THE RELATIONSHIP BETWEEN CLASSROOM AND LABORATORY LEARNING ENVIRONMENT WITH ATTITUDE TOWARDS LEARNING SCIENCE AMONG LOWER SECONDARY SCHOOL STUDENTS

by

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LIST OF ABBREVIATIONS

AMOS	Analysis of Moment Structures
AVE	Average Variance Extracted
CB-SEM	Covariance-based Structural Equation Modeling
CFA	Confirmatory Factor Analysis
CFI	Comparative Fit Index
HOTS	Higher Order Thinking Skills
IFI	Incremental Fit Index
KSSM	Kurikulum Standard Sekolah Menengah
KSSR	Kurikulum Standard Sekolah Rendah
MOE	Ministry of Education
OECD	Organization for Economic Cooperation and Development
PISA	Programme for International Student Assessment
PPSMI	Pengajaran dan Pembelajaran Sains dan Matematik dalam Bahasa Inggeris
RMSEA	Root Mean Square Error of Approximation
SEM	Structural Equation Modeling
SLEI	Science Laboratory Environment Inventory
SRMR	Standardized Root Mean Square Residual

STEM	Science, Technology, Engineering and Mathematics
STI	Science, Technology and Innovation
TIMSS	Trends in International Mathematics and Science Study
TOSRA	Test of Science-Related Attitude
TPB	Theory of Planned Behaviour
WIHIC	What Is Happening In this Class?

LIST OF APPENDICES

HUBUNGAN ANTARA PERSEKITARAN PEMBELAJARAN BILIK DARJAH DAN MAKMAL DENGAN SIKAP PEMBELAJARAN SAINS DALAM KALANGAN PELAJAR MENENGAH RENDAH

ABSTRAK

Persekitaran pembelajaran bilik darjah dan makmal merupakan faktor penting dalam pembentukan sikap pembelajaran sains dalam kalangan pelajar menengah rendah. Ini kerana pelajar-pelajar menghabiskan kebanyakan masa pembelajaran dalam bilik darjah dan makmal. Kajian ini mentaksir hubungan antara bilik darjah dan makmal dengan sikap pembelajaran sains. Peranan jantina sebagai moderator juga ditaksir secara serentak. Soal selidik yang digunakan dalam kajian ini adalah terdiri daripada tiga set soalan soal selidik iaitu *Test of Science-Related Attitude (TOSRA), What Is Happening In this Class? (WIHIC)* dan *Science Laboratory Environment Inventory (SLEI)*. Berdasarkan hasil kajian rintis, item-item yang sesuai digunakan dalam kajian adalah 10 item daripada TOSRA, 10 item daripada SLEI dan 20 item daripada WIHIC. Kajian ini melibatkan 465 pelajar dari bandar dan luar bandar. Kaedah *covariance-based structural equation modeling* telah digunakan untuk mentaksir hubungan antara persekitaran pembelajaran dengan sikap pembelajaran sains. Hasil kajian menunjukkan kedua-dua persekitaran pembelajaran bilik darjah dan makmal mempunyai kesan terhadap sikap terhadap inkuiri sains. Walau bagaimanapun, hanya persekitaran pembelajaran bilik darjah sahaja yang mempunyai kesan terhadap kesenorokan dalam pembelajaran sains. Hasil kajian juga menunjukkan bahawa jantina tidak berperanan sebagai moderator dalam hubungan antara persekitaran pembelajaran dan sikap pembelajaran sains (diwakili oleh sikap

terhadap inkuiri sains dan keseronokan dalam pembelajaran sains). Kesimpulannya, kajian menunjukkan bahawa guru-guru perlu sentiasa menyesuaikan diri dalam situasi pengajaran yang berbeza-beza dan tidak terbatas kepada kekurangan sumber seperti makmal sains yang serba kekurangan.

THE RELATIONSHIP BETWEEN CLASSROOM AND LABORATORY LEARNING ENVIRONMENT WITH ATTITUDE TOWARDS LEARNING SCIENCE AMONG LOWER SECONDARY SCHOOL STUDENTS

ABSTRACT

Classroom and laboratory learning environment are important factors in the formation of positive attitude towards learning science among lower secondary students. This is because the students spend most of their learning time in these settings during school hours. In this study attempt was made to assess the relationship between classroom and laboratory learning environment with students' attitude towards learning science. Simultaneously, the role gender as a moderator was assessed as well. For this purpose a survey was conducted using three different sets of adapted questionnaires: Test of Science-Related Attitude (TOSRA); What Is Happening In this Class? (WIHIC) and Science Laboratory Environment Inventory (SLEI). The pilot study results revealed that TOSRA with 10 items; SLEI and WIHIC with 10 and 20 items respectively were appropriate to be used in the real study. A total of 465 students from both urban and rural schools participated in the real study. Covariance-based structural equation modeling was employed to examine the relationship between the exogenous variables and the endogenous variables. The findings of this study revealed that both classroom and laboratory learning environment had significant direct effects on students' attitude towards scientific inquiry. However, only classroom learning environment had significant direct effects on students' enjoyment of science lessons. The findings also concluded that there were no moderating effects of gender on the relationship between learning environments and attitude towards learning science

(represented by attitude towards scientific inquiry and enjoyment of science lessons). The findings inform the teachers should stay adaptable in any situations to improvise ways in imparting science concepts to students and not to be restricted by the lacking of physical resources such as under-equipped laboratories that might hinder the teaching and learning processes.

CHAPTER ONE

INTRODUCTION

1.0 Introduction

Workplace in the 21st century very much emphasizes on the ability of the workers as creative problem solvers besides having good communication skills and self-management skills (Osborne, 2013). In this context education of the nation is one of the key players in determining its success. The education system has to cater to the transition process of producing future knowledgeable and skillful workforce to face the challenges of the 21st century. The 21st century puts a premium on workers who possess critical and analytical skills. As such it is imperative for the current students to be taught on 21st century skills to fulfill the needs of future global work force (Osborne, 2013).

However, in science education, contradicting trends were reported. For instance, in a research done in US, it was found that only 14 % of the lessons had infused the element of constructive criticism and included challenging ideas during teaching and learning of science and mathematics (Weiss, Pasley, Seam Smith, Banilower, & Heck, 2003). In most cases science concepts have been often presented as the 'final form' of knowledge which is not contested and teachers usually reiterate the science knowledge in the final form during the teaching (Duschl, 1990). In Malaysian context the current form of assessment which emphasizes on examinations has impeded the young minds from further exploring the knowledge beyond the requirement of the examination. As the world ushers into the 21st century, students

who do not possess functional and critical thinking skills will be ill-equipped to survive in a competitive working environment (Donovan, Green, & Mason, 2014).

In realization of this pressing concern Malaysia has embarked on an education transformation plan to enhance the quality of education in general and this includes science education. Under the Malaysian education transformation plan, a comprehensive review of the national education system was conducted with an objective to develop the National Education Blueprint 2013-2025. The development of a standard-based curriculum that is on par with international benchmarks is one of the initiatives with the aim of providing students with 21st century learning and knowledge. This includes incorporating Higher Order Thinking Skills (HOTS) in teaching and learning (MOE, 2013). The seriousness of the government in this matter is also reflected from the on-going review of the Science, Technology and Innovation (STI) policy by the National Science Council under the Prime Minister's Department (OECD, 2014).

In tandem with the Malaysian government's aspiration in developing scientific community this study intends to investigate the factors that are instrumental in developing the students' attitude towards learning science. A more positive attitude will increase the motivation and intention to learn science among students (Potvin & Hasni, 2014; Raved & Assaraf, 2011). For the past decades various attempts have been made by researchers around the world to investigate attitude towards learning science. It was highlighted that among the crucial variables that influence the attitude towards learning science are classroom learning environment, science laboratory learning environment, effective teaching practices and science curriculum content (Barmby, Kind, & Jones, 2008; Chen, Lin, Wang, Lin, & Kao, 2012; Fraser, 2012; Osborne, Simon, & Collins, 2003; Potvin & Hasni, 2014). And for gender, inconsistent results

were reported on gender effect on the attitude towards science. Quek, Wong, and Fraser (2005) reported significant differences between males and females in the learning environment and attitude. Females were found to have a more positive perception towards learning environment (Goh & Fraser, 1998; Koul, Fisher, & Shaw, 2011; Wahyudi & Treagust, 2004). However, males were found to be more positive in attitude towards science (Liu, Hu, Jiannong, & Adey, 2010; Cherian & Shumba, 2011; Francis & Greer, 1999).

All these studies were conducted separately, focusing on only one of the independent variables and the attitude towards learning science. Realizing the need to galvanize the research area involving factors that influence attitude towards learning science this study intends to generate a model that explains students' attitude towards learning science based on classroom learning environment and science laboratory learning environment. The model is derived from the covariance-based structural equation modeling (CB-SEM) using AMOS. The model attempts to link the different variables and investigate the significant effects that they have on each other. The findings from a valid model could be a guide for teachers as they seek to improve the outcomes of the students through increased motivation to learn science among students with a positive attitude.

1.1 Background of the study

As a developing nation aspiring to be fully developed in 2020 Malaysia is in need for more professionals in Science, Technology, Engineering and Mathematics (STEM). The positive correlation between improvement in economic growth and improvement in science expertise highlighted the urgency to set the nation's path right from the beginning. The implementation of the 60:40 ratio (Science: Non Science) for

the streaming of students into different fields in Form Four is one of the strategies to produce more scientists or workforce which has the expertise in science and technology. However, the enrolment of students in STEM related fields is undergoing a steady decline over the years. Statistics presented by the Academy of Sciences Malaysia painted a gloomy picture of our progress in encouraging more students to enrol in STEM related fields (Academy of Science Malaysia, 2015). In 2010, the ratio of science to non-science students was 48:52. But in 2014, it was reported that the ratio stood at 47:53 with only 29% of Form 5 enrolled in the pure science stream (Academy of Science Malaysia, 2015). The obvious decline of interest in science among students poses a difficult challenge to the current government in filling up the talent gap in the workforce that will become wider if it is not tackled with a sense of urgency.

In addition, there are many findings that showed that the quality of Malaysian students enrolled in science stream is deteriorating as well. These are shown by the poor performance by Malaysian students in international assessments such as Programme for International Student Assessment (PISA) and Trends in International Mathematics and Science Study (TIMSS). In PISA 2012, Malaysian students have scored below the global average. According to the results, Malaysia only scored 420 in Science compared to the global average score of 501 in science. In terms of ranking, Malaysia is lying in the bottom third. Nearly half of the 15- years old Malaysians failed to meet the minimum international standards in science. Similarly, Malaysia's performance in TIMSS indicates that the quality of our students' performance has deteriorated ever since the very first participation in 1999 (Academy of Science Malaysia, 2015).

In Malaysian education system the lower secondary level is a very crucial transition period for science education. During this period they have to make important

decisions on the direction of their involvement in science education at the upper secondary level. However, it is at this stage that the students tend to change their mind to not to learn science by choosing arts stream (Talib, Luan, Azhar, & Abdullah, 2009). This subsequently creates a large vacuum in students taking up science related courses at higher levels. This phenomenon is not new in science education literature as there are many existing studies, as early as 2003, which reported that many students begin to show disinterest in science at this crucial stage (Lindahl, 2003; Osborne, Simon, & Collins, 2003). In a review by Christidou (2011) it was suggested that students rapidly lose their interest in science as they advance from primary to secondary education and distancing themselves from the aspirations to succeed in science. Unfavourable learning environments have been cited as one of the causes that leads to the decline in students' attitude towards learning science (Chen et al., 2012; Wolf & Fraser, 2008).

Attitude is an important variable that influences science learning (Koballa & Crawley, 1985). Attitude towards learning science is a multidimensional construct. Hillman, Zeeman, Tilburg, and List (2016) presented attitude towards science in four dimensions (attitude towards the subject of science, desire to become a scientist, value of science to society and perception of scientist). Simpson and Troost (1982) reduced the dimensions of attitude towards science into a five factor model which includes measuring the extent the science class was motivating, the intensity of self-learning in science, the influence of family and peers and the extent that science was enjoyable. Fraser (1978) in his well-known questionnaire Test of Science-Related Attitudes (TOSRA) justified that attitude towards science is a multidimensional construct because the scales in the instrument showed low intercorrelation. TOSRA measures attitude as students' perceptions about the social implications of science, the norms working as a scientist, attitude towards scientific inquiry, adopting scientific attitudes,

the level of enjoyment of science lesson, leisure interest in science related activities and interest in pursuing a science-related career in the future.

Recognizing the importance of attitude various attempts were made to measure and to identify the factors that influence attitudes (Fraser & McRobbie, 1995; Barmby et al., 2008; Chen et al., 2012; Tytler, 2007; Osborne & Collins, 2001). Throughout the history of this attitudinal research a number of factors have been suggested as factors that contribute to the formation of positive attitude towards learning science among students. Among the most frequently investigated factors are learning environments (Fisher & Khine, 2006; McRobbie & Fraser, 1993; Fraser, Aldridge, & Adolphe, 2010; Aldridge, Fraser, & Huang, 1999; Khoo & Fraser, 2008; Baek & Choi, 2002; Kim, Fisher, & Fraser, 2000; Lee, Fraser, & Fisher, 2004) and gender (Bybee & McCrae, 2011; Barmby et al., 2008; Liu et al., 2010)

Classroom learning environment in the school has been outlined in many studies as a major factor that influences attitude (Fraser, 2012; Chen et al., 2012; Myers & Fouts, 1992). Classroom learning environment is a component whereby both the environment and its interaction with the individuals will determine the human behaviour (Walberg & Anderson, 1968; Moos & Trickett, 1974; Fraser, 1986). It includes the nature of the activities and interactions that take place during science lessons and how these activities and interactions influence the way students perceive science, both affectively and cognitively. Activities which encourage the nurturing of meaningful bonds during different tasks in the classrooms learning such as investigations, discussion and presentations form a major part in classroom learning environment (Fraser, 1986).

Science learning in schools also takes place in science laboratories. Numerous studies have pointed out the positive relationship that science laboratory learning

environment has with attitude towards learning science (Fraser & McRobbie, 1995; Henderson & Fisher, 1998; Fisher, Harrison, Henderson, & Hofstein, 1998). The hands-on experience in science laboratory during science learning activities is an important element in promoting positive attitude towards learning science because integration of scientific knowledge can take place live in front of the students (Fisher et al., 1998). Science laboratory learning environment is an environment whereby students conduct experiments during practical work to investigate the scientific concepts (Moeed, 2015). Science laboratory learning environment provides a safe and organized space to develop students' scientific view through investigations in the laboratory which involves manipulation of materials in the laboratory and integration of knowledge with their hands-on practical tasks.

Previous research studies have identified that attitude towards science is significantly different across gender (Osborne, Simon, & Collins, 2003). These were reported in studies by Schibeci (1984), Becker (1989) and Weinburgh (1995). It was suggested that boys consistently have more positive attitude towards learning science than girls especially in physics (Becker, 1989; Weinburgh, 1995). The outcome of the extensive literature on the subject since the 1980s suggested that girls' attitude towards science is less positive compared to boys (Osborne et al., 2003). However, some evidences in the more recent studies showed that girls are starting to be interested in careers in science and are confident in enrolling for science courses (Colley, Comber, & Hargreaves, 1994; Havard, 1996). Hence, this area concerning the influence of gender towards attitude towards learning science still needs more conclusive results.

1.2 Problem Statement

For the past many decades extensive researches have been conducted on students' attitude towards learning science. It was shown that the quality of the classroom environment in schools is one of the major significant determinants of students' attitude towards learning science (Fraser, 2012). It was also highlighted by Chen et al. (2012) who reported that classroom environment has direct effects on attitude towards learning science. Findings which pointed out the effects of learning environment have on the learning outcomes of the students are aplenty as well. This was evident in the studies conducted by Margianti, Fraser, and Aldridge (2001) and Fraser and Chionh (2000).

However, studies conducted in Malaysia so far regarding to the affective component in science learning such as the enjoyment of science lessons were found to be not comprehensive (Talib, Luan, Azhar, & Abdullah, 2009). Some of the researches that were conducted which relates to the learning of science are investigating aspects such as relationship between students' achievement and attitude (Kamariah et al., 2010), language influence on students' understanding (Loo, 2007), problems with visual analysis and translation in science concepts (Subahan, 1996) and application of science process skills (Najib, 1999). Other studies conducted in Malaysia which touched on attitude towards science is more specifically related to a pure science subject. For example, Yunus and Ali (2013) conducted a research to study on attitude towards learning chemistry among secondary school students in Malaysia. It was shown that generally there was a lack of studies being conducted on the attitude towards learning science among the lower secondary students focusing on enjoyment of science and scientific inquiry. Hence, this study aims to fill in this gap which exists in Malaysia educational settings.

Learning of science takes place in both classrooms and also school science laboratories. Therefore, science laboratory learning environment is a unique element which is not documented in other fields. It incorporates an environment which encourages students to collaborate as they investigate scientific phenomena and relationships (Hofstein & Lunetta, 1982; Lunetta, 1998). Due to this nature school science laboratory's role in promoting positive science attitude has been well documented in many previous studies. For example, in a study by Fraser and McRobbie (1995) significant associations between the nature of laboratory environment and several attitudinal outcomes were highlighted.

In addition, there were also studies being conducted to examine the effects of science laboratory learning environment on students' attitude towards learning science. These include a study that assessed the learning environments in senior science laboratories (Henderson & Fisher, 1998) and a study that assessed laboratory learning environments and practical tasks in science classes (Fisher et al., 1998). However, it was highlighted that most of the studies on the science laboratory learning environment have often focused on the how to improve the science laboratory and the perceptions that students and teachers have on the science laboratory environment (Che Ahmad et al., 2013). There lacks concrete studies that relate attitude and scientific inquiry despite the notion science inquiry forms the integral component of KSSM syllabus and inquiry also an important dimension in 21st century learning environment.

Gender has been one of the focal point in many researches in science education. For decades, educational research has reported the differences in attitude between boys and girls in science education. However, the inconclusive results reported for the past decades highlighted the need for further investigations in different perspectives. Some researchers argued that males are perceived to possess more positive attitude towards

science (Weinburgh, 1995; Hill, Corbett, & St. Rose, 2010). At the other end of the spectrum, there are also results showing that girls tend to be more positive in their attitude towards science (Wahyudi & Treagust, 2004; Skamp, 1989). All these studies hypothesized gender as a factor that directly influenced attitude towards learning science. However, the results were divergent with no conclusive trend being observed. In recent times, it was suggested that there was no gender gap in science education (Koul et al., 2011; Scantlebury, 2012). Hence, this study intended to re-examine the role of gender by assessing its role as a moderating factor.

Studies which involve attitude towards learning science have always been on the radar of most education researchers. This is not surprising considering the influence that attitude has on the motivation and intention of students to learn science. However, most of the past studies were focusing only one or two of the aforementioned factors (Barmby et al., 2008; Chen et al., 2012; Fraser, 2012; Osborne et al., 2003; Potvin & Hasni, 2014). This leads to a gap in understanding how these factors influence the attitude towards learning science when being investigated simultaneously. It was pointed out that the body of knowledge in this field lacks a structure that has the ability to illustrate accurately the big picture of how different factors influence attitude towards learning science simultaneously (Osborne et al., 2003). Judging from these observations this study aims to generate a model that can describe the whole matter of concern in a single structure. The different equations of the relationships between the variables can be explained empirically in the model which then informs us about the comparative strength of relationships each of the variables has. Hence, this study was utilizing covariance-based structural equation modeling to generate the empirical evidence to explain the model.

1.3 Research Objectives:

The general objective of this research is to assess the relationship between classroom and laboratory learning environment with the students' attitude towards learning science (represented by attitude towards scientific inquiry and enjoyment of science lessons) and to investigate the role of gender as a moderating factor in these relationships. Based on these variables a model that explains students' attitude towards learning science was developed. Among the specific objectives of this research are to examine:

1. the effects between classroom learning environment and attitude towards scientific inquiry.

2. the effects between science laboratory learning environment and attitude towards scientific inquiry.

3. the effects between classroom learning environment and enjoyment of science lessons.

4. the effects between science laboratory learning environment and enjoyment of science lessons.

5. the moderating effect of gender for the relationship between classroom learning environment and science laboratory learning environment with attitude towards scientific inquiry.

6. the moderating effect of gender for the relationship between classroom learning environment and science laboratory learning environment with enjoyment of science lessons.

1.4 Research Questions:

1. Is there any significant direct effect of classroom learning environment on attitude towards scientific inquiry?

2. Is there any significant direct effect of science laboratory learning environment on attitude towards scientific inquiry?

3. Is there any significant direct effect of classroom learning environment on enjoyment of science lessons?

4. Is there any significant direct effect of science laboratory learning environment on enjoyment of science lessons?

5. Is there any significant moderating effect of gender for the relationship between classroom learning environment and science laboratory learning environment with attitude towards scientific inquiry?

6. Is there any significant moderating effect of gender for the relationship between classroom learning environment and science laboratory learning environment with enjoyment of science lessons?

1.5 Hypotheses:

Based on the research questions, the following hypotheses were formulated:

H_a1: There is significant direct effect of classroom learning environment on attitude towards scientific inquiry.

H_a2: There is significant direct effect of science laboratory learning environment on attitude towards scientific inquiry.

H_a3: There is significant direct effect of classroom learning environment on enjoyment of science lessons.

H_a4: There is significant direct effect of science laboratory learning environment on enjoyment of science lessons.

H_a5: There is significant moderating effect of gender for the relationship between classroom learning environment and science laboratory learning environment with attitude towards scientific inquiry.

H_a6: There is significant moderating effect of gender for the relationship between classroom learning environment and science laboratory learning environment with enjoyment of science lessons.

1.6 Significance of Research:

The present research intends to contribute to the science education by assessing the relationship between classroom and laboratory learning environment with students' attitude towards learning science in a structural model. Numerous previous studies focused on investigating the relationships between learning environments and attitude toward learning science by using either classroom learning environment or science laboratory learning environment but not both of them simultaneously. This research intends to fill the gap on the lacking of studies that collectively reports on the effect of classroom and laboratory learning on attitude towards learning science using structural equation modeling. The structural model also informative to assess the role of gender in attitude towards learning science.

In the newly implemented KSSM emphasis has been placed on learner-centred approaches and also personalized education with more implementation of problem-

solving based projects (MOE, 2013). It also encourages inquiry method in the teaching and learning of science in secondary school. Among the student-centred approaches are constructivism, problem-based learning, mastery learning and other related teaching strategies (MOE, 2016). According to the standards all experiments that are described have to be conducted using inquiry approach. In this study, attitude towards learning science is represented by the attitude towards scientific inquiry and enjoyment of science lessons. Therefore, the findings are relevant in Malaysia context as the information gathered can provide inputs and feedback to our policy makers as they strive to improve further on what has been implemented.

The identification of strong factors that influence the students' attitude toward learning science can help teachers in modifying their current practices to suit the needs of the students in the 21st century. The findings can also provide valuable inputs for teachers to design unique lessons which can accommodate to different groups of students as they seek to tackle the pressing concern of declining interest among students in pursuing science.

1.7 Limitations of the study:

Various factors determine individuals' attitude towards learning. In science education particularly, classroom learning environment, science laboratory learning environment, teaching practices and science content (Fraser, 2001; Wong & Fraser, 1996; Fraser & Lee, 2009; Osborne et al., 2003; Gibson & Chase, 2002; Osborne & Collins, 2001) dominates the research on attitude. And in the advent of digital learning, virtual learning environment and multimedia learning environment form the science learning environment in addition to home learning and outdoor learning environment

(Chou & Liu, 2005; Mayer, 2002; Braund & Reiss, 2006). However, in this research only classroom learning environment and science laboratory learning environment were investigated. The objective of such decision is to ensure a more focused and in depth study about these two major and more important factors which are very relevant to both students and teachers.

Fraser (1978) in his well-known questionnaire Test of Science-Related Attitudes (TOSRA) justified that attitude towards science is a multidimensional construct. This is because the scales in the instrument showed low intercorrelation. In TOSRA, there are a total of seven dimensions which measures attitude as students' perceptions about the social implications of science, the norms working as a scientist, attitude towards scientific inquiry, adopting scientific attitudes, the level of enjoyment of science lesson, leisure interest in science related activities and interest in pursuing a science-related career in the future. In this study, two dimensions, attitude towards scientific inquiry and enjoyment of science lesson, were chosen as the constructs to represent the attitude towards learning science. Peer and Fraser (2015) employed these two constructs from TOSRA as well in their research on learning environment and attitudes towards science in Singapore primary schools. Similarly, Oser and Fraser (2015) employed these two constructs in their study to measure high school students' attitude towards science. These two constructs have the ability to represent best the attitude towards learning science among lower secondary students compared to the other dimensions in TOSRA. The constructs, enjoyment of science lessons and attitude towards scientific inquiry, are closely related to the school elements such as science lessons and the scientific activities which are investigative in nature.

The sample of respondents is in the northern region of Malaysia and consists of lower secondary school students from Form 1 and Form 2 only. Therefore, the

results might not be able to represent the whole population of lower secondary students in Malaysia. Composition of students from different cultures in this study is not able to replicate the national ratio. The sample size which is in the region of 450-500 reaches the minimum standard to generate a valid model but might not be able to represent the overall situation in Malaysia.

1.8 Operational Definitions:

Attitude towards learning science

Attitude towards learning science is defined as students' emotional orientation or personal opinions towards learning science (Chen et al., 2012). Attitude towards learning science could be described as the level of enjoyment that the students experience when they are learning science in schools and the extent students obtain information about the natural world through scientific experimentation and inquiry. The constructs that were adapted for this study were attitude towards scientific inquiry and enjoyment of science lessons from the Test of Science-Related Attitude (TOSRA) (Fraser, 1981).

Attitude towards scientific inquiry

Attitude towards scientific inquiry is defined as students' towards scientific experimentation and inquiry as ways of obtaining information about the natural world (Fraser, 1981). Attitude towards scientific inquiry could be described as the level of students' preference in conducting experiments and investigation to learn science. It was shown through the tendency to find out more about scientific knowledge through hands-on activities instead of just purely through reading.

Enjoyment of science lessons

Enjoyment of science lessons is defined as the enjoyment which the students have during the science learning experiences (Fraser, 1981). Enjoyment of science lessons could be described as the level of students' excitement and joy in learning science in schools. It was shown through their level of interest in following the science lessons in school.

Classroom learning environment

Classroom learning environment is an environment which includes aspects such as intellectual, social, emotional and physical to facilitate students' learning process (Fraser & Fisher, 1983; Dorman, Fisher, & Waldrip, 2006). Classroom learning environment could be described as an environment which provides the avenue for students to nurture relationships among themselves and to cooperate as a group in completing the given tasks during science lessons. It also promotes the development of investigative skills during the learning activities. The constructs which were adapted from the What Is Happening In this Class? (WIHIC) for this were student cohesiveness, investigation, task orientation and cooperation (Fraser, McRobbie, & Giddings, 1993).

Science laboratory learning environment

Science laboratory learning environment is an environment whereby students work cooperatively to investigate scientific phenomena in laboratory practical work (Hofstein & Lunetta, 1982; Fraser, Giddings, & McRobbie, 1995; Moeed, 2015). Science laboratory learning environment could be described as an environment which develops students' scientific view by providing an avenue to conduct investigations in the laboratory which involves manipulation of materials in the laboratory and integration of knowledge with their hands-on practical tasks. Two constructs were

adapted from the Science Laboratory Environment Inventory (SLEI) for this purpose: material environment and integration (Fraser et al., 1995).

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

This chapter starts by looking at the history and development of science education in Malaysia since independence until the recent educational transformation under the Malaysia Education Blueprint (2013-2025). Section 2.2 reviews past studies on attitude towards learning science. Section 2.3 reviews previous studies which have been conducted in the area of learning environment. The focus of the review is on the classroom learning environment and science laboratory learning environment. Section 2.4 and 2.5 describes the associations between learning environments (classroom and science laboratory) and attitude towards learning science. Section 2.6 and 2.7 discusses gender differences in students' attitude towards learning science and their perceptions on learning environment. It explores the role of gender as a moderating factor in the relationship between classroom learning environment, science laboratory learning environment and attitude towards learning science in the present study. Section 2.8 explains the theories that describe the learning environment which consists of activity theory and situated learning theory and its relevance in this research. The theory of planned behaviour will also be discussed in relation to the construct attitude in the present study. Finally, Section 2.9 describes how the variables are interacting with one another and a model was suggested to explain it empirically.

2.1 Science Education in Malaysia

Malaysia envisioned to attain the status of fully developed nation by the year 2020 according to its own principles and values (Lee, 1999). Undoubtedly, the realization of this ambition requires the development in research and technology to support the industrialization in the country. In pursuing this aim quality education is an important element. One of the crucial components of education is the teaching of science in schools.

Science teaching in both primary and secondary can be categorized into two major components: science as a product and science as a process (Millar, 2004). Science as product basically emphasizes on the teaching of scientific facts, principles, theories and models. Meanwhile, science as a process is the promotion of students' skills in scientific methods and problem solving. However, immaterial of the components teaching of science faces a lot of challenges in the new century and need a reform to ensure its relevance (Bybee & Fuchs, 2006). They argued that the science teaching needs high quality teachers, coherent curricula and appropriate assessments to ensure its objectives are met.

In the Malaysian education system, the science curriculum was initially adopted from England. This gave rise to the concern of Malaysian students faced difficulties in engaging in science experiments which was very much influenced by the Western culture (Tan, 1991). The overemphasis on exams has changed the direction of teaching science from imparting and explaining everyday's phenomena to completing syllabus for the sake of good performance. In most lessons teachers prefer to explain the outcomes of scientific experiments without hands-on experiment (Sumintono, 2015). Realizing the importance of having a locally relevant curriculum,

the Curriculum Development Center was set up in 1972 to develop a robust curriculum to cater to the local needs (Tan, 1991).

In the next significant wave of change in the Malaysian science education was the implementation of PPSMI policy whereby English was used as the main medium of instruction for teaching science and mathematics in schools. After several years of implementation, researches have shown that PPSMI has failed to produce the benefits as being highly anticipated in the beginning stage (Chan & Tan, 2006; Phang, 2010). After much round table discussion with the stakeholders the government finally stopped the PPSMI policy and revert it back to the former system which used Bahasa Malaysia as the medium of instruction for science and mathematics in secondary schools. However, Dual Language Programme was initiated by the government to create a hybrid system which caters to all groups (PADU, 2015).

A significant decline in Malaysian students' performance in TIMMS has raised an alarm bell and the Ministry of Education has taken corrective measures to address this concern. One of the initiatives as stated in the Education Blueprint is to improve the current science curriculum (MOE, 2013). Another emphasis recommended in the blueprint is to cultivate 'high order thinking skills' (HOTS) in the curriculum. All these measures were suggested with the intention of improving the students' competitiveness as they face the challenges posed by other countries once they leave their formal education (MOE, 2013; Sumintono, 2015). Hence, new Standard Curriculum for Primary Schools, also known as Kurikulum Standard Sekolah Rendah (KSSR) and the Standard Curriculum for Secondary School, also known as Kurikulum Standard Sekolah Menengah (KSSM) have been formulated.

In general, KSSM intends to emphasize on learner-centred approaches and also personalized education with more implementation of problem-solving based projects (MOE, 2013). The elements of STEM formed part of the new KSSM with the intention to provide opportunities for every student to explore STEM (MOE, 2013). The integration of STEM into the KSSM enables the intersection of knowledge across science, mathematics, technology and engineering through various projects or across disciplines (Bryan, Moore, Johnson, & Roehrig, 2016). One of the most crucial impacts of integration of STEM in learning is the ability to make STEM meaningful and relevant to students (Stohlman, Moore, & Cramer, 2013). This will definitely increase the students' motivation to learn science in particular as they see the importance of science in the society.

KSSM has also taken a stance on the importance of using inquiry method in the teaching and learning of science in secondary school. The inquiry approach will infuse many student-centred approaches such as constructivism, problem-based learning, mastery learning and other related teaching strategies (MOE, 2016). Thinking skills are also highlights of the new KSSM which aims to develop critical and creative thinking skills among students. Pupils will also be taught thinking strategy such as conceptualizing, making decisions and also problem-solving. On the other hand, science process skills still remain as one of the major components in the new KSSM science. These skills includes observing, classifying, measuring using numbers, making inferences, predicting, communicating, use of time-space relationship, interpreting data, defining operationally, controlling variables, making hypothesis and experimenting.

As aforementioned a great emphasis has been placed on the incorporation of inquiry approach in the teaching and learning of science in the new KSSM. This

approach prompts the pupils to be more active in learning as they have to find information and ask questions as they seek to investigate a phenomenon. Activities such as conducting experiments enable the pupils to investigate, gain first hand information through observations and form conclusions based on the findings that they have after the experiments. According to the standards all experiments that are described have to be conducted using inquiry approach (MOE, 2016). This will help to develop science process skills and also 21st century skills in the long run.

2.2 Attitude towards learning science

Extensive studies on students' attitude towards learning science have been conducted for the past 40-50 years (Osborne, 2003; Zacharia & Barton, 2004; Pell & Jarvis, 2003; Freedman, 1997; Weinburgh, 1995; Haladyna & Shaughnessy, 1982). Decline of interest among students to learn science has been prevalent for many years (Hofstein, Maoz, & Rishpon, 1990; Weinburgh, 1995). This has raised a lot of questions among science educators on how to arrest this decline because many students who relate to science negatively will distance themselves from pursuing science (Md Zain, Samsudin, Rohandi, & Jusoh, 2010). It was reported that students' attitudes toward science generally decline over the middle and high school years (George, 2000). Therefore, in the community of science educators it is of utmost importance that students' attitude toward school science is being thoroughly studied (Osborne et al., 2003).

According to Koballa (1998), attitudes are dynamic and not static which means they can be changed when there is intentional effort to do so. The disposition that students have towards science is a learned process instead as an inborn characteristic.

It was also observed that attitude is multidimensional and consists of many subconstructs which contribute towards a person's attitude towards learning science in varying degrees (Osborne, 2003). A better understanding of the attitude towards science will facilitate the formation of positive science-related behaviours of students and teachers.

According to Fishbein and Ajzen (1975), attitude is a learned disposition to feel, think or behave positively or negatively towards an object. Attitude is also explained as a positive or negative evaluative reaction toward an object, shown in ones beliefs, feelings, or behavior (Myers, 1992). Attitude can be viewed as our favourable or unfavourable feelings toward objects, persons, groups or any other aspects in our environment (Koballa, 1988).

Attitude contains three components: affective, cognitive and behavioral. The affective component refers to how one feels about the object. Cognitive component highlights the person's beliefs and knowledge about the object. The behavioural component refers to the behaviour that is acted out towards the object (Gall et al., 2003; Eagly & Chaiken, 1993; Salta & Tzougraki, 2004). Hence, attitude was widely defined as a positive or negative inclination towards an object and formed by the person's belief, feelings and behaviours (Potvin & Hasni, 2014). There were articles which proposed that attitude is a construct which has other subconstructs such as enjoyment.

Attitude can only be measured once the object was specified. The object can be in the form of a visible physical object or in the form of an abstract idea which cannot be seen. In this study, the object that we are referring to is science which is a body of knowledge that explains the phenomena that we see in our daily surroundings. Hence, the attitude towards science can be defined as how one feels, thinks or behave

towards science (Gall et al., 2003). In a research conducted by Osborne et al. (2003), attitude toward science is defined more specifically as the feelings, beliefs and values held about the different aspects of science which include school science, science in general and the impact of the science on society. Attitude towards learning science is defined as the emotional orientation or personal opinion that a student has towards learning science (Chen et al., 2012).

2.2.1 Previous studies on attitude towards learning science

Attitudes towards science were investigated frequently in the past together with different variables such as the type of instructional practices being applied, classroom interactions, and the availability of support provided by the teachers (Logan & Skamp, 2008; Osborne et al., 2003; Simpson & Steve Oliver, 1990). In a longitudinal study conducted by Simpson and Steve Oliver (1990), a few major findings were reported: steady decline in attitude across grades, attitude towards science is higher among boys, achievement motivation correlates with attitude towards science, adolescents attitudes are found to correlate positively with their peers' attitude, school in particular classroom are variables which have the strongest influences on attitude, attitudes towards science are influential in determining the amount of science exposure a student has (Simpson & Steve Oliver, 1990). Results from past researches suggested that students with positive attitudes toward science will have the tendency to excel (Talib, Luan, Azhar, & Abdullah, 2009; Freedman, 1997; Weinburgh, 1995; Oliver & Simpson, 1988).

In general, previous studies have reported that teachers' character, classroom learning environment and the relevance of the science topics to real life experiences have significant influence on students' attitude towards science (Osborne & Collins,