Meeting linguistic challenges in the science classroom: pre-service ESL teachers' strategies

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Meeting linguistic challenges in the science classroom: pre-service ESL teachers’ strategies

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This study explores the perceptions and challenges of Malaysian pre-service teachers teaching science in a second language. A qualitative case study method was used with multiple sources of data to provide insights into the challenges that a group of pre-service teachers faced during their teaching practicum. The pre-service teachers had to overcome various challenges that arose due to factors such as lack of competency in the medium of instruction and the students’ varying levels of language ability. In addressing the challenges faced, they employed various strategies, including code switching and mixing, teacher-student collaboration, rephrasing and re-emphasizing, the use of instructional aids, and the use of analogies. The evidence presented in this study suggests that attention should be given to addressing the English language policy in the science teacher education programme.

Keywords: second language policy; medium of instruction; science teacher education

Introduction

The medium of instruction (MOI) in teaching science has been a controversial issue in Malaysia since the implementation of English as the language of instruction in 2003. Science has been taught in both primary and secondary schools in Malaysia since Malaysian pre-independence. English was used in the English-medium schools, while Malay was used in the national schools. After the passing of the Education Enactment Bill in 1971, English-medium schools were phased out and the Malay language became the MOI in all national schools. However, it was implemented in phases, beginning with the social sciences, such as history and geography. In 1975, science was taught in Malay beginning from Form 1, which is equivalent to Grade 7. The main aim of using the national language was to foster a sense of unity among the diverse ethnic groups in Malaysia since Malaysia is a multiracial country comprising of Malays, Chinese, Indians, Iban, and other minority races. Since then, English was only taught as a separate subject in schools.

After almost 30 years of using the national language for teaching science, the government has reintroduced English as the MOI for science. This action was taken as a response to address the issue of the decline of English language proficiency among Malaysian graduates. The Malaysian government and the private sector expressed concern that many local graduates had failed to secure jobs because of their lack of competence in the English language (Chan & Tan, 2006). In light of the Malaysian Vision 2020 mission, which envisages Malaysia to be a fully developed country by the year 2020, English
is recognized as the language of knowledge and expertise. The policy makers argue that teaching science in English will enable students to gain access to materials related to science, mathematics and technology, which are abundant in English. This will also prepare them to think and generate scientific ideas in English (Zain, 2004). Thus in 2003, science and mathematics were taught in English in Year 1 (Grade 1) at the primary level and Form 1 (Grade 7) in secondary school. In Malaysia, primary school extends from Year 1 (Grade 1) until Year 6 (Grade 6), and secondary school from Form 1 (Grade 7) to Form 5 (Grade 11). The change in the MOI policy has an impact on the teaching and learning process in schools, particularly in science and mathematics.

Prior to 2003, the MOI in teacher education programmes, such as the Bachelor of Science with Education (BScEd) programme, was in Malay. With the sudden change in the policy on the MOI, higher institutions that are involved in science teacher education have made it compulsory for courses related to the teaching and learning of science and mathematics to be taught in the second language (L2), that is, in English, in order to prepare science teachers to be competent in teaching science in L2. However, this was found to be insufficient in preparing pre-service teachers for teaching science or mathematics in English (Saat, 2007). The pre-service teachers were mostly unprepared for integrating English with their subject matter. Some were not proficient in English as their educational experience had largely involved the use of Malay as the MOI. The change in the language policy for mathematics and science has now become especially challenging to pre-service teachers who themselves are grappling with the English language.

In preparing effective science teachers, Yu (2002) rightly points out that second-language pre-service teachers need to be proficient in L2 in addition to acquiring subject content knowledge in the full range of competencies that make up the core skills of a science teacher. Additionally, Lee and Fradd (1998) advocate that L2 teachers need to establish a connection between the nature of science and the language of the students. According to them, to establish the connection with science students, “it requires that teachers have (a) an understanding and appreciation of students’ language and cultural experiences, (b) scientific knowledge and habits of mind, and (c) abilities to relate science to students’ background experiences” (p. 18). In short, science teachers cannot avoid the fact that they are teachers of scientific knowledge, scientific language, and also of the English language. Because of the task they are faced with, a restructuring of science teacher education programmes is called for, especially in the Asia-Pacific region where science is taught in L2 in countries such as Malaysia and Hong Kong.

Literature on teaching science to English language students (e.g., Lee, 2005) focuses on immigrants to English-speaking countries where they are categorized as non-mainstream students. In these situations, L2 learners are immersed in a native language (L1) situation and English proficiency becomes a de facto prerequisite for science teaching (Lee, 2005). There are limited studies (e.g., Alvarez, 1991; Nunan, 2003; Yip, Tsang, & Cheung, 2003) that focus on L2 teachers teaching L2 students. Alvarez (1991) reported that L2 science teachers in the Philippines lacked the necessary cognitive skills to comprehend the science concepts written in L2, which affected their competence in teaching science. The lack of trained and skilled teachers teaching in L2 in Hong Kong has caused the teachers to communicate in L1 even though they were teaching in schools that were categorized as English Medium of Instruction (EMI) schools (Nunan, 2003). Most of the other studies on L2 teachers (e.g., Yanagihara, 2007; Yip & Tsang, 2007; Yip et al., 2003) investigated the effect of using L2 on students’ performance in science and mathematics. Local studies, on the other hand, focus on in-service teachers (e.g., Idris, Loh, Nor, Razak, & Saad, 2007; Ismail, Maarof, & Yamat, 2008), and there is therefore very little information known about
pre-service students’ perceptions of the language policy and their experience in teaching science in L2 during their practicum.

Students from the BScEd programme undergo a teaching practicum for 10–12 weeks at the end of their final year. The practicum allows students to experience teaching under real conditions. Thus, the main aim of this study was to explore the perceptions of the change in the language policy and the challenges of pre-service science teachers currently in the field. Implications of this study will be considered in the review of curriculum of BScEd programme, which is conducted once every five years as part of the quality assurance requirement of the university.

The context and demographics

This is part of a larger study in gaining insights into pre-service science teachers’ perceptions of the change in the MOI policy and the challenges they face in teaching science in L2. This article will only focus on findings based on the qualitative component of this study. A total of 17 pre-service teachers in the BScEd programme from eight secondary schools were involved in the qualitative component of this study. Data was collected from four cohorts of the programme: in 2004, five participants from three schools were involved in the study; six pre-service teachers from two schools in 2005; four participants from two schools in 2006; and two pre-service teachers from one school in 2007. Based on the characteristics of the students enrolled in each school, the schools were categorized as shown in Table 1.

The majority of students in Category A schools were ethnic Malay, and the schools categorized under this category were situated in urban areas. Since most of the students were Malay, they communicated mostly in the Malay language and English was only spoken during English language lessons. Students from Category B schools were mostly Chinese, and spoke Mandarin and other Chinese dialects. Students from both Category A and B schools came from middle socio-economic homes, where most of their parents or guardians worked in the government sector or were involved in small- and medium-sized businesses. Students from Category C schools, on the other hand, were a mix of Malays, Chinese and Indians. English was widely spoken among these students and the majority of them were of high socio-economic status, where most of the students’ parents were professionals and worked in the corporate sector. The school categories, therefore, are shown to be demographically influenced by social and economic factors. Students with

Table 1. Profile of participating schools.

<table>
<thead>
<tr>
<th>Number of schools</th>
<th>Category</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>A: Urban &amp; Malay-speaking</td>
<td>Majority were Malay students, Malay language was widely spoken, Majority came from middle socio-economic status</td>
</tr>
<tr>
<td>1</td>
<td>B: Urban &amp; Mandarin-speaking</td>
<td>Majority were Chinese students, Mandarin and other Chinese dialects were widely spoken, Majority came from middle socio-economic status</td>
</tr>
<tr>
<td>2</td>
<td>C: Urban &amp; English-speaking</td>
<td>Mixed in race, English was widely spoken, Majority came from high socio-economic status</td>
</tr>
</tbody>
</table>
a high socio-economic status had a high proficiency in English, and this was dominant in Category C schools. Students of an average socio-economic status had average or low English proficiency, and this was prominent in Category A and B schools. Categorization of low and high English proficiency was done qualitatively. High English proficiency refers to students who could converse well in English and vice versa for low English proficiency students. There were no students of a low socio-economic status or from rural schools because placement of the pre-service teachers was made within the vicinity of their university, which is located in an urban area.

Table 2 shows the characteristics of the participants in the study by gender, category of school in which they were teaching during the practicum, and their native or first language. Nine pre-service teachers were placed in Category A schools for their teaching practicum, four were placed in Category B schools, and another four were in Category C schools. Only one participant acknowledged that English was his native language, while the other native languages were Malay, Iban, Chinese and Tamil (a language spoken by most Indians). However, the students Kalisah, Madi, Becky, Siew Chin and Darshana spoke English at home as well as in school, and they were confident about teaching science in English.

**Methodological considerations**

Exploring the perceptions, challenges and practices of these pre-service teachers required extended interaction with them, thus interviews and classroom observations were employed as techniques in gathering data. The main purpose of the interviews was to engage in dialogue with the pre-service teachers to elicit their perceptions of teaching science in English and their classroom practices. Interviews were conducted in both English and Malay language, and it was based on an interview protocol that had been developed and agreed upon by both researchers. The interview questions were designed to give an indication of a pre-service teacher’s perception of the change in the language policy, the challenges that they encountered during practicum, and strategies they employed in addressing the challenges. The protocol served as a guide for both researchers.

<table>
<thead>
<tr>
<th>Year</th>
<th>Name*</th>
<th>Gender</th>
<th>Ethnicity</th>
<th>Category of school</th>
<th>First language (L1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>Noel</td>
<td>Male</td>
<td>Indian</td>
<td>A</td>
<td>English</td>
</tr>
<tr>
<td></td>
<td>Kalisah</td>
<td>Female</td>
<td>Malay</td>
<td>A</td>
<td>Malay</td>
</tr>
<tr>
<td></td>
<td>Oliya</td>
<td>Female</td>
<td>Malay</td>
<td>A</td>
<td>Malay</td>
</tr>
<tr>
<td></td>
<td>Ema</td>
<td>Female</td>
<td>Malay</td>
<td>A</td>
<td>Malay</td>
</tr>
<tr>
<td></td>
<td>Haikal</td>
<td>Male</td>
<td>Malay</td>
<td>A</td>
<td>Malay</td>
</tr>
<tr>
<td>2005</td>
<td>Ika</td>
<td>Female</td>
<td>Malay</td>
<td>A</td>
<td>Malay</td>
</tr>
<tr>
<td></td>
<td>Myra</td>
<td>Female</td>
<td>Malay</td>
<td>A</td>
<td>Malay</td>
</tr>
<tr>
<td></td>
<td>Baiduri</td>
<td>Female</td>
<td>Malay</td>
<td>A</td>
<td>Malay</td>
</tr>
<tr>
<td></td>
<td>Madi</td>
<td>Female</td>
<td>Malay</td>
<td>A</td>
<td>Malay</td>
</tr>
<tr>
<td>2006</td>
<td>Timah</td>
<td>Female</td>
<td>Malay</td>
<td>C</td>
<td>Malay</td>
</tr>
<tr>
<td></td>
<td>Shadia</td>
<td>Female</td>
<td>Malay</td>
<td>C</td>
<td>Malay</td>
</tr>
<tr>
<td></td>
<td>Wendy</td>
<td>Female</td>
<td>Iban</td>
<td>B</td>
<td>Iban</td>
</tr>
<tr>
<td></td>
<td>Becky</td>
<td>Female</td>
<td>Iban</td>
<td>B</td>
<td>Iban</td>
</tr>
<tr>
<td></td>
<td>Siew Chin</td>
<td>Female</td>
<td>Chinese</td>
<td>B</td>
<td>Chinese</td>
</tr>
<tr>
<td></td>
<td>Kym</td>
<td>Female</td>
<td>Chinese</td>
<td>B</td>
<td>Chinese</td>
</tr>
<tr>
<td>2007</td>
<td>Kar Mun</td>
<td>Female</td>
<td>Chinese</td>
<td>C</td>
<td>Chinese</td>
</tr>
<tr>
<td></td>
<td>Darshana</td>
<td>Female</td>
<td>Indian</td>
<td>C</td>
<td>Tamil</td>
</tr>
</tbody>
</table>

*Participants’ names reported are pseudonyms*
so that they would focus on the same issues. Some of the questions asked were: “How do you feel about the change in the medium of instruction for science?”, “Do you encounter any problems in conducting your science lesson in English?”, and “What strategies do you find suitable in teaching science in English?” Interviews lasted between 30–45 minutes and were conducted after the science lesson.

A total of 64 classroom observations were made while the pre-service teachers were interacting with their students. This technique gave the researchers a first-hand encounter with the phenomenon of interest (Merriam, 1998). The present study employed the method of non-participant observation. The role of the researchers was to directly observe in the research setting and to note relevant phenomena. Observations were constantly analysed, for example, “What was going on here?” (Glesne & Peshkin, 1992). Apart from direct observations, the teaching and learning sessions were also video-recorded. Some examples of behaviours that were recorded included students frowning and scratching their heads; these behaviours indicated that they were confused during the lesson.

Sampling was done using purposive sampling. According to Patton (1990), purposive sampling is able to yield information-rich cases. In this study, the main criterion for selecting these participants was their ability to express themselves freely while being audiotaped. They were able to provide in-depth insight of the challenges that they faced and the strategies they employed. Data reached saturation where no new categories emerged after the 15th participant. However, two more participants from the fourth cohort were interviewed and observed just to ensure that no new theme would emerge.

All the audio and video tapes were transcribed and analysed using the constant comparative method of analysis (Merriam, 1998; Strauss & Corbin, 1990). Basically, this method of analysis involves comparing of data with another to determine similarities and grouping them in one dimension. The dimension was then coded tentatively. These codes were then laid in a matrix in search of patterns, which were then further reviewed for emerging themes that represented the different types of challenges and the various strategies that the pre-service teachers employed. The categories were gradually refined until consensus was reached among the researchers to ensure trustworthiness of the findings (Merriam, 1998).

**View on the change of policy**

The change in the language policy created mixed reactions among the pre-service teachers. The views varied from being receptive to disappointment. Eight of the participants interviewed were very receptive to the change in the policy of changing the MOI of science from Malay to English. In fact, two of them preferred teaching as well as learning science in English. They felt more confident teaching in English. According to Kalisah, science terminologies are easier to comprehend in English than in Malay:

Because sometimes, the English terminology...if translated to Malay, it’s confusing. For example, *jisim* (mass) with *jirim* (matter) is almost the same. If it’s in English it’s entirely different...matter and mass. So, it is easier.

However, a few of the pre-service teachers felt that the change was too abrupt for teachers as well as students, as noted by Ema:

Actually, the policy is good. However it is too abrupt especially for the Form 1 students. Teaching of science in English should start with Year 1 students. When they changed it, there are students who can’t even understand English, they can’t even read nor write in English. So, it’s difficult for them to understand our lessons in English.

Ema’s opinion was shared by Noel and Oliya, who felt that students at Form 1 level should have learned science in English from the primary level. They argued,
The students [Form 1] would already have a language of their own, which they are used to. So, when you start teaching them in English, a lot of students here doesn’t understand actually. Haikal shared the same view and believed that this could be one of the factors for the poor achievement in science among his students.

Kym felt that the change should be made gradually to give time for teachers and pre-service teachers to adapt to the change. She is Chinese-educated and had worked hard preparing herself to teach in Malay. Kym expressed her disappointment:

My two years in higher institution, I have prepared myself to teach science in Malay. I mixed with Malay friends, talked with them in Malay, gather materials in Malay. I felt confident to teach in the Malay language. Suddenly, when they change the medium of instruction to English, I felt so frustrated. All my effort was wasted.

Ika and Siew Chin, on the other hand, had reservations about the change in the policy. They felt that the change in the MOI to English was not suitable for science subjects. In their opinion, the change in the policy had affected students’ learning in science. Students need to undertake dual tasks – that is, first to understand the English language, and second, to understand the science content.

The experience of teaching science in a second language

Two main themes emerged from analysis of data, namely, (1) a mismatch between the English proficiency of teachers and students, and (2) low English proficiency pre-service teachers teaching low English proficiency learners. The first theme refers to English-proficient pre-service teachers teaching science in L2 to low English proficiency learners, and vice versa. In the case of pre-service teachers who were proficient in English teaching students in Category A schools, where most of the students were grappling with the English language, there was difficulty in making the students understand their lessons. As Noel explained,

If I started teaching in English, I noticed students are just not interested. Something I’m teaching that they cannot understand.

He added,

English and learning science in English are two different things. I think they are eager to learn English. I guess they see its importance but because English is already hard enough for them, you throw in another subject in English which is equally as difficult, can be quite overwhelming for them.

Kalisah supported Noel and she was frustrated that her students were reluctant to even read aloud because they were so afraid of making mistakes. This situation mirrors findings of studies reported in the USA, Canada and Australia, of English language learners having difficulty in subject content in L2. These students were not able to engage with the subject content as they had a limited command of the MOI (e.g., McGlynn & Martin, 2009; Probyn, 2009). English language learners, for example in the USA, perform poorly in science in international and national studies, and show persistent gaps between mainstream and non-mainstream students (Lee, 2005).

The scenario for pre-service teachers teaching in Category C schools was the opposite. Most of the students came from high socio-economic status and were well-versed in English. Only one of the four pre-service teachers in this school category was proficient in English, and she did not have much of a problem in teaching science in L2. Pre-service teachers with low English proficiency teaching in these schools admitted that the students made fun of their teaching. For example, Timah’s main problem was that she was not able
to pronounce English words fluently. Malay was her first language and the Malay language as the medium of instruction throughout her education, ever since she was in primary school. English was learnt only as a subject. The following video transcript illustrates an episode where,

After the experiment, Timah tried to explain the concept of conduction. Instead of pronouncing “conduction” she uttered “konduksyen”, which resembled the Malay pronunciation. A group of students burst into laughter and imitated Timah’s pronunciation. Timah blushed and struggled to correct herself.

Timah’s students laughed and teased her whenever she pronounced English scientific terms with a thick Malay accent.

The pre-service teachers also had very limited vocabulary, as Ema noted,

My vocabulary is rather limited. Moreover, we seldom use these scientific terms in our daily communication, for example, isotope, trachea, and mass. I began to learn English language seriously not until during my final year in the university.

In Ema’s case, she lacked the necessary cognitive skills to read and understand the scientific terminologies and its concepts, which were written in L2 (Alvarez, 1991). The use of unfamiliar scientific terminologies, coupled with her limited vocabulary in explaining the scientific concepts, posed a big challenge in teaching science in a foreign language. The students of Ema and her peers, who were inexperienced in teaching using a language in which they were not able to communicate fluently and freely, also faced difficulties in comprehending their science lessons.

The second theme that was prevalent was of low English proficiency pre-service teachers teaching low English proficiency learners. This situation was prominent in Category A schools. In this scenario, the pre-service teachers did not feel the stress of teaching science in English since the students themselves were not proficient in the language. However, in upholding the language policy as well as part of their assessment in their teaching practicum, they had to teach science in English. Based on the classroom observations, they struggled to deliver their lessons in English but managed to communicate slowly with their students in English. Madi noted that her students could not understand her teaching. The basic problem, she felt, was that her students did not understand English. This sentiment was also shared by Oliya. According to her, “The students have a lot of problems. They can’t understand even simple words such as ‘stir’”. Ika also found that her students could not understand her lesson in English. They could not respond in English verbally or in writing, such as in answering the exercises and test questions: “They know the answer but they could not construct the sentences in English.” She added that whenever she started teaching in English, the students negotiated with her to teach in Malay. She admitted that teaching science in English was difficult with these students while she was also struggling with the language.

The situation was similar in Category B schools. Instead of Malay, students in these schools spoke Mandarin and other Chinese dialects. There were four pre-service teachers teaching in these schools and all of them could speak Chinese. All four of them faced the same challenges as their peers teaching in Category A schools.

Based on the scenarios in Category A, B and C schools, the challenges were influenced by the English language proficiency of the pre-service teachers as well as the proficiency of the students. There was a mismatch between language proficiency of the pre-service teachers and the students. Low English proficiency students had difficulty in understanding science lessons taught by high and average proficiency pre-service teachers. The students could not understand the L2 used in the science lessons. Students of high English
proficiency, on the other hand, could not comprehend lessons taught by low proficiency pre-service teachers. The pre-service teachers could not articulate their thoughts in explaining the science concepts and could not communicate freely, thus impeding learning.

How did the pre-service teachers cope?
Several coping strategies were employed in addressing the challenges the pre-service teachers’ experienced. One common strategy in cases where pre-service teachers were teaching low English proficiency students was code-switching and code-mixing. Ayeomoni (2006) provides the following definitions:

Code-switching is the mixing of words, phrases and sentences from two distinct grammatical (sub) systems across sentence boundaries within the same speech event. Code-mixing is the embedding of various linguistic units such as affixes (bound morphemes), words (unbound morphemes), phrases and clauses from a co-operative activity where the participants, in order to infer what is intended, must reconcile what they hear with what they understand. (p. 2)

Ferguson (2009) regards code-switching as a communicative and pedagogic resource, and it is perhaps the most common feature in a bilingual education context. Code-switching and code-mixing were rampant in the present study. To illustrate, in the case of Siew Chin who taught in a Category B school, she believed,

When it’s about understanding certain concepts, I did not use 100% English. For me, I would rather have them understand the concept. So I’ll try to explain, even in Chinese, if necessary, for the sake of those who were struggling (with English).

Noel and Madi also employed a similar strategy. Madi explained,

I had to “put back” the Malay [terminology] and translate totally in Malay language. However, this is really time-consuming.

Noel reiterated that he had to say one sentence and then translate it wholly into Malay. To him, his students seemed to understand better when he explained in Malay.

Like most of the pre-service teachers, Siew Chin, Noel and Madi believed that it was more important for their students to understand the science rather than the language. Language is the medium for imparting scientific knowledge as well as procedural knowledge, which is also an integral part of science learning. If the students do not understand the language, most of the pre-service teachers would switch to the language the students were most familiar with. This practice has created a clash between classroom practice and the policies imposed by the authorities, which has led to many conflicts and tensions (Wei & Martin, 2009).

According to Wei and Martin (2009), code-switching in the community context is regarded as acceptable, but in the classroom context it is seen as inappropriate or unacceptable. Teachers who switch to the learners’ mother tongue in their teaching have been accused of being “guilty of sabotaging the (language) policy” (Martin, 2005, p. 76). One of the reasons that the Malaysian government reintroduced the language policy is to enable learners to benefit from the abundant scientific materials and references available in English and also to enhance their second language acquisition. On the other hand, as Probyn (2009) and McGlynn and Martin (2009) argue, code-switching is inevitable for increasing students’ learning. This finding concurs with Yip, Tsang and Cheung’s (2003) study, which was conducted in Hong Kong. Teachers in Hong Kong had to use a mixed mode of instruction (Chinese and English) in teaching science, where the MOI is a second language regardless of the students’ abilities. Cleghorn, Mtetwa, Dube and Munetsi (1998) also found that a number of teachers admitted that their language-use behaviour was
largely purposeful; the teachers felt that their students needed to hear as much of the mother tongue as possible.

Besides code-switching, the pre-service teachers had to use simple English to deliver their lessons. As Noel explained, “I need to convey it in easier and a simpler way without using too complicated words.” He added that he would re-emphasize, “I will read it out to them and after that they repeated after me.” The pre-service teachers had to rephrase and re-emphasize in order to make their students understand. This was done when their students looked confused, as Siew Chin experienced:

If I say something and they looked blur, and they say they don’t understand. What I’ll try to do is to rephrase my sentences.

Participants teaching in Category C schools employed a strategy that benefited both the pre-service teachers and students. Instead of being intimidated by the students, the pre-service teachers collaborated with them. Students who corrected the teacher’s spelling errors, grammatical mistakes, or incorrect pronunciation during class were awarded merit points. This strategy was employed by Kar Mun, Kym and Timah. In one of the classroom observations, Kar Mun was teaching the topic on digestion. She was explaining that excess water was reabsorbed from the large intestine. In her electronic presentation slides, the word “excess” was spelt “access”. Realizing the mistake, one of her students corrected her. Kar Mun responded positively to the remark. She made the other students check the dictionary for the correct spelling before making any correction on the slides. She then awarded a merit point to the student who had corrected her. As for Timah, although her students initially laughed at her because of her language handicap, she employed the same strategy as Kar Mun in the latter part of her teaching practicum. The strategy worked, and she later expressed that she did not feel threatened when she was being corrected by her students. “If they corrected me, I say, ‘Thanks!’ I know that I’m still learning.” Kar Mun, Kym and Timah all treated threats as opportunities, and this created a win-win situation between the pre-service teachers and the students.

During their teaching practicum, all pre-service teachers were required to prepare lesson plans. Becky, Kym and Madi prepared their lesson plans with notes and scripts to help them. The notes and scripts were evidenced in their lesson plans. These notes included some reminders on certain terminology and vocabulary, English words that might be helpful in their class teaching, and examples that they would use in their teaching. Some practically prepared teaching scripts embedded in their lesson plans. Kym said the scripts helped her in times where she forgot what to say during her lessons. Ema added that she memorized the scripts so that she would become fluent in her lesson delivery. In preparing the lesson plans, some participants also referred to the teaching scripts prepared by the Ministry of Education. Since the implementation of English as the MOI for science in 2003, the Ministry of Education had prepared teaching scripts for science teachers. These teaching scripts include topics to be taught, suggested activities to be carried out, the sequence of the lessons, and dialogues that might take place in the lessons. Most of the pre-service teachers referred to the scripts to get teaching ideas for their lessons and the correct scientific terminology to use. Based on observations during their teaching, some followed the scripts in their lesson plans closely and managed to appear confident.

The pre-service teachers also brought teaching aids to class. For example, Shadia and Ika brought e-dictionaries, software, and downloaded relevant websites to assist them in pronunciation. According to them, these aids helped them in pronunciation and were used in teaching, as explained by Shadia:
There’s one student asked me, is it i-sofagas or iso-fagas [for oesophagus]? So, what I did... I run the software that I downloaded from the internet, I clicked on the word oesophagus, and the programme pronounced the word followed by some explanation of oesophagus. Isn’t that good?

Shadia felt that this strategy was helpful. She argued that sometimes her students distrusted her. Using the programme during her lesson made her students accept the pronunciation without much argument.

Besides using programmes downloaded from the Internet, the pre-service teachers also used teaching courseware, particularly the ones provided by the Ministry of Education. As Kym explained, “The courseware has sound, then we can learn the terminologies and pronunciation.” According to these pre-service teachers, the courseware provided good explanations on the concepts. All they needed to do was to re-emphasize what was explained in the courseware.

Some pre-service teachers also used other teaching aids, such as realia. Kym’s mentor, who was the senior science teacher in her school, described Kym as the teacher with the “magic bag”. She prepared a lot of realia made from readily available materials, such as newspapers, unused calendars, drinking bottles and other materials. She found that it was helpful in explaining the scientific concepts. “I’m not good in explaining. So, I showed them the things, at least they can understand.” She also used numerous hands-on activities to engage her students in their learning rather than explaining to them. Kym tried to minimize talking by using realia and hands-on activities since she was not confident explaining scientific information in L2.

Another strategy that the pre-service teachers employed was the use of analogies. According to Siew Chin, although the analogy she used was simple and related to their daily lives, it seemed that the analogy made sense to them. She recalled:

Like the other day, they were asking me this, they just don’t understand why enzyme, when put to the substrate, (the substrate) becomes simple molecules. They just cannot get it. So, what I did was, I tried to come up with a very simple analogy. But, actually it doesn’t quite make sense, but I came up with something like, “You know the porridge when put some kicap [soy sauce] on it, and then it comes up as something else. So, amylase, the enzyme, is a chemical substance, almost like the kicap that you put on the porridge, so in the end you get a different taste of the porridge.” Just things like that. I tried to use simple daily examples, just to illustrate my point.

By providing analogies they could relate to, such as porridge, the students could imagine the function and mechanism of enzymes on the substrate. Analogies are a widely used tool in science teaching and they provide the students with some form of visualization (e.g., Thiele & Treagust, 1994).

**Discussion and conclusions**

The pre-service teachers had no alternative but to follow the language policy. Although some felt frustrated and many faced various challenges in teaching science in L2 during their teaching practicum, they had to overcome those challenges. Most of the challenges were attributed to their level of competency in L2 and their students’ level of proficiency. This concurs with findings by Yore (2003), Yip et al. (2003), and Lee and Fradd (1998) who found that interactions between teacher and students during teaching and learning depend on the teacher’s ability to communicate fluently and the learners’ language proficiency. If teachers are not proficient in the MOI, then explaining scientific concepts, being the facilitator in inquiry-based investigations, or engaging in high level questioning is problematic. On the other hand, if the students’ language proficiency is low, students
cannot comprehend the scientific concepts. As emphasized by Vygotsky (1986), the most important factor in the transformation of thinking from others, such as teachers, to self-regulation is language. When students are unable to construct and internalize information because of a language barrier, it impedes learning, resulting in students losing interest and motivation (Cummins, 1980; Yip et al., 2003; Yip & Tsang, 2007).

Past studies (e.g., Cleghorn et al., 1998; Laplante, 1997) have shown that L2 science teachers face a dual task when teaching science in L2 because they are actually teaching the language as well as the science content. This challenge is more complicated in situations dealing with pre-service teachers teaching science in L2. As shown in the present study, the pre-service teachers were grappling with teaching science content using appropriate teaching methods, such as inquiry-based instruction, coupled with teaching in L2. As some of them admitted, they tended to focus too much on the language of instruction and neglect the science. Balancing the two was difficult (Buxton, Lee, & Santau, 2008).

In addition, science has its own language and learning science is like learning a new language (Wellington & Osborne, 2001; Yip & Tsang, 2007). Many scientific terms have a different meaning in our daily lives. For example, many Malaysian students would associate “proton” to a brand of a car in Malaysia rather than one of the subatomic particles of an atom, and “circuit” to the F1 circuit located in Sepang. To further complicate the matter, many scientific terms are only specific to science, and these words are not applicable in the students’ daily lives and are, therefore, foreign to them. Pre-service teachers need to be trained in making the unfamiliar something that students can relate to.

This study offers some implications for the science teacher education programme. The majority of pre-service teachers felt that they were not competent to teach science in the new MOI. A study by Idris et al. (2007) also found that in-service teachers felt that their pre-service training did not enhance their readiness to teach science in English. It is important to understand that the pre-service teachers experienced a sudden change in the MOI from Malay to English. Most of the pre-service teachers had only been exposed to learning science in English during their tertiary education. One of the components that might be lacking in the structure of the present science teacher education programme is the competency in the “language for teaching science”. In addition, Clarkson (2007) highlighted that conceptual development in mathematics and science is dependent on an appropriate understanding and the use of the academic language of the subject. This academic language needs to be taught formally.

Science teacher education programmes could include various strategies for science language learning. These strategies include reading science texts with comprehension, writing in science, and using science talks (Rosebery & Warren, 2008; Wellington & Osborne, 2001). The pre-service teachers also expressed the need for more practice in enhancing their proficiency in L2, particularly for more micro teaching, real-life school experiences prior to their teaching practicum, and additional courses on English, such as English for specific purposes.

The findings of this study also point to the need for science teacher education to address multilingual issues and training in dealing with linguistics differences (Buxton et al., 2008; Yu, 2002). In a multiracial country, such as Malaysia, there is a need for pre-service teachers to have greater exposure and practice in responsive teaching to linguistically diverse students, in addition to being competent in teaching the subject matter and in integrating English in science. They should be trained to take into account their students’ native language and their level of L2 competency in order to make their students’ learning meaningful.
These issues need to be addressed in the science teacher education programme. It is evident that effective instruction lies with a good command of the language of instruction as well as the learners’ first language and with competency in the scientific content being taught. This is crucial for effective science teacher development in Malaysia as well as in the Asian region, where the English education policy has changed in response to globalization (Butler, 2004). In order to successfully implement the new language policy, it is particularly important to have highly trained teaching staff. Policy makers and science teacher educators must find ways to help these pre-service teachers to acquire the necessary skills for teaching science effectively.

References


