Exploring Teachers' Approaches to Science Practical Work in Lower Secondary Schools in Malaysia

By

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Abstract

Practical work in science is a teaching approach that aims to enable students to develop procedural and conceptual understanding and an understanding about the nature of science. Practical work is required by the Malaysian Science Curriculum at all school levels. The purpose of this research was to gain an understanding of teachers' views and practices in conducting practical work in lower secondary schools. This research, which adopted a case study approach, was underpinned by constructivist views of learning and investigated the phenomenon of practical work in three co-educational schools in the state of Melaka. The participants were three science teachers and their classes of about 35 students each. Data were collected through teacher interviews, classroom observations, document analysis and focus group interviews with students. Findings suggest that teachers' understanding about practical work were aligned with their purposes for conducting practical work. Practical work that teachers offered promoted low levels of inquiry and at best students were developing a view that in science we follow a set of procedures to arrive at a well-known conclusion. Teachers' practices were constrained by limited resources, prescribed texts, the amount of content to be taught, and their science content knowledge. Student learning was constrained by the limited exposure to authentic science investigation, low teacher expectation, a focus on hands-on rather than minds-on learning, and the language of instruction. The findings have implications for teacher practice and science education policy for lower secondary schools in Malaysia.

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Chapter 1: Introduction

1.1 The background to the study

In the 21st Century, the education system has been the main approach used in Malaysia to achieve Vision 2020[1] that was inspired by its former Prime Minister of Malaysia, Tun Dr. Mahathir Mohammad on 28th February, 1991. One of the aims is to achieve the status of a developed country in all aspects, such as economic, social, spiritual, psychological, and cultural. In order to achieve these aims, one of the challenges is for the country to establish a progressive and scientific society, which can contribute to science and technology advances for civilization in the future. The National Science Education Philosophy stated that:

> *In consonance with the National Education Philosophy, science education in Malaysia nurtures a Science and Technology Culture by focusing on the development of individuals who are competitive, dynamic, robust and resilient and able to master scientific knowledge and technological competency (MOE, 2002b, p. ix).*

In realizing the importance of science education in establishing a progressive and scientific society, the Ministry of Education (MOE) has revised the science curriculum. The current curriculum aimed to produce a workforce that was knowledgeable, skilful, and thoughtful (MOE, 2002a). As the curriculum implementers, the teachers have a huge responsibility to meet the needs of the country in accordance with Vision 2020, where the students can grasp scientific knowledge in different situations and approaches. In order to prepare the students to face these challenges, they must be literate in science.

Scientifically competent citizens can be produced if the students have the chance to cultivate science in their lives. Subjects related to science and technology have been introduced in schools to provide a motivation for students to choose science-related careers in the future. Through the Malaysia Education Blueprint 2006-2010, MOE emphasises the implementation of student-centred teaching and learning strategies that allow students to involve more in conducting practical work, carrying out discussion, and problem solving (MOE, 2006a). These teaching strategies may provide opportunities for students to "acquire knowledge, master skills

[1] Vision 2020 was an aspiration to be a fully developed country by year 2020 and was introduced by the former Prime Minister, Tun Dr. Mahathir Mohammad, in 1991. One of the approaches to achieve the aim was through education where science and technology was given a high priority (Mohammad, 1997).

and develop scientific attitudes and noble values[2] in an integrated manner" (MOE, 2002a, p. 12).

In an effective teaching approach, the students should be actively involved in the teaching and learning activities because they do not learn passively (Woolnough, 1994). Learning can take place once the students are ready to learn and when they are involved in teaching and learning activities. Thus the students must be trained to learn the concepts, principles, facts, skills, and values through hands-on activities (Daud & Noordin, 2008). The hands-on activities refer to a process where the students are involved in observing, measuring, analysing, recording, and interpreting information systematically. The students have the opportunity to develop the skills through practical work.

According to Berg (2003), students can learn effectively if they are actively involved in conducting their own investigation to gather the information. Practical work may provide positive impacts on the development of scientific knowledge, scientific skills, and positive scientific attitudes (MOE, 2003b). Students develop scientific skills as they are involved in planning, carrying out activities, analysing data, and handling laboratory apparatus and chemical substances (Berg, 2009). Practical work can foster positive scientific attitudes, such as honesty, recording data accurately, being systematic, and performing with teamwork, as students normally carry out practical work in groups (Christensen & McRobbie, 1994).

Hodson (2014) argues that the best way to learn to do science is by doing science. He argues that through practice under the guidance of the teacher students get better at doing science. Whereas Lederman, Antink, and Bartos (2014) prioritise learning about the nature of science and science investigation, Hodson (2014) asserts that the aim of science education should be to develop: conceptual understanding; procedural understanding; understandings about the nature of science; as well as developing the ability to make informed decisions on socio-scientific issues. Roberts, Gott, and Glaesser (2009) believes that practical work is more than doing science, it should require students to think about their data to draw conclusions and use evidence when presenting their arguments.

[2] le values are referred to positive values such as "being kind-hearted and caring, being cooperative, and diligent and persevering" (MOE, 2002a, p. 10).

1.2 General statement of the problem

Internationally, and in Malaysia, science education aims to help students gain an understanding of scientific knowledge and help students to develop an understanding of scientific methods from which scientific knowledge is constructed (Hassard & Dias, 2009; Millar, 2004). In order to develop students' understanding of scientific knowledge and methods, students need to be actively involved in learning activities to construct *new knowledge* by seeing, handling, and manipulating real objects and materials around them .The *new knowledge* students learn in science at the school level is knowledge that is already known by science teachers or scientists (Millar, 2004).

The *new knowledge* that students acquire is both conceptual and procedural knowledge (Millar, 2004). Conceptual knowledge includes "factual knowledge, concepts, laws, and theories" (Glaesser, Gott, Roberts, & Cooper, 2009, p. 5) whereas, procedural knowledge includes skills that students need in handling laboratory apparatus and skills to gather, analyse, interpret, and communicate their results (Wellington, 2006). Science educators propose different models of teaching to assist students to acquire the *new knowledge* in science classrooms (Hassard & Dias, 2009).

Teaching science in secondary school can be carried out through different models of teaching. A model of teaching is an instructional design that includes a plan or pattern of a lesson (Hassard, 2005). Hassard and Dias (2009) suggested different models of teaching, which included conceptual change, a social-cultural model, inquiry teaching, and the direct or interactive model. Interestingly, all the teaching models at some point involve students in observing and manipulating real objects to construct new knowledge to test against old ideas (Hassard & Dias, 2009). One teaching and learning approach that allows students to actively construct new knowledge is practical work.

Practical work commonly used as a teaching strategy in science lesson (MOE, 2002a). It is important for science teachers to understand the nature of practical work; not only why (aims of practical work) practical work is conducted in science lessons, but also what (different types of practical work), and how (ways by which practical work is conducted) (Wellington, 2006). Practical work is conducted to maximize student learning (Pekmez, Johnson, & Gott, 2005; Wellington & Ireson, 2008). Implementation of practical work as a teaching strategy puts a huge demand on teachers in terms of time and resources (Millar, 2004). Sometimes, practical work involves the use of expensive apparatus that students may not have access to outside

the science laboratory. Schools need to employ laboratory assistants to maintain the apparatus and materials in the laboratory (Wellington & Ireson, 2008).

Although practical work is widely accepted by many countries, science educators express their concern about student learning in terms of the acquisition of conceptual and procedural knowledge as a result of engaging students with practical work (Millar, 2001). There is evidence to suggest that students failed to learn the conceptual knowledge that science teachers had planned for them to learn from practical work tasks (Abrahams & Millar, 2008). Additionally, the mismatch between the students' interpretation of the tasks with what science teachers intended students to learn, reduced the opportunities for students to achieve the intended learning objectives (Berry, Mulhall, Gunstone, & Loughran, 1999). Students failed to understand the intended phenomenon that they should observe in order to appreciate the patterns, trends, and explanations (Millar, 2001). Consequently, the mismatch reduced the cognitive value of the tasks and students' goals were to complete the tasks rather than learned from them (Berry et al., 1999).

According to Thulstrup (1999), secondary school science teachers in Malaysia devote more than 50% of their time in science lessons to practical work. It shows that science teachers frequently used practical work as a teaching approach. However, a recent study shows that practical work has become an unpopular teaching approach among teachers (Zainudin, 2008). Teachers do not like to conduct practical work. Despite that, little attempt has been made to understand the implementation of practical work and its effect on student learning in the Malaysian context especially at the lower secondary school level. This study intends to investigate the following research questions:

i. How did form two science teachers understand practical work at the lower secondary school level in different types of schools in Melaka[3]?;
   a. How did form two science teachers understand practical work?
   b. How did form two science teachers practise practical work?

ii. How did teacher talk, especially questioning, facilitate classroom interactions in conducting practical work?

iii. To what extent were practical work tasks effective in helping students to do what the science teacher intended?

[3] aka is a state located at the southern part of Peninsular Malaysia and it is among the smallest states in ysia. Melaka is a multiracial state with a total population of approximately 180,000.

iv. To what extent were practical work tasks effective in helping students to learn what the science teachers intended?

1.3 The organization of the thesis

This thesis is made up of 10 chapters. Chapter one has introduced the background and the rationale of the study. The researcher also highlights research questions that will be addressed in this thesis. In chapter two, the researcher provides an overview of the Malaysian education system and particularly science education. In this chapter, the researcher highlights the uniqueness of Malaysian education system starting from the British colonial era until now. It provides an overview of how science is taught in school, the development of the science curriculum, the challenges in implementing the science curriculum, the organization of the current curriculum, and assessment, particularly related to science practical work. In chapter three, a review of the literature related to science teaching and learning, particularly regarding practical work, at the secondary school level is presented. The theoretical framework of the study is explained in chapter four. Chapter five presents the methodology framework for data gathering and data analysing. In chapter six, seven, and eight the findings related to the aims of conducting practical work from teachers' perspectives, teachers' practices in conducting practical work, and teacher questioning in practical lessons respectively are presented. Key themes emerging from this study are highlighted in chapter nine. Lastly, in chapter ten the pedagogical implications and recommendations to strengthen the implementation of practical work in lower secondary schools along with suggestion for future research to enhance teaching and learning in science are discussed.

Chapter 2: The Curriculum Context of the Study

2.1 The landscape of the Malaysian education system

The goal of the national education system in Malaysia is to develop the potential of each individual and fulfil the aspiration of the nation, as outlined in the National Philosophy of Education:

> *Education in Malaysia is an on-going effort towards further developing the potential of individuals in a holistic and integrated manner, to produce individuals who are intellectually, spiritually, emotionally, and physically balanced and harmonised, based on a firm belief in and devotion to God. Such effort is designed to produce Malaysian citizens who are knowledgeable and competent, who possess high moral standards and who are responsible and capable of achieving high levels of personal well-being, as well as being able to contribute to the harmony and betterment of the family, the society and the nation at large (MOE, 2002a, p. v).*

In Malaysia, all children must undergo at least nine years of schooling, which consists of six years of primary school (age 7 to 12-years-old) and three years of lower secondary school (age 13 to 15-years-old). Then, there are two years of upper secondary (age 16 to 17-years-old) and a further two years of post-secondary school education (age 18 to 19-years-old), before they can embark on education at the tertiary level.

The education system in Malaysia is unique in comparison with other multicultural countries, as it is the only country in the world to organize a primary education based on three major races, Malay, Chinese, and Indian and it has three types of race-based schools, which are the national schools, the national-type Chinese schools, and the national-type Tamil schools. Each of these schools uses their mother tongue as the medium of instruction. This vernacular school system began during the British colonial period in the 1800s and continues today.

At primary school (age 7 to 12-years-old), students move to the next level despite their academic performance. After six years of primary education, the students sit the standard test, known as Primary School Evaluation Test (Ujian Pencapaian Sekolah Rendah - UPSR). The examination includes Bahasa Malaysia (comprehension and writing), mathematics, science, and English (comprehension and writing) (Lembaga Peperiksaan Malaysia, 2011). However, it is not compulsory for students in the national-type Chinese and Tamil schools to sit the comprehension and writing tests in Chinese and Tamil languages, respectively.

The students then move to the lower secondary school level (age 13 to 16 or 14 to 16-years-old), which is divided into core and additional subjects. The core subjects are compulsory for all students and are aligned with the aspiration to provide general education for everyone. The core subjects are: Bahasa Malaysia, English, Islamic education (for Muslim students), moral education (for non-Muslim students), mathematics, science, history, geography, living skills, physical education and health care, and arts education. The Ministry also offers additional subjects, such as Mandarin, Tamil, and Arabic for communication, which are not compulsory. After three years of schooling, students sit another examination, the Lower Secondary Assessment (Penilaian Menengah Rendah - PMR[4]). Again, regardless of the students' academic performance they continue their studies to the upper secondary school.

At upper secondary school level, from age 16 to 17-years-old, the Ministry provides students with different study streams, academic, technical, vocational, and Islamic. At this level, students also choose which field of study they want to pursue in tertiary education. There are two academic streams, arts (humanities) and science. Students can also choose to continue their studies in either a technical, or a vocational stream. The core subjects at upper secondary school level are similar to core subjects at the lower secondary school level. Science is one of the core subjects at this level for students in art, vocational, and Islamic studies streams. Before they graduate from upper secondary school, they sit Malaysian Certificate of Education (Sijil Pelajaran Malaysia - SPM), which is equivalent to The British General Certificate of Secondary Education (GCSE).

At the post-upper secondary school level, students have the opportunity to pursue their studies at tertiary level or join the workforce. If they choose to continue their studies in school, after two years they have to sit another examination – Malaysian Higher School Certificate (Sijil Tinggi Pelajaran Malaysia - STPM) equivalent to General Certificate of Secondary Education (GCSE 'A' Level). At this level, students can choose to study any five subjects on offer at this level, and General Studies. Most schools stream their students into science, arts (humanities), or Islamic studies. The subjects can be categorized into three fields, language and literature, social studies and Islamic studies, sciences and mathematics (MOE, 2011). Students can also pursue their studies at the tertiary level where they choose to enter the matriculation or join certificate/diploma programmes offered by polytechnics and private or public universities.

[4] Penilaian Menengah Rendah (Lower Secondary Assessment) is a Malaysian national examination taken by Form Three students.

Science is a compulsory subject from primary school upwards. It has a long history in the Malaysian education system, since independence from Britain. Changes to the curriculum and in teaching approaches have grown steadily to meet demands to create a critical mass of science and technology labour for a knowledge-based economy. The Malaysian government is committed to producing citizens who are competent in science and technology, with good scientific skills, attitudes, and who are able to cope with the rapid advances in science and technology. The development of science education in Malaysia is presented in the following section.

2.2 The development of science education in Malaysia

The importance of science education in improving the standard of living is highlighted in the Higher Education Planning Committee Report 1966 (clause 100):

> *The importance of science and technology in developing both resources (human and natural) cannot be denied. A strong foundation in science subjects with sufficient human capacity to specialise in various fields of science is important, not only for research, but also for development (Meerah, 1999, p. 10).*

Science education in Malaysia has changed gradually since its introduction during the British colonial era from 1786 until 1957 (Lee, 1992). In 1939, the government of Straits Settlement (Penang, Malacca, and Singapore) and Malay States established a committee to change science education and the science curriculum. Initially, the government introduced general science for only four years in secondary schools. In 1948, there was only one school in the Malay States that offered science, and during the Second World War (WW2), science education was terminated. After the war, science education based on the British curriculum was reintroduced in all schools in the Malay States and Straits Settlement.

After Malaysia gained independence from Britain in 1957, science was taught as nature studies, hygiene, and agriculture. However, as science and technology was considered important for boosting the economy and for social development, science education was expanded and strengthened to cope with the demands. The importance of science education was emphasised through several policies, such as: The Second Malaysia Plan, Razak Education Committee (1956), and Cabinet Committee of Education (1979).

In the late 1960s, the Ministry of Education implemented a number of strategies to improve the ity of science education. One strategy reformed the science curriculum through a number ojects. Strategies included: the Special Science Project for Primary Schools (Projek Khas

Sekolah Rendah); an Integrated Science Syllabus for Lower Secondary Schools (Kurikulum Sains Paduan Sekolah Menengah Rendah); the Modern Science Curriculum for Secondary Schools (biology, physics, chemistry, and science); Kurikulum Sains Tulen Moden (Biologi, Fizik, Kimia, dan Rampaian Sains); the New Primary School Curriculum (Kurikulum Baru Sekolah Rendah-KBSR); and the Integrated Curriculum for Secondary Schools (Kurikulum Bersepadu Sekolah Menengah - KBSM) (Lee, 1999).

The Special Science Project for Primary Schools aimed to overcome the weaknesses in science learning among students, especially at primary school level. The two main objectives of this project were to ensure that all students learned science and mathematics appropriate to their age through experiencing it, conducting investigations, and developing their own conceptions by the use of logic. The second objective was to ensure that all students were able to memorise scientific facts and acquire basic science skills. The Ministry introduced a new syllabus that emphasised suitable science content (facts, terms, and concepts) and planned appropriate teaching and learning activities that were suitable for the achievement of the learning objectives (Meerah, 1999).

Traditionally, since the 1950s, the science curriculum for secondary schools has emphasised scientific facts and concepts, which changed in the 1960s to vague curriculum goals that only listed topics and gave instructions for laboratory work (Meerah, 1999). Students who experienced this science curriculum had to memorise scientific facts rather than understand the concepts of science itself. The involvement of students in laboratory work focused on fostering their manipulative skills, rather than improving their scientific skills. This curriculum was also unable to provide actual science practice, because the main concern of science education was to prepare students for examination (Meerah, 1999).

In 1969, the ministry took progressive action and reformed the curriculum. In 1969, the Integrated Science Syllabus (adapted from the Scottish Integrated Science) for lower secondary schools was implemented with the Ministry introducing the syllabus at the lower secondary school level. In 1972, the Ministry introduced modern chemistry, modern physics, and modern biology for science students at the upper secondary school level, using a syllabus from the British Nuffield Science O-Level project. In 1974, the Ministry adapted and implemented the General Modern Science Curriculum from the British Nuffield General Science project at the upper secondary school level for students who studied in the arts stream. The aims of introducing the new curricula were to upgrade the science content by using suitable local materials, implementing inquiry discovery approaches as teaching and

learning activities, and broadening the understanding of scientific concepts and their application in real life situations. There were three main reasons for adapting and implementing the new curricula. Firstly, the objective of the science curriculum was to be relevant to current development and daily activities. The approach was consistent with the philosophy of a modern lifestyle. Secondly, the education system in Malaysia was influenced by the British education system; therefore, the Ministry relied on British expertise to provide support, training, and preparation in implementing the curricula. Thirdly, the Ministry believed that adapting the existing curricula was sufficient rather than inventing a new one, as Malaysia did not have enough expertise at the time to develop a new science curriculum (Lee, 1992). It was decided that the language of instruction would be English.

In 1983, the Ministry implemented a new primary school curriculum (KBSR), nationally. The major concern of this curriculum was to ensure that all students could grasp the basic skills of literacy and numeracy. It also focused on the development of students' intellectual, physical, spiritual, and emotional talents, and on their attitudes and aesthetic values by using a holistic approach. The Ministry combined science with other subjects, such as, history, geography, health, and civic studies to form a new subject called 'Man and His Environment' (Alam dan Manusia). In 1982, the Ministry introduced this subject to students in primary school (age 10 to 12-years-old). The students were taught about abiotic components (energy, water, air, shape, and electricity), the environment, types of diseases, the respiratory system, the reproductive system, and a healthy diet. The purpose of introducing this subject was to expand students' knowledge and understanding regarding the interactions of humans with their environment. The teachers used the national language (Bahasa Malaysia), to instruct the students, which aimed to create a Malaysian identity and unity (Daniel, 2005).

However, in 1994 this subject was switched to science because the Ministry encountered a lot of problems at the implementation stage (Meerah, 1999). Teachers and students experienced problems, with teachers claiming that the in-service training programme was insufficient and they were unprepared to teach the new subject. They claimed that the subject itself was tough and only suitable for high achievers (Seth & Ismail, 1993).

In 1994, the Ministry introduced science to year four (age 10-years-old) to replace the 'Man and His Environment' subject. Science provides opportunities for students to learn about themselves and their environment through everyday experiences and scientific investigations the Ministry believed that its aims were to prepare students with sufficient background wledge and skills to continue with their studies at the lower secondary school level (MOE,

2003a), where their knowledge and skills would continue to be nurtured and strengthened. The MOE hoped that through KBSR, students would develop positive attitudes towards science, levels of achievement would be enhanced, and enrolments would increase.

The Ministry introduced the Integrated Curriculum for Secondary Schools (science) after seven years of the implementation of KBSR. In agreement with the National Philosophy of Education, the aim of science in KBSM was to foster scientific skills and knowledge and also to nurture scientific thinking and promote noble values, so the students would appreciate and understand the application of science in real life. The new curriculum focused, not only on knowledge and skills, but also on the abilities of the students to solve everyday problems in order to become responsible citizens (Meerah, 1999).

In summary, the science curriculum in Malaysia has undergone several changes since independence. There have been significant changes in term of aims, contents, and teaching approaches, influenced by views regarding science and science learning. Rapid technological changes and the demand to produce a mass of science knowledge and technology labour for the knowledge-based economy have influenced the development of the curriculum and changed the policy in terms of teaching approaches and language of instruction. A description of The Integrated Science Curriculum for Secondary Schools in Malaysia follows.

2.3 The Integrated Curriculum for Secondary Schools (Science)

The Integrated Curriculum for Secondary Schools (Science) offers three core and four elective science subjects (MOE, 2002a). The science subjects are science at the primary school level, science at the lower secondary school level, and science at the upper secondary school level. The elective science subjects are physics, chemistry, biology, with additional science offered to students at the upper secondary school level. The aims of introducing core science subjects for primary and lower secondary school are to "...provide students with basic science knowledge, prepare students to be literate in science, and enable students to continue their science education at the upper secondary level..." (MOE, 2002a, p. 1).

The aims of core science subjects at the upper secondary level are to "...produce students who are literate in science, innovative, and able to apply scientific knowledge in decision making and problem solving in everyday life..." (MOE, 2002a, p. 1). The Ministry offers the elective science subjects to "...prepare students who are more scientifically inclined to pursue the study of science at the post-secondary level..." (MOE, 2002a, p. 1). At the upper

secondary school level, practical work becomes more common, especially in elective science subjects (MOE, 2002a).

As well as the aims, the Ministry has developed detailed science curriculum specifications for each science course. The curriculum specifications used at the lower secondary school level are, *Integrated Curriculum for Secondary Schools Curriculum Specifications Science Form One* (MOE, 2002b), *Integrated Curriculum for Secondary Schools Curriculum Specifications Science Form Two* (MOE, 2002a), *and Integrated Curriculum for Secondary Schools Curriculum Specifications Science Form Three* (MOE, 2002c). These are formal documents used by science teachers to teach science.

In 2003, the fourth Prime Minister, Tun Dr. Mahathir Mohammad, introduced a new policy: English for Teaching Mathematics and Science (ETeMS). The policy began in year one at primary school level, at form one at secondary school level, and in lower sixth classes (pre-university). The Ministry acknowledged that science and mathematics were important to the development and modernisation of a country, and they gave science a high priority because of the increasing and rapid development in both fields. Thus, it was important to keep citizens abreast of rapid changes in order to fulfil the 2020 vision through education (Mohammad, 1997). English became the language of instruction for both subjects to allow students to tap into knowledge from a wider range of sources. They can obtain information about science and mathematics in English in different contexts, which helps them to understand more about the developments in science and technology, giving them access to knowledge beyond the confines of their classrooms. In addition, they have more opportunity to use English to communicate, which increases their proficiency in the language (MOE, 2002a).

Over the past decade, MOE has developed strategies to implement the new policy. In order to produce science teachers who are competent to teach science in English, in-service teachers are provided with support, especially in upgrading their proficiency in the English language. The language of instruction in pre-service teacher programmes is now English. The textbooks and other teaching resources have been translated into English. MOE has encouraged teachers to utilise Information Communication Technology (ICT) by providing a teaching course as one of the teaching aids to help teachers integrate ICT in their lessons. They have translated and upgraded the curriculum in English.

The science curriculum is organised around several themes and each theme comprises several learning areas. Each learning area has a number of learning objectives and each

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The science curriculum is organised around several themes and each theme comprises several learning areas. Each learning area has a number of learning objectives and each

learning objective has one or two measurable learning outcomes. The Ministry has based the outcomes on the cognitive and affective domains of knowledge, understanding, application, analysis, synthesis, and evaluation. The affective domains includes "to be in awe, to be aware of, to be appreciative, to be thankful, to love, to practise, and to internalise" (MOE, 2003b, p. 3). The Ministry has integrated the teaching of positive scientific attitudes and noble values into teaching and learning activities. Teachers can modify the suggested learning to suit student ability, learning style and availability of equipment. Teachers are also encouraged to design teaching and learning activities that can achieve the learning outcomes. Teachers are provided with notes to remind them of the learning objectives and check the meaning of scientific terms.

The Curriculum Development Centre has planned the science curriculum in detail to ensure achievement of learning outcomes. For example, Figure 2-1 shows the details of the form Two Science Curriculum Specification (MOE, 2002c, p. 16).

THEME: MANAGEMENT AND CONTINUITY OF LIFE

LEARNING AREA: 1. THE WORLD THROUGH OUR SENSES

Learning Objectives	Suggested Learning Activities	Learning Outcomes	Notes	Vocabulary
1.1 Understanding the sensory organs and their functions.	Carry out activities to make connection between the five senses, the sensory organs and the stimuli. Discuss what happens in our body after a stimulus is detected.	A student is able to: • identify and relate a sensory organ to its stimulus, • state the pathway from stimulus to response: Stimulus→ Sensory organs → Nerves→ Brain→ Nerves → Response	The five sensory organs have been introduced in Primary Science.	brain – *otak* nerve – *saraf* response – *gerakbalas* stimuli – *rangsangan* sensory organ – *organ deria*
1.2 Understanding the sense of touch.	Carry out activities to study the following: a) structure of the human skin involved in stimuli detection, b) sensitivity of the skin at different parts of the body towards stimuli. Discuss the sensitivity of the skin in connection to the following situations: a) receiving an injection, b) using Braille.	A student is able to: • identify the structure of the human skin involved in stimuli detection, • state the function of different receptors – pressure, heat, pain, • draw conclusion on the sensitivity of the skin at different parts of the body towards stimuli.	The structures of the receptors are not required.	cold – *kesejukan* heat – *kepanasan* pain – *kesakitan* pressure – *tekanan* receptor – *hujung saraf* sensitivity – *kepekaan* skin – *kulit* touch – *sentuhan*

Figure 2-1: Details of the curriculum specification for Form Two Science Curriculum (MOE, 2002a, p. 16)

2.3.1 The organisation of the content

The science content is organised into the different areas of science, biology, physics, chemistry, and astronomy. The themes are:

i. Introducing science
ii. Man and the variety of living things
iii. Matter in nature
iv. Maintenance and continuity of life
v. Force and motion
vi. Energy in life
vii. Balance and management of the environment
viii. Technological and industrial development in society
ix. Astronomy and space exploration (MOE, 2003b, p. 5).

The number of themes for each form-level is different. In form one, there are four themes; *Introducing Science, Man and the Variety of Living Things, Matter in Nature,* and *Energy*. Form two has five themes out of nine themes from the integrated science curriculum at lower secondary school level. These are; *Management and Continuity of Life, Man and the Variety of Living Things, Matter in Nature, Force and Motion,* and *Technological and Industrial Development in Society* (MOE, 2002a, p. iii). In form three, there are five themes; *Management and Continuity of Life, Matter in Nature, Energy in Life,* and *Astronomy and Space Exploration* (MOE, 2002c, p. iii).

Students learn similar themes in each area of science. The learning areas in each theme are organised according to the complexity of the theme. For example, in form one; students cover the first learning area, which is *The Cell as a Unit of Life in Man* and *the Variety of Living Things* (MOE, 2003b). Then in a similar theme, students learn about *The Variety of Living Things and their Classification* in form two, where they learn about cells as building blocks of an organism and, in the next learning area, about the diversity of organisms that includes animals and plants. The themes aim to provide an understanding of human beings and biological entity.

2.3.2 The learning aims

The aim of the Malaysian science curriculum is to develop active learners. The Ministry expects students to participate in teaching and learning activities that will help them to develop science concepts, gain scientific skills, and that foster positive scientific attitudes and noble values. In addition, the activities should be "geared towards activating students' critical and ative thinking skills and not be confined to routine or rote learning" (MOE, 2003b, p. 3). stly, students acquire scientific knowledge so that they can make decisions in their daily