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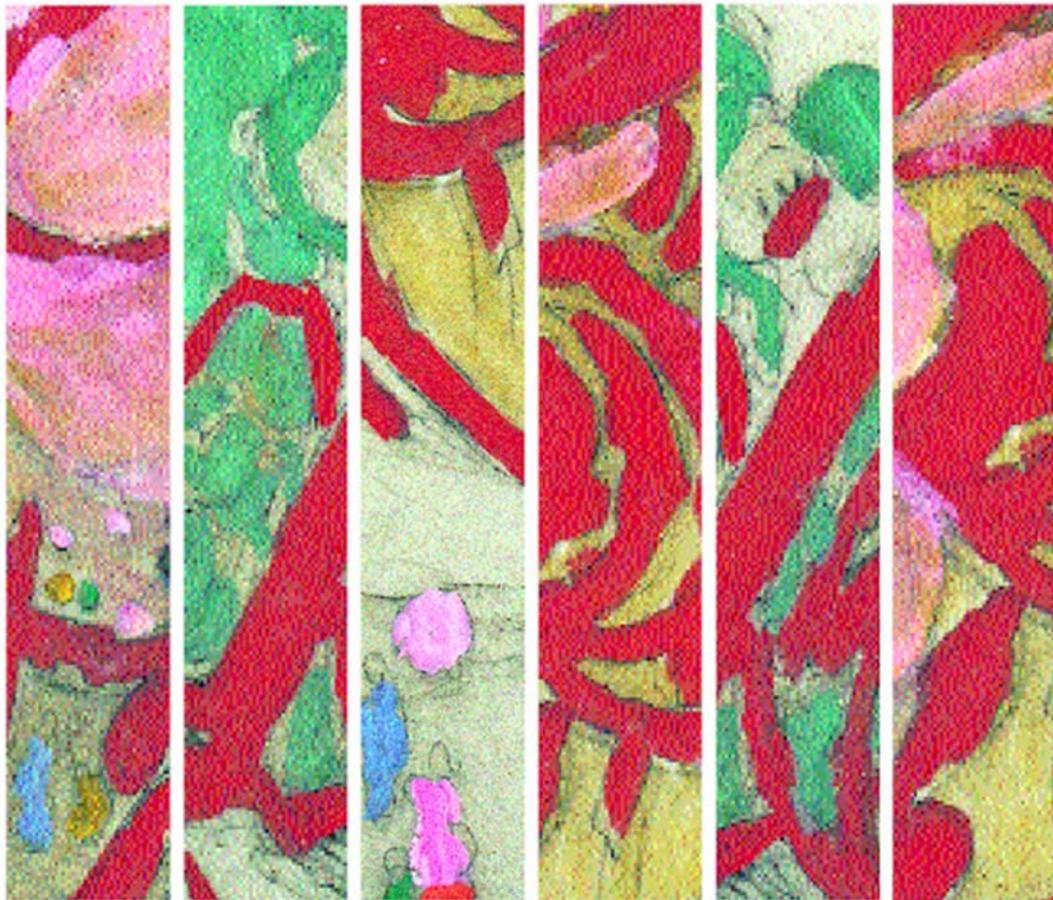
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Specialist Language Style and Supposedly Adept Monolingual Science Students

Mitch O'Toole and Gjyn O'Toole

Secondary school science curricula are becoming increasingly conscious of communication issues in mainstream classes. However, the perception that 'language difficulties' are confined to minority students remains widespread among science teachers. This paper reports the results of a number of investigations into the impact of the specialist style of scientific English on mainstream science classes made up of monolingual speakers of the locally standard dialect of English. Communication difficulties in specialist contexts do not appear to be restricted to 'minority groups'.

This paper briefly describes the local education situation in which the authors find themselves and a small study which was prompted by changes in that situation. The bulk of the paper is made up of progress report on a larger study of monolingual student difficulties with the language of science. The final products of the research reported here will include baseline data for an international attempt in increase undergraduate student success in science courses and a minimally invasive diagnostic tool for use in secondary science classes.

Local changes in examination patterns

Science examinations in New South Wales, Australia have traditionally relied on multiple choice items supported by questions requiring students to write answers of no more than eight to ten lines. These examinations have been norm-referenced, ranking instruments. The tests were based on common curricula. They were designed, and the student scripts marked, to produce a wide distribution of student scores which could be defensibly used to determine individual student access to relatively scarce educational resources. This reliance on norm-referenced, high stakes, curriculum-based public examinations is a characteristic feature of secondary schooling in New South Wales

The norm-referenced approach adopted in the past has recently been replaced by a standards-based one. The format of the Higher School Certificate examinations has also changed somewhat. One of the changes included in the 'newHSC' involves reduced reliance on partitioned questions which scaffolded student writing and the use of unscaffolded essay questions in science papers. The most able science students are identified on the basis of their ability to write 10-15 line answers to essay-style questions.

Essay-style questions were part of the original intention of the New HSC and the process which leads to them is fairly clear in some of the changes between the *Examination, Assessment and Reporting Supplements* (eg., BofS 1999 p16) and the later *Specimen Papers* (eg., BofS 2000? p16). The intent is further clarified by the *Examination Mapping Grids* (eg., BofS 2000?, unnumbered fourth page of booklet).

The grids make clear that, while many of the examination questions are targeted at students performing in specific band ranges, the unscaffolded essay questions are expected to produce broadly spread scores. There are two such questions in the compulsory first section of each specimen paper in the sciences and a further two in each of the optional sections. This pattern allocates at least a quarter of the possible marks on the science papers to unscaffolded essays. It is possible that the student rank order on these questions may correlate strongly with their final rank order. The examination data released by the Board of Studies since the first examination round (2001) seems to suggest that the final ranks were leveraged by student response to the language-rich formats.

The impact of the removal of scaffolding from examination questions was explored by O'Toole, Irwin and Jolliffe (2001). This investigation was carried out with a group of 16 year old monolingual speakers of the local prestige dialect of English. These students could reasonably be expected to have fewer difficulties with decoding the language of test items than others within their statewide cohort. Their results suggest that the prior knowledge which is brought to an assessment task is more important than the format of the question. Unscaffolded questions will advantage those students who know more and so may serve to identify able students. However, the results of this investigation also suggest that the removal of scaffolding will produce lower student scores because of the change in format rather than any difference in student understanding of the science content. It is likely that the removal of scaffolding may have an even greater impact on the apparent science performance of students from more linguistically diverse backgrounds.

These changes foreground monolingual student control of the features of the specialist language style which characterises discussion of science in English.

Scientific English

Language use in science contexts has been a concern for a very long time (see O'Toole 1996 and Rollnick 2000 for reviews of the area). The language of laboratory, teacher, book and examination continues to thwart student access to science and provoke teacher attempts to help those students (Henderson & Wellington 1996, Wellington & Osborne 2001). Technical words are an obvious (and obviously problematical) feature of the scientific style and the use of formal alternatives to some common words and the changing meaning of others also provides significant difficulty for students (Prophet & Towse 1999). The scientific style of English can cause difficulties for students as they attempt the project work which is at the core of much 'best practice' in contemporary school science teaching (Moje et al 2001). However, talk (Rivard & Straw 2000) and writing (Hand et al 1999) provide vehicles for enhanced science understanding. That seeming contradiction provides one reason for continuing interest in the area.

Student difficulties with science language fall into a number of areas (Cantor 2001). There are problems with talk (Dagher & Crossman 1992, Lemke 1982, 1990, 1998; Ogborn et al 1996, Roth et al 2001), reading (Koch & Eckstein 1995, Wellington 2001), writing (Prain & Hand 1999, Unsworth 1997) and assessment (Lawrence & Pallrand 2000).

Investigating student difficulty

An earlier investigation used 12 language tests based on an enhanced version of cloze technique to identify the features of the language of science which were causing difficulty for 2606 secondary science students from 57 different linguo-cultural backgrounds (O'Toole 1998). Changes in the local examination contexts have thrown the difficulties of monolingual, 'mainstream' students into high relief.

The data coming from the use of one of the cloze tests from the wider study have been re-analysed to form the basis of the following discussion of language difficulties of monolingual science students. A sample of 870 junior secondary school students from schools in four nations completed the particular cloze test on which the following discussion is based. Three schools in Australia were involved as were two schools each in Singapore and the Philippines and one school in Britain. A further 200-300 Australian student scripts remain to be analysed. The language difficulties of the students from the sample were exposed through the use of a fifth word deletion cloze test based on a sample drawn from a school science textbook (Heffernan & Learmonth 1990).

An enhanced cloze strategy

The student replacements of the words deleted to form the cloze test were analysed in detail. Deletions which were filled with exactly the same word as was in the original passage were coded as instances of "*exact replacement*". Suggestion of words which are clearly wrong were coded as "*error replacement*". A response was coded as "*conceptually correct*" if it differed from the "exact" term but its use maintained the meaning of the passage. Summing the exact and conceptually correct replacements yielded the *conceptually correct total*, while the sum of the clear mistakes yielded the *error total*. Omissions were coded as errors when they preceded an entry attempt but were not so interpreted when they followed a student's last attempt at inserting a deleted word.

As an example of the impact of conceptual coding, consider the following sequence of items from the test used in this investigation. The "exact" replacement appears in boldface at the head of a list of italicised words which were considered to be acceptable alternatives.

"Certain smaller white blood (34 **cells**) arrive in the blood (35 **and**, *which, can, to*) attack the invaders directly. (36 **Any**, *some, the*) leftover microbes, and dead (37 **and**, *or*) dying cells are removed (38 **when**, *by*) a larger cell type (39 **arrives** *sometime, much*) later."

The alternatives may not appear appropriate when the replacements are considered in isolation. For example, *any, some* and *the* all carry different meanings and would hardly be considered as synonyms. However, if the context of the passage as a whole is considered then it becomes clear that different students are reconstructing different passages while maintaining the original meaning. This can be seen more clearly if the alternatives produced by different students are separated.

Original form (exact replacement):

“Certain smaller white blood **cells** arrive in the blood **and** attack the invaders directly. **Any** leftover microbes, and dead **and** dying cells are removed **when** a larger cell type **arrives** later.”

Acceptable alternative #1 (conceptually correct replacement):

“Certain smaller white blood **cells** arrive in the blood **to** attack the invaders directly. **Some** leftover microbes, and dead **or** dying cells are removed **by** a larger cell type **sometime** later.”

Acceptable alternative #2 (conceptually correct replacement):

“Certain smaller white blood **cells** arrive in the blood **which** attack the invaders directly. **The** leftover microbes, and dead **or** dying cells are removed **when** a larger cell type **arrives** later.”

Acceptable alternative #3 (conceptually correct replacement):

“Certain smaller white blood **cells** arrive in the blood **can** attack the invaders directly. **Any** leftover microbes, and dead **and** dying cells are removed **by** a larger cell type **much** later.”

It is worth noting that this use of conceptually correct coding is sensitive to student response to the passage beyond the context of the words immediately surrounding the deletion. The supposed lack of such sensitivity to this wider context has been one of the major objections to the use of cloze techniques (O’Loughlin 1992). Cloze techniques were purportedly unable to respond either to students’ meaningful approximations or identify situations where they were exhibiting evidence of difficulties beyond mere collocation. This may be the case when only exact replacement is coded as correct (the ‘strict marking regime’) but regular deletion techniques become considerably more sensitive if conceptually correct replacement is also coded as correct (the ‘conceptual marking regime’).

The distribution of total scores for both conceptually correct replacement of deleted items and error scores were both sufficiently normal to allow the use of multivariate statistical tools. The data also satisfied the other assumptions implicit in such tools, such as linearity, independence and absence of influential outliers or leverage points (Hair, Anderson, Tatham & Black, 1995 pp. 112, 127, 143, 156, 276; Stevens, 1996 pp. 12, 109, 115).

A two-stage language description

The investigation on which the following discussion is based used a two stage language model, categorising each deletion by its traditional (or dictionary) category and its modern grammar category. These groupings allowed the formation of language feature sub-tests whose results could be discussed separately.

The dictionary categories are the traditional parts of speech: Noun, Pronoun, Adjective, Article, Verb, Adverb, Conjunction and Preposition (Crystal 2000). The modern grammar categories used in this study were Technicality (Herbert, 1965; Martin, 1993), Grammatical Metaphor (Halliday & Martin, 1993 p. 13), Word Stacks (Stevens, 1977; Trimble, 1985 p. 134), Voice (Cooray 1965, Kess, 1993; Trimble, 1985 p. 115) and Cohesion (Connor & Johns, 1990; Halliday & Hasan, 1967). These

latter categories can be further divided. 'Technicality' can be split into Technical, Semi-Technical, Formal and General content words which may include a number of parts of speech. 'Grammatical Metaphor' divides into cases of verbs acting as nouns, verbs acting as adjectives, nouns acting as adjectives, adverbs acting as adjectives and adverbs acting as conjunctions. 'Word Stacks' can have 2, 3, 4, 5 or more adjectives (or products of grammatical metaphor) preceding their noun. 'Voice' refers to Active, Passive or Stative verb forms and 'Cohesion' can be referential, explicit, conjunctive or repetitive.

A few examples may make these categories clearer. The following short extracts are taken from the base text used in this study. The passages contain **nouns** (words 7, 8, 16, 17 and 34), **pronouns** (words 14 and 38), an **adjective** (word 36), **articles** (words 9 and 11), **verbs** (words 10, 12, 15, 39, 42 and 44), an **adverb** (word 40), **conjunctions** (words 35 and 37) and **prepositions** (words 13 and 41).

“(7.*Hairs.*) to keep out disease-carrying (8.*dust.*) particles are contained in (9.*the.*) nose, and any that (10.*get.*) past the hairs into (11.*the.*) nose or lungs are (12.*caught.*) by the sticky mucus, (13.*from.*) where tiny hairs, provided (14.*that.*) they have not been (15.*killed.*) by tobacco and marijuana (16.*smoke.*), remove mucus and trapped (17.*microbes.*) quite efficiently. Certain smaller white blood (34.*cells.*) arrive in the blood (35.*and.*) attack the invaders directly. (36.*Any.*) leftover microbes, and dead (37.*and.*) dying cells are removed (38.*when.*) a larger cell type (39.*arrives.*) later. Some invaders, such (40.*as.*) worms, are too large (41.*for.*) white blood cells to (42.*engulf.*), so there is a (43.*third.*) group of scavengers that (44.*release.*) enzymes outside their cell (45.*body.*), which then attack the (46.*skin.*) of the invading parasites.”

These dictionary categories can be enhanced by looking at more modern grammar classifications. The extracts contain **technical** (word 17) and **semi-technical** (words 33 and 34) words, examples of noun to adjective **grammatical metaphor** (word 8), a three-item **word stack** (also word 8), **passive voice** (words 12 and 15) and referential (word 11), conjunctive (words 35 and 37) and repetitive (words 34 and 42) **cohesive devices**.

Test reliability

The conceptually scored results of the cloze test at the core of this investigation exhibited a reliability of 0.94 (Cronbach's ALPHA; SPSS 1986 p. 857), enabling some confidence in the interpretation of the data (Guilford & Fruchter, 1973 p. 418). The reliabilities of the language feature sub-tests extracted from the cloze test were lower. Table 1 shows the number of deletions representing each language feature in the test and the reliability of the subtest derived from analysis of student insertions into them.

Table 1: Language Feature Subtests

Language Feature	Test (reliability=0.94)		
	C [#]	I [@]	R ⁺
nn	870	18	0.77
pn	870	2	0.20
aj	870	2	0.18
at	870	5	0.59
vb	870	12	0.81
ad	870	1	0.46
cn	870	3	0.46
pp	870	5	0.52
T	870	10	0.69
M	870	4	0.35
S	870	6	0.50
P	870	4	0.60
C	870	15	0.75

Notes

- nn nouns
- ad adverbs
- pn pronouns
- cn conjunctions
- aj adjectives
- pp prepositions
- at articles
- vb verbs
- T Technicality
- M Grammatical Metaphor
- S Word Stacks
- P Passive Voice
- C Cohesive Devices

Cases: number of students completing subtest.

@ Items: number of test items classified as representing nominated language feature.

+ Reliability: Cronbach's Alpha.

The reliabilities of the language feature subtests are not as high as those obtained for the intact cloze test. Such an outcome was expected as the subtests are considerably shorter than the intact test from which they were drawn. If this investigation made use of multiple-choice test items conventional practice would dictate that the individual items making up the subtests be examined and those performing badly be replaced with more reliable alternatives. In this way the overall test composition would be altered until the subtests achieved higher figures for Cronbach's alpha. However, such a procedure could not be carried out here without sacrificing the authenticity which is one of the major attractions of the cloze procedure. An increased reliability would be achieved at the cost of decreased face

and content validity. This would be regrettable and, since this investigation is focussed on group rather than individual performance, reliabilities above 0.5 will be considered to be satisfactory (Fraser, 1974). Such reliabilites are printed boldface in Table 1. The data contained in subtests with reliabilities less than 0.5 is most unlikely to yield useful information and so the results of such subtests were discarded.

The remaining subtests (noun, article, verb, preposition: technicality, word stacks, passive voice and cohesive devices) are reliable enough to permit meaningful analysis. Student results on the cloze test described above were compared on the basis of the status of the school they attended, their age and the language they specified as being spoken in the homes from which they came. In general, it appeared that students from higher status schools had less difficulty with all language features than those from lower status schools and older students had less difficulty than younger students. These results are fairly predictable. However, the results which emerge when students claiming linguistically diverse backgrounds were compared with those admitting to monolinguality are more surprising. Many people would expect the monolingual students to have less difficulty than their more linguistically diverse fellows. However, the two groups experienced the same level of difficulty for four of the eight categories (articles, verbs, passive voice and cohesion) and monolingual students experienced a **greater** degree of difficulty with nouns and word stacks. There may be a linguistic basis for the impact of changing question formats on science examination results in New South Wales.

Linguo-cultural aspects of student difficulty

The data gathered in this investigation also allows more precise linguo-cultural contrasts to be drawn. The 870 students in the sample specified 32 different languages as being spoken in the homes from which they came. Thirty six of these students specified 23 heritage languages which they shared with less than 1% of the entire sample. The results of these students were removed from the study, reducing the sample by less than 5%.

Table 2 shows the comparison between the difficulties with the scientific style of English being experienced by students from nine specific linguo-cultural backgrounds, as shown by their results on one of the cloze tests which was the basis of the wider investigation. The passage on which this cloze test was based was drawn from a widely used local secondary science text (Heffernan & Learmonth 1990 pp. 299, 300) and dealt with the human body's defenses against infection

The differences between the means shown on Table 2 are statistically significant at the 0.005 level. MANOVA techniques (taking language category as the dependent variable and heritage language as the independent variable) indicate that there is a less than 5 in 1,000 probability of the differences between the means shown on Table 2 being due to chance. The results are robust enough to allow meaningful discussion.

The result cells on Table 2 represent the percentage of category deletions which students who claimed the particular heritage language could not process correctly. For example, the 167 English language background students in this sample got 44% of the noun-deletions clearly wrong on the particular cloze test, compared to a reduced sample mean difficulty level of 43%, yielding a comparison score of +1 for noun difficulty. Students who identified English as the only language spoken in their homes were unable to conceptually correctly replace an average of 36% of the

deletions making up this cloze test and that percentage also indicated the reduced sample mean level of difficulty (the error total) for this cloze test.

Table 2: Who is having trouble with what?

	<u>Student Specified Heritage Language</u>	<u>No.</u> <small>(% of whole sample)</small>	<u>Noun</u> <small>% wrong Comp. Sample D'fclty</small>	<u>At'cle</u> <small>% wrong Comp. Sample D'fclty</small>	<u>Verb</u> <small>% wrong Comp. Sample D'fclty</small>	<u>Prp'n</u> <small>% wrong Comp. Sample D'fclty</small>	<u>Tchlty</u> <small>% wrong Comp. Sample D'fclty</small>	<u>Word Stacks</u> <small>% wrong Comp. Sample D'fclty</small>	<u>Pas'Ve Voice</u> <small>% wrong Comp. Sample D'fclty</small>	<u>Cohsv Device</u> <small>% wrong Comp. Sample D'fclty</small>	<u>Avg. D'fclty</u> <small>% wrong Comp. Sample D'fclty</small>
A	English	167 (19.2%)	44 +1	28 0	38 -1	40 -6	36 +4	24 +5	35 -1	40 -5	36 0
B	Patwa <small>(spoken by Londoners of W. Indian ethnicity)</small>	12 (1.4%)	56 +13	43 +15	48 +9	57 +11	49 +17	43 +24	44 +8	54 +9	49 +13
C	Greek	9 (1%)	50 +7	38 +10	57 +18	47 +1	46 +14	33 +14	70 +34	48 +3	50 +14
D	Mandarin	166 (19.1%)	33 -10	18 -10	26 -13	37 -9	22 -10	13 -6	18 -18	35 -10	25 -11
E	Cantonese	19 (2.2%)	41 -2	21 -7	28 -11	37 -9	29 -3	19 0	28 -8	40 -5	30 -6
F	Hokkien	32 (3.7%)	32 -9	21 -7	29 -10	41 -5	21 -11	13 -6	26 -10	38 -7	28 -8
G	Other Chinese	48 (5.5%)	34 -11	18 -10	24 -15	35 -11	24 -8	15 -4	24 -12	36 -9	26 -10
H	Pilipino	369 (42.4%)	48 +5	33 +5	48 +9	55 +9	36 +4	19 0	45 +9	52 +7	42 +6
I	Other Philipino	12 (1.4%)	43 0	43 +15	54 +15	63 +17	30 -2	19 0	53 +17	54 +9	45 +9
	Reduced Sample	834	43	28	39	46	32	19	36	45	36

NOTES:

Table 2 is based on analysis of student responses on a single cloze test.

- Student data was recoded so that a clear error = 1 and acceptable replacement or defeat was = 0.
- Cloze test deletions were classified by language category.
- Two SPSS routines were written (“dictionary categories” + “modern grammar categories”).

These did the following:

1. count number of items representing a particular language category (eg., nouns) a student got wrong
2. divide that number by the number of items representing that category (eg., nouns) deleted (in this case, 18) to give the mean category (in this case, noun) difficulty
3. multiply that mean by 100 to yield a percentage.

Monolingual Student Difficulties

The light this data throws on dialect related issues is discussed in another place (O'Toole and Absalom 2003). The performance of monolingual English-speaking students (Row A on Table 2) is of more interest in the present context.

Student difficulties with nouns and technicality are predictable but difficulties with verbs, prepositions and cohesive devices may come as more of a surprise to mainstream science teachers. The relatively high degree of difficulty experienced by students who indicated they came from monolingual English-speaking homes is particularly notable (comparatively: nouns +1, technicality +4, word stacks +5). These difficulties can have real consequences for student learning and their demonstration of it: after sifting markers' comments on almost 9000 Physics scripts, examiners remarked "Candidates did not always observe the instruction of the key verb in each question. This omission often resulted in a loss of marks, for example if a candidate only provided a description when an explanation was required" (BofS 2002 p.5). Table 2 indicates a mean verb difficulty of 39%, ranging from 24% to 57%. The monolingual difficulty level of 38% leaves scant room for complacency. The difficulties identified thus far in this on-going study seem to be reflected in responses to high-stakes testing.

Monolingual student difficulty with **nouns** (44% wrong – 1% higher than reduced sample mean) may reflect lack of conceptual understanding. However, that is no cause for comfort to science teachers and, given that the base text for this cloze test dealt with widely understood immune responses, is unlikely in this case. It is possible that the degree of difficulty reflects a lack of attention on the part of students. This seems to be the explanation favoured by the Physics examiners quoted earlier as they continue their comments (BofS 2002). Difficulties with **Technicality** (36% wrong – 4% higher than mean) may be similar in cause and impact.

Monolingual students participating in this study experienced less difficulty with **verbs** (38% wrong for verbs in general and 35% wrong for passive constructions) but the centrality of such words in making meaning implies that this degree of difficulty may well impede student understanding and production of comprehensible text. **Prepositions** and **cohesive devices** also seem to provide relatively less difficulty for monolingual students but the absolute numbers are not pleasing (40% wrong in both cases) and coherence (or the lack of it!) was also singled out for special comment by the Physics examiners: "In answering larger-mark holistic questions, candidates are expected to be able to communicate their responses in a coherent and logical manner" (BofS 2002 p.5). Such 'logic' is communicated in English through the use of a suite of conventional cohesive markers and the results of this on-going study indicate that assumptions of monolingual student control of them may be misplaced.

Using these results

Much resistance to direct treatment of language issues in mainstream classrooms rests on arguments of 'majority equity': "Most of my students are ordinary <insert nationality> children (meaning monolingual speakers of the local prestige dialect of English), why should I slow them down for the sake of the few who are having trouble with the language I use?" This data (and that presented in O'Toole 1996) demonstrates that even the supposedly linguistically adept are having trouble with the language of science. The authors would suggest that action designed to help those

students who are experiencing greater difficulty will be of assistance to those of their classmates who might be expected to experience less.

The information on Table 2 has a number of uses. Science teachers could use it to provide advance warning of the features of scientific English which might cause difficulties for students in their classes. For example, the results for the small number of students where Greek was spoken suggest that such students **might** have difficulty with the Passive Voice in English (70% of Passives wrong, comparative +34) and so teachers might choose to use the structure less **or** to teach it directly in science classes containing significant numbers of students from Greek-speaking homes. The fact that monolingual students averaged 35% of these structures wrong indicates that such direct treatment would do them no harm either!

The prospect of assuming responsibility for teaching language is not pleasant for many science teachers. Language development in science is more likely to be effective if teachers are helped to recognise the difficulties which their students are experiencing and provided with accessible ways of beginning to address those difficulties. The two-stage language description used in this investigation is readily accessible and applicable. Teachers who have discovered that their students are having difficulty with verbs or prepositions need only a dictionary to be able to identify such words in text on which they decide to base language development material.

A diversion into mass media

Do you remember a film called *Romancing the Stone*? There is a scene in it where the heroine, with reluctant hero in tow, walks into a nest of drug smugglers in Colombia's interior. Luckily the drug baron is a fan of the heroine's writing (probably Mills and Boon!) and agrees to help the hapless duo. There follows a high spirited chase. Our hero and heroine are crammed into a highly powered four wheel drive, driven by the cocaine exporting fan himself. He drives madly towards a river, closely pursued by corrupt members of the local constabulary. Our reluctant hero is quite sure that they are headed for a quick baptism, followed by an even more rapid funeral. However, the romantic pulp fiction loving driver activates a radio transmitter and, before you can say 'cocaine makes you crazy', a metal ramp rises out of the river bank. The jeep hits the ramp at precisely the right speed and sails over the river. The ever-thoughtful drug baron pushes the button again. The ramp moves up into a vertical position. Whammo!!! The pursuers ram headlong into a small steel wall. End of chase.

School Science is like that little steel platform. Set up properly, and approached at the right speed, it is a bridge to somewhere new. However, it can also be a highly effective barrier. Well-taught science is based on first-hand activities which can be one of the most fertile contexts for language development which is available to teachers. Science subjects still enjoy a relatively high status among students. Science is seen as real, useful and important. Students entering secondary school **want** to study science. Science is made up of practical activities which are carried out by students working together in groups. Very often these groups are made up of students with differing levels language competence. These groups work together to reach the solutions to problems which sit on the bench in front of them. Many of the things which are important in language acquisition are already present in well taught science.

However, science is also characterised by a formal specialised style of English, far removed from the language of playground and shops. If the activity base is 'science-as-bridge', the specialist style is definitely 'science-as-barrier'. The style is a historical artifact which arose as scientists adapted the standard dialect to suit the needs of their emerging study. The style is more than merely a matter of jargon. There are good reasons for the characteristic selection of its particular features. However, it seems that the style is the source of many problems for a wide range of students. These problems seem most obvious among students who do not speak the local prestige dialect of English but they do not seem to be confined to such students.

Features of the style which science teachers expect can be dealt with directly in science classes. Word and sentence level features can be effectively treated through language conscious supplementary exercises (O'Toole, 1992). These are content rich language exercises which are keyed into the sequence of concepts, skills and attitudes which are being developed through practical and discussion work in class. Such exercises can be sequenced so that they form the vehicle for information which is still, all too often, transmitted through transcription or dictation. Exercises which focus on written language can also support the development of appropriate spoken language if they form the basis of group work in science classes. The use of such exercises with junior secondary classes has been found to make a measurable difference to the language and content performance of students from a wide range of backgrounds (O'Toole 1985, 1998). Such exercises are deeply embedded in their context and they meet many of the objections to grammar teaching (such as, for example, Watson, 1994 pp. 70, 71, 124). They form an effective, defensible strategy for the development of student control of the scientific style of English.

Paragraph and passage level features can be a focus of language work in the upper years of secondary science. In the later years of secondary school, emphasis shifts away from skills towards student acquisition of a rather large body of knowledge, their control of which plays a large part in their selection for further education. At this time, student control of the format features of text can become very important. Science texts are structured in a fairly predictable way and helping students to see that structure and use it to make and maintain meaning can be very effective (Morris & Stewart-Dore, 1984; O'Toole, 1994; Spiegel & Barufaldi, 1994; Thelen, 1984). Work in this area has been going on for a long time. It might be wise to take advantage of it.

Conclusions

External pressures, such as local changes in examination formats, can impel specialist teachers towards accepting more responsibility for the language development of students in their classes. This is an uncomfortable prospect for many teachers. The on-going study described in this paper is intended to provide them with a clear understanding of the language difficulties which students in their classes may face and an accessible tool for the analysis which needs to underlie the preparation of conceptually coherent sets of language development activities. We may be able to do something about the problem of language in specialist subjects!

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