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Writing their way into Science: Gaining access to the discourse of Biology

ABSTRACT Essential for any student's successful study in the discipline of Life Science is attainment of a sense of belonging in the discipline, and mastery of the academic genres that are important in the discipline. Students in the Science Foundation Programme (SFP) at the University of KwaZulu-Natal, Pietermaritzburg, are English second-language students with poor background knowledge of science, and far less previous experience of writing than would be ideal. In teaching an SFP Biology course, we used two approaches for student acquisition of literacy practices as an indispensable part of acculturating them into the discourse of Biology. Firstly, a variety of experiences (most importantly a visit to the rocky shores) and written tasks (formal and informal) developed in students a sense of belonging in the discipline. Secondly, an explicitly scaffolded approach was used to teach students the discipline-specific experimental report genre that is central to experimental sciences. Analysis of students' reports following these approaches showed as yet incomplete acquisition of certain discourse conventions such as those related to use of source texts, lack of certainty about where to put certain information within the structure of the report, ability to focus on relevant material and inadequate use of logical connectors. However, students portrayed a growing sense of the audience they were writing for, as evidenced in features such as avoidance of personalised language. This information enabled further strategies to be developed for students to reach a level of competence as novice writers within the discipline.

Keywords: Biology, genre, scientific report

1. Introduction

It has been observed by Gee (1990) and others that acquiring the literacy practices of a discourse community involves acquiring the culture and values of that discourse community. In teaching

a Biology course to a class of foundation (pre-university) students, we found that student acquisition of literacy practices was an indispensable part of acculturating students into the Biology discourse community. In this article we describe this gradual acculturation, and focus in particular on the literacy practices that were involved. These included informal writing (of a journal), drama, a more formal but not discipline specific written form (a formal letter), and the highly formal discipline specific research report genre that is central in the experimental sciences. We reflect on this acculturation process by providing examples and analysis of student writing and by examining students' written reflections on their learning as a result of a field trip and of the course as a whole.

For Gee (1990:175) being a "member of a Discourse" involves not only using language but also sharing the values, ideas and emotions of the Discourse and behaving in a way regarded as appropriate by members of the Discourse. Because a 'Discourse' comprehends behaviour and values, it is thus wider than the meaning usually associated with the word 'discourse' i.e. 'language produced as an act of communication'. One must be able to take on a role recognised by other members of the Discourse. As Gee points out, this makes a Discourse more difficult to teach/acquire than we would otherwise expect, because in order to acquire the Discourse one must become acculturated into it in order to play the role convincingly. To become a member of the Discourse of science a student thus needs to participate in and regard as natural and self-evident the values of research science.

For Lemke (1990:1), for example, learning to "talk" science means "learning to communicate in the language of science and act as a member of the community of people who do so". Lemke suggests that as it is taught, science is often overly impersonal (1990:137). He recommends that students be encouraged to talk science not only in formal ways but also in colloquial language. This is all the more important for students who have had little prior experience of reading and writing in any language. A number of studies (e.g. Taylor & Vinjevold, 1999; Niven, 2005; Pretorius, 2005; as well as current research by the third author) have shown that many African students in South Africa have had surprisingly little experience of reading and writing. Listening to a text being read is likely to have been as frequent an occurrence in school as reading a text for oneself, and copying from the board has often been the most common previous experience of writing of many of our students.

In science, little attention has been given to the power of using writing to enable learners to express what they already know, feel, and question about the world (Brand & Graves, 1994). Yet the language of science as well as ways of thinking, doing and valuing science are specific and unfamiliar to new students, as we will demonstrate in this article. Part of being an insider to this discourse is being able to communicate with other insiders using the language, writing and conventions of science.

Science students need to learn to write the experimental report genre, as these form the bulk of writing tasks of undergraduate science students (Braine, 1989) and may be regarded as developmental in writing research articles (Parkinson & Adendorff, 2004). A genre is a 'staged goal-oriented purposeful' text (Martin 1984: 25) with obligatory structural elements. As in many research articles in science, the obligatory structural elements of an undergraduate experimental report are usually the Introduction-Methods-Results-Discussion sections. Here, students are

expected to use the scientific method as a framework, placing the investigation in the context of the literature, hypothesising, describing methods accurately, synthesising the results, then discussing and concluding on these again with reference to relevant literature. The report also reflects characteristic grammatical features of scientific discourse (Parkinson & Adendorff, 2004) such as a high level of nominalisation, no personal language, and in the Method section in particular, the use of the passive voice. Writing of experimental reports is unfamiliar to entry-level life science students yet it is a skill that they are expected to master relatively quickly as it is central to the discipline.

The Science Foundation Programme (SFP) at the University of Natal (now University of KwaZulu-Natal), Pietermaritzburg (UKZNP) is a year-long programme which precedes entry into the Science Faculty. SFP students are not only outsiders to the discourse of the Life Sciences as new biology students, but are also educationally underprepared, English second-language students. Thus SFP is designed to equip academically able, but educationally underprepared students with the skills, resources and self-confidence to complete a science degree. Students are selected into the SFP only if they come from underresourced schools, identified as such by the Department of Education. This means that almost all SFP students are black African students, and this makes the SFP a mechanism for redress, and for correcting the demographic imbalance of the student population. Almost entirely as a result of alternative access programmes such as SFP, black African students have increased from a meagre 10% of the student population in the Science Faculty at UKZN in 1990 when SFP started, to 50% at the time of writing.

In a holistic way we wanted to familiarise SFP students with the discipline of biology. This study presents a facet of this where our aim was to scaffold acquisition of relevant Biological literacy practices (most centrally the experimental report) as an indispensable part of acculturating SFP students into these literacy practices. There has been support for combining writing with activity through the study of genre as mediating socially organised activities (Bazerman & Russell, 2003). University study for all students involves the taking on of a new identity, in the case of our students an identity as a scientist. De Kadt and Mathonsi (2003) have noted that for many South African ESL students, this new identity is experienced as in conflict with or a denial of an African identity, instead of the new academic identity being congruous with or able to co-exist happily with the student's African or pre-university identity. Students in McKenna's (2004) study too experienced the literacy behaviour that was necessary for success as alienating, and the institution as failing to accommodate their African identity.

To avoid this conflict, and enable the new developing identity as a scientist to be as congruent as possible with the pre-university identity, our first approach was to use expressive writing, including a range of non discipline-specific writing on the topic of biology. These tasks were largely informal, but included a formal letter. We discuss these informal tasks in greater detail later in the article. It was expected that this approach would allow students to express their present knowledge and values, as well as extend their identity to include an identity as an aspirant biologist. Our approach follows Lemke (1990: 174) who suggests that the accessibility of science would be improved if other genres such as drama and narrative were included in the teaching of science. This is all the more true for students who come from a more oral culture and one not traditionally accommodated at University. We then extend this use of non-science genres to develop students' experimental report writing as a key genre in biology, by explicit

teaching of the key features of this genre and by marking a draft of the assignment to guide students' acquisition of these features.

2. Methods

2.1 Expressive writing: encouraging the development of an identity as a biologist

The SFP student cohort of 1997 (n = 36) was used in this study. Although some time has elapsed since the data was collected, this does not diminish the value of the methods employed. Initial use of informal and nondiscipline-specific writing as a means of developing an identity as a member of a Discourse has not been reported as in use in South Africa in any of the literature we consulted.

To begin their journey into becoming a member of the Discourse of life science, a theme unfamiliar to the majority of students, the marine theme was used. This theme is described in detail in Downs *et al.* (2001), which provides details of the teaching and assessment for the semester. In short it introduces students to elements of marine biology and conservation in a number of ways, including a visit to the shore, practical sessions, relevant reading and the writing tasks outlined in what follows. To establish students' background knowledge and resources acquired from previous educational and general experience, writing tasks used included questionnaires administered to students designed to measure students' general and specific biological knowledge. These were administered before and after the teaching intervention, and again one semester later, to assess the effect of the intervention. We provide details of these questionnaires in Downs *et al.* (2001). Questionnaires to elicit information about secondary school facilities of students were also administered.

During the first semester course, SFP Biology students were taken on field trips, given information to read, and numerous written and oral tasks (described below) to complete on the marine theme. Authentic communicative tasks were set to prompt students to begin to write and express their existing knowledge, while establishing their identity as a biologist, as can be seen from the responses to these tasks, some of which we include below. Following a field trip to the beach (described in Downs *et al.* 2001), the SFP Biology students were required to write a letter of motivation to the manager of SFP concerning whether the Biology SFP field trips should be continued. Although this is not a regular pedagogic genre, letters of motivation, which have some similarities to funding proposals, are important genres for scientists to acquire, and this task can thus be regarded to a certain extent as falling within the discipline of Biology. In addition, it gave learners the opportunity to express their own opinions while working within the discipline of Biology. Students also visited a nature reserve and spent time sitting alone in this setting and, once back in class, wrote a journal-style response to their experience.

Group presentations at the end of the semester (detailed below) gave students an opportunity to personalise their knowledge acquired during the course. Students articulated concepts orally, in the form of skits, in a manner they chose. They were given half an hour to prepare the skits and then performed these for the rest of the class and staff.

At the end of the semester all students completed a course evaluation. This included their responses to what they had found most and least interesting in the course, and why. As they were regarded in the light of scaffolding a bridge between a pre-university identity and an identity as a scientist, none of the above assessments or feedback contributed to students' final marks.

2.2 The experimental report: learning the language of the discourse community

To assist students in acquiring the literacy of scientific report writing, students were guided through the process of report writing, with the concepts outlined in a series of three tutorials and a practical on "Scientific Method". This included discussion on the limitations and ethics of research. They were briefed orally about the format of a scientific report and were expected to follow the Introduction-Methods-Results-Discussion structure. Students were given marking criteria and written instructions about the outline of the sections as follows:

Title (5); Introduction (10); Materials and methods (20); Results (25); Discussion (20); Conclusion (5); Acknowledgements (2); References (3). The contents of each section of the report were made explicit on a handout containing the mark criteria.

During the semester students were required to write two complete experimental reports on two different experiments they had undertaken. For reasons of space, and because our focus here is on our marine theme, we focus only on the second report, based on "An investigation of conditions along a rocky shore gradient". In each case they had to hand in a draft, which was returned with comments, which focused on content and organisation of the report, from the Biology lecturer. Each student submitted a final corrected report that had been computer typed. In this way students were led to see writing as a recursive process with improved drafts.

Final reports were returned to students with a mark scheme showing their performance in the respective sections of the report. Students' performance in terms of the assessment criteria used by the Biology students is not presented here.

To assess the effectiveness of this approach in assisting students to acquire the skills of scientific report writing, the final version of the second report was analysed. In analysis of the second report (n = 36), various aspects of the completed task of writing an experimental report were assessed. We wanted to assess the students' ability to perform an authentic task rather than assessing discrete skills in separate tasks. The aim was to assess students' performance in report writing, not only in terms of effective communication of the "argument" of the report, but how that had been achieved, from overall coherence, down to detailed aspects of language usage. It was expected that two sections of the report, namely the *Introduction* and the *Discussion*, would reveal a number of features of the kind of writing and scientific language our teaching aimed to develop in students. These key sections correspond with a literature survey and Discussion/Explanation of results in a research article, and students in general find them difficult and take some time to acquire these sections.

Each report was analysed in terms of four criteria. We mention these here, but discuss them in greater depth below:

1. Familiarity of the writer with the stated (assessment) criteria for both sections of the report. We discuss some of these below, but for example in the case of the Introduction these would include inclusion of relevant factual information from other written sources to assist in analysing and explaining (in the Discussion) their results and observations.
2. The writers' use of the additional readings, whether they had in fact been consulted (showing that students are beginning to see themselves as part of a community constructing knowledge together) and whether students were able to include this information as part of their own constructed sentences, or whether it was copied verbatim.

3. Evidence that writers are aware of the audience and take steps to make the report coherent. Awareness of the reader is reflected for example in the deference to the research community as implied in consultation of the literature; steps to make the report coherent include links made between sections using logical connectors among other elements.
4. Grammatical (usage) errors, in particular those that flout the conventions of science writing such as contractions.

Consequently, *Introductions* and *Discussions* from the final report from 36 students were evaluated. Frequencies (expressed as a percentage) were calculated to show students' performance. Percentages shown in the discussion that follows refer to the number of students who produced the feature compared to the whole group, and do not refer to number of occurrences of a feature in any one report.

3. Approach

To facilitate students' acquisition of the experimental report genre, we emphasised a process approach. Use of the process approach has been criticised in favour of genre-based approach (Johns 1995, Hyland 2003). A process approach has often been associated with creative writing, or with an unwillingness to restrict students to particular forms or genres. It has thus been seen in opposition to a genre-based approach where students are formally taught the features of a particular genre. However, in our teaching of report writing, elements of both approaches were combined. We used a process approach viewing writing as a recursive process (Emig, 1983), in which writers produce drafts and obtain feedback. In addition they focussed on their purpose in writing and who their readers were, and were also given explicit guidance in the structure and rhetorical features of the target genre. We also saw some place for expressivism, a feature of early process approaches (Furneaux, 1998; Johns 1995) particularly in early stages of acquiring the genre. Use of expressive forms like journal responses and dramatic presentations facilitated students' development of fluency. Such forms attempt to avoid the acquisition of the new scientist identity being experienced as a negation of students' pre-university identity. Instead, use of these forms encouraged students to build on the genres, experiences and culture they knew, and extend these to the genre and culture of science.

Our teaching of report writing was one where learning was scaffolded. Scaffolding is a process in which someone who has mastered a particular activity takes steps to support the attempt by another to carry out a task which is initially too difficult to be carried out independently (Wood, Bruner & Ross, 1976, in Mercer 1995). Firstly, through informal writing, an attempt was made to link students' present knowledge with new specialised knowledge gained in Biology. Secondly, support was provided by verbal and written guidance of what to include in each report section, and feedback on students' drafts. Such scaffolding placed learning and writing in the act of doing under the guidance of an expert, the Biology lecturer. This participation in the real activity of writing an experimental report, a key genre, assisted students in developing as members of the discourse community.

Freedman's study (1993: 239) of student acquisition of the law essay genre found that students learnt the genre in response to what she calls the 'disciplinary conversation' of their learning context. Our context included reading, tutorials, a field trip, expressive writing and feedback on drafts of two reports. Freedman (1993) found that students gradually acquired the target

genre in spite of no explicit teaching of the staged elements of the genre, or provision of examples of the target form. Consequently, Freedman (1993) argues against too much explicit teaching of the staged elements of a genre, but sees a place for teaching gross features of organisation (in our case these would include what to include in the *Introduction, Methods, Results* and *Discussion* sections) and revising. This argument against explicit teaching is in contrast to work on genre by Swales (1984) and Dudley-Evans (1995). A genre-based approach has increasingly been adopted in teaching writing in science (Parkinson, 2000).

The highly structured nature of the experimental report and research articles (Bazerman, 1988; Myers, 1989; Swales, 1984; Hyland, 2000) requires explicit guidance into the kinds of information that should be included in the various sections. We concur with Hyland's (2003:19) argument that the inductive 'discovery' element of the process approach, where no explicit guidance as to genre structure is provided, is practical only in contexts where students understand the genre. Our SFP students had little experience of factual writing and no prior knowledge of the experimental report genre.

Apart from giving students explicit guidance on genre structure, we also found it to be essential to guide students in the acceptable academic conventions regarding use of source texts in the construction of their own texts. Pennycook (1996) points to the difficulties in using texts experienced by second-language students. These students who copy verbatim from written texts despite knowing the rules for using source texts, appear to use this to cope with conceptual difficulties (Currie, 1998) or as a result of poor note-taking techniques (Pennycook, 1996). Furthermore, these students have difficulties in understanding what constitutes plagiarism with regard to use of written text in their report writing (Angelil-Carter, 2000).

4. Results and Discussion

4.1 Expressive writing: encouraging the development of an identity as a biologist

4.1.1 Questionnaires

As we discussed in detail in Downs et al. (2001), responses to initial questionnaires indicated that the SFP Biology students had little background knowledge of Biology, and subsequent questioning showed that their knowledge base had increased. As far as secondary school experience was concerned, SFP Biology students' responses revealed that only half of them had done experimental work themselves at school, only 26% were taught by teachers with university training, and only 23% had ever been on a field trip. Such findings are enlightening for the lecturers at university because they compel a re-assessment, on the part of the teacher, of the level of students' experience in the laboratory, library or out in the field.

4.1.2 Letter of motivation

Students' expressive writing task, a letter of motivation to the manager of SFP, gave learners the opportunity to express their opinions (as a means of validating them and allowing them to feel connected to their developing identity as a Biologist) while working within the Biology discipline. They discussed elements of the course content in their own voice, exploring what they thought about the material before consulting scientific readings or moving on to write in formal academic style, thus developing continuity between the pre-university and the scientist identity, and developing confidence in their ability to write in English in a less demanding, but

nevertheless legitimate, Biology writing task. Analysis of this writing task, the letter of motivation, showed that students were reflecting on their learning and attempting to articulate what was important for them in the learning process. In their letters of motivation, students were unanimous in arguing for the field trip to the rocky shore, discussing a number of advantages such as experiencing the marine environment – seeing and handling the organisms and asking questions about the ecology and the adaptations of the marine life. A number of students perceived this as practical learning rather than theoretical learning:

> "What I have seen with my eyes sticks in my mind...(we) become more interested in things when we see them and touch them, rather than just learning about them."
>
> "at the beach everything is real: animals are alive, information from texts is compared with the real world"

This writing task not only provided evidence of students' enjoyment, but also demonstrated that they were grappling with course-related biological content and concepts while they were given the opportunity to reflect on their personal experiences:

> "It was wonderful for me to see how tiny organisms fight for a place in the rocks..."
>
> "There on the beach we saw the intertidal region which I could not imagine before."

Students' writing showed a strong awareness of the satisfaction they found in making connections between what they learnt in the classroom or from a book, and the actual experience of studying something in relation to its complete environment. Many had never visited the sea before and most expressed their delight at being able to understand their Biology better because of the field trip. They valued working in a more informal way with peers and teachers. Although we do not claim that the writing described above would in the normal way of things be produced by biologists, we view it as important in allowing students access into the discipline, firstly because of issues of identity as indicated above and also because the personal response is always present for any scientist; although this personal response is not usually for public consumption as the experimental report or research article is, it may well find expression in field notes.

4.1.3 Journal

SFP Biology students wrote another expressive writing task in the form of a journal-style response to their experience after they had visited a nature reserve and spent time sitting alone in this setting. This task gave the students a voice to express their personal experience as a means of identifying with elements of the discipline of Biology; we view knowledge of their personal feelings as necessary in order to operate successfully in the more "academic" writing genres of the discipline. This expressive writing, as well as the group presentations (see below), established the link between students' own lives and real context of biology, the Discourse of which students are becoming a member.

Analysis of the expressive journal writing of the students (n = 36) revealed how they felt about being alone in a natural setting and indicated to us that this approach was a valid way for the students to identify with the discipline. Most found being alone in the bush enjoyable. They mentioned the awareness of themselves as part of nature, thus identifying with the natural world that is the focus of their study in Biology. Course content was thus no longer isolated

from their life experiences. This is an important step in the process of being acculturated into the Biological discourse community because it avoids the lack of congruence described by De Kadt and Mathonsi (2003) between the student's pre-university or African identity and an emerging scientist identity. Comments included:

> "I was going with the rhythm of the nature being alone in the natural place that made me feel accepted as part of the group of the dead, non-living rocks, water, air, soil etc as well as living things like birds, insects, monkeys etc."

and :

> "I never imagined me in the woods before. But the field trip made me see myself in the middle of them which was a very good experience."

SFP Biology students, with the freedom to write in their own voice (their own response rather than the constrained highly structured and unfamiliar experimental report), identified aspects of the world around them in their own terms. Their comments reflected how the field trip encouraged them to establish a new identity for themselves as biologists/ecologists. An example shows how one student is able to understand a biological principle, such as the interrelationship between elements of an ecosystem, by relating what was experienced first hand to the familiar discourse of music and singing in a choir. Interestingly this metaphor explicitly relates the experience of nature to an oral form prominent in the rich oral tradition from which many of our students come. The experience thus provides a link between this oral tradition and the developing literate identity as a scientist:

> "...I continue listening to the stream. I heard the movement of water. The noise was constant. As I tried to mix the noise, bird noises and stream noise, I came up with a choir, where I can put birds as girls and river as boys with bass and tenor."

Almost a third of the students reflected on the way in which vandalism, pollution and lack of conservation policies can destroy opportunities of having unspoilt areas to enjoy. Thus they expressed their own opinions, arguments that they will later study impersonally and scientifically. In our experience, without a personal response of this kind, it is easy for students to fail to appreciate conservation issues:

> "I was looking at different trees, different plants and the relationship between plants and animals... Then I thought about those people who do not know about the beautifulness of the nature, who just vandalize it without any reason. I thought if plants can be vandalized where would that relationship occur again, where would animals (like birds and monkeys) can sleep."

4.1.4 Group presentations

Students' small group presentations at the end of the semester gave them an opportunity to personalise the knowledge that they had gained, articulating the concepts they had come across in a familiar genre, rooted in oral tradition that is so strong for many South Africans, by presenting material orally in a way they chose.

Presentations by the students were in the following forms:

Songs about pollution and its effect on a colony of molluscs

A rap song on conservation

A gospel song about marine life

A debate between the inhabitants of a rock pool

A television talk-show on the effects of pollution in the sea

A drama on a meeting between sharks and fish

A parade, toyi-toying and singing to promote awareness of the environmental destruction of the sea-shore.

These group presentations opened up opportunities for learners to bring means of oral expression, with which most are very familiar, into the classroom. This was designed as a means of creating continuity between a pre-university identity rooted in a rich oral tradition (which as the above presentations reflect, draw on not only religious but also political and popular forms), and students' developing identity as a scientist. Singing, acting and oral expression are areas in which many of the students excel. Thus, giving these expressions a place in the science classroom built up learners' confidence about their performance in the discipline as they expressed elements of what they had covered in class in an informal and less intimidating manner. Most students performed excellently and with great enthusiasm.

4.1.5 Course evaluation

The SFP Biology course evaluation at the end of the semester was very informative. Students' most positive feedback came in response to the field trips and marine theme. The course evaluation again gave learners the voice to express their own opinions, while also informing their teachers of students' experiences of, and feelings about, the course. This insight offered helpful guidance for continued efforts to assist students in entering the science discourse community. In completing the evaluation, students also showed their understanding of Biology.

4.1.6 Use of expressive writing in encouraging the development of an identity as a biologist

In summary, by completing the course evaluation and in the informal writing tasks students, although not "doing Biology" in the traditional sense, were writing about their personal response to Biology. From these writings they established a positive link between this study and the organisms and processes that they see in their own everyday lives. Such identification with the discipline is crucial if the process of becoming a member of the Discourse of Biology is to be successful. Gee (2003) notes that students need to relinquish this kind of informal writing to become members of a science discourse community; we use informal writing as a bridge between students' two identities: the pre-university and the scientist identity; the informal writing supports the development of the new literacy whose development is essential if the student is to be integrated into the Discourse of science.

We believe that understanding the knowledge and experiences students bring to a Life Science course is an important first step in facilitating learners' entry into the discourse community. As a consequence of their needs, specific writing tasks can be designed to help them to bridge the gap between their existing and required knowledge, and to see themselves as emerging

members of the Discourse of Life Science. The expressive writing task provided students with the opportunity to make connections between their old and emerging identities showing a sense of belonging in the discipline of Biology. These writing tasks familiarised students with the discipline, building up their encyclopaedic knowledge, and further contributing to their successful access into the Biology discourse community.

The informal writing tasks showed that all students became more interested, in a general sense, in Biology as well as developed confidence in their abilities as learners and writers in this new subject (as their enthusiasm and some of the journal responses above illustrate). Learning to write science genres can thus be developed formally as part of the tasks of the course, and builds on what learners bring to the learning situation. Rather than more content in Biology, such tasks reaped handsome dividends for the time invested, because the learners had begun to take responsibility for the way in which they constructed their sense of themselves as biologists.

4.2 The experimental report: learning the language of the discourse community

Our feeling was that evidence from report analysis must thus be found within a complete, and real task, rather than testing students explicitly for particular features. Firstly, gathering evidence based on discrete item testing does not necessarily have validity in terms of claims that a student has internalised a skill to the extent that he or she will be able to use it in the context of a larger task in the discipline. Secondly, it is felt that the final product of the report, as a real and complete response to a task, is required to communicate effectively to the audience, who in this case, are members of the discipline who will assess the product. Consequently, the report was more than just the sum of its parts. It represented an ongoing process of writing, reflecting, consulting and re-working on the part of the author.

To gauge effectiveness of scientific report writing in providing students' access to the discourse, it was analysed in terms of the four criteria outlined earlier.

4.2.1 Familiarity of the writer with the stated (assessment) criteria

Trying to promote within the learner a sense of how all aspects of their background knowledge of the current task will affect how well they complete a task, implies that the assessment criteria of the product of any task must take as fundamental the holistic, integrated nature of that product (Hamp-Lyons, 1993). According to the lecturer's assessment, students met most aspects of the assessment criteria for the experimental report (Table 1). However, a number of them (31%) put information into the *Introduction* of reports that should have been used elsewhere in the report. Thus while most writers understood what aspects should be included, some went beyond that and, in a sense, created additional criteria for themselves, as did 31% in the *Discussion*.

The most common omission in the *Discussion* (78% of students) was the experiment's shortcomings. Although we did not interview students on this omission, we attribute it to two factors. Students simply forgot to include this discussion, or they did not appreciate that the experiment was one of their own design, and so could potentially be redesigned more effectively. Students may feel that there is a "correct" answer to the finding, and have yet to become aware of the absence of the "right" answer in all conditions.

4.2.2 Evidence of writers' use of the additional readings

Elsewhere (Parkinson & Adendorff, 2004), we argue that the student laboratory report is a kind

of "proto-research article". One similarity is that writers of both genres must show continuity with literature in the field. By doing so both groups demonstrate deference to the powerful research community (Myers, 1989). Students' ability to draw on relevant readings in order to provide accurate scientific information to contextualise their *Introduction* and to discuss their findings in *Discussion* are shown in Table 2. All students had a reference list because it was specified as a section of the report. They had all referenced the book of Marine Theme Readings there but not in the text. They also wrote information using direct quotations without quotation marks or paraphrased text by other writers without references. All students demonstrated a poor understanding and use of referencing conventions.

However, despite not having completely acquired the conventions for use of source texts, such use of sources did nevertheless provide evidence that students were attempting to use the ideas of others in their writing. The reports showed that 58% of students had integrated material from their reading with their own writing in the *Introduction* and furthermore, 58% showed evidence of integration of readings in the *Discussion*. In the *Introduction* 86% of those who had drawn on readings included one or more lengthy verbatim quotation, while 38% of those who used readings in their *Discussion* used verbatim quotations. This latter result was lower than the corresponding feature in the *Introduction*, possibly due to students' sense that the *Discussion* needed less lengthy descriptions than those used to contextualise the problem in the *Introduction*. More than half of the students attempted to integrate what they wanted to say with what other writers had said, and thus showed a rudimentary understanding of a very important aspect of academic writing. It could be argued that this attempt to integrate what they say with what previous writers have said is the beginning of students' seeing themselves as part of the Biology discourse community, and thus as evidence of taking on an identity as a biologist.

By contrast, some students had not yet begun this process. Some students, in the *Introduction* 25% and in the *Discussion* 33%, showed little or no use of readings to contextualise the experiment by incorporating material from previous findings. They may have found this task difficult and additional to writing up the experiment they had conducted. Alternatively, these writers are poor readers who do not see what they have read, or could read, as being a resource that they can access; rather the poor reader sees additional reading as an additional burden in an already task-filled situation. Students who avoided other information completely gave a personalized and commonsense commentary unacceptable in scientific writing. At the other extreme, some included very little in their own words. In the *Introduction* 17%, and in the *Discussion* 8% of students, produced text that consisted of a patchwork of quotations. They were unable to integrate what they had read with writing, and so picked snippets of text and joined them together.

Although we did not interview students concerning use of source texts, we view both of these strategies (that is underuse and overuse of readings) as indicative of students' inability at this point to master academic writing in science. By extension they still have some way to go towards developing an identity as a scientist. These experimental reports showed how students either achieve, or fail to integrate, what they have read with what they were trying to say in their own writing. Some students (58%), after a semester in the new discipline, showed development of these skills, indicating that these writing tasks are a valuable investment of course time.

It was more difficult to come to conclusions about the students' reading of academic texts based on their writings. An important aspect of developing enthusiastic and competent biologists requires gathering information through reading what others have discovered. The ability to make skilful and acknowledged use of other sources of information to provide the foundation for the researcher's own ideas, insights and experimental design is a highly regarded aspect of the craft of academic writing. As Pennycook (1996: 211) notes, the concept of originality and use of one's "own words" in academic writing is not a simple one. Novice writers find it difficult to avoid plagiarism. In our experience, such competence at referencing takes time to develop. Apart from the abovementioned aspects of learning conventions of referencing, novice academic writers do not appreciate the value that readers of an academic article place on a reference list for other ideas on the subject under discussion.

4.2.3 Evidence that writers are aware of the audience and take steps to make the report coherent

If students have an awareness of the audience of a scientific report, they will know this is a specific group with certain expectations of a report: writers will need to assume general knowledge about the subject matter, but will have to provide detailed specific information that may be unfamiliar to the reader. In writing this report, students are embarking on a path which, if pursued, ends in the writing of research articles. A further similarity between the writing of research articles and the writing of laboratory reports is that like writers of research articles, writers of student reports address a more powerful reader: the research community in the case of a research article (Myers, 1989) or the course lecturer in the case of student writing.

A measure of the writer's attention to the audience has been characterised in terms of the coherence of the report so the whole text "makes sense" to the reader. Hubbard (1993: 57-58) defines coherence as the "extent to which a piece of discourse hangs together to form a unified whole". Inglis and Kaunda (1996) noted that coherence goes beyond text and is part of the construction of meaning on the part of the reader. Although a research report has a high level of coherence as a consequence of having defined sections, writers have to make each section coherent as well as make links between section sequences. In the two sections analysed, students had to make explicit links between their hypothesis in the *Introduction*, and their acceptance or rejection of this in the *Discussion*. Writers had also to provide sufficient information and logical argument. If important information was omitted, explanation of important concepts neglected, or unrelated material included, coherence of the report was diminished.

Students' reports were categorised in terms of strategies (Table 3), the presence or absence of which enhanced the overall coherence of the report. Such categorisation meant that use of specific language items enabled readers to understand text, with as little "detective work" as possible. If the writer had relied completely on the reader to make the necessary links, the report was classed as "no linking strategies". If the writer had shown some sense of explicit linking, it was classed as "some attempt at linking" while good use of explicit linking signals, or logical connectors, was classed as "good linking strategies".

In the *Introduction*, 45% of students gave no explicit evidence of linkage strategies. It appeared that they had difficulties linking forward into text to facilitate readers, as well as in contextualising the purpose of the report. However, in the *Discussion* only 17% of students used no linkage strategies. The purpose of the *Discussion* is to argue for a particular conclusion, and writers

appeared to address this by calling on evidence from earlier in the report. Also, writers were drawing the report together here and in 22% of cases, reports showed that writers were capable of doing this effectively, while 61% were developing use of necessary lexical items to do this.

Often students failed to make a coherent point, not because of lack of content, but because the content was written so that it was seen to be unimportant by the reader. Use of information is irrelevant until the writer shows why it was included. Similarly, poor expression of ideas and/or the imprecise use of words require readers to make unrealistic inferences. Ways to counter misleading readers through poorly expressed ideas, is for writers to provide explanations or definitions of specialist terms that the writer expects readers to find unclear. This expectation was anticipated by 28% of writers in the *Introduction*, but by only 8% in the *Discussion*.

4.2.4 Grammatical (usage) errors

We focussed on two problems of language usage that affect the readability of reports (Inglis & Kaunda, 1996). Although both contribute to diminished coherence of the writing, their contribution is considered less important than other aspects of the report such as content and overall organisation. Firstly, those aspects that flout conventions of formal scientific writing were identified including use of contractions, personalised style and inappropriate tense. Secondly, language usage errors were identified including verb-noun disagreement, incomplete sentences, misuse or absence of an article, and misspelt words.

Most students had learnt the conventions of scientific writing about personalised style of language use, and showed competence (Table 4). More than half used relevant grammatical features in sections of the report, such as use of the passive voice and past tense in the *Method* section, or use of tentative language in explanations in the *Discussion* section. Despite students writing in English as an additional language, and that the scientific register was new to them, this was not an area where they struggled to make themselves understood. This may be because this was not the first draft of the report. Emphasis on writing as a process made students familiar with editing as a part of writing the report, and many technical errors were addressed by them following the draft submission.

5. Conclusion

The two approaches to facilitating students' entry into the science discourse community used expressive writing and formal experimental report writing. Using a scaffolding approach, these assisted SFP Biology students to develop their writing of scientific reports to meet the criteria of the genre as far as content and structure of the text were concerned. This included making suitable use of readings, writing coherently so as to convey their message appropriately to the audience, and using meaningful and acceptable scientific language of the genre. SFP students gained access to the discourse not only by learning the conventions necessary to write as scientists but by becoming acculturated by a range of expressive writing tasks and activities that allowed students to build on their present knowledge and values. Having taken the first steps towards becoming members of the Biological discourse community, they can continue studying a science degree with the confidence and mastery of skills that this requires. We feel that the students learnt to "write their way into science" by bridging the gap between the identity they bring from own backgrounds and experiences and a new scientist identity they need to

forge; part of this development involves developing the writing skills necessary for acceptance and success in the field of Life Science.

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Appendix

Table 1: Analysis of Introduction *and* Discussion *of scientific reports to assess the performance of the SFP Biology writers in terms of the stated criteria.*

Assessment criteria	Satisfactory	Unsatisfactory/ missing	Misplaced information
Introduction			31%
1. Gives background information	86%	14%	
2. States hypothesis	83%	17%	
Discussion			
3. Acceptance/rejection of hypothesis	89%	11%	
4. Justification	86%	14%	
5. Shortcomings of the experiment	22%	78%	

Table 2: Analysis of SFP Biology writers' use of readings in the text of their Introduction and Discussion of their scientific reports.

Use of Readings	Introduction	Discussion
1. Integration of content from readings with own writing purpose – included one or more long (unacknowledged) quotes	58%	58%
2. Text made up of (unacknowledged) quotations patched together.	(86%)	(38%)
3. Text showed little or no use of readings	17%	8%
	25%	33%

Table 3: Analysis of SFP Biology writers' awareness of the audience and their attempts to make their scientific report coherent.

Coherence of text	Introduction	Discussion
1. Good linking strategies	19%	22%
2. Some attempt at linking	36%	61%
3. No linking strategies	45%	17%
4. Important information left out	36%	39%
5. Content that is unrelated/ irrelevant/not made relevant	44%	25%
6. Poorly expressed ideas /imprecise use of words	61%	61%
7. Explanation (definition) of terms	28%	8%

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7. Explanation (definition) of terms	28%	8%

Table 4: Analysis of shortcomings of the SFP Biology writers' scientific report in terms of language usage. The absence of contractions and a personalized style are important features of a scientific style.

Language Usage	Introduction	Discussion
1. Contractions	3%	65
2. Personal style	17%	17%
3. Inappropriate tense	36%	31%
4. Verb-noun disagreement	25%	25%
5. Misuse and/or absence of article	44%	31%
6. Misspelt words	44%	39%