MATHEMATICS AND SCIENCE IN ENGLISH: TEACHER VOICE

Ambigapathy Pandian
Revathi Ramiah
Universiti Sains Malaysia

ABSTRACT

In January 2003 Malaysia re-adopted the English language as a medium of instruction for science and mathematics in a move to keep abreast with scientific and technological development that is mostly recorded in the English language. To understand how this move changes the dynamics of teaching and learning mathematics and science in the Malaysian classroom, a study was conducted to obtain some feedback from Form One mathematics and science teachers. This paper reports the findings of the study and discusses some of the implications of the study for Malaysian school teachers and students.

Introduction

In January 2003 Malaysia took a bold step in re-adopting the English language as a medium of instruction for science and mathematics. This change in policy was deemed necessary to ensure that Malaysians are able to keep abreast with scientific and technological development that is mostly recorded in the English language. At the same time, this move is envisaged to provide opportunities for students to use the English language and therefore increase their proficiency in the language (Ministry of Education, 2002a).

This change in policy is congruent to significant developments and understandings in second language acquisition that emphasise the role of meaningful, understandable input. In this case, teaching mathematics and science in English provides a rich context for genuine language use and as such serves as a focal point around which oral language and literacy in English can develop (Kesseler & Quinn, 1987). Whilst this move may be seen as desirable and progressive, it is one that changes the dynamics of teaching and learning mathematics and science in the Malaysian classroom.

Teachers and students who have been teaching and learning in Bahasa Melayu are now expected to perform effectively in English, to teach and acquire subject specific knowledge. This is indeed a formidable challenge, seen in the light of concerns voiced about English teachers' proficiency and competency (Pillay, 1998) and the overall declining standards of English (Pillay, 1998; Pandian, 2001). On one hand we have students who must learn mathematics and science content while they are still learning English (McKeon, 1994) and on the other, we have teachers, who themselves have proficiency problems with the new medium of instruction. When the competency of English teachers themselves becomes questionable, what more can we expect of teachers of mathematics and science? These teachers who are not language specialists will have to cope with the double demand of transmitting content as well as language. Will they be able to cover their subject area in an accurate and effective manner?

Therefore to understand the task at hand, it is important for us to understand the perceptions, knowledge, attitudes and readiness of these teachers towards the teaching of mathematics and science in English. As Pandian (2002) asserts, what teachers know and can do, affect all the core tasks of teaching. Furthermore, numerous studies (Gambrell, 1996; Chakravarthy, 1997; Pandian, 1999) have stressed the roles of teachers in influencing the behaviour of students. With this in mind, the purpose of this study is to investigate:

1. The reaction of these teachers to using English as the medium of instruction
2. The problems encountered by these teachers in using English in the classroom
3. Teachers' awareness of the nature of mathematical and scientific discourse
4. Availability of language support systems.

Research Design

This study sought to obtain some feedback from teachers teaching mathematics and science in Form One, in respect to the change in the medium of instruction.

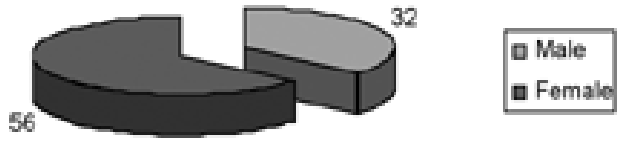

Figure 1: Gender composition of sample population

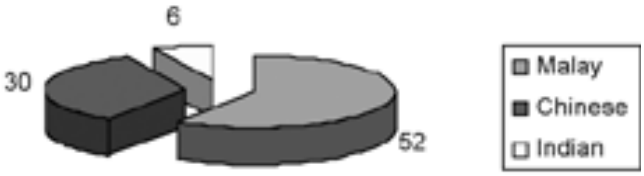

Figure 2: Ethnic composition of sample population

Instruments

The instrument used in this study is a questionnaire that consists of two sections. Section A solicits selected personal background information of subjects and section B comprises twenty-four statements related to teacher views and teaching practices in regard to teaching mathematics and science in English. The choice of answers was given on a Likert scale ranging from 'always' to 'never'.

Semi-structured interviews were also conducted on a smaller sample of respondents for cross-validation purposes.

Figure 1: Gender composition of sample population

Subjects

Eighty-eight teachers currently teaching Mathematics and Science in Form One were invited to participate in the study. These teachers come from sixteen schools (urban, semi-urban and rural) situated in one

district in Perak. The subjects comprised thirty-two (32) male and fifty-six (56) female teachers (see Figure 1). This ratio is quite reflective of actual gender ratios in the teaching profession in Malaysia.

In terms of ethnicity, there were fifty-two (52) Malays, thirty (30) Chinese and six (6) Indians (Figure 2). All eighty-eight subjects have at least a pass in English at the SPM level (equivalent to GCE 'O' levels).

Data Analysis

The subjects' responses were analysed using descriptive statistics. Percentages and frequencies of their responses to the items related to their reaction to the change in the medium of instruction, the problems encountered in terms of the use of English in the classroom, their awareness of scientific and mathematical discourse and the support available to them were calculated. Interview data were qualitatively analysed with initial descriptive codes being assigned to teachers' responses. Related codes were then grouped according to categories and common themes (Bogdan and Biklen, 2003). Illustrative quotations representing each theme are used to support findings of the survey.

Findings

Reaction to the Change in the Medium of Instruction

It was found that 76.1% (Figure 3) of the respondents felt that the move to switch to English as the medium of instruction was timely and necessary. Reasons given were,*" It is important as English is the language of knowledge", "Significant findings in terms of science and technology is in English, therefore there is a need for us to learn maths and science in English*". These respondents cited the fact that scientific and technological knowledge is in English and therefore it is important to acquire the necessary language skills to access this information. However, 22.9% (Figure 3) did not agree with the move and the main reason given was the fact that their students were not proficient in English and as such are not able to follow the lessons in class. One respondent said: "*This move has been implemented in an abrupt manner, the government should think of students and teachers in rural schools – my students cannot cope with English*".

Figure 3: Reaction to change

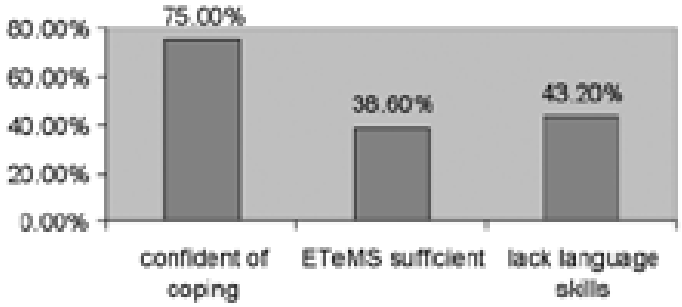

Figure 4: Details of change

Figure 5: Awareness of mathematical and scientific language

When the announcement regarding the policy was made, 46.6 % of the subjects indicated shock and feelings of inadequacy in coping with the task but 75.0% (Figure 4) indicated that they were confident of coping with the change after attending the ETeMS course organised by the Ministry of Education. One respondent explained: "*Of course, I was*

shocked at first, my training has been in BM but after ETeMS I am more confident. Anyway, this is a do or die mission, we have to do it". However, only 38.6% (Figure 4) indicated that the ETeMS course was sufficient to enable them to teach in English and 43.2% (Figure 4) felt that they still lacked the necessary language skills. One respondent mentioned: "*I still need help with my English, I'm afraid of not using correct grammar when I teach*".

It was found that the main problem encountered by teachers was in explaining concepts in English. One teacher in a rural school responded: *"My students cannot understand me when I explain concepts. I need to use Bahasa Melayu. They understand simple instructions in English but it is difficult to make them understand science concepts in English*". Further, 85.2% of the respondents indicated that they had problems explaining concepts in English and 81.8% admitted to using Bahasa Melayu (L1) to give explanations when faced with a breakdown in communication when using English. As one respondent said: "*What am I to do? I have to use BM, if not, how am I to finish the syllabus*".

Problems Encountered in the Classroom

Other problems mentioned by the respondents interviewed were related to the textbook and multimedia courseware provided by the Ministry. The textbook was said to be too brief with inadequate examples and descriptions and thus was not very useful, especially for LEP (Low English Proficiency) students. The multimedia courseware was also said to be unsuitable for LEP students, as they were not able to understand the language used to deliver the content. As one respondent pointed out: "*The CDs are good but my students don't understand so I have to stop and translate for them".*

Awareness of Scientific and Mathematical Discourse

Subjects such as mathematics and science use academic language, which has its own register, syntax, semantic properties and discourse features. These texts are also different from general English as they lack redundancy, are conceptually packed and contain symbols, charts and graphs. It was found that 70.5% (Figure 5) of the respondents indicated that there was a difference between general English and the language of mathematics and science. Additionally, 93.2% of the respondents

indicated that it was the duty of the mathematics or science teacher to teach "the language of math and science" to their students. Finally, 90.9% of the respondents felt that mathematics and science teachers should guide students to understand and use graphics that are normally found in mathematical and scientific texts. However, interviews with the respondents revealed that these teachers are not clear about the linguistic features of their content subject. As one respondent explained: "*I know I have to help them with the language, but I do not know how to do this, we were not taught how in maktab* (college)". Therefore, these teachers are unable to help their students to cope with academic language.

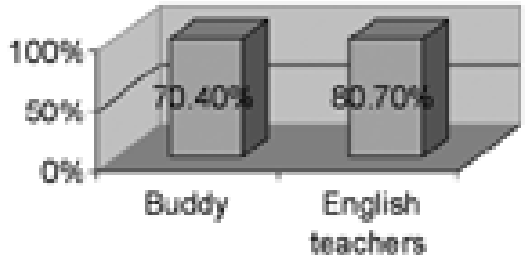

Figure 6: Language support

Availability of Language Support

Apart from the ETeMS course, teachers of mathematics and science are supposed to get language support from the "buddy system" whereby they can get help from identified resource persons in their respective schools. It was found that 70.4% (Figure 6) of the respondents indicated that they have language support from the "Buddy" and "Critical friend" assigned to help them. Interviews with respondents revealed that "help" in this sense meant assistance mainly with vocabulary and grammar. Respondents also indicated that they were unable to use self-learning materials such as the multimedia courseware and grammar books provided by the Ministry due to lack of time.

In terms of language support from the English panel, 80.7% (Figure 6) of the respondents indicated that their English counterparts provided assistance. Interviews with the respondents disclosed that this assistance

was mainly with vocabulary and grammar. It was found that 76.2% of the respondents indicated that they often discussed language problems related to the teaching of mathematics or science with their English counterparts. In addition, 73.8% of the respondents felt that the English Panel is equally responsible in facilitating the change in the medium of instruction. According to the respondents the English Panel contributes by having programmes such as 'Learn a word a day' to improve general proficiency.

In terms of collaborative teaching between the mathematics and science teachers with their English counterparts, 36.4% of the respondents claimed that they do collaborate with their colleagues. However, the interview with respondents revealed that 'collaboration' in this sense meant using their English counterparts as a source of reference when they have difficulties with grammar or vocabulary. As one respondent said: "*Yes, the English teachers help us. We always refer to them for meanings of words that we are not sure of or when we don't know how to say some thing in English*".

It was found that 87.5% of the respondents felt that the multimedia courseware supplied by the Ministry to teach science and mathematics is well planned and effective in terms of content. However, respondents who were interviewed claimed that these materials were more suitable for proficient students. Most respondents maintained that LEP students had trouble following the content presented because of language difficulties.

Summary of Findings and Discussion

The findings of this study reveal that teachers of mathematics and science:

1. are generally perceptive of the change in the medium of instruction,
2. still require some form of sustained programme for their own language development,
3. are prone to using Bahasa Melayu (L1) when faced with difficulty in explaining concepts to their students,
4. require content materials that are more suited for LEP students,
5. are generally aware of scientific and mathematical discourse but are unable to communicate the linguistic elements of this form of discourse to their students, and
6. need intensive language support to help them deal with LEP students.

The purpose of introducing English as the medium of instruction in the teaching and learning of science is mainly to enable students to keep up with the developments in science and technology by making it possible for them to access this information which is mainly available in the English language. Teachers of science and mathematics generally understand this need and are trying to facilitate this move. However, some of these teachers feel that they themselves lack the necessary language skills to teach in English. The ETeMS programme that was introduced by the Ministry is only an urgent interim measure to ensure that these teachers have some basic capacity to use English as the medium of instruction (ETeMS Module, Facilitators Notes, 2002). Therefore, there is obviously a need for sustained content specific language input for the personal language development of these teachers. As these teachers play a important role in modeling good language practices in their classrooms, it then becomes crucial for them to master the language elements of their content subject.

In terms of language problems in the classroom, it is alarming to note that 81.8% of the respondents studied used the L1 (Bahasa Melayu) to explain concepts when students faced problems in understanding these concepts in English. These teachers maintained that students' low English proficiency was the main cause for using Bahasa Melayu in class.

Whilst the Ministry of Education has initiated nation-wide training to address language problems faced by teachers teaching Mathematics and Science in English, the same cannot be said for students who are required to learn Mathematics and Science in English. Apart from the English lessons that are mandatory, these students have not been given extra language support to help them deal with academic content that is in English. The kind of language associated with the learning of mathematics and science is very different from general English. Scientific and mathematical discourses are less contextualised and require high cognitive levels of comprehension. Cummins (1986) suggests that there are two levels of language proficiency: the basic interpersonal communicative skills (BICS) and academic language proficiency (CALP). CALP involves language that is context-reduced and highly demanding cognitively. Cummins points out that in order to perform effectively in mathematics and science, students would need to develop CALP.

Furthermore, one of the reasons for teaching and learning mathematics and science in English was to provide opportunities for

students to engage in the use of the language. Seen in this light, the use of L1 in the classroom is worrying. While it is necessary to some extent to draw upon background understanding and literacy in the first language, it is dangerous to rely on the L1 as a crutch. As Bowering (2003) points out, limited use of Bahasa Melayu in the classroom will be of great benefit in helping students meet the challenge presented by English but total translation as an easy way out defeats the purpose of teaching these subjects in English. Instead these teachers should be exposed to alternative instructional approaches that use a wide range of scaffolding strategies to communicate meaningful input to their students. In this manner the content taught is expressed to suit the proficiency level of their students. Perhaps it is time for these teachers to recognise that subjects such as science should be viewed as an active process of developing ideas, rather than as a static body of already–existing knowledge to be passed on to students (Main & Eggen, 1991).

Other problems mentioned by the teachers are related to the prescribed textbook and the multimedia courseware supplied by the Ministry. Mohan (1990) points out that in many content classes reading a textbook is the main means of studying the content to be learned. Mohan also further explains that students' success in understanding their textbook is dependent on two factors — the content factor and the language factor. Mohan maintains that the language factor, is actually knowledge that is related to the formal organisational structures of different types of texts. This knowledge of text types actually falls within the domain of the language teacher. Thus successful reading of content textbooks is actually dependent on having content knowledge and knowledge of text types. Therefore to facilitate successful reading among LEP students, joint action by the mathematics, science and language teachers is required.

Accordingly, joint action is the kind of collaboration that is required to ensure success in using English as the medium of instruction. In order to help LEP students to overcome linguistic barriers in the course of learning mathematics and science, the language teacher together with the mathematics or science teacher must assess the needs and required language skills of these students (Dale and Cuevas, 1987). Of course this sort of action requires extended time and effort on the part of the teachers and thus may not be practicable in our present school context. However, governing curricula bodies such as the Curriculum Development Center or joint working-committees at district or state levels could look into this suggestion.

Conclusion

The findings of this study suggest that teachers of mathematics and science recognise the need for the change in the medium of instruction and are reacting positively to this change. However, it is apparent that the prevailing language support mechanisms do not meet their needs. Apart from their own language inadequacies, these teachers also face the burden of managing the language development of their students in respect to their content subject. Therefore, it is important that measures are taken to support these teachers in the teaching of science and mathematics in English.

Whilst the Ministry of Education has introduced support programmes such as the "Buddy System", it still needs to be accountable to ensure that these programmes are effective and sustainable. One way of ensuring this much-needed support is by co-ordinating collaborative and co-operative efforts between teachers of mathematics and science with their language counterparts. In this case, the Ministry can make provisions for teaching and administrative relief so that the two groups of teachers can work together to develop teaching strategies and curricula material. The Ministry should also be responsible for providing training workshops and other forms of outside assistance that cannot be obtained through collaboration between teachers.

It is also equally important that pre-service teachers are exposed to collaborative and co-operative efforts. This would entail teacher educators of various disciplines (English, mathematics and science) working together to come up with courses that will help pre-service content and language teachers. Such trans-disciplinary courses will be able to provide mathematics and science teachers with a basic understanding of second language acquisition and academic discourse, whilst language teachers can be sensitised to address academic language needs.

The teaching of science and mathematics in English should not be left to chance. In order to successfully implement the teaching of science and mathematics in English, policy makers and teacher educators must deliberate and focus on the needs of the teachers concerned.

References

Bogdan, R.C. & Biklen, S. K. 2003. *Qualitative Research for Education: An Introduction to Theory and Methods.* Boston: Allyn & Bacon

Bowering, Margaret, 2003. Challenging students with the use of english in the mathematics and science classrooms. Paper presented at the *International Conference2003 Mastering English for Science and Technology (HELP)*, 27-28 September 2003, Kuala Lumpur.

Crandall, J. 1992. Content-centered learning in the United States. *Annual Review of Applied Linguistics*, 13, 111-126.

Cummins, J. 1986. Empowering Minority Students: A framework for intervention. *Harvard Educational Review*, 56,18-36.

Dale, T.C., & Cuevas, G. J. 1987. Integrating Language and Mathematics Learning. *ESL Through Content-Area Instruction.*(Ed) JoAnn Crandall, Prentice Hall,U.S.

Gambrell, L.B. 1996. Creating classroom cultures that foster reading motivation. *The Reading Teacher*, 50: 14-25.

Main, J. & Eggen, P. 1991. *Developing Critical Thinking Through Science*. Midwest Publications, U.S.

McKeon, D. 1994. Language, culture and schooling. In *Educating Second Language Children,* ed. Genesee, F. Cambridge University Press. New York.

Ministry of Education. 2002a. English for Teaching Mathematics and Science (ETeMS) Facilitator's Notes. English Language Teaching Centre, Teacher Education Division.

Ministry of Education. 2002b. Preface. Curriculum Specifications, Science Form One, Curriculum Development Center, Ministry of Education

Mohan. B. A. 1990. LEP students and the Integration of Language and Content: Knowledge Structures and Tasks. Proceedings of the First Research Symposium on Limited English Proficient Student Issues OBEMLA,http:// www.ncbe.gwu edu/ncbepubs/

Pandian, Ambigapathy, 1999. Whither reading in malaysia: confronting reading reluctancy among pre-university students. *Global Literacy – Vision,*

Revision and Vistas in Education, ed. Ambigapathy Pandian, Universiti Putra Malaysia Press, Serdang.

Pandian, Ambigapathy, 2001. English language education in malaysia- past, present and future. *Literacy Matters – Issues for New Times*. ed. Mary Kalantzis & Ambigapathy Pandian, Common Ground Publishing, Australia.

Pandian, Ambigapathy. 2002. Literacy and Learning. *Learning for the Future*, ed. Mary Kalantzis, Gella Varnava-Skoura and Bill Cope, Common Ground Publishing, Australia.

Pillay, H. 1998. Issues in Teaching of English in Malaysia. *The Language Teacher Online*, 22.11, http://www.langue.hyper.chubu.ac