The Holes in the Cheese: Improving Engineering Students' Generic Communicative Competencies

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Abstract

Engineers spend considerable time communicating technical details to various audiences. This requires communicative competence which is linked to the underlying knowledge and skills in the engineering disciplines.

The metaphor 'holes in the cheese' is used to describe a particular group of reading and writing competencies which are not yet adequately developed in students, but which are expected to be in place at their educational level, and which are further characterised as follows: (a) while it is reasonable to include limited revision of prior topics or competencies in a mainstream programme, substantive interventions to address them must be extra-curricular; (b) a significant proportion of students require development in this regard; (c) they are seldom explicitly taught; (d) most engineering academics are not explicitly trained to identify or address them; (e) identifying and addressing them through traditional assessment of written work ('red ink') is time-consuming for academics; (f) moreover, addressing them through traditional assessment is seldom successful: while the document may have been corrected, an improvement in competence is seldom established by this method.

By way of evidence, this paper attempts to name, explain and illustrate these 'holes in the cheese' in terms that are sufficiently explicit and concrete so that fellow engineering academics can readily understand and relate to them. This evidence is illustrative and anecdotal, serving as a point of discussion rather than a conclusion of fact.

With regard to reading fluency and comprehension, the reading speeds of students on intake to supplementary interventions, over a three year period, have typically been below the reading speeds regarded as a lower threshold for university students when reading fiction and non-technical materials. With regard to writing, typical challenges include grammatical errors as well as structure, organisation, logic, and integration / synthesis of information from multiple sources.

Introduction

McLeod and Reynolds (2007) argue that we are teaching and learning in times of overwhelming changes in the way we know, the way we teach and in what is expected of us as educators and learners. This is no less true in engineering education. Regardless of whether our teaching and learning environment *has* in fact changed or whether it is simply our *perception* of that environment that has changed, it is the anecdotal observation of the authors over a period of about five years that - certainly in the four-year engineering degree programmes offered at the University of Johannesburg (UJ) - a significant number of senior students (nominally between the 2nd and 4th year of study) face particular challenges that were either not faced by their predecessors or were not noticed before. Over that same period, the

throughput rates on the mainstream programmes – measured as the percentage of students in a starting cohort who *ever* graduate – appears to be falling from around 40 to 50% for cohorts starting six or seven years ago to - from what can be observed at this stage - about 30 to 40% for cohorts of the past two or three years (Van Ryneveld and Wallis, 2010). To use a well-known metaphor, then, the cheese appears to have been moved. This paper attempts to name, explain and illustrate the challenges students face with regard to academic literacies, which admittedly is only one facet of the challenge engineering educators and students face.

There is increasing international recognition of the need for communicative competence in virtually all fields of industry (Sulcas & English, 2010). This is also the case in Engineering where much of an engineer's time is spent communicating technical details to various audiences (Ostheimer & White, 2005). For the purpose of this paper, generic communicative competence is linked to the underlying knowledge and skills in the engineering disciplines. Analysis of the Engineering Council of South Africa's (ECSA's) exit level outcomes (ELOs) identified three categories of literacy practices that should be engaged with during the tertiary education of engineers (Simpson & Van Ryneveld, 2010):

- Reading (including reading an array of text types; discerning essential from non-essential information; comprehending, summarising, paraphrasing, synthesising and referencing information from various sources);
- Writing (including language competence; audience-awareness; genre- or purpose-awareness); and
- Critical thinking (including argument, evaluation and reasoning; reflection and independent learning; relational and analytical thinking).

Of these three categories, the 'holes in the cheese' focus primarily on the first two, as there is more opportunity for the development of the third category – critical thinking – at university level.

This paper begins with a fuller definition of what is meant by the 'holes in the cheese'. Thereafter, it examines the 'holes in the cheese' through the particular lens of the academic literacies literature. Included in this section is background about the Engineering Education initiative at UJ. The following section discusses the particular difficulties our students appear to face with regard to reading and writing. This discussion is supported by evidence and examples from our experiences with students. However, it is important to note at this point that this data is merely illustrative and anecdotal; it serves as a point of discussion rather than a conclusion of fact. Our concern is primarily to name, explain and illustrate the challenges students face in terms that are sufficiently explicit and concrete that fellow engineering academics from a range of disciplines (e.g. mechanical/civil) and sub-disciplines within engineering (e.g. structures/transportation for civil) can readily understand and relate to them. The paper concludes with tentative examples of interventions which may be implemented in order to assist students in developing the literacy practices required for engineering study and work.

Defining the 'holes in the cheese'

According to Crawley, Malmqvist, Ostlund and Brodeur (2007), "[engineering] students must learn how to merge the physical, life, and information sciences at the nano-, meso-, micro- and macro- scales; embrace professional ethics and social responsibility, be creative and innovative, and write and communicate well. Our students should be prepared to live and work as global citizens, [and] understand how engineers contribute to society". All of the

important expectations expressed in this statement represent the anticipated 'product' of an Engineering degree programme. However, it is difficult to match up to these expectations if generic communicative competencies are not in place. Herein lies the relevance of the analogy alluded to in the title of this paper. Reading and writing competence, if not developed within the course of university degree curricula, can become holes in the cheese that detract from the technical quality of the graduates from those degree programmes.

The literature is clear on the fact that communicative competencies are important. For example, the World Chemical Engineering Council (2004, in Crawley et al, 2007) developed lists both of engineering graduates' most significant shortcomings and of the most important abilities for engineering graduates to possess. Effective communication is the only ability to feature prominently on both of these lists. That is to say, while it is considered one of the most important abilities with respect to employment, it is one of the greatest deficits with regard to education. Similarly, the Massachusetts Institute of Technology (also in Crawley et al, 2007) conducted a survey of lecturers, professionals and alumni aimed at ascertaining the relative importance of a number of skills for engineering graduates. Again, these results placed communication among the most important skills necessary (along with reasoning, analysis and teamwork). In another study (reported on by Sulcas & English, 2010), effective communication was rated as the second most important skill in engineering after problem solving.

Reading and writing competence is important both after graduation and during students' studies. This is because writing is one of the primary means by which students are evaluated (Angelil-Carter, 2000) and because reading is one of the primary means by which students are expected to acquire information which can be used to construct knowledge. As Evers, Rush & Berdrow (1998) argue, there is little point focusing on technical engineering content if students' reading and writing competence is so poor as to prevent the comprehension and communication of the content. As such, while questions of reading and writing competence may not be an explicit focus of engineering curricula, they are nonetheless vital as they have the potential to hinder students' achievement of the learning objectives of these curricula. As Dempster and Reddy (2007) argue: it is impossible to learn effectively (or at all) without the necessary language skills to do so. The longer these competencies remain under-developed, the more glaring these holes in the cheese become. What this means is that communicative competence appears to be both required and taken for granted within engineering disciplines. However, when it is absent, engineers appear to lack the tools to be explicit in addressing this teaching and learning challenge.

For the purposes of this paper, the 'holes in the cheese' are defined as particular competencies which are not yet adequately developed in students, but which are expected to be in place at their particular educational level. It is the observation of the authors that these 'holes in the cheese' have a number of other general characteristics:

- It is reasonable and appropriate to include a limited amount of revision of prior topics or competencies in a mainstream programme, before proceeding to new subjects. However, any substantive interventions to address them must be extra-curricular. ECSA is explicit in this regard that '...[p]reparatory or remedial courses are not included in the [specified minimum number of credits that make up a particular programme]...' (ECSA, 2011).
- A significant proportion of students require input into the development of communicative competence.

- Communicative competencies and literacy practices are seldom explicitly taught.
- Most engineering academics are not explicitly trained either to identify or to address communicative competency.
- Identifying and correcting them through traditional assessment of written work ('red ink') is extremely time-consuming for academics. One suspects that partly for this reason, it is often not done, and is therefore often not reflected explicitly in the allocation of marks.
- Moreover, correcting them through traditional assessment of written work is seldom successful: While the document may have been corrected, an improvement in competence is seldom established by this method.

An Academic Literacies perspective on the 'holes in the cheese'

Lea and Street (1998) propose three approaches to the development of student academic literacy. The first approach is an academic skills approach. This approach is similar to Street's (1984) autonomous model of literacy, which maintains that literacy is acquired through learning a discrete set of skills that are transferable across varying contexts. The second approach, academic socialization, focuses on academic disciplines as unique 'cultures' and requires that students be inducted into these disciplinary cultures. The third approach, advocated by Lea and Street, and many others since, is termed academic literacies. It stems from an acknowledgement that literacy is a social practice, that is, that it is made manifest differently across varying social contexts and that the literacy practices employed within academic communities are a result of the dominant power-relations within that community.

However, as Archer (2010) argues, each of the three approaches in the Lea and Street model of academic literacies encapsulates the others; as such, they are not mutually exclusive and nor are they linear stages of progression. Archer (2010) further argues that the academic literacies approach is better suited to advanced students and can be seen as the end of a process rather than the beginning. This research is conducted within the framework of the Lea and Street model but is located at the beginning of that process, rather than the end. It examines the basic communicative competencies upon which academic literacies are supposed to be developed. As Bartholomae (1985) argues, the higher the level of competence required, the fewer general cognitive strategies there are; that is to say, writing, thinking and learning become increasingly field specific as students progress through their academic careers. With this in mind, this paper is not concerned with the specific discursive practices of the engineering disciplines *per se*, but the more generic communicative competencies upon which the discourse/s of the engineering disciplines is founded.

In addition, one of the goals of this paper is to begin the process of interrogating what the academic literacies model means, in practice, for engineering education in South Africa. The notion of academic literacies appears not to have been adequately explained within an engineering context. It is the observation of the authors that what appears to be commonly understood in the academic literacies community appears not to be as well-known to engineering academics – at least not within the UJ context.

The academic literacies perspective locates student challenges with academic literacy within various contextual factors. As such, addressing the challenge of student writing requires an understanding of the culture of the various disciplines as well as the dominant knowledge-making practices within those disciplines (Lea and Stierer, 2000). However, this leads to

what Archer (2010) calls the double-bind that ensnares university educators. This is due to the simultaneous pull towards ensuring learners conform to institutional expectations while also attempting to allow students from diverse literacy backgrounds to achieve success in the institution. Archer (2010) refers to this as the access paradox where the key question is how to provide access to dominant forms of meaning-making while at the same time valuing the diversity of resources our students and our societies bring to the educational experience.

It is one of the aims of the Engineering Education initiative at UJ to address these issues. The initiative was established in 2009 in order to pursue specialist engineering education matters from within engineering so as to complement the approaches of Academic Development. To this end, the focus has been on the higher years of study rather than on the school/university interface (in line with the recommendation of Jacobs, 2007). As part of the initiative, an academic literacies practitioner was appointed as a subject specialist within one of the engineering departments. The rationale for such an appointment was to assist with the integration of academic literacies into the mainstream engineering programmes.

The particular context of engineering poses three challenges to the implementation of an academic literacies model. Firstly, it is typical of engineering programmes for the curriculum to be 'jammed', meaning that time is at a premium to cover what is considered to be necessary content. Secondly, the curriculum is strongly loaded towards maths problem-solving courses at the expense of writing-intensive courses. Thirdly, students in engineering (at UJ at least) tend to begin to take writing-intensive courses only in their third year of study, the tacit assumption being that basic communicative competencies are already in place by the time students progress to the senior years. In reality, this lack of practice with regards to academic literacies poses significant challenges to students in their final year research projects, when it is extremely difficult to address these challenges.

It is thus evident that the structure of the curriculum does not strongly support the development of student academic literacies. Nevertheless, students are expected to communicate the findings of their studies both orally and in writing through tests and exams, essays, reports, and presentations. Communicative proficiency also forms part of the ECSA ELOs, with students being expected to communicate effectively, both orally and in writing, with engineering audiences and the community at large. These expectations may be further strengthened by international trends: either explicitly or implicitly, both the American Society of Civil Engineers (ASCE) and the American Society of Mechanical Engineers have identified priority goals for their professions which broadly require improved communicative competence (ASCE, 2008 and ASME, 2008). In addition, communicative proficiency is critical to learning in quantitative areas as well as qualitative areas (Simpson and Van Ryneveld, 2010; Howie, 2003). As such, academic literacies 'punch above their weight' in a curriculum that, in terms of credit allocations, strongly favours maths problem-solving courses.

In conclusion, as Lillis (2001) argues, in order to be successful, students must learn the conventions of and gain access to the literacy practices of, in this case, engineering. However, these literacy practices are often taken for granted and are surrounded by "institutional mystery". This paper does not seek to posit solutions to this paradox; instead, it outlines the challenges students face as a point of departure for addressing this paradox. This point of departure stems from two key assumptions. First, as Jacobs (2007) argues, while students tend to gain expertise in the content of academic disciplines, they often fail to gain expertise in the rhetorical processes by which that content is created and communicated. Second, the development of student literacies is not solely dependent on students' individual

actions, but also depends on the developmental opportunities offered by their environment (Norton and Toohey, 2001).

Where are the 'holes in the cheese'?

This section provides evidence to name, explain and illustrate the 'holes in the cheese' with respect to communicative competence. The illustrations have been compiled by the authors over a period of three years from student work in both formal coursework and informal supplementary support interventions ('informal' used here to mean that they are not part of the university curriculum), with students drawn from all engineering disciplines, and spread over the senior years (2nd to 4th year). There is no intention in this paper to *differentiate* between years of study or disciplines. Rather the intention is to name, explain and illustrate, in general terms, the academic literacy challenges evident across this broad group of students.

One overall indicator of the 'holes in the cheese' is demonstrated by the results of the PTEEP test (Placement Test in English for Educational Purposes) of the University of Cape Town's AARP (Alternative Admissions Research Project) suite, normally used for benchmarking students on admission to university. On this test, carried out on a group of about 100 students on a BEng/BIng programme in their 3rd year of study, about 35 to 40% of the group recorded PTEEP scores below the 'proficient' level. The PTEEP is generally used to test first year students (sometimes for admission or placement purposes) and the fact that third year engineering students are failing to achieve 'proficiency' on this test, suggests that very little development of these competencies is taking place during the programme. This may also be a contributing factor towards the fact that many Engineering students struggle to complete their studies in the prescribed time. This is supported by Howie (2003) who found, albeit at school level, that language proficiency plays an important role in determining success in mathematics.

More specific examples of the 'holes in the cheese' within the categories of reading and writing have been observed and measured through individualised supplementary support interventions over a period of three years with about 25 BEng/BIng students between 2nd and 4th year of study. These interventions were undertaken with volunteer students across Civil and Mechanical Engineering and were conducted with small groups of students over the period of one semester. Although undertaken in small groups, the presence of at least two facilitators ensured a degree of individualised instruction for each student. One of the aims of these voluntary supplemental classes was the development of students' reading speed. Measurement of reading speeds was undertaken through proprietary software (Reader's Edge). Each reading speed test in this software package is followed by a series of short multiple choice questions on the passage read. The proportion of questions answered correctly is then applied to the raw reading speed to obtain an effective reading speed (which are the figures reported).

Reading speeds of students on intake to these supplementary interventions, over a three year period, have typically ranged between 60 and 160 words a minute. This is at a level of difficulty that would be considered to be below Grade 12 school level. Comprehension on this level ranged from 50 to 100%. This is well below the 250 words a minute regarded as a lower threshold for university students when reading fiction and non-technical materials (Cambridge University Students Union, 2011).

Voluntary online reading speed tests were also completed by the 2011 third year cohort of engineering degree students across the Faculty. These reading speed tests were again conducted using the Reader's Edge software. Approximately two-thirds of the cohort

completed the tests. The results indicate that around 80% of the cohort were unable to read at 250 words per minute as per the above-mentioned guideline. Figure 2 illustrates the distribution and cumulative distribution of the reading speed test results.

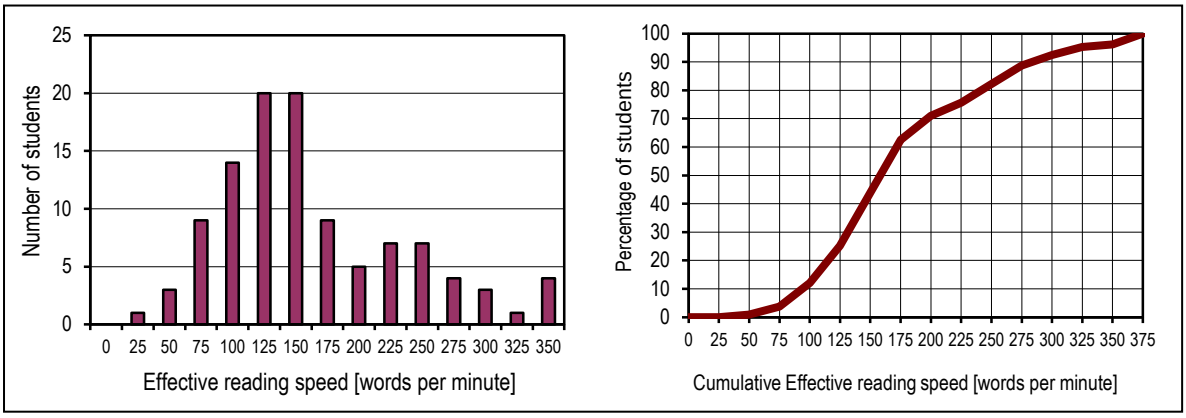

Figure 2. Distribution and cumulative distribution of effective reading speed of 3rd year cohort of engineering students

Reading fluency and comprehension are important considerations for student success. This is because it influences students' ability to keep up with work load and understand the highly technical nature of engineering content. Kalman (2008) argues that reading material in engineering textbooks is one of the major obstacles that face our students. Kalman goes on to argue that obstacles such as this can only be overcome through a holistic approach to developing student competencies which may include classroom-based intervention. Furthermore, as implied in the very title of this paper, a lack of reading fluency and comprehension prevents students from understanding engineering content as what Elder (2009) calls a "mode of thought" rather than as fragmented bits of information.

In addition to reading speed, the voluntary supplemental classes described above also aimed to develop students' written English language competency. In the written work they produced in these classes, typical difficulties experienced are indicated in Table 1. These are basic linguistic challenges but they can detract from students' overall success – as students and as graduates. In addition to these challenges around language proficiency, the authors, through close observation of the students' engagement in literacy activities, also noted a number of challenges relating to the students' mastery of academic literacy practices. For example, it was noted that the students did not undertake advance planning when they wrote reports. It was further observed that a basic problem that many of the students encountered was extracting key words or ideas from the materials presented and it was further necessary to teach planning skills such as mind-mapping. The authors also noted that the students did little to no revision and editing, instead writing their ideas in a 'stream of consciousness' manner, that is, in a random order without focussing on the point of the written work. Many of the students were also unfamiliar with the passive tense and, as such, were unable to depersonalise their writing.

Two key points stand out from the experience of these supplementary voluntary interventions: firstly, it is difficult to give these competencies the attention they need within traditional university modules given the mismatch between the level of material to be covered and the level at which these competencies need to be addressed. Secondly, ECSA does not permit significant "make-up" material to be included in curriculum credits. As such, while it

is desirable to integrate the development of these competencies into the curriculum, a variety of integrated and complementary approaches may be necessary.

Table 1. Typical examples of language errors made by students.

Type of Error	Examples
Tense	"When I came to the university the medium of instruction is English" "The mountain glaciers are decreasing, desertification was growing exponentially, an increase in degraded coastal areas and the list goes on"
Concord	"There are a lot of things that makes me want to be a civil engineer" "I now realise that not only rural areas needs developments"
Misuse of pronouns	"It is known that one has to know their English before they become good writers" "I'm a person who loves doing things on their own"
Misuse of verb forms	"Engineering is one of the most paying industries in the world" "Then thus I am committed myself to use the occasion of this assistance program"
Inability to express ideas clearly	"Engineering has a lot to do with calculations than the theory reports writing" "I need to be able to come up with the most simple and possible ways in solving problems and not make them simpler"
Incorrect vocabulary	"As a full time student, I am enrolling every day..."
Sentence construction	"... a slum is defined by any one of five deprivations, these deprivations are ..." "And it will also help as to research and gather a lot of information in the different sector"
Colloquialisms	"I have found that this keeps me in tune with industry trends and as a result I have now made it part and parcel of my weekly activities"
Repetition	"... would be good for any person and could help a person in all walks of life"

The challenges students face with regard to generic communicative competencies can also be seen in practical examples of student work drawn from courses in Mechanical and Civil Engineering. For example, the text in Figure 3 is a brief, one-page essay produced in class by a senior Civil Engineering student. The essay has been typed 'as is'. The topic for the essay was the importance of infrastructure asset management in addressing the poor state of municipal infrastructure in South Africa, using the water services sector as an example. It is evident in the example text provided that many of the same problems with grammar and syntax described above can also be identified here. However, there are other concerns evident in this particular student essay that illustrate key challenges a student such as this experiences in terms of reading and writing. The discussion that follows is an outcome of a process of reflection undertaken by the lecturer involved.

The first concern is the students' lack of comprehension of material he has read. The essay contains numerous attempts to integrate what he has previously read with the topic given. For example, the opening sentence of the essay is an attempt to provide a definition of 'built environment infrastructure' which the student has misinterpreted as 'building environmental infrastructure'. One of the aims of the course in which this essay was written is to encourage

students to interrogate how engineering activity is impacted upon by the full range of social, economic, political and environmental factors at play in a country such as South Africa. The student's attempt to do so largely fails – in part because of a lack of comprehension of the materials he has read.

Building an environmental infrastructure is part of a nations capital stock that produce services that are consumed by members. Infrastructure supports the quality of life and the economy. I will now discuss the Infrastructure Asset Management (IAM) to address the poor state of infrastructure.

The Infrastructure Asset Management (IAM) is defined by a formal approach to the planning and practice of responsible municipal asset management, which is to ensure quality that last longer, which is cost-effective and sustainable to the community.

As the water sector plays a big role in South Africa as a poor infrastructure, is due to the amount of people not having a sufficient, durable, effective supple of water for irrigation and sanitation. To address these problem which contribute to the inequality of SA is by gathering a sufficient amount of information of the problem like, its functionality, effectiveness, performance, management and cost.

South Africa is stil seen as a developing country as it have a high population growth, low economic activity and high inequality, this all contribute to an individuals health and prospects.

The water thats being provided to SA community should be an sustainable infrastructure to allow that every person could have fresh water and sanitation facilities. This by great infrastructure planning one could ensure that sanitation and fresh water is supplied equally to the growth rate. Doing this have huge cost implecations that the government could not spend due to the nations growth rate and that only 33% of people contributes to the economy.

This by ensuring and allowing business development within a community and getting private investors this could be possible.

By improving the asset management Infrastructure would allow SA to meet key regulatory requirements, more productive relationships between parties as it also improve the credit rating. This will contribute to SA becoming a first world country.

Figure 3. Text produced by a senior Civil Engineering student.

A further concern in this particular essay is the student's ability to logically develop and link thoughts and ideas in writing. For example, the third paragraph begins with a description of the poor state of infrastructure in the water sector in South Africa. Rather than elaborating on this with examples, the student then attempts to argue that more systematic infrastructure management can address this problem (by gathering information on functionality, effectiveness etc). The next paragraph then moves on to a separate issue, namely, the economic challenges facing South Africa. While all three of these points warrant development in this essay, the student has failed to logically connect them in a way that allows the reader to understand the relationship between the poor state of water services infrastructure, the need for information on infrastructural assets and the challenge presented by South Africa's developing economic state. As such, it is evident that this student (and others) lacks understanding of the ways in which written language works (through paragraphing, coherence and cohesion) to systematically organise thoughts and ideas in ways that help readers to easily follow the logic of what has been written.

Similarly, in the context of Mechanical Engineering, Figure 4 provides an example of a 600 word essay written by a senior Mechanical Engineering student on South Africa's role in global mineral production. Once again, the discussion below is an outcome of reflection undertaken on the part of the lecturer of the course.

Although not common, many of the students failed to adequately address the given question, which ultimately negatively affected their grades. This was despite the fact that the students were provided with assessment rubrics which outlined the assessment criteria. The students appeared to struggle to demonstrate an understanding of the subject in question, where

random and unrelated theories were presented to support unstructured arguments. In addition, common problems which students appeared to encounter involved structuring reports in a coherent and logical composition. Students also appeared to find it difficult to organise their thoughts.

> While South Africa is as rich as it is economically as a result of its mineral patches it is also hindered greatly in that it export raw materials and not process goods. The exports around 50-60% of it's raw minerals. It's massive economic blow to the country as most of its industrial potential isn't being utilized to the best of its ability. It is the goal of the country to become world's biggest exporters when it comes to finished goods rather than raw materials as it will launch South Africa in to becoming a first world class country.
>
> Africa is known for it's rich mineral reservoir, and one of it's biggest producer of mineral wealth in South Africa. South Africa is one of the world's biggest mineral suppliers, it's extremely mineraly rich geological landmasses provide significantly to the countries international wealth. [1]
>
> South Africa has been between 85 to 90% of the world's platinum metal, which is also the world's most expensive industrial metal on the world market. [2]
>
> It supplies a lot of other mineral and ranked number 1 and 2 for Manganese, Chromium, gold, vanadium and alumina-silicates along with non-metal materials such as Coal. The world rely heavily on the exploitation of South African Raw material export to fuel the production industry. The countries rich mineral sources come from a lot of rich underground and vast geological construct made of multiple mineral rock formation scaling over massive distance. [3]
>
> The Bushveld Igneous Complex is such a construction, and a lone spans over 60000Km^2 and is responsible for having the highest concentrate of a Platinum metals in the world. The occurrence of Complex as rich as these have resulted in a vary expansive and heavily monitored mining industry in the country and there is a high demand of people of a mixture of professions to be involved as development of the industry will enrich the country radically. For the engineering stand point, not only is their need to derive new ways of obtaining raw materials, but their is also need for refining the raw materials it repeatedly exports, as this has a great affect on the countries potential.

Figure 4: Text produced by a senior Mechanical Engineering student.

Once again, it appeared that the student(s) in question struggled to adhere to basic academic literacy expectations, reinforcing the notion that these literacy practices warrant development within curricula. Paxton (2007) argues that very few students enter their university education having mastered the "academic discourses" of higher education, that is, the rules that dictate how things should be written at university. Paxton continues that, as students enter higher education, they embark on a process of "interim literacies" where they begin to learn these rules.

Intervention

As stated above, the aim of this paper is merely to draw attention to the challenges that engineering students face with regard to the development of basic academic literacies. However, in this brief section, tentative suggestions are made that may go some way towards overcoming these challenges. It would appear that the 'holes in the cheese' may best be addressed within course content through innovative teaching and assessment practices. However, to supplement this, Engineering Education at UJ has piloted three extra-curricular programs in order to address this challenge.

- Self-paced use of a range of interactive computer software aimed at developing reading and writing competence, and critical thinking skills.
- Individualised instruction by professional reading and writing instructors using the same or similar computer software.
- 'Writing supervisors' to work alongside traditional supervisors in guiding students in preparing their final-year research report.

Conclusion

Most academic staff value clear and effective written and oral communication across the curriculum. Despite constraints on the curriculum and on academic staff time (Jackson, Meyer, & Parkinson, 2006), a range of integrated and complementary interventions appears necessary in order to develop students as communication practitioners. The argument presented in this paper can be summarised as follows:

(1) Communicative proficiency is gathering importance in all fields of industry, including Engineering.

(2) However, students need to be inducted into disciplinary content as well as the academic literacy practices of those disciplines, which depends on affording them opportunities to develop these practices.

(3) In terms of reading, a number of students struggle to read texts with the fluency and comprehension expected at university level.

(4) Similarly, with regard to writing, examples of student writing produced by senior engineering students demonstrate a number of concerns with regard to academic literacies.

(5) It is thus necessary that engineering educators engage with the challenge of developing academic literacies (the 'holes in the cheese'), both explicitly and within the context of the discipline.

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