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In January 2003, Malaysia re-adopted the English language as a medium of instruction for science and mathematics. This change in the medium of instruction brings with it challenges of its own. What does it mean to 'do' science in the Malaysian context and to do so in English? How does the change in the medium of instruction from Bahasa Malaysia to English impinge upon the instructional and literacy practices of teachers and learners? What kinds of changes are required of the communities and stakeholders involved in the teaching of science? This article will address these questions by critiquing some dominant assumptions behind the literacy practices of 'doing' science in the Malaysian context based upon the findings of a qualitative case study conducted to investigate how two teachers working in diverse and different contexts in Malaysian schools cope with the new medium of instruction.

Keywords: Discourses, literacy practices, qualitative case-study, Teaching Science in English as a medium of instruction, learning and teaching

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Pada tahun 2003, kerajaan Malaysia telah memperkenalkan semula Bahasa Inggeris sebagai bahasa perantaraan bagi pengajaran mata pelajaran Sains dan Matematik. Perubahan bahasa pengajaran ini telah membangkitkan pelbagai cabaran. Apakah maksud belajar Sains dalam Bahasa Inggeris? Bagaimanakah perubahan bahasa pengajaran daripada Bahasa Malaysia ke Bahasa Inggeris memberi kesan kepada amalan literasi bagi para pengajar dan pelajar? Apakah perubahan yang diperlukan daripada komuniti yang terlibat dalam pengajaran Sains? Makalah ini meneliti persoalan-persoalan ini melalui kritikan terhadap andaian-andaian dominan mengenai pembelajaran Sains dalam konteks Malaysia. Kritikan ini dilakukan melalui satu kajian kes kualitatif untuk meneliti bagaimana dua orang pengajar yang bertugas dalam konteks yang berlainan di sekolah masing-masing menyesuaikan diri dan menyahut cabaran yang timbul akibat perubahan bahasa perantaraan daripada bahasa Malaysia kepada bahasa Inggeris bagi pengajaran Sains.

Kata kunci: Wacana, amalan literasi, pengajian kes kualitatif, Pengajaran Sains dalam perantaraan B. Inggeris, pembelajaran dan pengajaran

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What is Science?

Ask any thirteen year-old Malaysian this question and this is the answer that you will probably get:

“Science is the systematic study of nature and how it affects us and our environment.”

Science Form One, Volume 1 (p. 2)

But what does science mean for the Malaysian learner? What is science for the learner who comes from a urban school in Kuala Kangsar or from a semi-urban school in Kamunting , Taiping, where the school population is mostly made-up of learners who come from working class homes, or for the privileged urban learner whose school is situated in an exclusive area in Petaling Jaya or what about the Murut learner located in the most remote areas of Sabah? These diverse contexts speak to us that there is no ‘one’ Malaysian learner but rather multiple types of learners with varying needs. What does it mean to teach ‘science’ to all these learners in the Malaysian context and to do so in English?

Why do we ask these questions? The move to teach science in English prompts us to question what science education is all about in the Malaysian context before we can even talk about what it means to teach science in English, in Malaysia. There are many questions that need to be answered: What are the aims of the Malaysian science curriculum? How are these aims translated in literacy practices of teachers and learners? What are the kinds of supporting structures that facilitate or hinder these aspirations?

In order for us to explore what it means to engage in science in English for Malaysian learners, it is necessary for us to address these questions. To do so, we would need to peel away the layers of so called ‘truths’ that have been constructed to allow common-sense notions of what it means to do science in the Malaysian context, to come into being. The purpose of this paper is to explore some of these notions in relation to teaching and learning secondary school science (specifically Forms One and Two) in English. In order to do so, we will examine curricular documents, namely the Curriculum Specifications for Science Form One and we will draw on some strands from this examination to understand the teaching practices of two teachers who is part of an ongoing case-study in a school in Perak, Perak being one of the states in West Coast Peninsula Malaysia.

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Current thinking in science education is moving away from a behavioural, cognitive view (Gee, 2004; Aikenhead, 2000 and Lemke, 1999) and is looking towards a paradigm that is more inclusive of the diversity that exists in our life-worlds. Science is increasingly seen as a process of meaning-making and countries such as the United States, Canada, Australia and South Africa

(Aikenhead, 2000) are implementing science teaching approaches that take into account the learners' cultural and linguistic bearings. As such, the science classroom is seen as an interactive and multidiscursive space, one that allows the teacher and students to work together in creating knowledge.

When science is viewed as a discursive meaning-making process, learners are invited to use their personal knowledge to make sense of new information that is introduced. This interactive view of science teaching is significant to understanding second language learning that emphasises the role of meaningful understandable input (Krashen, 1982). It is this very nature of meaning-making in science which is desirable, as it allows space for the development of oral language and literacy (Kessler and Quinn, 1987). Thus, the enhancement of language and literacy is seen as a by-product coming from the interactions that take place during the learning and teaching of science. This obviously points to a need for a particular kind of pedagogy in the classroom - one that will allow learners to interact and engage in the joint-construction of scientific knowledge with the teacher.

In order to create space for an interactive pedagogy, the Malaysian science teacher has to mediate, at least for now, at two different levels. She has to help learners to bridge the differences between their theories of science and the study of formal school science (the subculture of western science), and to assist students with the language switch from Bahasa Malaysia to English. At this juncture, it is important for us to understand that the English language used in the science classroom is different from the everyday English language that is learnt in the language classroom. This is because the features and function of science discourse include formulating hypotheses, designing investigations, collecting and interpreting data, drawing conclusions and communicating results (Chamot and O'Malley, 1994). Additionally, the language of science employs non-technical terms that have meanings unique to scientific contexts, for example words such as matter, force, energy (Hart and Lee, 2003). Therefore learning science in English is a formidable challenge for science learners who are still in the process of learning English. See in this light, science teachers would need to be the "raconteurs of science" (Wellington and Osborne, 2001, cited in Moses, 2005) – meaning that the teacher is the one who makes scientific discourse accessible to learners who are being socialised into the science community. However, the problem in this situation is that most of the teachers themselves lack proficiency in the language. Further, they have not been trained to deal with language issues in the teaching and learning of science including the specialist terms in science, the genres of science such as expository texts. At the same time, t is important for us to understand that whilst the teacher has some power in the classroom to select instructional strategies, they are still subject to external influences that decide what they do in the classroom.

This study is informed by understandings that see language and knowledge as socially constructed, that doing science through the medium of language is dependent on a community of people who share particular beliefs and values (Lemke, 1990). As such, the classroom practices and the beliefs and values of the science teacher are not just determined by her but are brought into being by external influences such as ministry imperatives, examination bodies, parental and societal expectations and learners' desires. It is within this complex matrix that teaching and learning takes place. This study draws from a critical post-modern framework to interpret the complexity of the situation at hand. The underlying assumptions of this study are that the challenges of teaching science in English are layered and interpenetrating and these layers are related to each other and to social, cultural and political issues, of which the teacher is but a single stakeholder. But often, being weaker within the institution of schools, she tends to be held responsible for the problems of teaching.

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The work reported in this article is based on selected findings from a longitudinal case study (the principal writer's Ph.D research project) that focuses on four teachers who are teaching science at Form One and Form Two levels in secondary schools situated in varying locales in Perak. However, this paper will focus only on two teachers, Norah[1] and Elsa, both who are seen as entry points into the Malaysian science education system. Norah has about eight years of teaching experience and teaches at an urban 'elite' school. She is able to converse in English. Although educated in the Malay medium, Norah has been proactive in trying to improve her English proficiency. She is enthusiastic about the ETeMS[2] courses and tries her very best to converse in English with her colleagues in school. Elsa teaches in a school situated at the periphery of a small town. Her students come mainly from surrounding rural areas and are generally from very low social economic backgrounds. She has twenty two years of teaching experience and was educated at a missionary school and is fluent in English.

The methodology employed in exploring Norah's and Eve's discursive spaces was Narrative Inquiry, which is both a process and a product-based methodology. Researching and writing in this form, enables the researchers to create a dialogic genre in which knowledge is created and (re)presented at the same time, as suggested and demonstrated by Ellis and Bochner (2002). Narrative Inquiry is not new as educational researchers have used it to research teacher lives, teacher thinking and the curriculum in general (e.g., Carter, 1993; Clandinin and Connelly, 1988,1991; Elbaz, 1991).

The main method of data collection was interviews. The principal researcher/writer audio-taped interview sessions with Norah and Elsa. These sessions were not structured; instead the researcher chose to be a fellow ‘traveller’ (Kvale, 1996) and invited Norah and Elsa to tell her stories of and around their teaching lives and science teaching. This was done by putting to them open-ended questions which allowed them to construct answers narratively. The interviews were supplemented with classroom observations of two classes taught by Norah and one by Elsa over a period of one year for Norah and eight months for Elsa. Observations were done for two lessons a week for both classes. The researcher also observed Norah and Elsa in their interactions with other members of the school community – this included panel meetings, staff meetings and extra activities carried out with students. The reasons for doing so, was to look for a wider context in order to understand Norah’s perspective (Munro, 1998). The researcher took field notes during observation with a focus on recording what was not possible to be caught in the audio mode. Other ethnographic techniques were also employed, such as the collection of personal and school documents. Alongside the collection of these artefacts and recordings, the researcher also maintained her own journal to record her personal reflections. Efforts were also undertaken to interview Norah’s and Elsa’s students and members of the school community. In fact, the researcher was able to establish correspondence through the use of ‘dialogue journals’ with some of Norah’s students to understand their perspectives of Norah’s teaching. However, it was not possible to do the same with Elsa’s students as they were not inclined to doing ‘extra’ writing; instead they chose to speak about their teacher. The principal researcher recorded notes of their thoughts through informal chats.

In this article, we will only be focusing on a few aspects given the constraints of an article of this nature. Therefore, it is only right for us to claim that we are not attempting to be exhaustive in this discussion, but rather what we are offering are partial glimpses into scenarios of discursive interactions around science teaching in English.

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Norah’s school is considered one of the premier schools in the district. Every year-end, parents throng the principal’s office to get their daughters into the school. The school culture is attuned to academic achievement and the teachers and students of the school are explicitly reminded that the school’s priority is to achieve excellent academic results.

Norah teaches five classes of science – a mixture of Form One and Form Two classes. The classes selected for the study were one Form One class and another class in Form Two. The Form One class consists of 32 girls who have been streamed based on their UPSR exam. All of them have got the maximum number of A’s – five. A majority of these girls come from middle-class homes. Most of them are able to speak English spontaneously but there are a few who are not able to converse proficiently in English. The Form Two class consists of 28 Malay girls. This is a special class set-up for Malay students who come from surrounding rural primary schools. These students are placed in a special class for a transition period of two years before they are assimilated into the normal classes. Most of these girls are hesitant to use English, preferring to use Malay among themselves.

Elsa’s school on the other hand is generally classified as ‘rural’ by district education officials as the students come from feeder schools situated in rural areas surrounding the school.

Elsa also teaches five classes of science – all Form One classes. Each class has around 30 students and the first class is streamed – this class has students with better UPSR results (meaning they have scored one or two As). The rest of the classes are not streamed. Students generally come from low income homes. Their hardship is such that some come from homes that only have dirt floors. The researcher has not heard the students conversing in English outside their classroom. The students prefer to communicate in Bahasa Melayu and vernacular languages such as Hokkien and Tamil. There is minimal use of English in formal contexts in the science classroom.

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The narrative mode of thought concerns itself with the details of experience. In this mode, researchers “collect descriptions of events and happenings and synthesize or configure them by means of a plot into a story or stories” (Polkinghorne, 1995: 12). These stories then answer the questions that the researcher started off with. However, constructing these stories is not a simple matter. Whilst there are many ways to approach transcription and analysis, the researchers found Riessman’s (1993) suggestions useful for transcription and construction of narratives. Reissman recommends that the researcher should transcribe for words and non-lingual features and attempt to put down a first draft on paper. She then suggests that portions can be selected for re-transcription and content that is finally selected may emerge or change as the researcher constructs the story through a process of retrospection.

Other forms of data analysis that are relevant to this research endeavour are thematic, content and discourse analysis. Interviews and journal writings were subjected to Foucauldian thematic analysis (Cahnmann, Rymes and Souto-Manning, 2005). The documents collected were submitted to content analysis. Stemler (2001) drawing from Berelson, GAO, Krippendorf and Weber says that content analysis is a technique of reducing text into a number of categories based on coding. According to Stemler, this technique is particularly useful in examining trends and patterns in policy documents. In this paper, the document that will be discussed in detail is the Curriculum Specifications for Form One science although other documents such as Ministry imperatives were also submitted to analysis.

The term discourse used in the context of this article not only refers to “all spoken and written forms of language use as social practice” (Wood and Kroger, 2000: 19) but also discourse in the Foucauldian sense – which sees discourses as systems of language and power. Foucault’s understanding of discourse is not limited to language or social interaction but extended to areas of social knowledge (McHoul and Grace, 1993). In other words, speech, writing or thinking about social objects, events or practices occur in particular ways, according to shared assumptions and unspoken rules that regulate what can be said and cannot be said, what is valued as knowledge and what is not. Thus, the purpose of using discourse analysis is to find threads or strands that allow us to understand these shared assumptions and unspoken rules.

In short, there were two levels of analysis: a broad interpretive approach and a detailed textual analysis of aspects pertinent to the nature of the study. The outcomes of these analyses were then re-constructed to present the following narratives.

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To understand the Malaysian science narrative, it is necessary for us to delve into curricular documents that outline the curriculum and its purposes. Due to space constraints, only some aspects of the document will be highlighted. The aims of the Malaysian science curriculum are as follows:

> “The aims of the science curriculum for secondary school are to provide students with the knowledge and skills in science and technology and enable them to solve problems and make decisions in everyday life based on scientific attitudes and noble values.
>
> Students who have followed the secondary science curriculum will have the foundation in science to enable them to pursue formal and informal further education in science and technology.
>
> The curriculum also aims to develop a concerned, dynamic and progressive society with a science and technology culture that values nature and works towards the preservation and conservation of the environment.”

Curriculum Specifications, Science Form 1 (p.2)

The understanding here is that: knowledge of science is primarily important for everyday life, and learners are engaged in science education to help them make “enlightened’ decisions to solve problems in the course of living their lives. Thus to make enlightened decisions, learners will have to utilise scientific knowledge to participate in meaning-making. This would require learners to be able to think and synthesize information to make informed decisions. The thinking component is emphasised heavily in the curriculum and will be discussed shortly.

The aims also denote that the curriculum is designed to meet the need of two sets of learners – those who will pursue “formal” further education in science and technology; meaning the “potential scientists” (a term coined by Costa, 1995; cited in Aikenhead, 2000) – i.e. learners who are pursuing science to build careers in science and technology and those for whom science will be informal engagement; meaning learners who will use science in their daily lives but not study it for a particular purpose.

Also, importantly, the curriculum states the need to develop a particular science “culture”; one that is “*concerned, dynamic and progressive*” yet “*values nature*”. Like all other countries that are striving for developed nation status, Malaysia is caught-up with the need for modernisation. Modernisation as a phenomena is often linked with advancement in the field of science and technology. Therefore, the understanding here is that to emulate the more progressive nations of the First World, Malaysians would have to be able to access the kind of scientific knowledge required to participate in this arena (Sharifah Maimunah Syed Zin, 2003). The use of the phrase “science and technology culture” is interesting; in this case the proposition here is that there is a culture of science and technology, specifically a culture of concern for the environment. However, the culture of science and technology referred to in the document is mostly associated with a western science point-of-view – an inheritance from the country’s colonial rulers. This point of view is usually taken to be natural, universal and neutral, a position which is normalised (Koo, 2004); that this point of view IS science, thus denying the existence of other science cultures. As pointed out by Frankenstein and Powell (1994) who draw from D’Ambrosio (1985), notions of general universality of science are often used as a cover for Eurocentric particularities. While the writers do not intend to undermine or belittle the contributions of the subculture of western science, we would like to draw attention to the multicultural nature of science. Malaysia is a country that is rich in its cultural diversity and as such learners coming from diverse backgrounds would have their own cultural theories to explain the physical world and its accompanying natural phenomena, generally referred to as “*Ethnoscience*” (Kessler and Quinn, 1987: 61). The writers are not suggesting that the subculture of western science should be abandoned, but think that it is necessary for us to acknowledge that there are varieties of local science that make up our learners life-worlds. Indeed, this paper is oriented toward pluralist diversity in knowledge and meaning-making in Science.

The problem in this case is legitimizing these cultures of science and coming to understand that the majority of Malaysian learners come into schools with their own cultural identities and understandings of science, and therefore will have to negotiate the western subculture of science in school. Perhaps, this is, in part, the reason why there is difficulty in engaging Malaysian learners in science education, resulting in government intervention in introducing the 60/40 policy, whereby 60% of the upper secondary school population is 'encouraged' to go into the 'science stream' to facilitate the country's intention of having a science based knowledge culture.

In the same document, the need to teach science and mathematics in English is accounted for in the following manner:

> "In a recent development, the Government has made a decision to introduce English as the medium of instruction in the teaching and learning of science and mathematics. This measure will enable students to keep abreast of developments in science and technology in contemporary society by enhancing their capability and know-how to tap the diverse sources of information on science written in the English language."

Whilst science is seen as a tool for economic empowerment, the English language is seen as the key for the acquisition of this tool. There are some underlying assumptions in the curricular statement that need to be (un)packed. In this case, that "*quality science education*" is necessary for the nation to compete as a global player and at the same time this "quality science education" is achievable if students are adept enough to be able to '*tap*' scientific knowledge that is recorded in the English language. Therefore, attributes of a quality science education include enabling Malaysians to 'tap' the knowledge that lies there awaiting, and to 'get' at this knowledge, students must master the language. This view sees the body of science knowledge as something to be amassed, not as joint construction of meaning. It ignores the pluralistic, cultural nature of science and the negotiable, constructive nature of science education. Science knowledge is seen as primarily coded in textbooks, teaching courseware and reference books (Sharifah Maimunah Syed Zin, 2004).

In the same light, the word "quality" needs troubling (to be troubled). Kumashiro(2004: 8) explains the word 'troubling' as "to work *paradoxically* with knowledge, that is, to simultaneously use knowledge to see what different insights, identities, practices, and changes it makes possible while critically examining that knowledge (and how it came to be known) to see what insights and the like it closes off”. Thus, the question that arises here is what kind of quality science education do these assumptions make possible and what does it disable?

“Quality science education” in the Malaysian context views science education as a means to an end – the end being mainly for enhanced economic outcomes in a globalising discourse committed to liberal and economistic agendas. The idea that scientific knowledge is available through accessing literature on science and technology that is in English reflects the view that science is thought of as a static body of factual knowledge and “quality” science learning means being able to ‘tap’ at this information. Thus, achieving quality science education means being able to appropriate knowledge that is already in existence; static knowledge that is largely Western in nature and tradition and learners are required to so in a language that is foreign to most of them (Pillay, 1998). Such a stance automatically privileges a particular learner – one who has the cultural capital (Mclaren, 2003; Apple, 1996) to negotiate this particular discourse. Thus learners, who come from homes where the English language and western worldviews are dominant, have an edge over others, and learners who do not come from such privileged backgrounds find their cultural and linguistic resources devalued (Cummins, 1998). In a sense, this stance is paradoxical. On one hand, it hopes to secure the economic well-being of the country, on the other, its implementation promotes the kind of elitist education that the country’s affirmative action policies are against. The devaluing of the minority cultural and linguistic resources of the learners robs them of confidence and also shuts down the possibilities of alternative ways of making knowledge. Also as Barker (2005: 1) points out “ a teacher’s prioritising the acquisition of the new target language (by, from the outset, controlling and defining the vocabulary to be used, and adjudicating on students’ use of the target language) can discourage the exploration of prior knowledge about the topic, the free flow of science ideas, and the spontaneous co-construction of meaning” which arguably, may be done more easily in Bahasa which was the language of instruction in schools since 1970.

The Malaysian science curriculum also places a heavy emphasis on ‘thinking’. The thinking element which is supposed to be enacted through problem solving and inquiry, is denoted as follows:

> Science emphasises inquiry and problem solving. In inquiry and problem solving processes, scientific and thinking skills are utilised
>
> Curriculum Specifications Form One, (p.3)

> Thinking is a mental process that requires an individual to integrate knowledge, skills and attitude in an effort to understand the environment.

> One of the objectives of the national education system is to enhance the thinking ability of students. The objective can be achieved through a curriculum that emphasises thinking skills is a foundation for thoughtful learning.
>
> Thoughtful learning is achieved if students are actively involved in the teaching and learning process. Activities should be organised to provide opportunities for students to apply thinking skills in conceptualisation, problem solving and decision-making.
>
> Curriculum Specifications Form One (p.4)

The understanding here is that learners build science knowledge through the process of inquiry and problem solving. The inquiry method requires learners to employ a plethora of skills: gathering and setting up apparatus, making observations and measurements, gathering data, drawing graphs and diagrams, analysing data, evaluating results, preparing reports and communicating findings to others. The curricular statement also draws attention to 'thoughtful learning' or in other words meaningful learning. Clearly, this method of teaching and learning goes beyond rote memorization and regurgitation and yet references are made in the curricular document to appropriating knowledge in the English language that lies awaiting – a disruption between aspirations and actual translation of these aspirations. There is an enormous gap in teacher readiness which has not been acknowledged sufficiently by the authorities in terms of transitions to be made by teachers of Science trained to teach Science in Bahasa Malaysia to teachers having now to teach Science in English. Whilst the policy to shift language of Science to English is lauded as an attempt to move Malaysia into a globalising age, the training of teachers to make the necessary transitions have not been carefully thought through especially in terms of teachers' limited proficiency in general English and in the genre of Science in English, a double challenge for most teachers (and learners).

The stress on the inquiry method in the Curriculum Specifications indicates that the classroom is imagined as an interactive space, one where there is not only teacher voice, but learners' voices as well. However, to be able to think and to voice, learners will need a medium through which to make their new understandings to come into being. Therein lies the problem; with the introduction of the new language of instruction most Malaysian learners are actually served with a double whammy (Koo Yew Lie, email communication, 2005). Not only are they required to negotiate a foreign culture (subculture of western science), they are required to do so in a language that is also foreign to them. How much interaction can we then expect? Yet, these are the day-to-day realities that teachers face in implementing science in English in their classrooms. These teachers themselves are not without problems as most of them have been educated in the Malay medium and are not proficient in the English language (Ambigapathy Pandian & Revathi Ramiah, 2003).

The discussion above has made some comments as to how science education is perceived by the policy makers and curriculum planners. The following narrative serves to explain how these aims are experienced and translated by learners and teachers at the grass-roots level.

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One of the first questions that the principal researcher forwarded to Norah was: what does teaching science mean to you? At that point, Norah's facial expression registered confusion. She was troubled by the question. For some time there was silence before she said:

I have to teach my students to learn science – you know, facts and concepts……

Clearly from Norah's answer, she found it difficult to explain her perception of science teaching. Norah is not alone in this sense. The researcher raised the same question to Norah's colleagues and once again these teachers were stunned and seemed to be grappling for an answer. The answers given by these teachers were similar to the answer given by Norah. "To help students access the scientific body of knowledge" was one answer given by one of Norah's senior colleagues. One other colleague evaded the question and actually remarked that "I don't like teaching science, my students are always waiting for me to provide the answers". Perhaps this is a difficult question – one that requires teacher's to reflect on the purposes of science education and their role as teachers.

What is teaching science to Norah? A structural analysis of her lessons indicates that she has a set of routines, namely: Question-Answer-Evaluation, ordinary question and answer, lecture and summary monologues. In starting a topic or unit, she introduces the concepts and proceeds to carry out experiments related to the concepts. She then discusses the outcomes and links the outcomes to the concepts that she has introduced. To carry this out she would pose questions to the students and usually students will provide answers individually or in unison. The following vignette is typical of student-teacher exchanges in Norah's classroom:

Norah : Look at page 51 (refers to the textbook). This is an experiment, so you have hypothesis and variables.

She allows the students some time to read the textbook.

Norah : Ok, oxygen is needed for respiration, right? What is respiration?

Students : Breathing. (*Students answer in unison*).

Norah : What gas do you inhale?

Students : Oxygen.

Norah : What gas is released?

Some girls seated nearby the researcher were asking their friends "Apa itu inhale?" and their friend responded "Breathing lah, bernafas".

Students : Carbon dioxide.

Norah : Ok, how do we test for oxygen?

There is no answer forthcoming from the girls, so Norah repeats the question and one student shouts out an answer.

Mary : Cobalt chloride paper.

Norah : Cobalt chloride paper?…. No, no….

Eilyn (student): Glowing splinter?

Norah : Ok! Glowing splinter. What do we use cobalt chloride paper for?

This formulaic pattern of questions and answers is used in every lesson. Norah's lessons are still very traditional and expository in nature. At the beginning of the observations, the principal researcher was surprised when the girls almost always had the right answer to Norah's questions. It was only after a couple of observation sessions that the researcher realised that the girls had their textbooks opened at the page that the teacher was discussing and that the girls were merely reading out answers. The students refer to the textbook even when the teacher does not specify the pages. The textbook plays a very prominent part in Norah's teaching repertoire. She depends on it heavily for conducting experiments and for structuring her lessons. She also supplements the textbook with notes that are taken from commercial revision textbooks. She asks the students to paste these notes into their note cum exercise book. On the whole, Norah and her students seem to revere the textbook and the commercial revision books. Norah's lessons were contained within a predictable format and the students were always able to anticipate the teacher's next move. Norah would use the software supplied by the Ministry – usually at the start of a new topic or at the end of a topic. Even with the software, the students are able to anticipate the teacher's actions.

Sometimes, Norah would get students to do presentations. She would assign particular sub-topics to groups of students and require them to come out in front of the class to explain those topics. In order for the girls to carry out this assignment, Norah would allocate some time during lessons for the students to prepare their materials. Students would usually refer to their textbooks and commercial revision books and write notes on transparencies or 'mahjong'[3] paper. In fact, the students' presentations were somewhat similar to the way the teacher presents information during lessons – a 'telling'. At all times, the textbook and the revision books were referred to. Therefore, a codified body of knowledge always took centre stage. Even in activities that required the girls to present their understandings, there were no attempts to access their 'naive' knowledge or to allow this knowledge to become visible in an effort to negotiate meaning. Legitimate knowledge from the textbook and the revision books was accorded privileged status and the learners attempts at (re)presenting this knowledge was reduced to regurgitating 'facts' and providing 'one' word correct answers. Therefore there was hardly any attempt to allow learners to use their English to construct their understandings.

Norah's approach to teaching science is centred on teaching facts, concepts and memorising. This mode of science teaching seems to be sanctioned by other members of the science teaching panel. The science panel has frequent meeting to discuss supporting activities to facilitate the teaching of science in English. To most of the teachers in the panel, the change in the medium of instruction means that students will need to learn scientific terminology in English. Members of the panel think that effective science learning can take place if students are able to master scientific terms in English. In fact Norah's perception of successful science learning is:

> To understand science – students need to have good vocabulary. That is why I ask them to keep a vocabulary book. Once they know the vocabulary – they will be able to understand the content.

Thus, for Norah, the change in the medium of instruction means that her students have new words to memorise and she believes that if they are able to appropriate the vocabulary, they would be able to understand science. Norah also believes that her method of instruction is inquiry based because she does experiments with the girls. She conflates inquiry teaching and learning with carrying out experiments in class. However, inquiry teaching and learning is more than just carrying out experiments, it is concerned with investigative skills that require understanding of processes, and broadly speaking it is a way of thinking and doing that allows one to understand – a process of knowledge in the making. However, in Norah's classroom, opportunities to think are directed towards getting the predetermined 'right' answer. Students are not given opportunities to voice their conceptions of the phenomena that they are learning and to participate in the construction of science knowledge, thus limiting their use of the language as a way to make meanings in science. The problem is that learner proficiency is a fundamental challenge.

The thrust of teaching in this case is to impart abstract scientific concepts and to expect that students take this on as valid representations (Gallagher, 1998 cited in Aikenhead, 2001). There is no attempt to take into account these students' cultural or common-sense notions of science. On the students' part, they take to this form of teaching with passive acceptance despite the boredom that they complain of. As one student voices out:

> Learning science is 'leceh' (troublesome), sometimes even boring lah. There are too many new terms to memorise. Some more I have to memorise facts.

Other students in Norah's class also complain that they 'hate' memorising terms in English and this makes them dislike science. Therefore learning science has been "reduced to obsession with details and the ability to memorise and regurgitate vocabulary words and pieces of information" (Tobbins, Tippins & Gallard, 1994: 70).

So, what then happens to language in this science classroom? Curriculum planners emphasise the importance of inquiry based teaching and learning. An inquiry-based science classroom allows learners ample opportunity to interact not only with the teacher but also with each other. In such a situation, meaningful, understandable input will be generated from the interactions that take place and it might be possible to enhance the acquisition of literacy and language. The curriculum planners explain that one of the reasons for teaching science in English is to provide opportunities for learners to use the language (Preface, Curriculum Specifications, 2002). However, the transmission of knowledge method practised by teachers like Norah does not allow learners to make much use of the language.

Why does Norah choose to teach in this way? Why does Norah hang on to the banking mode of teaching when there are other alternatives? Is it because she is unaware of the existence of other methods that are more interactive? This is not the case. Norah is aware of other ways of teaching science but she is hampered by enormous top-down pressure to complete the curriculum/syllabus for the year and the stress of carrying out evaluations that is imposed by an educational system that is extremely examination-dominated system (Koo, 2004). She says:

> I know that the girls sometimes find the lessons boring. I would like to incorporate other methods of teaching. I would like the girls to watch documentaries on Astro but there is not enough time to do that. I would like to carry out cooperative learning but there is not enough time We have to cover the syllabus and I have to give them enough practise to answer exam style questions. You know, we have to give students the target number of questions set by the panel

Therefore, Norah's role is that of disseminator of knowledge that is necessary for students to cope with examinations, which is a dominant discourse in the Malaysian Schooling and educational system (Koo, 2004). Her work practices are considered are sanctioned by institutional power of schools, examination bodies and curriculum centre. . Her immediate superior approves by saying:

> Our duty as teachers is to finish the syllabus. Parents expect us to cover all the topics. At the same time we must make sure that the girls have exposure to exam-style questions. It is not that we don't want the students to have fun but activity-based teaching and learning is left to be done at the end of the year when the teachers have finished the syllabus.

So, in the eyes of her colleagues and superiors at work, Norah is a 'good' science teacher. This is what her students have to say about her:

> Miss Norah is a good teacher. She gives us lots of notes and exercises.
>
> *(*Hanim*)*
>
> She practices a lot of exam questions with us. She even has extra classes with us.
>
> *(*Kam Pei)

Hence, these students have their definition of a good teacher – someone who provides notes and practise with examination style questions. Parents too, have nothing but praise for Norah as she meets their expectations of a 'good' science teacher. So, what makes a good teacher in the eyes of those who share her discursive space? The ideal teacher is one who covers the syllabus, provides extra notes and makes sure her students get ample practice in answering examination-style questions. This definition of what it means to be a good teacher is socially constituted and reconstituted by Norah. While she is aware that her teaching practices do not meet her desires, she still makes choices that will allow her to fit into the mould that is expected of her, the mould that is dictated by the dominant discourse. Norah sees the science curriculum as 'facts' – universal truths that need to be imparted. To her the change in the medium of instruction means that apart from the language, nothing else changes. When Norah says she is aware of other ways of teaching – her alternative methods still bend towards transmission. Her teaching practices are still focussed on meeting the demands of those who inhabit her discursive space.

Let us now take a peek into Elsa's classroom. The following vignette comes from a lesson on the concepts of mass and weight. Earlier on in the lesson, Elsa had introduced other apparatus to weigh objects.

Elsa: Okay look at the apparatus behind. Group 3 and group 6. Spring balance is used to measure, weight. W-E-I-G-H-T. SI unit for weight? Starts with N? The answer is already on the balance itself. Helmi? Look at the spring balance. Look at the unit stated there. Okay what is the name of the unit? N? Tak tau sebut, spell. Ha. Tak tau baca? Mula dengan N.

Student: Mewton.

Elsa: N-E-W-T-O-N. Newton bukan Mewton. Okay, what is the difference between mass and weight? Apa beza di antara mass and weight? Why do we use triple weight balance, lever balance to measure mass? Or spring balance, or compression balance, to measure weight?

(students talking)

Mmm? Norman? Mengapa ada alat-alat berbeza untuk measure mass and weight? So mesti ada beza kan. So what is mass and what is weight? Did you read the notes I gave you? Ada baca nota tak? Hah? Illa …

(Students giggle)

Elsa: Stop playing with the apparatus. I'll let you play with it later on. Ah. What is the difference between mass and weight? Yang mana berat? Mass or weight?

Student: Weight!

Elsa: Weight! Ah, pandai. Weight, dalam Bahasa Melayu, berat. Mass? Mmm?

Elsa: Mass? Jisim. Sudah belajar di sekolah rendah kan - jisim. Sudah ke belum?

Students: Belum! Dah! Belum!

Elsa: Belum ah? Darjah 6 kan? Mass and weight, darjah 6 ada kan? Anak buah saya di sekolah rendah tahu. Sudah belajar ke ta dak, saya boleh tahu. Okay, where are we now? To understand further what is mass and weight, where are we now? Kita di mana sekarang? Di atas bumi. Dalam Bahasa Inggeris, bumi panggil apa?

Students: Earth!

Elsa: Earth. Okay. Now look at me. Tengok cikgu. Mengapa saya boleh berdiri? Kenapa saya tak jalan, macam orang terbang?

Students: Sebab ada kaki!

Elsa's use of language in her classroom is a mix of Malay and English and even one word of Tamil (which drew laughter from her students). We have even heard Elsa say phrases in a mixture of Malay and Chinese to help her students remember scientific names or sequences of processes. Even though a structural analysis of Elsa's lessons indicates that she too, has the same set of routines like Norah, namely: Question-Answer-Evaluation, ordinary question and answer, lecture and summary monologues. Yet, the manner in which these routines come into play is significantly different from Norah's pattern. Elsa initiates a Question-Answer-Evaluation routine but she constantly switches languages to allow her students to follow the science content that she is trying to impart. She also uses more English for socialising and class management purposes.

Elsa’s use of the language may be looked upon as code switching (alternating rapidly between two languages), for example she questions:

“Okay, what is the difference between mass and weight? Apa beza di antara mass and weight?”

She questions first in English and asks the same question in Malay. She code-switches primarily to put science content through to her students. Analysis of other instances of her classroom talk indicates the same pattern- use of English for socialising and classroom management, and code switching to help students acquire scientific knowledge. During dialogue sessions with the principal researcher (usually after classroom observation), Elsa revealed that her reason for switching was in the hope that it would activate students’ prior knowledge of scientific concepts that they have already learnt. She says that this makes teaching new content in English a little easier. Elsa is enacting transitions for learners who are caught in the difficult shifting spaces between two languages, English and Bahasa Melayu.

At this point it is necessary for us to examine the kind of contexts that these two teachers work in. In Norah’s school, the students are considered top performers and the pressure is to ensure as many students as possible score the “A” for the exam; whereas in Elsa’s school, getting students to even come to class is an effort. The principal researcher remembers countless times when Elsa had to make trips to the classroom to ensure that all the students were in the laboratory for her science lesson. Despite such problems, it is obvious from Elsa’s manner of teaching (her ease at using the L1[4] when she feels the need unlike Norah who mechanically sticks to an all English delivery) that her teaching context allows her more room to manoeuvre her lessons to meet the needs of her students. Although most of Norah’s students seem to be proficient in English, there were still some who could not follow and kept asking their peers for Malay equivalents of the English scientific terms that Norah used.

Another interesting feature of Elsa’s classroom language is the way she mixes both the languages, for example, she says:

Apa beza di antara mass and weight? or *So mesti ada bezakan?*

This switch of words at the lexical level; “and” instead of “dan” and “so” instead of “jadi” indicates a kind of hybridity (Gutierrez et al., 1999) to Elsa’s language. This hybridity is interesting as it can be seen as a strategy to not only to put the content through but also to stimulate literacy amongst learners who are not sufficiently proficient in the English medium of instruction.

CONCLUSION

The two narratives presented above indicate continuities, ruptures and discontinuities of teachers and learners in the uneven and difficult translation of the pragmatic assumptions and desires of the policy makers, and curriculum planners with the practice that takes place at grass-root levels. Perhaps, it is necessary for these pragmatic assumptions to be reconsidered. If the desire is to have inquiry-based science learning as documented by the curricular documents, it is then necessary for those in positions of power to rethink how science can be (re)presented as a discourse to practitioners at grass-roots level so as to establish an interactive pedagogy in teaching science. When there is minimal need to interact in the science classroom, the hopes of attaining language learning as a by-product is greatly diminished. However, in order to establish an interactive pedagogy in the classroom, there is a need for all parties involved to come to a new consciousness in respect to what knowledge is and how to go about making knowledge. At the same time, the role of language in meaning-making has to be considered very carefully. It is simply not enough to say that teachers must change their teaching practices. It is also necessary for us to review the nature of science that we teach. At the same time, we also need to be sensitive to the needs of the learners. It is necessary for us to realise that in imposing a 'language' on learners, we take away some of their meaning-making resources, thus limiting their participation and ultimately curtailing their learning. Whilst there are learners who are able to cope perfectly well in English, there are also those who cannot. Perhaps it is necessary to maintain both languages in the teaching of science, so that we can open horizons to the 'potential' scientists as well as serve the needs of those who need science to become informed citizens. The present discourses revolving around science and science education indicate that there is a need for Malaysian science educators to develop different ways of thinking and evaluating the knowledge of science. Therefore, bridging the gap between theory and practice not only requires changes at classroom level but involves a change of perspective at various levels including dialogues between the various stakeholders in the teaching of Science in Malaysian schools. There is a need for us to question ourselves as to what is science in the Malaysian context.

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[1] The names of all participants are fictious.
[2] ETeMS is an acronym for ‘English for the Teaching of Science and Mathematics’ programme.
[3] Large pieces of white paper traditionally used to cover the ‘mahjong’ table.
[4] This particular class of Elsa’s comprised of all Malay students.