding the course: 65% expected an A or B on the assignment, while 89% anticipated an A or B in the course. This suggests that students expect their performance on writing tasks to negatively impact their overall performance on the course.

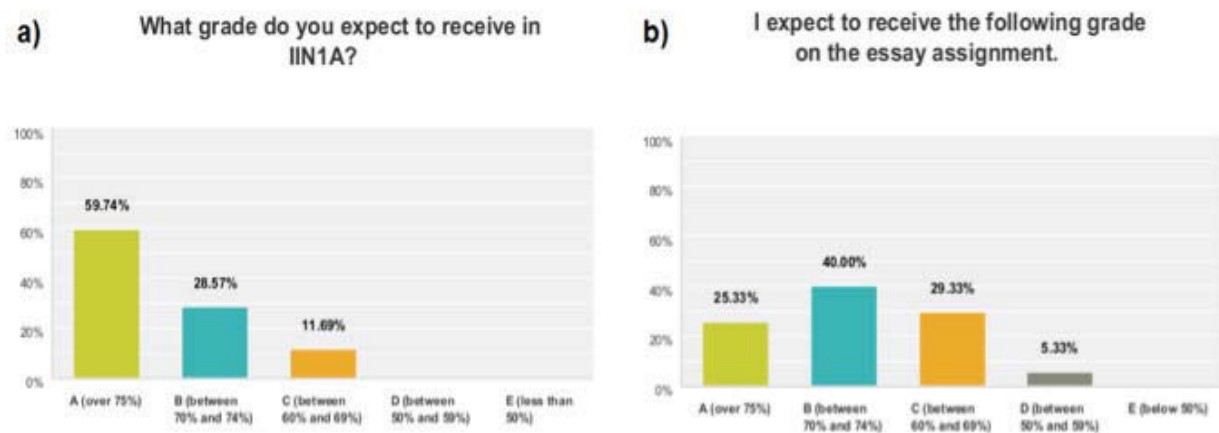


Figure 4. Students' expectations of the grade that they will obtain for the a) course in general and b) the essay assignment.

The students' sense of self efficacy as writers may derive in part from their matric English results. According to the survey data, 96% of the student participants indicated that they received a C-grade (between 60 and 69%) or better for English; as Pajares suggests, this result has likely been interpreted by the students as a mastery experience, one of the four likely sources of self-efficacy. In contrast to these survey data, only 16% of students received a C-grade (between 60 and 69%) or better when marks from all six assessment criteria in the researchers' rubrics were averaged. This implies that there is a disconnect between secondary school and university expectations of students' writing skills.

Nonetheless, the contrast between the survey results and the analysis of the writing samples suggests that instructors need not only to take advantage of student confidence (which is a condition of possibility for effective learning) but also to develop interventions that will help students develop the writing skills they need to succeed. These findings demonstrate the adage that "students don't know what they don't know" and clarify precisely what it is that the students don't know. It is the task of well-designed engineering curricula to address these related challenges. To put it rather bluntly, engineering educators must pitch interventions at an appropriate level without damaging their students' confidence.

The survey instrument also asked respondents to state the extent to which they agreed with the statement that 'even if I don't know anything about the topic, I will

still be able to write a good essay'. As can be seen in Figure 5, well over half the respondents expressed some agreement with this statement. This result suggests that the respondents do not see the writing process as integral to the processes by which engineering (or any) knowledge is constructed. This is concerning and may help to explain the general weaknesses the assessors found in the students' arguments. Although knowledge in engineering is also constructed through graphics, tabulations and calculations, these are generally integrated into written documentation and are deployed as evidence to support claims most often made using written language.

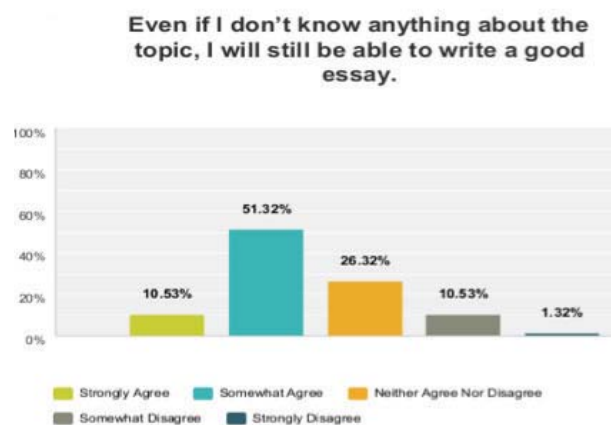


Figure 5. Students' expectations of the grade that they will obtain for the a) course in general and b) the essay assignment.

Finally, all of these observations must be considered in terms of students' responses to a question in the survey instrument about whether communication skills or technical skills are more important to their future. The vast majority of students (over 90%) seem to understand that communication skills are of equal or greater importance to the technical skills they will develop throughout the course of their degrees. These data suggest either that the students believe they already possess these important communication skills or that they would be willing participants in interventions designed to improve their writing skills.

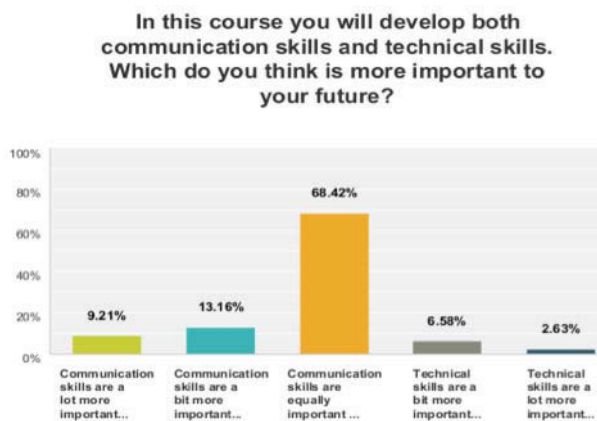


Figure 4. Students' perceptions of the importance of writing skills in relation to the importance of technical skills.

Discussion and Implications

These findings reiterate the importance of explicit knowledge regarding conventions of academic writing. Students need to access this knowledge, both as readers and as writers. The prompt given for this assignment was intentionally vague so as to ascertain how students might independently interpret the context for the task and adjust their writing accordingly. As was demonstrated in Figure 2, very few students interpreted the context as requiring an essay that included a formal introduction (with clearly stated, arguable thesis), focused and well-developed paragraphs (with clear claims and evidence in support of the thesis), and a conclusion. The conventions of academic writing, often encapsulated in the notion of "essayist literacy", invoke a particular way of constructing knowledge that has been privileged and taken for granted in higher education (Lillis, 2001; Starfield, 2007). If the engineering curriculum presumes that students know what is meant by "essay", or "lab report", or any other text-type deployed in engineering writing (and if lecturers assess students' knowledge accordingly), then the findings of this paper suggest

an obvious gap in students' knowledge that will significantly detract from student success at university.

Furthermore, this analysis also indicates that students need specific instruction on how to connect the writing process (and writing more generally) to knowledge construction in their discipline. This is because literacy practices are implicated in the knowledge-making, or epistemological, practices of disciplinary communities (Starfield, 2007, p. 883). The 'content' of the engineering disciplines is not an assemblage of information; instead, it is a mode of thought (Elder, 2009) expressed through writing, in conjunction with other forms of meaning-making.

Students' inability to perceive their writing as implicit in the construction of engineering knowledge was made manifest in the students' writing samples (for example, in the writing samples provided in Figure 3). Figure 2 also demonstrates that many of the students' essays did not provide evidence that supported the arguments that the students were (apparently) trying to make. Sometimes the evidence simply did not exist; at other times, it did not connect logically to the claim that preceded it; still other times, it connected to the claim, but needed more explanation or analysis to make the connection clear. In the sample included in Figure 3(b), the introduction suggests that the 'argument' of the essay is that "engineering has brought a lot of changes in this world". (Note, however, that the topic required students to discuss the impact of one, specific technological breakthrough, and not the contribution of engineering more broadly, so this student has also missed the point of the assignment in a significant sense.) The remaining paragraphs, rather than providing claims in support of this argument, provide examples that illustrate the initial claim, such as advances made in communication, lighting, heating and refrigeration. This is a good illustration of students' general tendency to present lists of evidence disconnected from a thesis-driven argument.

Another way of explaining this feature of student writing is through what Paxton refers to as the process of 'fact-telling'. Paxton (2007, p. 52) argues that such fact-telling is typical of students in a stage of 'interim literacy' as it involves drawing on practices that previously aided those students at school. This, Paxton (2007) continues, also goes some way towards accounting for the lack of coherence in student writing. This is evident in both writing samples discussed in this paper. In most cases assessed in this study, students do not seem to know how to introduce or explain the evidence in a way that links it back to the topic

sentence in the paragraph and/or the thesis of the paper. A simple transitional expression preceding or following the evidence would help signpost the logic of the paper and mitigate this problem considerably. Other rhetorical strategies (warrants/claims; patterns of argument) are similarly lacking.

These conventions of "essayist literacy" are not merely arbitrary conventions. Instead, they are central to the ways in which engineering knowledge is constructed. When students develop the ability to organize their thoughts (on heating and telecommunication, for example, in Figure 3(b)), they are also developing the ability to generate abstractions, to categorise information and provide thematic observations about the world. At stake, therefore, in these writing excerpts is not simply the need for a topic sentence and supporting sentences, for claims and sub-claims, but the need to argue that heating and telecommunications are two of the myriad ways in which engineering knowledge can be applied to the issue of improving human health and granting enhanced access to a global economy. It is this level of abstraction and reasoning that is absent from many of the students' writing. As Lerner (2007) argues, physics and writing are both laboratory subjects in that each inculcates students into an approach to thinking and reasoning. When we argue that engineering students should be effective 'problem-solvers', this does not just mean that they must have effective mathematical, physics or design knowledge; it also means that they must be effective writers who can employ the conventions of academic writing that elevate their thinking beyond (for example) the statement that "everyone can now cook without looking for wood in the forest" and instead can help them think about food preparation within the broader contexts of time, health, the economy or progress.

Of course, we must be careful not to use the conventions of academic writing to stifle creative reasoning. As Devitt (2009) insists, it is imperative that instructors teach genre awareness rather than the formulas or templates associated with a genre. The developing writer that produced the text in Figure 3(b) displays a high level of passion and a good amount of knowledge about technological advancement. We must recognize this passion and knowledge, and we must engage students in a scholarly conversation about how greater awareness of the conventions of academic writing can themselves be harnessed by writers so as to enhance their ability to make sense of, and enact change within, the world.

These data imply a need for writing instruction that teaches students the relevant conventions for presenting and explaining evidence and argument. They suggest a requirement to teach writing practices through subject content, in a discipline-specific rather than generic context (Kloot, Case & Marshall, 2008). In short, our research indicates that writing development initiatives in engineering are likely to be most effective when the mode of writing is conceptualized not as an isolated, technical skill, but rather as a practice that is integral to how engineers come to know and talk about what they know — as an integral part of their conceptual understanding of engineering activity (Lerner, 2007). Engineering students need to be initiated into the 'social language' of science (including its genres) if they are to function within the 'culture of science' (Kloot, Case & Marshall, 2008).

Another significant finding of our research is the contradiction between students' high sense of self-efficacy as writers and their poor performance on the writing task. While all of the literature demonstrates writing self-efficacy is a predictor of writing outcomes (Pajares, 2003), this is clearly not the case with the current study. We believe these students' high levels of self-efficacy do not correlate to their writing performance because the sources of their self-efficacy were not connected to the specific kind of writing they did for this research. Students were required to write an academic essay and were assessed using standard criteria for evaluating academic writing produced at the university level, but their sense of self-efficacy was likely related to the writing they did in high school. In other words, their perceptions of their abilities were based on their experiences producing a very different kind of writing for a very different kind of audience.

Students' high sense of self-efficacy is largely based on their "mastery experiences" in high school—their interpretation of the successes they had producing written texts that were not likely academic essays. Their beliefs would also be based on their observations of their peers, the feedback they received, and the physical experience they had when writing in high school. Self-efficacy derived from these sources would have correlated with high writing outcomes in high school, but it would not necessarily produce the same results in a different context with different tasks and assessment practices.

This suggests a need for interventions and pedagogical practices that can not only leverage students' perceptions of their abilities, but also build on the skills

and knowledge they have developed in high school or elsewhere. Our students' prior knowledge must be activated. Their positive attitudes towards and experiences of writing must be nurtured and directed towards new applications. All of this must be done before students receive the discouraging message that everything they learned in high school is useless; and it must be achieved through interventions and assessment practices that do not lower the university's standards.

Finally, the spirit of this paper has been to acknowledge and leverage what students already know and do. In this spirit, it is heartening to learn that the just over two thirds of the students claim to believe that communicational abilities, such as formal academic writing, are as important to their future success as technical skills are, while another 20% claim that communicational abilities are in fact more important than technical skill (see Figure 6). These unexpected results suggest that students are predisposed to be receptive to future writing development activities integrated into the engineering curriculum.

Conclusion and Recommendations

This paper has made three inter-related arguments:

1. Students' sense of self-efficacy is an important facet in the development of academic literacies. In this study, the student-participants' confidence in their abilities as writers is a resource that can be harnessed when designing and implementing activities aimed at student writing development. A further resource that can be harnessed is the students' general recognition of the importance of communicational ability in their engineering study and beyond.
2. However, students' sense of self-efficacy as writers has been established in a context very different from that of a first-year engineering course, and so the students do not achieve the writing outcomes typically associated with these beliefs. Across the board, the student-participants' perceived abilities did not match their instructors' expectations regarding key aspects of formal academic writing, such as paragraphing, argument, and coherence and cohesion. It is the task of well-designed engineering curricula to address these gaps in a way that does not demean students' confidence in their extant abilities. Future research needs to be conducted to identify the precise sources of the students' self-efficacy, the best practices for activating their prior skills and knowledge, and the

- best strategies for building on the experiences that have given them confidence and agency as writers.
3. Furthermore, writing development initiatives should focus on the dual concern of developing students' explicit knowledge of the conventions of engineering writing, and the need to link writing processes and practices with the processes and practices by which engineering knowledge is constructed.

These findings suggest that efforts aimed at implementing writing development initiatives across engineering curricula are necessary and important. One way of achieving this aim is through a process of curriculum mapping (Felder & Brent, 2003; Crawley et al, 2007). The need for such curriculum mapping stems from the fact that it is evident from this research that students do not enter into engineering programmes with the required control of foundational writing practices that correspond to the relevant 'exit level outcomes'. Such a process of curriculum mapping involves identifying the relevant exit level requirements and, working backwards to where the students are upon entry, identifying where and how the relevant writing practices can be embedded into modules in each year of the programme. It also involves a clear identification of the wide variety of skills and abilities that students possess in all modes of communication, not just the mode of academic writing. This approach would allow curriculum designers and instructors to take better advantage of students' sense of self-efficacy which research suggests is more typically correlated with writing outcomes.

Such an 'infusion model of curriculum development' (Kloot, Case & Marshall, 2008) demonstrates a genuine attempt at incorporating professional communication abilities into the curriculum, and goes beyond paying mere 'lip service' to the required exit level outcomes. To be successful, curriculum mapping must be an activity that involves entire departments, rather than isolated individuals, so as to ensure that the relevant academic skills and practices are being developed at multiple points within engineering programmes. This avoids the problem of academic development initiatives in the first year of a programme being undermined through a lack of follow-up in subsequent years of the programme (Onsongo, 2006). Data such as those collected in this study are vital in establishing the benchmark from which such developmental interventions can begin. As Paxton (2007, p. 53) argues, students' interim literacies (and, we would add, students' sense of self-efficacy) must inform our teaching because they tell us who our students are and where they come from.

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