The Value of Understanding Students' Prior Writing Experience in Teaching Undergraduate Science Writing

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Abstract

How should undergraduate science students' writing be understood when it does not meet the conventions of scientific writing? Studies have shown that the writing that students produce in their course work on tasks that imitate authentic scientific writing practices often do not match the tone, vocabulary and grammatical choices made by professional scientists. However, from the perspective of looking at the students' word and grammar choices alone, it is not easy to understand why students make their particular and varied word and grammar choices and how those choices can be related to their understanding of the goals and discourses that are typical of science practices. Studying the writing of four first year earth and geographical sciences students on a science faculty's alternative access program, from an assignment in a course that introduced them to the research article, it seems that the students persist with the social purposes of their various school writing practices in attempting their new university writing tasks. It is this variety in the social purposes of the writing that the students continue to draw on in university that can explain some of the ways in which student writing does not meet even the broadest writing conventions of the discourses of science. Yet it seems that some of the social purposes and the related writing practices of some students can help them transition their writing more easily into a form that has the usual characteristics of a typical science genre. Therefore, understanding the social purposes that students bring with them can be crucial to successfully introducing them to the discourses of science and showing them how the social purposes of scientific practice can be served in a genre such as the research article.

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Introduction

How do undergraduate science students learn to imitate the language of science, particularly in reading and writing research articles, and what should be understood when they do not get this right? Given that the technical language of the research article is a resource that scientists use to persuade the scientific community of the validity of their knowledge claims (Myers, 1985, 1989; Latour and Woolgar, 1986; Martin and Veel, 1998), what are science lecturers and academic literacy specialists to make of students' writing when it does not conform to the conventions of this genre?

This paper presents a study of four students' texts that were written as an assignment in an environmental and earth sciences undergraduate course at a South African university in 2012. The course was offered to students who did not quite meet the Science Faculty's entrance requirements and therefore entered through an alternative access program. Most of the students on the course spoke English as Additional Language (EAL)[2]. Given that graduation rates in higher education in South Africa remain skewed along historical lines (Scott, Yeld and Hendry, 2007; Soudien, 2007; Gilmour and Soudien, 2009), the access programme, the course and the assignment in particular aimed to improve these students' chances of success in their science degree. The assignment (see Kelly-Laubscher and Van der Merwe, 2014; Inglis et al., 2007, for similar teaching interventions) was designed to introduce the students to the genre of the research article (following this format: Introduction, Methods, Results, Discussion or IMRD) and it required the students to write a research article about data and related readings that they were provided with.

The writing that these four students produced for this assignment showed some interesting differences between them which contrasted with the conventions and the broad discourse rules of the science research article genre. In their 'Discussion' sections in particular, there was variety in the way that the students restated their observed results and in the way they stated their inferences. Only one of the students conformed to the genre's conventions in both respects. Through interviews with the students about their assignments, it seems that the variety in their writing is consistent with their specific expectations of such a writing exercise as determined by their previous school experiences. In general, each student wrote his/her assignment in a way that served a purpose that was far removed from the

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[2] In the Academic Literacy literature, these students are identified as 'non-traditional' students as their entry into higher education is the result of a recent expansion in access to South African higher education (Lea and Street, 1998).

purposes that are usually served by scientists writing according to the conventions of the research article. It is in these differences that the specific nature of each student's writing can perhaps be explained. Therefore, studying students' writing closely in science-related writing assignments and talking to the students about the marked features of their writing reveals a variety of student purposes that are determined by their specific school and other literacy backgrounds. Understanding student purpose can help lecturers to teach science writing more effectively by making the students aware of the purposes that are served by scientists when they publish research articles and thereby enabling students to adapt their own writing accordingly.

Literature

In the area of applied linguistics, there have been studies that have characterised the contrast between student writing and professional writing in some scientific genres and disciplines by comparing corpora of texts from each of the two groups of writers – student and professional. For example, Parkinson (2011: 174), by comparing a collection of course assignment laboratory reports with published research articles, observed that undergraduate physics students are more likely to use a conversational tone, make stronger claims of proof, and use a more restricted range of word and phrase choices than professional physicists when writing. But while it is true to say that the students are yet to learn the science discourse conventions necessary to position themselves as the scientists do, it is also possible to argue from these observations that the students are writing in one discourse and the professional scientists in another, and these discourses correspond to the goals that are achieved by studying for a degree and those achieved by doing research in physics, respectively, which partly explains the contrast in writing styles.

Making a similar point, Goodier (2008) has suggested that non-matching goals and context was the reason why patients were the object of student radiology reports while clinical knowledge was the object of the professional radiology reports. Furthermore, looking at student writing only, Inglis et al. (2007) and Parkinson and Adendorff (1996) found that students were not fully acquainted with the science discourse conventions but were rather at an intermediate stage of development, which again could reflect a contrast of goals. Beyond the South African context as well, similar observations about student writing can be found in some applied linguistics research (Granger and Paquot, 2011; Shaw, 2011). However, as

Coffin and Donohue (2012: 71) have argued about Systemic Functional Linguistic studies in general, these applied linguistics studies set out to characterise student texts in the context of a scientific discipline but they did not set out to study the students' lived experiences of learning to write in scientific genres. By not focusing on the meanings and purposes students associate with academic writing, these studies do not make an explicit link between what is distinctive about the students' writing and the students' specific experiences of learning scientific discourses.

In the field of Academic Literacy, there have been studies that understand student writing from the perspective of student purpose with an emphasis on individual student experiences and discourses. From this perspective, written texts do not exist in isolation but are bound up with what people do in a social context (Lillis and Scott, 2007: 12), what they practice, for socially determined purposes; while an undergraduate student writes a research article to score well in a university course as part of his or her studies, a scientist writes a research article to be published in a science journal in the course of his or her research. The differences in the writing between the student and the scientist can be explained for the most part by this contrast of purpose. Paxton (2007), studying essays written for an economics course at South African university, draws on the idea of student purpose to coin the term 'interim literacies' to describe first year student writing as that practice of taking discourses and texts from school, home and other contexts to craft new texts as they make the transition to learning new academic literacy practices. With varying degrees of success, the students use a mix of writing styles, each of them familiar to them from their own prior experiences or exposure, to write an academic essay which is intended to serve different social purposes as determined by the discipline of economics.

Ivanič (1998), studying the essays of adult learners at a university in the United Kingdom, also draws on the notion of student purpose when she argues that it is identity that explains the nature of student writing. Every act of writing develops interpersonal relationships in an institution and a culture, however far apart the social actors may be. In the social sciences and the humanities, where the student essay is usually expected to represent a variety of discourses, the adult student will find the ideology of one or more discourses more appealing than others according to their personal history and their individual professional goals. The student's social purpose in the writing of the essay then is to identify with her/his preferred discourse by emulating its style of writing and repeating its claims while at the same time distancing her/himself from the other discourses by not emulating those

discourses' styles of writing and denying those discourses' claims (Ivanič 1998: 61). Taken together this strengthening of some relationships over others establishes the identity of the student in their writing.

For Lillis (2003), also working with adult learners at a university in the United Kingdom, student purpose is central to moving Academic Literacy research towards a design frame from one of critique. While all acts of writing are utterances addressed to someone in a chain of communication in a way that is determined by the social and historical context (Lillis 2003: 197), the student's overall purpose in writing the essay is realised when the student tries to bring in, or even deliberately avoids bringing in, new discourses and meanings according to their personal goals (Lillis 2003: 201). Furthermore, Lillis would have the conventions of academic writing open up to allow students new ways to make meaning, moving away from a monologic to a dialogic approach to student writing.

As with the study presented in this paper, all the above mentioned academic literacy studies sought to make a connection between the nature of the student's writing and the student's purpose in the writing exercise, by working alongside the students who were 'co-interpreters' of their own writing. However, academic literacy studies are often set in the context of the social sciences and the humanities rather than the natural sciences. To begin to address this gap, this study looks at student writing in the genre of the research article in the natural sciences and tries to identify the experiences and discourses that are particular to each student's writing as they tried to emulate a science discourse in writing.

In their seminal article defining Academic Literacy research Lillis and Scott (2007: 21) are concerned that a focus on practices can threaten the detailed analysis of texts altogether. While the strength of this research has been to shift the primary focus of analysis from texts as linguistic objects to the practices in which they are embedded, a limitation of some Academic Literacy work is the 'lack of attention to texts as linguistic and cultural artefacts'. In this article I have drawn on the theoretical perspective and on the methods of Systemic Functional Linguistics (SFL) to attempt the detailed analysis of texts to which Lillis and Scott refer. However, to ensure that this article is accessible to a wider readership, I have also tried to avoid as far as possible the technical and complex terminology of SFL methods.

Systemic Functional Linguistics is a theory of language centered on the notion of language function in a social context. In this conceptual framework, the text of any communication is simultaneously organised by three systems called metafunctions, which are

the ideational, interpersonal and textual metafunctions. Every utterance, written or spoken, is made up of choices in each of the three systems and the function of those choices is both to represent and to realise the social context in the text. Meaning is construed by making choices in a fixed system. Choices in the ideational system construe what is going on in the world, choices in the interpersonal system construe the social relations between the writer and reader, speaker or listener, and finally choices in the textual system construe the message in time and space (Halliday and Matthiessen, 2013). These metafunctions apply to various levels of a text from the semantics down to its wording and down further to the smallest units of meaningful expression. At the level of wording, SFL provides a metafunctional description of the grammar and this is centred on the clause.

Methodology

To study the words and grammar the students chose in their clauses, I shall be using only one resource of the ideational system, the grammatical metaphor (Halliday and Matthiessen, 2006: 227, 2013: Chapter 10), and one resource of the interpersonal system, namely hedging (Myers, 1989; Hyland, 1996, 1997). I have chosen these resources because they are both salient features of scientific language. Needless to say, these are only two of many linguistic resources available to anyone writing in the register of science and they do not alone characterise scientific writing.

Nominalisation occurs when a word that is a verb, adjective or adverb in its natural dictionary meaning is used as a noun; for example, using the verb 'grow' as the noun 'growth'. A grammatical metaphor is a meaning that would be more naturally construed by one grammatical form but is construed by another (Halliday and Matthiessen, 2013: Chapter 10). For example, the clause

the population is growing

may describe the change in the number of people in a city. However, the clause

population growth is a factor of pollution

not only construes what is meant by 'the population is growing' with the noun group 'population growth' by using the nominalisation mentioned above but it goes further and construes a relationship of identity between that process and a factor that is contributing to the pollution of the city. Nominalisation is the single most powerful resource used in

grammatical metaphors, which is one of the signature features of the technical language of science, and these metaphors are used to construe abstract ideational meanings (Halliday and Matthiessen, 2006: 615). Grammatical metaphors enable a writer to develop an argument step by step, whereby complex passages that appeared earlier in a text are 'packaged' into nominal groups which are used as the starting points of more abstract statements that follow (Halliday and Matthiessen, 2013: 729). In general, this kinds of metaphorical nominalisation enables writers to produce more lexically dense texts; that is, sentences with more lexical words per clause. Lexical words are those that represent something beyond the text, such as 'tree', as opposed to those that are purely grammatical, such as 'the'. This technique has been important to the evolution of the modern discourse of science (Halliday and Martin, 1993). Although other discourses use nominalisation and the resulting lexical density merely as a marker of prestige, it remains a characteristic feature of current scientific discourse (Halliday and Matthiessen, 2013: 730).

In science, the writer uses hedges in the research article to help persuade the research community of their claims (Myers, 1989). Hedging enables the author to express a reluctance to commit to the truth of their proposition even when, and often especially when, it is the article's central claim (Lakoff, 1973; Myers, 1985, 1989; Latour and Woolgar, 1986; Hyland, 1996: 23, 1997). Hedging is often achieved by using a particular selection of words such as 'indicate', 'would', 'may', 'almost', 'likely' and 'possibility'. In this study, I focus on the use of modal verbs of probability only, such as 'may', 'might', 'would', 'could' and so on.

To describe each student's specific purpose in writing their assignment, it is necessary to introduce each student with a short biography that has been drawn up from interviews with the students. Each of the four students was interviewed twice; first to learn more about them and their background and second to invite them to be co-interpreters of their own writing, emulating Ivanič and other authors working in the area of academic literacies (Ivanič, 1998; Ivanič and Weldon, 1999; Lillis, 2001; Kapp, 2004; Paxton, 2007; Kelly-Laubscher and Van der Merwe, 2014). The students were chosen by me, and all interviews were preceded by them giving their informed consent[1]. The students were purposively selected following the discussions I had with them in the workshops and also out of my own intuition about whom I could work with effectively, and which texts were pertinent, in terms of the aims of this study.

My initial interaction with these students was as a guest lecturer on the course. In this role, I guided them through the numerical analysis of their data and its inclusion into their assignment. It is important to note here that I do not intend the writing or the specific purposes of each of these four students to be representative of the class as a whole. Instead, my aim is that the interpretation of these students' writing in terms of student purpose will provide some useful insights that can be applied to teaching science writing more generally.

The students

Monwabisi[3]

Monwabisi is from a township in Cape Town, a densely populated area that is characterised by low household incomes, low employment rates, poor social services and high rates of crime. Monwabisi's description of his school, as well as Nkosi's (see further down), had significant similarities to that given by Kapp (2004), where English is taught as a second language subject but it is also the official medium of instruction. While some students obtain conversational fluency in English, their literacy is limited to classroom exercises. Despite the fact that all his subjects were assessed in English, isiXhosa was the language of instruction and was predominantly spoken inside and outside the school. English is not his first language.

However, Monwabisi stood out for his facility with English. He also played word games with his English teacher:

> *I think when I wrote English I always wanted to impress my teacher so I would like look for those words, "bombastic" maybe, I don't know and maybe sometimes I would take a wrong word and he would correct me and be like no maybe not this one, this one would be better.*

Monwabisi described himself as altogether playful in his interaction with his teachers in the classroom. In other lessons, he said he would sometimes deliberately speak isiXhosa when he was asked a question, even though the teacher knew that he was one of the few students who could answer it well enough in English.

Nkosi

Nkosi is from a township in the city of Durban, where he grew up and went to school. He is the first member of his family to complete high school and his entrance to one of the most

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[3] All the students have pseudonyms here.

prestigious universities in the country is a big achievement for him. Again, English was not the language of instruction at Nkosi's high school but isiZulu instead, and Nkosi speaks English as an additional language. As Nkosi explained:

> *Well the physics teacher tried to use more English and that is what made more students to just lose more interest in physics because it was more than one problem now. It was having to understand physics and now this English now.*

Interestingly, Nkosi was specifically asked not to write with cohesive sentences in the Life Science (i.e. Biology) subject. As he put it:

> *… my teacher got back to us and emphasized that we shouldn't write an essay when the question comes and says we should write an essay. We should write bullet points. And that is what we did and we got full marks.*

Nkosi therefore missed the opportunity to practice making an argument using cohesive sentences in writing about scientific topics. A listing of the facts was all that was necessary.

Lesego

Lesego went to a fairly well-resourced high school in which all the teaching was in English. She speaks English fluently, but reported that her facility with the language only came when her family moved out of a low-income area to a middle class area in the south of Johannesburg when she was child. It seems that she is not quite a first or second language speaker of English but somewhere between the two. Her mother has studied microbiology, finance and accounting and her aunt and grandmother also had professional qualifications. This family background contrasts with Nkosi's, whose parents had working class jobs and no higher education qualifications.

At school, Lesego did receive a clear outline of what was expected when she wrote laboratory reports. She did not however find the report writing engaging. She did not like being restricted to a given structure. She much preferred the creative writing of her other subjects such as English and Life Orientation, because, as she put it:

> *You could get your emotions involved and I would be like "brilliant, yes" and you know for essays and like bringing up arguments and then usually for the other subjects [like Life Orientation] they weren't really strict.*

Anthony

Anthony grew up in a middle class area of Cape Town and went to a high school nearby. Unlike the other three students in this study, Anthony classifies himself as coloured, not African, and speaks English at home. He is a first language speaker of English. Like Lesego, he attended a well-resourced high school where English was the medium of instruction and everyone was comfortable speaking English.

At school, Anthony had much more practice with writing scientific reports. In his words:

> *In a lot of my classes in Physics we also had to do reports. We had to do two big reports. Just like this report [for the assignment]. I am quite accustomed to doing reports because we had to do two reports each year from grade 10 where we had to do a little experiment and then write a report on it.*

Furthermore, Anthony said he preferred the structure of the science report. He liked knowing more exactly what to do and how much to do. The open-ended nature of creative writing, for his English and Afrikaans subjects, unsettled him. He frequently went over the word count in these exercises. He did however get considerable support for his creative writing exercises. Ironically, it is the planning that he was taught to use in his creative writing exercises that Anthony drew upon for his assignment that is the subject of this study. One of the tools used for this planning was Mind Maps. As we shall see below, Anthony used these to help him structure his argument in the 'Discussion' section of his assignment.

Results and discussion

The course assignment asked the students to write a research article about the management of solid waste in a fictitious city called Metropolis. They were provided with realistic historical data about the city's population and waste production. In the research article, the students were asked to consider the extent to which the life span of a fixed landfill would be prolonged at different but realistic rates of recycling for the different waste components. In addition, the students were asked to incorporate comparisons with similar studies of solid waste management in real cities as reported in three adapted research articles taken from the earth science journals *Waste Management* and *Resources, Conservation and Recycling*.

Nominalisation and clause structure in the students' assignments

Anthony's assignment came closest to what is expected of scientific research article. His use of nominalisation and his hedging shall be an exemplar with which to compare the other three students' writing.

Consider Anthony's sentence below, which was taken from his 'Discussion' section.

Population growth, increased waste production per person and a higher average income in households in Metropolis are all factors that have affected the landfill space.

Anthony used this sentence to explain why the landfill is running out of space as he had observed in his 'Results' section. It contrasts significantly with the corresponding sentences from the other three students that make the same explanation. What stands out the most in the comparison is that it is has only one clause and the subject of that clause is the long compound noun 'Population growth, increased waste production per person and a higher average income in households in Metropolis'. This compound noun is the concatenation of three group nouns, 'population growth', 'increased production per person' and 'a higher income in households in Metropolis.' Each group noun is a grammatical metaphor as they represent in nouns what was represented earlier in his text by the clauses. For example his 'Results' section has the clause

the population in the Metropolis grew at a rapid rate from about 3.4 million in 2001,

which is a precursor to the group noun 'population growth'. To realise this grammatical metaphor, nominalisation has been used, reformulating the verb 'grew' as the noun 'growth'. Furthermore, the noun 'population' in the subject 'the population' in his earlier clause is reformulated as an adjective in the noun 'population growth'. The grammatical metaphor has allowed Anthony to represent a process in only a group noun when earlier in his results he had used a whole clause to do so. In this way, one process being the cause of another can be expressed with two nouns in one clause, 'this is a factor of that', rather than a sequence of two clauses, 'this is happening because that is happening'. This allows his sentence with the long compound noun in the 'Discussion' section to be lexically dense, which is to say it has many lexical words compared to the number of clauses, 15 lexical words to only one clause (Halliday and Matthiessen, 2013: 654).

Lesego's sentence making the same explanation is a complex of three clauses (their division demarcated by the '//') as follows.

> *As a result, landfill space is also running out// as land can only hold so much waste// and eventually not be able to accommodate any more waste.*

The second and third clauses represent the cause and result of the observation stated in the first clause i.e. the landfill running out of space. Here two processes relating to a third process are represented with three clauses rather than three nouns in one clause as in Anthony's text. There are little or no grammatical metaphors or nominalisations here, the word 'landfill' notwithstanding since this term was given to the student in the original assignment task. It is a less lexically dense sentence as there are only 13 lexical words here across three clauses.

Nkosi's equivalent sentence is, however, quite dense as it consists of only two main clauses.

> *The fact that people produce more waste in each decade compared with the previous must be caused by the ongoing process of world modernising// where lots of things are now bought in packets, containers, bottles etc.*

While there are fairly long noun groups here such as 'the ongoing process of world modernising', where the noun 'process' is plausibly the nominalisation of the verb 'proceed', this is not really using grammatical metaphor the way Anthony has used it. The group noun 'world modernising' is not a reformulation of any of his observations in his 'Results' section or any data provided to him in the assignment but rather a new insight of his own. Instead the restatement of his observed results is realised by the defining relative clause 'that people produce more waste in a decade compared with the previous', which is an embedded clause in SFL terminology, and not reformulated as a group noun. Moreover, the sentence is less dense than Anthony's with 16 lexical words in two main clauses, by which I mean clauses that are not embedded in another clause.

Monwabisi's equivalent sentence is altogether quite different. His sentence is much more complex than the other three.

> *Furthermore we have seen from the findings that waste produced by an individual increases// and because of that and the growing population it is possible that that the landfill space may run out even before 2080.*

While Nkosi had only one embedded clause, Monwabisi has three embedded clauses, which are 'that waste … increases'; 'produced by an individual'; and 'that the landfill space may run out even before 2080' where the second one is embedded in the first. Unlike Anthony's sentence, and more like Lesego's, causality is represented as a sequence of the main clauses 'Furthermore we have seen from the findings that … ' and 'and because of that and the growing population it is possible that … ' rather than as a relation between group nouns. And yet there is a grammatical metaphor here as well, which is the group noun 'the growing population'. Nevertheless, we may conclude that this sentence is less lexically dense than Anthony's because it has two main clauses, 16 lexical words and four embedded clauses.

Anthony's sentence is the most concise, even though all the above say more or less the same thing. While all the students do as they were expected to and conclude that there is a relationship of causality between processes (i.e. the process of population growth and that of landfill space depletion) in the 'Discussion' section of their assignment, Anthony does so with the most lexically dense sentence.

This contrast in writing style is fairly consistent across the students' 'Discussion' sections. For example, Anthony used more adjectives that are classifiers per ranking clause i.e. in non-embedded clauses, than did the other three students (See Table 1, Appendix). Anthony's 'Discussion' section shows us that he was more likely to use adjectives ('classifiers' in Table 1 and 2) such as those found in 'population growth' and 'waste production'. This difference is more pronounced when you look at the use of classifiers in relational clauses only (Table 2), which express a relation between two nouns such as identity, equivalence, membership, and possession.

These differences can be explained by considering the purposes for which each student wrote their assignment, as we shall see. First, however, I will consider the students' hedging.

Hedging in the students' assignments

Consider the sentence below taken from Nkosi's 'Discussion' section.

> *The fact that people produce more waste in each decade compared with the previous one **must** be caused by the on-going process of world modernising where lots of things are now bought in packets, containers, bottles etc.*

Nkosi does not hedge this claim, seeming to commit fully to the statement made here by using the word 'must', which is in bold text above. In the genre of the research article, it would be very unusual for a practising scientist to construe a relation of causality, as has been done here with the phrase 'must be caused by', without allowing for the possibility that the claim might not be true by using modal verbs such as 'could' or 'might'. In scientific research articles, this absence of hedging is what is expected of the 'Results' section where a summary of the observed data is summarised uncritically. The observations made in the 'Results' section of Nkosi's assignment and in the assignments of all four students are made uncritically, with phrases such as 'what is also very clear from the table'. Therefore, Nkosi's assignment contrasts with a scientific research article because he describes his inferences in the 'Discussion' section with the same lack of caution as he does his observations in the 'Results' section: Nkosi is too certain or too emphatic in the way he draws conclusions in the 'Discussion' section.

By contrast Lesego and Anthony used modal verbs to hedge their claims in the 'Discussion' section as a scientist would be expected to do in this genre. Table 3 shows that Anthony and Lesego were more likely to use modal verbs in verb groups of main clauses of the 'Discussion' section than Nkosi or Monwabisi would.

Like Nkosi, Monwabisi hardly used any hedging in his 'Discussion' section. Instead, he does something quite different.

> To **spinal up** the above claim in 1996 in Dar es Salaam City an individual waste production per day ranged between 0.34 and 0.39 kg, and chronicled in City of Metropolis City in 2001-2010 an individual produced 0.65 -1.2 kg per day (M E Kaseva et al).

Monwabisi seems to be using this sentence to support his earlier claim by referring to what has been said in the literature referenced. Interestingly, where hedging would have been expected he makes rather unusual word choices. As data from his interview shows, he may be trying to make his writing look more academic and more scientific through his choice of words. For example, he developed the verb phrase 'spinal up' after using the thesaurus function of a word processor program to change the word 'back' to 'spine'. Other examples of this include the word 'articulates' in the clause

> As in figure 5 which **articulates** the declining landfill space over the decades from 2000 to 2120,

and 'appealed' in the clause

> *Other studies have* **appealed** *that waste in commercial recyclers like Taylor Recycling.*

The students' reflections on their writing

In my interviews with the students, I discussed the word and grammar choices they made in the 'Discussion' section of their drafts as described above. Nkosi and Lesego were both of the opinion that it is was better to not be ambiguous and to not leave out information when making statements about their results. They said a more summarised reformulation would be imprudent when considering how their draft would be evaluated. Lesego said:

> *…because the thing is sometimes I never want to leave anything out. Because the thing is if I write too little I feel like "OK I might be leaving out something important so…*

And Nkosi said

> *Well kind of it is deliberate 'cause you know I wouldn't want to write a very short project…. By looking at it you think it doesn't deserve much marks if it is too short.*

Both Lesego and Nkosi preferred repetition over brevity because they thought they would be marked down otherwise. From Nkosi's perspective in particular, more was better than less and this seems to be a continuation of his school experience with English where he and his classmates often struggled to come up with enough words. Short essays were penalised.

Anthony's approach to his reader was quite different. When I asked him why he risked being a little vague in his use of nominalisation, he said:

> *I actually don't know. I usually just write and hope that it is right. Well sometimes, sometimes, I do put it in and think "ok maybe this is too much and maybe the reader will get bored because" … ja so repetition in my work I get irritated by.*

Anthony had a reader in mind who would not appreciate unnecessary repetition. He was not worried about what a tutor would think of his description. Instead it is a concern with the aesthetics of the sentence. In fact, Anthony had an elaborate redrafting process. Unlike Lesego and Nkosi, who both admitted to only a hasty preparation to their drafts, Anthony planned out his paragraphs with mind maps, which he learnt in his English creative writing

classes at school. Furthermore, Anthony said he read a fair amount of fiction and he is often impatient with books that are 'overly descriptive'.

Anthony's writing strategies brought out his school background, which was quite different from that of Lesego, Nkosi and Monwabisi. Unlike Nkosi, Anthony's concern with his creative writing assignments at school was that he often went over the word limit and was penalised. Anthony said he learnt to use mind maps for his creative writing assignments to keep him restricted to the chosen topic and limit his word count. Lesego, Nkosi and Monwabisi did not use mind maps to draft their reports because they had probably not been taught to do this at school.

Referring to his rather unusual word choice, Monwabisi said:

I can say it is that thing of me that tries to impress using those big words. Ja, maybe I did it because I wanted to like put a more complex word instead of just a simple word.

In school, Monwabisi used 'bombastic' (his term) and unusual words to get the attention of his teacher. This is an extension of that practice. It is possible that he is also trying to affect a scientific style with his word choices. It is perhaps an attempt to get the reader's attention by using unexpected words that inevitably and perhaps deliberately make his meaning difficult to understand. Halliday and Martin (1993: 69 – 70) say that students often characterise the difficulty of scientific language in terms of a jargon of technical terms. In the feedback on his assignment, his choice of words drew negative attention from the evaluator. It was only in my interviews with him that his intentions were more fully understood and only then did our conversation lead into the styles of scientific writing and for what purposes they are chosen.

Nkosi did not make much use of hedging with modal verbs as we have seen. In addition, although Nkosi presented information given in the assignment readings, he did not make explicit references to the literature. Furthermore, Nkosi was also generally unclear about what to include and what not to include in the 'Discussion' section of his report. When we spoke about this this he said:

Well I have to be honest that I wasn't so clear about the discussions when I was writing my first draft. Remember when I was here you advised me to take away graphs from the discussions to the results. You said I mustn't have so many graphs in the discussion part. So I took some of them that side.

While this is quite a serious misunderstanding for a student to have at the final draft stage, writing in this genre was a challenging learning experience for the majority of the class and

so the teaching team were unable to adequately address all their misunderstandings. And yet Nkosi's confusion also signals that he was not aware that the research article is a tool for making claims in a particular form with its own conventions and discourse rules and that the 'Discussion' section is where the claims are argued in light of the observations made in the 'Results' section. Nkosi's confusion suggests that in an assignment such as this one the purposes of scientists that are served by the genre should be taught explicitly to help avoid such misunderstandings and this I have tried to do in my teaching since.

Conclusion

How then can we understand these four students' writing both in the context of the genre of the research article as it is used by practicing scientists and in the context of the students' learning experiences? Although what has been observed in the students' use of grammatical metaphors and hedging in their assignment supports the observation made by Parkinson that the lexico-grammatical resources of non-traditional students need to be developed through teaching with authentic texts before their writing can match that of practicing scientists (2011: 174), it seems that there is more to it than that. Studying the students' writing and talking to them about their writing and school experiences, it appears that, like Paxton's economics students writing an essay (2007), these students applied the various writing practices and conventions they learnt at school and elsewhere to their science writing assignment in a university course. That is to say that they drew upon their various school discourse conventions as they tried to write in a genre of science discourse. This is an example of interdiscursivity (Ivanič, 1998: 47 - 51), whereby a writer incorporates two or more discourse conventions into the creation of one text. However, here the students' 'interdiscourse' was not always successful.

As we have seen, Lesego and Nkosi did not aim to be concise but were rather verbose and unambiguous as they had been at school, when they said they did not 'want to write a very short project'. Monwabisi rehearsed his play with words such as 'spinal-up' as he had done with his school teacher rather than hedge his claims. But Anthony's use of mind-maps and his literary aesthetics served him well in his report planning. Moreover, in the interdiscursivity observed here, where the students were writing in the genre of the research article for implicit high school related purposes, there was not much explicit recognition by the students of the purposes that are served when scientists write a research article.

Even though only four students have been studied here, it is my impression that this particular mixture of discourse conventions plays a large part in determining the students' writing choices in general. In light of this it seems that, in order to teach scientific writing more effectively, the goals of doing scientific research and the role the research article plays in communicating this research should be made more explicit to students and contrasted with the various writing purposes or conventions that the students may have picked up at school or elsewhere. Unfortunately, this was not practiced in the teaching intervention with those students who were outside this study as this insight only emerged in the process of studying these students' writing and talking to them in interviews.

Of course the students' grasp of English has a lot to do with the writing they produce. But while Nkosi and Monwabisi speak English as an additional language, Lesego's written and spoken English suggest that it is her first language and yet she did not use grammatical metaphors to be concise the way Anthony did. In addition to language proficiency, therefore, it seems that in order to understand student writing, teachers need to consider the match between the purposes associated with science writing practices in a particular genre and the implicit purposes students may bring to a writing exercise given the writing practices and discourse conventions they are familiar with.

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Appendix

Table 1: Words in noun groups in non-embedded clauses in the 'Discussion' section of the students' reports

	Deictic		Numerative		Epithet		Classifier		Qualifier		No. of Clauses
	No.		No.		No.		No.		No.		No.
Anthony	26	40.6	3	4.7	6	9.4	15	23.4	23	35.9	64
Nkosi	24	28.2	7	8.2	4	4.7	14	16.5	16	18.8	85
Lesego	29	34.5	3	3.6	9	10.7	15	17.9	30	35.7	84
Monwabisi	34	47.2	6	8.3	8	11.1	8	11.1	24	33.3	72

Table 2: Words in noun groups in non-embedded relational clauses in the 'Discussion' section of the students' reports

	Deictic		Numerative		Epithet		Classifier		Qualifier		No. of clauses
	No.		No.		No.		No.		No.		No.
Anthony	13	41.9	0	0	6	19.4	10	32.3	11	35.5	31
Nkosi	10	28.6	6	17.1	2	5.7	8	22.9	6	17.1	35
Lesego	14	43.8	1	3.1	6	18.8	3	9.4	11	34.4	32
Monwabisi	9	39.1	1	4.3	3	13	1	4.3	8	34.8	23

Table 3: Finite words in verb groups from relational and behavioural clauses

	No. modal words	%	Total No.	Non-modal finite words	Modal finite words
Anthony	6	43%	14	are, being, does, has (5), influencing, is(5)	could (2), might (3), should
Nkosi	5	25%	20	are (3), has, is (9), proven, must (3), proves, will	can (4), should
Lesego	5	36%	14	being, consists, has (2), have, having, is (4), makes (4)	can, could (3), should
Monwabisi	2	13%	15	are (3), articulate, being, employ, found, investigate, is (5), lead, present	can, tend