MOLE: FURRY ANIMALS, IN-HOUSE SPIES OR AMOUNT OF SUBSTANCE? VOCABULARY PROBLEMS IN TEACHING SCIENCE

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Abstract *Mata pelajaran Sains dan Matematik diajar dalam bahasa Inggeris di tahun satu, tingkatan satu serta enam rendah di sekolah kebangsaan mulai tahun 2003 sebelum dilaksanakan sepenuhnya pada semua peringkat sekolah menjelang 2008. Matlamat utama pelaksanaan pengajaran Sains dan Matematik dalam bahasa Inggeris ialah untuk membolehkan pelajar menguasainya sebagai bahasa ilmu dua bidang pengetahuan berkenaan sejak di peringkat awal. Namun pengajaran dan pembelajaran sains adalah suatu proses yang kompleks yang melibatkan pembinaan makna oleh dalam usaha mereka untuk memahami perkara yang diajar. Masalah dan kesukaran timbul bukan sahaja dari symbol yang digunakan bagi mewakili konsep, tetapi juga dari bahasa yang perlu dikuasai, terutama perkataan teknikal dan bukan teknikal. Artikel ini membincangkan dapatan daripada suatu tinjauan yang melibatkan 82 orang guru pelatih sains dengan tujuan untuk mengetahui sikap mereka terhadap mengajar sains dalam bahasa Inggeris dan kefahaman mereka tentang beberapa istilan bukan teknikal yang dikenalpasti menimbulkan masalah kepada pelajar sekolah menengah dari aspek maknanya dalam konteks sains (Johnstone, 1985). Dapatan menunjukkan kebanyakan daripada mereka berpendapat bahasa Inggeris adalah bahasa yang agak sukar dan lebih dari separuh berpendapat mereka akan menghadapi masalah bila mengajar sains dalam bahasa Inggeris. Dapatan juga menunjukkan facility value (bilangan mereka yang memilih jawapan betul) bagi setiap perkataan adalah rendah dan ini menunjukkan mereka mempunyai kesukaran untuk memahami maksud istilah berkenaan dalam konteks sains.*

INTRODUCTION

Science is generally defined as a set of concepts and relationships developed through the processes of observation, identification, description, experimental investigation, and theoretical explanation of natural phenomena. Through scientific inquiry, students develop learning processes inherent in thinking: observing, classifying, comparing, communicating, measuring, inferring, predicting, and finding space and time relationships. An important feature of science classrooms is the traffic of meanings concerning science, its processes and content. Science, therefore, offers a rich context for genuine language use. From a language acquisition perspective, science can serve as a focal point around which oral language and literacy in ESL (English-as-second-language) can develop. Specifically, science offers: interesting, relevant, and challenging content; opportunities for students to negotiate meanings; an abundance of appropriate language input; conditions for keeping students involved; material for development of reading; activities for development of writing; and experiences with the forms and functions of English.

Content-based ESL is a method that integrates English-as-a-second-language instruction with subject matter instruction. The technique focuses not only on learning a second language, but using that language as a medium to learn mathematics, science, social studies, or other academic subjects. Although this approach has been used for many years in adult, professional, and university education programs for foreign students, content-based ESL programs at the elementary and secondary school levels are just emerging. One of the reasons for the increasing interest among educators in developing content-based language instruction is the theory that language acquisition is based on input that is meaningful and understandable to the learner (Krashen, 1982).

Cummins (1981) has hypothesized two different kinds of language proficiency: basic interpersonal communication skills (BICS), which are language skills used in interpersonal relations or in informal situations; and cognitive academic language proficiency (CALP), which is the kind of language proficiency required to make sense of and use academic language in less contextually rich (or more context-reduced) situations. The basic interpersonal communicative skills (BICS) concept represents the language of natural, informal conversation and are used by students when talking about everyday things in concrete situations, that is; situations in which the context provides cues that make understanding not totally dependent on verbal interaction alone (Cummins, 1992). Cummins (1980) refers to this everyday conversational ability as context embedded or contextualized. It has been found by Cummins (1992) and more recently by Rosenthal (1996) that in context embedded or contextualized communication, the conversation deals with familiar events or matters that require that the speakers react and respond to each other.

The cognitive-academic language proficiency (CALP) concept is related to literacy skills in the first or second language. CALP is the type of language proficiency needed to read textbooks, to participate in dialogue and debate, and to provide written responses to tests (Cummins, 1980; Rosenthal, 1996). Cognitive academic language proficiency (CALP) enables students to learn in a context, which relies heavily on oral explanation of abstract or decontextualized ideas. This is often the context in which high school science is taught, with unfamiliar events or topics being described to students with little or no opportunity to negotiate shared meaning (Rosenthal, 1996). According to Cummins (1982), CALP requires both higher levels of language and cognitive processes in order to develop the language proficiency needed for success and achievement in school. Students who have not yet developed their cognitive-academic language proficiency (CALP) could be, according to these researchers, at a disadvantage in learning science or other academic subject matter. Data from studies (Carrasquillo & Rodriguez, 1996) have shown that there exists a relationship between English reading and writing and academic achievement.

In schools, the language used in science lessons is often context reduced or decontextualized. In other words, the events or topics being described to the student are unfamiliar and there is little or no opportunity to negotiate shared meaning (Rosenthal, 1996). Presenting a new scientific concept to a high school student according to Rosenthal is an example of context reduced language because the information presented may be abstract and unrelated to the students' everyday activities or life experience. Educational and linguistic theorists (Cummins, 1980; Krashen, 1982;) suggest that such is the case with Hispanic English language learners. These students may become quite proficient in the grammar, vocabulary and sentence structure of the English language, but may lack the necessary cognitive academic language proficiency to learn the subject matter that is presented to them in science classrooms. In other words, these students may be proficient in their English communication skills but may not have the cognitive academic language proficiency (CALP) required for learning science or other academic subject matter.

Cummins (1982) and Shuy (1981), have conceptualized the relationship of language proficiency and academic achievement by using an iceberg representation. In this representation, basic interpersonal communications skills (BICS), or skills which depend on the surface features of language and lower levels of cognitive processes, are represented above the waterline while the cognitive-academic language proficiency (CALP) or skills related to the meaning of language and higher level of cognitive processes are represented below the waterline. Cummins' (1981) contends that all children develop basic interpersonal communicative skills (BICS) and learn to communicate in their native or first language and that cognitive-academic language proficiency (CALP) reflects a combination of language proficiency and cognitive processes that determines a student's success in school. Cummins suggests that BICS are relatively easy to acquire, taking only 1 to 2 years, but that CALP is much more difficult, taking 5 to 7 years and necessitating direct teaching of the language in the academic context.

Technical vs. non-technical vocabulary

The learning of science for most students could be fraught with difficulties. These difficulties arise not only from the use of symbols to represent concepts, but also from the language that must be mastered, in particular the technical and non-technical vocabulary (Cassels & Johnstone, 1985). Non-technical vocabulary refers to terms that have one or many meanings in every-day language but which have a precise and sometimes different meaning in a scientific context (Cassels & Johnstone, 1985). Table 1 lists some non-technical terms that may appear in the text of computational problems or their solutions. These terms are amongst the ninety-five most difficult for secondary school students and their meaning in a scientific context is rarely well understood (Cassels & Johnstone, 1985). Of the 95 words tested, the vast majority showed that their comprehension was more difficult for non-English native speakers in most contexts (Johnstone & Selepeng, 2001).

Table 1: Difficult non-technical terms

Appropriate	Negligible
Component	Proportional
Consistent	Rate
Estimate	Relevant
Excess	Substitute
Magnitude	Valid
Negative	

Studies by Cassels and Johnsstone (1983, 1985) indicated that technical language of science posed a problem of familiarity, but students were seen to be able to cope reasonably well with this. Where a more acute problem lay, was in the use in science of normal, familiar language in a highly specific, often-changed and unfamiliar way. The term 'mole', for instance, has a number of meanings outside of its scientific context. Webster's New Collegiate Dictionary (1977) and the Oxford Concise Dictionary (1990) each give four to five meanings for 'mole' other than its scientific meaning. These may easily be overlooked in the teaching process, and the teacher may erroneously assumed a shared meaning. Thus, discussion of the language involved is essential if a shared meaning is to be established. Considerable advantage is to be gained, for both the teacher and the learner, in tackling these problems in the early stages. For the student, fluency in the related language can lead to a deeper understanding of scientific processes. The advantage for the teacher lies in the fact that once a shared meaning for symbols and terminology has been established and verified, more advanced or complex issues can be tackled with confidence.

METHODOLOGY

A descriptive study was conducted to identify the students' attitudes towards language learning and to assess their comprehension in some of the non-technical terms regularly used in science teaching. The survey instrument consisted of two parts: Part A assesses their beliefs and attitudes towards language learning and Part B assess their understanding of words commonly used in science. The items for Part B were taken from a repeated survey conducted by Johnstone and Selepeng (2001) using 25 words from the original list of 95. These were words that a science teacher would use naturally assuming that the students would readily understand them. The sample consisted of 82 second-year education students majoring in biology (26), physics (10), chemistry (11) and mathematics (35). Data were analyzed using SPSS and facility values (fraction of the class making the correct choice) were computed for the items in Part B. The questionnaires were administered during one of the lecture sessions and 82 completed responses were received.

FINDINGS AND DISCUSSION

Attitudes and beliefs about language leaning.

A total of 82 students enrolled in the science methods teaching course participated in the survey. These were second year students and they were required to fulfill the methods courses requirements before their student teaching that is scheduled next year, 2003. Students were also expected to register and obtain at least a grade C in the language courses as part of the graduation requirements. The course level would be determined by their SPM English results. The English SPM Examination is considered a reliable measurement (Saruddin, 1994) and thus could be used as an indicator of the students' competency in the language. Those who failed in their SPM English would be required to take the 100-level courses while those who obtained C5 and C6 could start from level 200. Table 2 shows the performances of these students in the various levels of the language course. About 27 students had to start with the 100-level courses. This indicated that they did not perform well in their SPM English. The results showed a downward trend as the level increases which indicated that the students have problems with the English language at the higher levels. About 84.3 % reported that they were fairly good in reading in English, however they ranked themselves as being fair or poor when it comes to writing and speaking (table 3). Furthermore, 39.8 % of the students perceived English as a difficult language while 45.8 % considered it to be of medium difficulty (table 4).

Table 2: Students' Achievements In The English Language Courses

Grade	LKI 120		LKI 220		LKI 320		LKI 420	
	No	%	No	%	No	%	No	%
A	3	3.7						
A-	9	11.0	3	3.7			1	1.2
B+	9	11.0	10	12.2	2	2.4		
B	3	3.7	12	14.6	4	4.9	1	1.2
B-	2	2.4	18	22.0	9	11.0		
C+			7	8.5	14	17.1		
C	1	1.2	2	2.4	6	7.3		
C-			1	1.2	1	1.2		

Mori (1999) has shown that learners' beliefs are related to achievement. Erroneous beliefs about language learning lead to less effective language learning strategies. Their convictions of their own effectiveness determine whether they will even try to accomplish the task. Thus, students should know and understand that the ability to learn a foreign language is not innately fixed and can be improved with effort. Student judgments about the difficulty of the language are critical to the development of expectations for and commitment to language learning. The high ranking in reading could be attributed to the fact that reference books for learning at tertiary level are mostly in English. Thus, they are required to be fairly proficient in making sense of the English texts that are constantly being referred. However, since the medium of instruction is in Bahasa Melayu, they do not have ample practice to communicate in English, hence the lack of confidence in their ability to communicate in that language.

Table 3: Proficiency in English

Skills /Levels	Good	Fair	Poor
Written	2 (2.4%)	47 (56.6%)	32 (38.6%)
Spoken	3 (3.6%)	35 (42.2%)	43 (51.8%)
Reading	20(24.1%)	50 (60.2 %)	11 (13.3%)

Attitudes influence the effectiveness of future learning. Wenden (1991) defines attitudes as 'learned motivations, valued beliefs, evaluation, or what one beliefs is acceptable.' Therefore, favorable attitudes tend to influence language learning. The responses in table 4 indicated the students had negative feelings towards the language. About 86% of the students indicated that the English language is a difficult language.

Table 4: Language Difficulty

English to me is;	
A very difficult foreign language.	5 (6.0%)
A difficult language.	33 (39.8%)
A language of medium difficulty.	38 (45.8%)
An easy language.	4 (4.8%)
A very easy language.	1 (1.2%)
The easiest foreign language.	

Table 5 shows the students' responses that relate to the difficulty of language learning. While acknowledging that languages are easier to learn than others (Q1), English was seen as being difficult or of medium difficulty However, the majority of the students believed that they will ultimately speak English well (Q2), possibly because they are prepared to invest the time required to learn and master the language and the belief in their own aptitude and ability to learn the language (Q6). Perhaps their exposure to the language courses at the tertiary level and the relatively good grades they received help to strengthen the beliefs about their own ability in language learning. Consistent with their perceptions of their own ability in reading, speaking and writing, the majority of the students felt that it is easier to read and write in English than to speak and understand it (Q3). Hence, it is

understandable if they should feel self-conscious speaking in front of other people (Q5). This shyness and over-concern with grammar and correct usage will inhibit their communication attempts. Furthermore, the greatest source of anxiety for anyone is to speak the language in front of peers when overly concerned about making errors.

Table 5: Attitudes And Beliefs About Learning And Teaching In English

Statements	Agree	Undecided	Disagree
Some languages are easier to learn than others.	57 (68.7%)	16 (19.3%)	8 (9.6%)
I believe that ultimately I will speak English well.	47 (56.6%)	24 (28.9%)	4 (4.8%)
It is easier to read and write in English than to speak and understand it.	46 (55.4%)	18 (21.7%)	16 (19.3%)
I have English aptitude.	21 (25.3%)	44 (53.0%)	11 (13.3%)
I feel self-conscious speaking English in front of other people.	38 (45.8%)	27 (32.5%)	14 (16.9%)
I have the ability to learn English language successfully.	46 55.4%)	21 (25.3%)	10 (12.0)
I know how to teach science effectively in English	11 (13.2%)	37 (44.6%)	33 (35.7%0
I find it difficult to explain to students in English	49 (59.0%)	17 (20.5%)	13 (15.2%)
I am typically able to answer students' questions in English.	20 (24.1%)	34 (41.0%)	25 (30.1%)
I wonder if I have the necessary skills to teach in English	48 (57.8%)	20 (24.1%)	9 (10.8%)
When teaching science in English, I usually welcome students' questions.	35 (42.2%)	26 (31.3%)	20 (24.1%)
I am confident of my ability to teach science in English	12 14.4%0	45 (54.2%)	24 (28.9%)

Q7 to Q12 assessed their beliefs about their ability to teach science in English. The responses received were not very encouraging. The students were seen to be uncertain of their own ability to teach in English despite their beliefs about their own ability to learn and master the language.

The findings indicate that our students need to be given more exposure in the teaching of science in English in order for them to acquire the confidence and competence to convey the information to their pupils. This lack in confidence does not augur well with the suggestion to teach science and mathematics in English. It is not enough to just learn the language, practice in delivery of content is deemed necessary for a teacher to be sure of his/her own ability.

Vocabulary Comprehension

Table 6 shows the facility values (FV= fraction of the class making the correct choice) for each word and also the commonest distracters (wrong meanings). The mean for the facility value is 0.51. The mean reported in the Johnstone and Selepeng's study (2001) involving 52 pupils of age 15-16 was 0.75 for first language pupils and 0.56 for the second language pupils. It is perhaps not fair to make this comparison. However, the findings suggest that the student teachers do have some problems understanding the non-technical terms and there is evidence of differences between first and second language speakers. Our student teachers obtained a higher FV for two items: limit and composition. Words like 'accumulate,' 'disintegrate,' 'estimate,' 'proportion,' and 'maximum' seemed to pose problems to the students for the percentage of correct responses for these words were very low. Popular distracters were words which 'sound alike' or 'look alike' word. Some distracters had the opposite meaning to the word under test. The findings could indicate that our students are unfamiliar with, and therefore confused by, the different contexts in which English words are used either in science or in everyday purposes. Pollnick and Rutherford (1993) have observed that learning through the medium of English poses problems for students whose mother tongue is not English. Linguistic and psychological effects could explain this mediocre performance of second-language learners.

Table 6: Facilty Values

Word	Facility values	Attractive distracters
Limit	0.92	
Average	0.68	
Accumulate	0.25	Accommodate
Effect	0.64	Effort
Disperse	0.41	Stayed in the ground Chanted and sing
Contrast	0.15	Contour
Composition	0.74	
Source	0.74	
Simultaneous	0.40	Simulate
Consistent	0.54	Constituent
Adjacent	0.50	Opposite each other
Illustrate	0.64	Gloss over the point
Isolate	0.46	Had to find out the cause
Classify	0.90	
Omit	0.37	Admit
Percentage	0.53	Average
Abundant	0.41	Shortage
Disintegrate	0.29	Changes color
Essential	0.42	Efficient, Enough

Estimate	0.26	Garden
Proportion	0.28	Proposal
Efficient	0.58	Sufficient
Reference	0.61	Remnant
Maximum	0.39	Average
Initial	0.49	Group

CONCLUSION

The ability to read, write and speak English clearly and precisely holds a special place in science learning. If students are to learn science, they must develop good language skills. Clear, precise writing demonstrates clear, precise thinking, and science learning requires clear, precise thinking. If we are to succeed in helping students learn science, we must integrate seamlessly English, mathematics and science so that students make the connections. We must also strive for excellence in each of these areas. The findings from this exploratory study showed that our student teachers are not ready and still lack confidence in their ability to teach science in English. Furthermore, the findings also showed that they have problems understanding some of the non-technical vocabulary that are used in science.

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