SCIENCE EDUCATION IN MALAYSIA: CHALLENGES IN THE 21ST CENTURY

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Abstract: This article analyses the development of science education in the Malaysian schools' context. Several big changes have shifted the direction of science teaching to Malaysian students over the last fifty years. It started with curriculum reforms adopted by western countries in the 1960s and 1970s. The introduction of a new curriculum with an underlying 'child-centred' philosophy was developed and implemented in the 1980s. The importance of information technology and English as medium of instruction were characteristic in the late 1900s and 2000s. The impact of international study's such as TIMSS and PISA paved a new direction for science education. Dynamics of science education in Malaysia shows interesting developments that informs us how the education system has adapted to challenges and trends.
Keywords: Science Education, Malaysian School, information technology

PENGAJARAN IPA DI MALAYSIA: TANTANGAN ABAD 21

Abstrak: Tulisan ini menganalisis perkembangan pengajaran IPA di sekolah Malaysia. Beberapa perubahan besar telah mengubah arah pengajaran IPA pada siswa-siswa di Malaysia selama 50 tahun terakhir. Perubahan dimulai dari perombakan kurikulum yang dilakukan negara-negara barat pada tahun 1960-an dan 1970-an. Pengenalan kurikulum yang didasarkan pada filosofi 'child-centred' dikembangkan dan diterapkan pada 1980-an. Pentingnya teknologi informasi dan bahasa Inggris sebagai media instruksional menjadi karakteristik pada akhir 1900-an and 2000-an. Dampak dari metode internasional seperti TIMSS and PISA menjadi arah baru dalam pendidikan IPA. Dinamika pendidikan science di Malaysia menunjukan perkembangan yang menarik yang membuktikan bagaimana sistem pendidikan telah menghadapi tantangan dan tren.

Kata Kunci: pengajaran IPA, sekolah Malaysia , teknologi informasi

INTRODUCTION

In January 1991, the then fourth prime minister of Malaysia, Dr Mahathir, introduced the country's target over the next 30 years which he called 'Vision 2020' (Ibrahim, 1996). The current direction of Malaysia's educational policy has been predominance by the efforts and initiatives outlined in the economic and social development policy already stated in the 'vision'. It is intended that in the year 2020 Malaysia would achieve the status of a developed country. The expectation in the near future was for Malaysia to attain world status in terms of "its economy, national unity, social cohesion, social justice, political stability, system of government, quality of life, social and spiritual values, national pride and confidence" (Lee, 1999, p. 87). Undoubtedly, as an industrialized country status provisioned by Vision 2020, Malaysia relied more on the development of research, technology and scientific discovery. An essential element for it is through quality improvement of education, where it is perceived in Malaysia as promoting national unity, social equality and economic development of the country. One part of the activities is teaching science in schools, where educating new generations of Malaysians take place.

For a long time, science teaching in primary and secondary schools generally can be divided into two major parts which are science as a product and science as a process. The context of science as a product is on the teaching of facts, principles, models, theories and laws that constitute science knowledge; while science as a process is the development of students' skills in scientific methods and problem solving. There are many challenges in the teaching of science in schools. According to Bybee and Fuchs (2006) there is a need to reform the teaching of science to make it more relevant to the challenges of the new century. However, the core components are the same, they (p. 350) write that "we need high quality teachers, rigorous content and coherent curricula, appropriate classroom tests, and assessments that align with our most valued goals".

This article explains the context of science education development in Malaysia and its issues through relevant literature reviews and analysis. The challenges faced could be similar to other developing countries, both in the political dynamics of policies and in efforts for improving their quality. It starts with the explanation of some general information about Malaysia and its education system, and then moves on to some prominent issues in science education development.

EDUCATION IN MALAYSIA

Malaysia is a country that consists of the Malay Peninsula and the northern part of Borneo Island that gained independence from the British in 1957.

Currently, the Malaysian population is around 30 million, where ethnic majority are Malays (55%), followed by Chinese (30%), Indians (10%) and others which reflect a plural society (CIA, 2014). In the last thirty years, the country has made progress with reduced poverty rate of 3%, economic growth above 4%, and income per capita has reached US$ 10,000 in 2012, which is 2.5 fold Indonesia. Two familiar landmarks, the Petronas twin towers and the administrative capital Putrajaya, became tourist attractions and the pride of the country. Because Malaysia is an Islamic state, it also became a symbol of a modern Islamic country by others.

In the field of education, it was reported in 2017, that one Malaysia university had been successfully ranked close to top 100 worldwide university ranking by QS (Quacquarelli Symonds). At the same time, researchers and lecturers from Malaysian universities appeared in reputable international journals that demonstrate research achievements. International students studying in various universities in Malaysia surpassed 100 thousand in 2012; a situation whereby Malaysia was labeled as an 'emerging contender' among the other countries that competed for international students (Verbik & Lasanowski, 2007). All of this indicates a positive trend in Malaysian education.

As a former British colony, Malaysia also adopted the British education system. The school system is divided into two major parts, namely basic education (*sekolah rendah*) for six years beginning at the age of seven and ended with a public national examination in year 6 (known as UPSR - *Ujian Pencapaian Sekolah Rendah*). Secondary education consists of three years lower secondary school followed by another public exam (called PT3) and continues with another two years of upper secondary school (form 5), with a final public exam for this compulsory education (known as SPM, or *Sijil Pelajaran Malaysia*); This is none other than the O-level (ordinary level) in the English education system. If the students want to go to university, they have to go through pre-university education for at least 1.5 years, which is called matriculation or pursue STPM (high secondary school certificate), equivalent to A-level (advanced level) in English education. One thing that stands out in the Malaysian education system is the allocation of significant funds, where the minimum budget per year for education is 20% (excluding salaries of teachers). This means that the quantitative expansion of the school system can be done in a relatively short period of time, such as for building new schools and training school teachers.

The Malaysian education system is managed centrally by the Ministry of Education in the capital city, despite the fact that Malaysia is a country with a federal system, whereas "not only in terms of a national school curriculum and a national examination system, but also in terms of finance and administration" (Lee, 1999, p. 89). The total student population of the school is around five million who go to 10 thousand more schools, which are mostly public schools (private school at primary level is 1% and 4% at secondary level) (KPM, 2013). Teacher population in Malaysia around 423 thousand people of which 70% are female teachers (KPM, 2014). The minimum qualification for teachers in Malaysia is an undergraduate degree (S1); teacher education for primary school level are conducted by teacher institutes (called 'maktab') which is supervised directly by the Ministry of Education; whereas for secondary school teachers carried out by 13 faculty of education at various public universities under the Ministry of Higher Education. Student teachers are recruited each year based on quota stipulated by the central government based on the projection for the next four to five years. The language of instruction in all Malaysian schools is Bahasa Malaysia, but in elementary schools it is permitted for national-type schools (vernacular schools) to use their mother tongue, which is Chinese and Tamil. This shows that the identity politics of the colonial era still survives.

DEVELOPMENT OF SCIENCE CURRICULUM

After independence from British, Malaysia continues to apply the science curriculum which originated from England. According to Tan (1991) and Lee (1992), three pieces of curriculum teaching of science were adopted, namely the Scottish Integrated Science Syllabus for lower secondary school, the Nuffield Secondary School Science Curriculum for the non-science streams of upper secondary school, and the Nuffield O-Level pure Science Syllabus for the upper-secondary science stream was implemented from 1968 to 1981. Imports of foreign curriculum like this would directly impact the school system. Studies conducted by Thair and Treagust (1997; 1999) showed that the trend of science curriculum in developing countries such as Malaysia and Indonesia, in the absence of expert design and implementation of the curriculum, revealed that they just adopted science curriculum from developed countries without taking the effort to adapt the curriculum to suit local conditions.

Implementation of the science curriculum caused many problems when applied in the classroom. The most evident is the availability of laboratory equipment for experiments and trained staff to implement it; where this cannot be solved completely in a short period of time. Furthermore Tan (1991) further describes the problems associated with the English curriculum, categorized as conceptual problems, pedagogical and psychological. Problems in terms of conceptual occurred where Malaysian students faced difficulty in connecting science experiments of the curriculum derived from Western culture with their daily lives. This happened because the content and structure of the curriculum follow the post-sputnik era which placed emphasis on “scientists’ science”. For example, understanding the context of science (subject content bias), including the use of Greek alphabets in the formula, which is something not easy for many students in developing countries to comprehend. In terms of pedagogical, teaching in Malaysian schools is centered on the teacher’s style, but the curriculum is no set pattern that is very different from the existing culture that is centered on students (student-centered approaches). In the psychological context, the exam-oriented education is geared to enable teachers complete the syllabus, and because of the limited time the teachers take a shortcut by explaining the outcomes of science experiments verbally, rather than allowing the students conduct the experiments.

Realizing this, the local education experts in Malaysia together with the ministry of education seeks a science curriculum format that could suit local needs. One effort was the establishment of the Curriculum Development Center in 1972 that was responsible for conducting research and development curriculum locally (Tan, 1991). The result is a design and product of integrated science curriculum both at the primary level and high school level in the late 1980s. Both the curriculum is none other than the result of the local education experts that engaged in dialogue and research, tailored to local needs.

Lee (1999, p. 90) writes that the new curriculum attempts “to introduce new emphases in the objective and content, new teaching styles and new types of instructional materials”. It is intended that the philosophy of the new curriculum incorporated a ‘child-centered curriculum’. However, as indicated by Tan (1991), the existing teaching culture is still traditional where teachers dominated the classroom. Also Lee (1999) notes that there are some controversies that emerged from this new curriculum, for instance when high school students have the option to choose science subjects, it made science subjects drop to a very small number compared to non-science subjects, which was 22:78. Another drastic change related to this in terms of the content of curriculum and choice of language, which occurred in the early 2000, will be explained later in the next section.

One of the exciting developments in science teaching was during the mid-1970s until the early 1980s. During that time, there was a drastic growth in the number of high school students in Malaysia in connection with the execution of the New Economic Policy which provisioned a greater role for the *bumiputera* (Malay) in terms of their participation in the field of education. Most noticeable is the large number of teachers shortage, particularly in this case where science teachers from Indonesia were imported to teach at various schools in Malaysia. The main reason is due to the same culture and background (*serumpun*), especially the use of language for instruction, where previously science was taught in English.

SMART SCHOOL AND ENGLISH LANGUAGE POLICY

The success of the economic development in the 1980s and early 1990s boosted Malaysia's confidence to take on another challenge. One of the important national agenda is to develop the Multimedia Super Corridor (MSC) to prepare for the digital economy. One aspect of MSC in education is the implementation of the Smart School (SS) concept. The SS concept entails "student to practice self-paced, self-accessed and self-directed learning" (Abdullah, 2006: 5). The Smart School idea at that time was progressive and futuristic, where SS is projected as a model school which will prepare the citizens of Malaysia to evolve into a modern community equipped with information and communication technology (ICT) (Bajunid, 2008).

At a practical level, the SS pilot project started in 1999 and ended in 2002, involving 87 primary and secondary schools chosen from various parts of Malaysia (Abdullah, 2006; Puteh & Vicziany, 2004). According to Chan (2002), the main component of the integrated SS are: teaching materials using web pages (web-based) for the Malay language, Science, Mathematics and English subjects; a computerized system for the management of schools; information technology infrastructure and computer networks; central assistance services and special services. In other words, the use of computer technology and multimedia will assist student learning in the SS programme, especially those who still use the existing curriculum.

However, some studies reported interesting facts and analyses about the smart school policy. A study conducted by Lee and Sellappan (1999) reported that the SS projects related to hardware, software and training turned out to be a big investment which in this case is difficult to maintain. In terms of the maximum limit of computer usage of around three years, computers will then need to be upgraded and it will cost a big amount of money; at the same time, a ratio of 5 students per computer benchmarks a good standard practice in schools but this is also something difficult and expensive to put into practice.

In terms of learning software products, the SS project produced 1494 courseware for four subjects (Abdullah, 2006) to be used by teachers and students; but as it is called by Puteh and Vicziany (2004) this figure is seen as a technical issue rather than pedagogical. Studies conducted by Halim et al, (2005, p. 112), found that "the courseware is predominantly based the resulting information in a directed form of instructional delivery". Ya'acob et al., (2005) and Abdullah (2006) revealed that some teachers still have trouble using the courseware because not all of them are involved in training, and teachers who have been trained do not always share their knowledge and skills with each other. Policy changes to teach science and mathematics in English in schools in Malaysia (called with PPSMI) that began in 2003, have also led many teachers to not use this courseware, because it is written in *Bahasa Malaysia*.

The smart school project as noted by Puteh and Vicziany (2004, p. 2) is a kind of "across-the-board solutions for all aspect of teaching, learning and management in schools", which unfortunately led to some inevitable consequences. For example, from the beginning this project did not involve experts and academics who are involved in research and who know the school system (Bajunid, 2004); courseware designers are also not educators (Halim et al, 2005; Ya'acob et al, 2005; Abdullah, 2006). Some research about SS found that teaching using multimedia technology is not easy, as it relates to the prevailing education system, where comments from teachers is mainly about completing the syllabus, needing more time, and feasibility testing (Ya'acob et al. 2005; Abdullah, 2006).

Another policy that surfaced consecutively after smart school is the language policy. Based on the cabinet meeting decision in July 2002, the Malaysian government took a drastic step in education, by implementing the use of English as the language of instruction for mathematics and science at all levels in primary and secondary education, called with PPSMI (*Pengajaran dan Pembelajaran Sains dan Matematik dalam Bahasa Inggris)* (Chan and Tan, 2006). The decision announced by the former Education Minister, Musa Mohammed, stated that PPSMI was implemented in the academic year 2003 (education calendar in Malaysia beginning in January each year). The preparation for the implementation of this policy is very short, about six months which involved a transformation of the whole system.

One of the reasons often cited in PPSMI policy, “the political leaders also realise the importance of English as an international language for trade and the transfer of scientific knowledge and technical know-how” (Lee, 1999, p. 91). So, it is important that Malaysia's youth understand the language used in the field of science that supports the development of technology (math and science). Approaching the implementation stage in early 2003, many activities were conducted, such as English training for science and mathematics teachers, and the compilation of science and mathematics textbooks written in dual-language (English and Bahasa Malaysia). The Malaysian government has also stipulated that mathematics and science teachers get incentives for the implementation of this policy in the classroom. It looks like the government has downplayed the curriculum change which usually takes several steps (initiation, mobilization and adoption, routinisation and finally institutionalisation) and not try to get support from other stakeholders (Chan and Tan, 2006).

At the beginning of the PPSMI policy implementation, several quarters criticized the likely impact affecting the nation's identity and language, the decline in the understanding of science and mathematics concepts, the drop in educational achievement, unprepared teachers etc., since there is no empirical evidence and research that could prove that at this stage, the policy was implemented without resistance (Chan and Tan, 2006). The only criticism at this stage was that it is executed without considering the change in regulations related to the national language policy as the language of instruction in schools, textbooks and examinations etc.

After several years of implementation, various research on the implementation of PPSMI shows that the benefits expected may be hindered due to some problems faced (Chan & Tan, 2006; Anonym, 2009; Phang, 2010). Research conducted on a large scale (involving academicians from nine public universities with respondents over 15 thousand students and hundreds of teachers) found that the PPSMI does not produce what is expected (Anonym, 2009). Based on analysis of public examinations on science and mathematics subjects, only students from urban schools and boarding schools get better results. However in the case of rural school children who are generally weak in English, their achievement gap appears to be widening.

Another practiceamong Malaysian teachers in the science and mathematics classroom, according to research, is the use of English words in their *Bahasa Malaysia* communicational expressions (Chan & Tan, 2006; Anonym, 2009). This can result in semantic misunderstanding that can lead to syntax failure.

Some quarters claim that PPSMI is a controversial policy that can have an impact on communication skills using native languages (*Bahasa Malaysia*, Chinese and Tamil), English language, and also students understanding in science and mathematics (Anonym, 2009). The fact remains that until the time this policy started in 2003, Malaysian teachers were not trained to teach science and mathematics in English. So, the improper use of English is an ongoing affair happening every day in science and mathematics classrooms. This could affect students who may regard science and mathematics as frightening and a subject difficult to understand.

Based on many criticisms, political tension and empirical research evidence, the Malaysian government in 2009 finally agreed to discontinue this PPSMI policy and it will officially end in 2012 (PPSMI, 2009). English as the language of instruction in science and mathematics remains mandatory but only to the level of pre-universities upwards. The withdrawal of the PPSMI policy indicates the end of the problematic social experimentation in Malaysian science education, which resulted in a very costly lesson slapped on Malaysian society and the drastic change brought about in Malaysian education.

EFFECT OF TIMSS AND PISA

Another development that shows the achievement of Malaysian students in science education comes from international studies such as TIMSS (Trends in International Mathematics and Science Study) and PISA (Programme for International Student Assessment). Malaysia participated in TIMSS since 1999 and has been joining four cycles of assessment; the result is undoubtedly a reflection on the impact of the PPSMI science education policy stipulated in 2000. TIMSS is a test that assesses student achievement in many countries internationally in mathematics and science. In 1999 (pre-PPSMI) to 2011 (after the introduction of PPSMI) apparently the Malaysian TIMSS results showed the most drastic decline compared to other countries (see Table 1). Malaysian students' science achievement increased slightly between 1999 and 2003, but after that it declined in terms of rank and score, to below the international average in 2011.

Table 1. Malaysian student performance in TIMSS 1999-2011

Rank	TIMSS 1999		TIMSS 2003		TIMSS 2007		TIMSS 2011	
	country	score	country	score	country	score	country	score
1	*Chinese Taipei*	*569*	*Singapore*	*578*	*Singapore*	*567*	*Singapore*	*590*
2	*Singapore*	*568*	*Chinese Taipei*	*571*	*Chinese Taipei*	*561*	*Chinese Taipei*	*564*
3	*Hungary*	*552*	*Korea*	*558*	*Japan*	*554*	*Korea*	*560*
4	*Japan*	*550*	*Hong Kong*	*556*	*Korea*	*553*	*Japan*	*558*
5	*Korea*	*549*	*Estonia*	*552*	*England*	*542*	*Finland*	*553*
	22. Malaysia	492	20. Malaysia	510	21. Malaysia	471	32. Malaysia	426

Source: KPM, 2013, p. 3-7)

As for PISA where Malaysia had participated in 2009 and 2012, the results obtained for science placed Malaysia's students in rank 53 among the 74 countries that participated. This results were below the international average. Further analysis from KPM (2013, p. 3-12) stated that for science, Malaysian students "have very limited scientific knowledge that can only be applied to a few familiar situations. They can present scientific explanation that follows explicitly from the given evidence but will struggle to draw conclusions or make interpretations from simple investigations." This was a wake-up call for the Malaysian government to do something with regards to improving the quality of science and mathematics teaching in the country.

At the same time the low achievement of students in science in the country is worrying. The government's intention for Malaysian students at the upper secondary school level to take science and social science course is on a ratio of 60% : 40%. However it is a known fact that in Malaysian secondary schools the number has not yet reached 30% for the science course, and this situation has not really changed since the 1990s. What is even more worrying is that for students who undertook pre-university education (A-level), only 22% of them are boys. The lack of interest in science from the young generation is certainly going to be a problem in the future, as it is difficult to get talented researchers, product development etc. Some research shows that Malaysian students do not dislike or fear science, but they chose the social sciences because relatively they are more in control (KPM, 2013).

The Malaysian Ministry of Education has taken drastic action to address this condition. Since improving the current science curriculum has been stated in the Education Blueprint (KPM, 2013), ithe revisions ares targeted for completion in 2017 where one of the content of the new science curriculum will be to incorporate more problem-based and project-based subjects, formative assessments and an accelerated learning pathway for high performing students to complete their secondary education in four rather than five years.

Another emphasis recommended by the Education Blueprint is that Malaysian students have to cultivate 'high order thinking skills' (called 'HOTS'). Again, the expectation is for students to be globally competitive and remain relevant with the expectations of the industry and current market, and be able to face the increasing international challenges and competitions, benchmarked by international measurements, TIMSS and PISA.

Further, the Ministry of Education has taken strategic initiatives to set up a special task force in 2012 (KPM, 2013), for the purpose of enhancing HOTS among students and also for the continuous professional development of teachers. A well designed literacy programme is being developed to improve HOTS among students, as well as to provide teachers the teaching support needed for their 'diagnostic assessment' and for monitoring students' academic achievements. The task force consists of experts and university lecturers working together with RECSAM (The Regional Centre for Education in Science and Mathematics), where they discussed and designed a pattern of teaching for teachers to be more challenging to students by applying higher order thinking skills.

As a result, public examinations as well as school-based assessments in Malaysians schools will implement a test paper that will be streamlined with 'high order thinking' questions by 2016. This will include an 80%

increase for the form 3 assessment (PT3), 75% increase for SPM core subjects and 50% increase for SPM electives. This renewed focus on HOTS, is to equip students with cognitive skills that will train them to think critically and be able to creatively extrapolate and apply logical reasoning in various settings. At the same time, this also will be reflected in the results of the next cycle of TIMSS and PISA. Additionally, science offered in public examinations will be upgraded by increasing its level of difficulty to make it fit in with 'HOTs', which is assumed to improve the quality of science education in the future. Something that need to be proved empirically in the near future.

CONCLUSION

There has been interesting developments in the dynamics of science education in Malaysia. Although the former colonial power has left the Malaysian education system, the adaptation of the science curriculum did not appear to always fit with local conditions. At the same time various initiatives for the development and improvement of the quality of science education such as PPSMI and Smart School policies do not always have expected results. At the same time international studies such as TIMSS and PISA, have an influence on the direction and development of science education where it become initiatives for change, in a bold move for Malaysia.

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