Perceptions on knowledge, attitudes and enjoyment in non-formal science learning: science educators', teachers' and students' views

Tuan Mastura Tuan Soh

Master of Philosophy

University of York
Education

September 2017

Perceptions on knowledge, attitudes and enjoyment in non-formal science learning: science educators', teachers' and students' views

Abstract

The study aims to examine the perceptions on knowledge, attitudes and enjoyment from school group visits to the Malaysia National Science Centre (MNSC) from the perspectives of students, teachers and science educators. The research objectives of this study are to, (1) investigate science educators' actions and contributions to students' science learning in non-formal settings conducted by MNSC; (2) investigate teachers' objectives for conducting school visits to the non-formal settings; and (3) investigate on how students perceived on knowledge, attitudes and enjoyment of school group visits to non-formal science learning. A mixed method approach was employed. The samples consisted of 353 students aged 10-14 for survey and 18 small groups interview from 26 primary and secondary schools in Malaysia. 40 teachers involved in the survey and 17 from them were interviewed. For science educator, eight of them were interviewed. The methods of data collection differentiated by locations of engagement; namely centre-based, single and multi-school outreach. Science educators' believes that their goals in teaching and learning science at out-of-school settings as to create i) Awareness and appreciation towards science; ii) General concept understanding; and iii) Develop skills. Teachers' believes their objectives of engaging their students in the out-of-school settings were to expose the students with new learning environment outside of school classroom. The main findings showed that overall students' perception towards knowledge and enjoyment was very high which means that students really enjoyed doing activities outside the classroom. The Kruskal-Wallis test showed that there were significant difference between locations of engagement for three scales measured in the study for students' perceived science learning in non-formal settings. This study indicates that non-formal learning has a great potential in enriching science learning in formal classroom with the support from teacher and science educators together with the informal science institutions.

Table of Contents

Appendices

List of Tables

List of Figures

Acknowledgements

I would like to express my sincere appreciation to all those who have academically, morally, emotionally and spritually inspired and supported me during my PhD program.

For the academic support, I would like to express my thanks to both of my supervisors, Professor Judith Bennett and Dr. Lynda Dunlop for their help and encouragement in the preparation, the conduct of the research and the writing of this thesis which were immensely helpful towards the successful completion of my thesis. I also would like to thank the member of the thesis advisory group, Dr Jeremy Airey for his invaluable advice, guidance, and support. Graduate school would not have been nearly as interesting and enjoyable without the intellectually stimulating discussions with my good friend and workout buddy, Telima Adolphus (Science Education), Suraya Sukri (Archaelogy Department). I will also here acknowledge and appreciate the informal but very helpful discussion and support from other members of the Science Education Research Group (SERG) – Dr Kerry, Maria, Aparna, Mythily, Maria, Wafa, Majid, Ghania, Yng, Estelia and Rasheedah.

The valuable data generated from my study would not have been possible without the help of staff of Malaysia National Science Centre (MNSC) (Pusat Sains Negara - PSN). I greatly appreaciated the assistance from MNSC staff during my pilot and actual collection of data. I would also like to thank the teachers and students who agreed to take part in my research. Without their cooperation and patience this study would not have been possible. I also would like to thank the Ministry of Higher Education of Malaysia and Universiti Kebangsaan Malaysia (UKM) for funded my study under the Academic Staff Training Scheme (ASTS) program.

Thank you to my family and friends, both in Malaysia and in the UK for their undying support of my PhD adventures. Above all, I am most grateful to the Almighty God - who has kept me in good health, sound mind and has granted me knowledge and wisdom to successfully end my PhD journey.

Author's declaration

I declare that the results and conclusions contained in this thesis are my original work and contribution to knowledge except as specified in acknowledgements and references, and that the entire thesis or any part of it has not been submitted by me or any other person to this university or any other institution of learning for the award of a degree.

Chapter 1

Introduction to the research

1.1 Overview

This chapter provides the background to this study. Firstly, it provides the general background on which this study conducted and then proceeds to explain the research rationale. The study then discussed the research aims, research objectives, and research questions of the study, followed by the scope and the significance of the research. Key concepts are provided in order to present a guide to terms used in the study. Finally, the organisation of the thesis is presented to provide a general overview of the study's evolution.

1.2 Background and rationale for study

Malaysia places great importance on education as a means of becoming a developed nation to meet the challenges and demands of science, technology, engineering and mathematics (STEM) driven economy, by 2020. Accordingly, the Malaysian government instituted the 60:40 Science/Technical: Arts (60:40) Policy in education in 1967 and started implementing it in 1970. The policy refers to the Ministry's target for the ratio of students with a significant science education to those with a greater focus on the Arts. This policy target has, however, never been met as reported in the "strategy to achieve 60:40 policy of 60:40 Scientific/Technical: Arts by the Ministry of Education (MOE) of Malaysia" (Ministry of Education, 2012) and the Malaysia Education Blueprint (2013-2025) (Ministry of Education, 2013).

Even though a lot of effort been made in the formal education system to increase students' performance in science and mathematics, it is still not successful in attracting students to pursue their study in the STEM fields. For example, for more than a decade, performance by Malaysian school-aged children on international tests such as the quadrennial Trends in International Mathematics and Science Study (TIMSS) and the Programme for International Student Assessment (PISA) has followed an inconsistent pattern but even worse in 2011 for TIMSS, which for science score (only 426) Malaysia's students average score for the last ten years has seen a marked decline from a high of 510 (above the benchmark score of 500) to a low of 426 in 2011 (Fadzil & Saat, 2014; Martin, Mullis, Foy, & Stanco, 2011). When looking into recently PISA result, it's even worse as Malaysia was ranked at 52nd out of 65 countries which participated in the assessment study (OECD, 2012).

Besides the international comparison, a survey to collect data on the awareness of the public on the science, technology and innovation (STI) at the national level also was conducted. The survey conducted by the Malaysian Science and Technology Information Centre (MASTIC) of the Ministry of Science, Technology and Innovation (MOSTI) was part of a broader initiative by governments to evaluate the attitude of people towards STI and the related issues. According to the 2010 Malaysian Science and Technology Indicators on the Public Awareness of Science and Technology in Malaysia; "a lot more need to be done to improve the public's understanding of S&T such that they would be considered scientifically literate. We need to look into the quality of science teaching, the appropriateness of science curriculum, and the content of non-formal programmes, as these factors may have affected the public's interest in, and understanding of science (MOSTI, 2010; Chap. 12, pg. 12-2). The same report also stated that we need to look into science learning in a non-formal setting. In 2008, a report stated that the places most frequently visited by Malaysian were the Zoo (30.0%), Museum (29.9%), and the Parks (29.7%). 18.6% visited the Aquarium, 11.1% visited the National Science Centre, 10.3% the Planetarium, and 13.9% Petrosains (the percentage here were calculated based on the results of the 2008 survey by MASTIC, in which 18,447 respondents were randomly selected and stratified according to zone, location, ethnicity, gender, and age in order to assess the public's awareness and understanding of, interest in, and attitude towards S&T). Roundtable discussions with the Malaysian public also reflected a lack of awareness about STEM-related career opportunities. Since only a small percentage of Malaysian usages/visits non-formal settings, therefore, it shows an opportunity to do research in this area.

Recent findings challenge the longstanding belief that the only place for science knowledge acquisition is the classroom; as formal schooling has long been assumed as the primary mechanism by which the public learn science, but in recent years there has been a growing appreciation for the fundamental role played by the vast array of non-school science education institutions in playing their part in science learning among the public (Falk & Dierking, 2010). According to the authors of “The 95 Percent Solution: School is not where most American learn most of their science” shows that international comparisons of trends in science knowledge over lifetimes suggest that much if not most science knowledge is acquired outside of school (Falk & Dierking, 2010).

Besides, research shows that collaboration between formal and non-formal learning experiences can promote increased engagement in science learning. As a matter of fact, there is in the recent years, many informal education institutions including science centre and museums have created outreach programs in a joint effort with schools to bolster interest and enthusiasm for STEM careers from an early age (Roberson, 2010). Hofstein and Rosenfeld (1996) make an important recommendation that "future research in science education should focus on how to blend effectively informal and formal learning experiences in order to significantly enhance the learning of science" (p. 107). Research shows that collaboration between formal and informal learning experiences can promote increased engagement in science learning (Garrity, Pastore, & Roche, 2010; Ruto, 2004). Therefore, this research will look into the impact of science learning outside the classroom to increase students’ cognitive and affective responses to science from the perspective of students, teachers and science educators as according to Kuenzi (2008), one approach to encourage science learning is through the use of informal education channels.

Science is indeed hard to learn as much of the research on children’s learning has shown (Braund & Reiss, 2004b). Science is frequently perceived among young people as too abstract, unpleasant, not enjoyable, not interesting, not fostering creativity or free expression of ideas and is furthermore associated with difficulty (Braund & Reiss, 2006; Tytler, Osborne, Williams, Tytler, & Clark, 2008). While Bennett believes that science is a fundamentally interesting subject to learn about, yet so many young people seem to reject it as they grow older claiming, for example, that it is boring, impenetrable and irrelevant to their needs (Bennett, 2003). The argument was supported by a study done by Barmby, Kind, and Jones (2008) stating that there is a steady decline in students' attitudes towards science over time, particularly emphasised for pupils in secondary schooling. According to OECD (2006) in Fadzil and Saat (2014), students' interest in Science and Technology (S&T) subjects may appear very early in primary schools and this phenomenon remains stable between the ages of 11 to 15. When pupils visit or are taught in places that explain science in new and exciting ways, they frequently seem to be more enthused (Braund & Reiss, 2004b). According to Braund and Reiss (2006), out-of-school science experiences through different mediators (such as science museums, science competitions, science books, magazines and television programmes, science fiction films or drama, computer games etc.) can positively or negatively contribute to the image of STEM studies, science profession and science in general among young people.

In Malaysia context, research in the outdoor education has already started since the 1950s since the introduction of Outward Bound School in Lumut, in West Malaysia. Unfortunately, highlighting the history and development of outdoor education in Malaysia is a very difficult process and subjective. This is because the outdoor education process are separated and there is no specific body to monitor it (Md Amin, 2011). Only in 1991, the Outdoor Education team was established within the Co-Curricular Activities Branch. It provides assistance and guidance to the Malaysian schools in the planning and implementation of their outdoor education as a complement to the classroom learning. Besides that the Ministry of Education (MOE) also collaborates with the Ministry of Science, Technology and Innovation (MOSTI) in accordance to lead the informal and non-formal science education (Tuan Soh & Meerah, 2013). The Second Science and Technology Policy provide the framework to enhance productivity and maintain growth and also strengthen the synergy partnership between government agencies, industries, universities, and research institutes. The role of MOSTI is in helping to achieve the aim of this policy in creating societal values and positive attitude towards science and technology including the need for lifelong learning. There are many agencies under MOSTI that operates to execute this aim.

The agencies under MOSTI that operate in order to introduce non-formal science education are the Academy of Science and National Science Centre. Besides that, the most popular organisations that introduce non-formal education in Malaysia are Petrosains which operates under PETRONAS and National Planetarium which operates under the Prime Minister's Department. Agencies or organization that indirectly plays their role in the informal and non-formal science education in Malaysia among others are Malaysian Nature Society (MNS) with aims to promote environmental education and global conservation through its School Nature Club (Kelab Pencinta Alam); World Wild Life Fund (WWF) Malaysia, which handled outdoor program such as Eco School (WWF-Malaysia, 2009). Besides that, in 2004, National Service Training Program, or Program Latihan Khidmat Negara (PLKN) was introduced by the Government of Malaysia as an outdoor education agent in order to empower and make a better youth in Malaysia (Jaffry, 2011). The latest institution or agency established in Malaysia, National STEM Centre was introduced to compile all STEM related methods, activities and programs both in formal and non-formal learning.

Given the many agencies and institutions that operate to introduce non-formal science learning that can complement the formal science classroom, unfortunately, in reality, there is no synchronising at the national level for non-formal and informal education programs (UNESCO, 2002; pg. 106) (here the term that were used is continuing education or life-long learning). Nevertheless, there is no particular system or structure that enables us to compile all these various programmes in the contexts of non-formal and informal learning in comparison to the formal learning which is more structured. Furthermore, these programmes are seldom documented for use as models for others (UNESCO, 2002; pg. 106).

Every agency has their own method and programs according to their roles although the general aim is the same which is to promote science among the public. Most of the non-formal educational programs are based on the needs of the respective agencies and once in a while; there will be overlapping of objectives. The recognition and various collaborations between the MOE and non-formal agencies should be planned in a more structured manner. The efforts to promote these institutions should be made in all schools; and encourage them to optimise the usage of these institutions as a complement to formal education in schools (Bozdogan & Yalcin, 2009). An existing strategic network should be improved and strengthened. Besides that, a systematic mechanism should be created to coordinate the implementation and supervision of informal and non-formal science education effectiveness, in order to ensure that its role as a complement to formal education could be realized, and this changed climate will bring a new opportunity for formal and non-formal education to get closer together than ever before (Coombs, 1976) specifically in Malaysian context (Tuan Soh & Meerah, 2013). Figure 1.1 illustrates the agencies that promote informal and non-formal education in Malaysia.

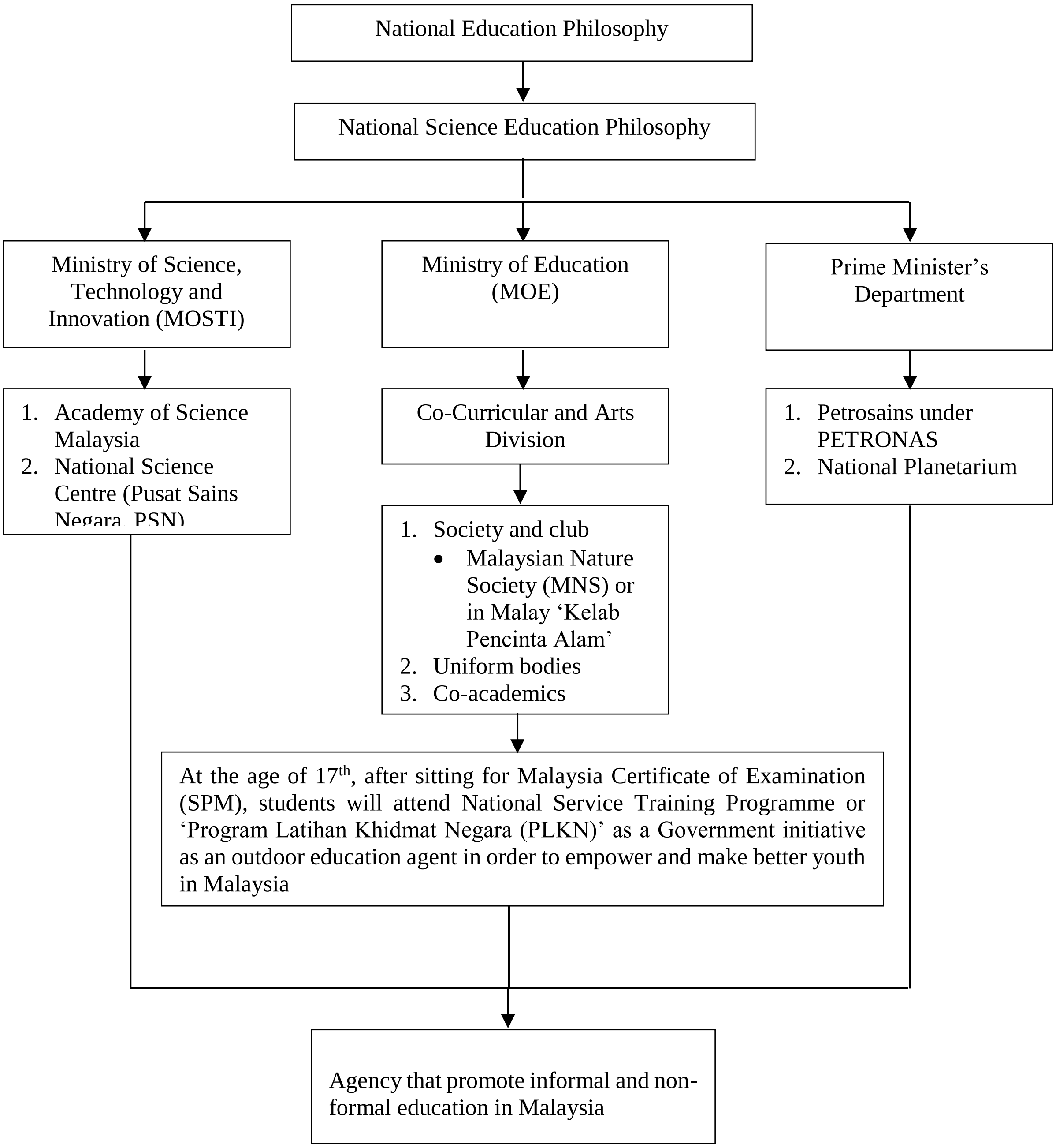


Figure 1.1. Agencies promoting informal and non-formal education in Malaysia

Current research by Ahmad Nurulazam, Mohd Ali, Robertus, & Azman (2010a) on 'Improving Students' Attitudes Toward Science Using Instructional Congruence' suggested that the finding implies that science curricula should be more connected to science outside of school activities. In other articles, the researchers finding reported that efforts should be given in order to make students appreciate more on science outside of school in their learning. In order this to happen, science teachers need, for example, to integrate more science activities outside of school (Ahmad Nurulazam, Mohd Ali, Robertus, & Azman, 2010b).

This is the primary focus of this research; to look into science learning outside the classroom focusing on Malaysia National Science Centre of Malaysia (MNSC) (Pusat Sains Negara, PSN). MNSC was chosen in this study because it aims are in line with the government insight to produce a contributing generation in the field of science and technology. In order to achieve it, the Malaysia National Science Centre (MNSC) has outlined a few strategies to raise awareness, understanding and appreciation towards science and technology which are; i) to provide the environment and facilities for the fun learning of science; ii) to provide interactive science exhibits; iii) to provide and organize interesting science programmes and activities; iv) to simplify the implementation of science and technology; v) to publish science and technology literature; and vi) to act as adviser on informal science learning.

According to Şentürk and Özdemir (2014), one way of overcoming the shortcomings of formal educational settings is to support students with non-formal (out-of-school) settings such as science centres, science and technology museums, cultural museums, nature centres, zoos, libraries, and open-air museums. This reason also reinforced with the recent national report by Bell, Lewenstein, Shouse, and Feder (2009) which summarised a growing body of data demonstrating that science centres and similar institutions have an educational impact on science, technology, engineering and mathematics and other complex subjects. Therefore, the focus of this research is to examine the perceptions on knowledge, attitudes and enjoyment in non-formal settings from the perspectives of students, teachers and science educators.

1.3 Research aims and objectives

The study aims to investigate science learning in non-formal settings. More specifically, this study examined the perceptions on knowledge, attitudes and enjoyment from school visits to the Malaysia National Science Centre (MNSC) (in Bahasa called Pusat Sains Negara, PSN) from the perspectives of students, teachers and science educators. In particular, the objectives of this study were to;

1. Investigate science educators' actions and contributions to students' science learning in non-formal settings conducted by MNSC.
2. Investigate teachers' objectives for conducting school group visits to the non-formal settings; and
3. Investigate on how students perceived on knowledge, attitudes and enjoyment of school group science learning in non-formal settings conducted by MNSC.

1.4 Research questions

The questions were derived in order to guide these investigations which were;

1. **What are science educators' actions and contributions to students' science learning in non-formal settings conducted by MNSC?**
   a. RQ_{1-1}: What are the science educators' goals and roles for science lessons taught in non-formal settings?
   b. RQ_{1-2}: How do science educators teach science lesson in non-formal settings?
   c. RQ_{1-3}: To what extent science educators' objectives met from the visit?
2. **What are teachers' objectives for conducting school visits to the non-formal settings?**
   a. RQ_{2-1}: What are the teachers' objectives for conducting school visits to non-formal settings?
   b. RQ_{2-2}: How do teachers' plan the school visit in order to achieve the objectives?
   c. RQ_{2-3}: To what extent teachers' objectives met from the visit?
3. **How the students perceived on knowledge, attitudes and enjoyment of school group science learning in non-formal settings conducted by MNSC?**
   a. RQ_{3-1}: What do students gained from their engagement with MNSC in term of students' responses to science?
      i. $RQ_{3-1.1}$: Is there any differences on students' perceptions between different locations of engagement (centre-based, single and multi-school outreach) in term of knowledge, attitudes and enjoyment towards science learning;

ii. RQ$_{3-1.2}$: Is there any differences on students' perceptions between centre-based, single and multi-school outreach in term of attitudes; [how easy, enjoyed, helpfulness in doing the activities conducted by MNSC]

1. How easy students' perceived success in working with the activities?
2. How much students enjoyed doing the activities?
3. What is students' perception of the helpfulness of the visit to the activity conducted by MNSC?

1.5 Significance of the study

This study was significant for a number of reasons. The first significant aspect of this study was it contributed to the beginnings of a general body of knowledge concerning science learning in in non-formal settings in Malaysia, specifically at the National Science Centre. This knowledge was sorely lacking in term of non-formal science learning literature as Malaysia, a country where students were rarely taught in out-of-school settings, students valued learning mathematics outdoors and enjoyed the new learning environment as showed in a research study by Noorani et al., (2010) in a study on mathematics outdoor camps in Malaysia.

This study also contributes to understanding the relationship between science educators, students and teachers during the school visits. School visits, normally are a break in the usual school routine and potentially take place in locations new to students. By conducting this study, it explored more on how the teacher, educator, the programmes and activities, the learning environment interact and the final consequences that we want to see on how can we maximize students' experiences on, and gained from, school visits to the non-formal settings.

Another contribution of this study was a collaboration between teachers and science educators in sharing their expertise when handling school visits. Teachers are still "novices" at planning, conducting, and integrating school visits (Kisiel, 2003; Storksdieck, 2001), while the educators are "experts" in the educational potentials of the programs and resources available at their institutions. Therefore, it was hoped this study produced a systematic collaboration among them and potentially help a critical contribution to science learning in non-formal settings.

1.6 Limitations of the study

It should be noted that the proposed research had a number of important points of limitations that should be considered. This study only involved Malaysia National Science Centre (MNSC) as the context of the study and the interviewed sessions afterwards were take place in the respondents corresponding schools (it depends on the availability of the respondents and the agreement of consent received). The survey and semi-structured instrument were designed to elicit students' responses to science learning from the perspective of students, teachers and science educators. The outcomes and interpretations of the study were, in essence, limited to the context of the students within this study, since other age groups, contexts, and experiences will vary. However, the outcomes were likely to be of interest and provide some clear messages to teachers, science educators, and the science education community on how the responses to science learning can be gained from the visits to the non-formal institutions, specifically to the science centre in this study.

.

1.7 Operational definitions

This section shows the definition that were employed throughout this research. These definitions were deemed suitable for this research as central to the learning activities occur in non-formal institutions in Malaysia.

1.7.1 Formal learning

Schools, historically, are seen as formal learning institutions. Reasonable agreement can be found for the definition of formal learning as that which is a structured learning experience in the classroom, led by the teacher, evaluated, sequential, and compulsory (Colley, Hodkinson, & Malcome, 2002; Eshach, 2007). Completing an assigned science investigation in school classroom would be an example of formal science learning. The term formal education in this study refer to the education given by specialised organisations representing the school system from pre-school to university.

1.7.2 Informal learning

Informal learning is commonly defined as unstructured, voluntary, non-sequential, and usually learner led (Eshach, 2007). Term informal is often treated as a residual category to describe any kind of learning which does not take place within, or follow from, a formally organised learning programme or event. However, for those of us who believe that most human learning does not occur in formal contexts, the utility of such a catch-all label is not very great. Moreover the term 'informal' is associated with so many other features of a situation - dress, discourse, behaviour, diminution of social differences – that its colloquial application as a descriptor of learning contexts may have little to do with learning per se. To avoid such confusion, the term 'non-formal learning' as the contrast to formal learning was used, and to make further distinctions within that heading.

1.7.3 Non-formal learning

Non-formal learning is a term that is, at times, used to describe the bridging between formal and informal learning, taking an intermediary position between the two with varying degrees of factors from both approaches. Eshach (2007) describes non- formal learning as that which occurs in a "planned or prearranged manner in institutions, organizations, and situations beyond the spheres of formal or informal education. According to Lowe (1975: 24-25), Maaarschalk (1986), Bishop (1989: 131), non-formal also means any education that is organised and has clear goals but occurs outside the official school system. It shares the characteristic of being mediated with formal education, but the motivation for learning may be wholly intrinsic to the learner (Eshach, 2007, p.173). Non-formal learning can occur at an institution out-of-school, or can occur in school led by a community institution or individual, and is not usually evaluated (Eshach, 2007). Using this definition, a school group visits to a science centre would be an example of non-formal science learning, as would a program led by an outreach science educator in the classroom. Thus, non-formal learning terminology was used in this study, involving out-of-school programs conducted by MNSC in three locations of engagement, centre-based (i.e. at the MNSC itself), single-school outreach (i.e. MNSC outreach at one school), and multi-school outreach (i.e. MNSC outreach for several schools gathered together at one school).

1.7.4 Out-of-School Education

Often in the literature, out-of-school learning is used interchangeably with informal learning, yet definitions of informal learning can include everything from "all learning out-of-school" (which by this definition would include school group visits) to "all things learned in free time in day-to-day life" (which arguably could take place at school) (Eshach, 2007). Whereas, for out-of-school education, it means education that happens during school time, and according to the curriculum, but uses settings and institutes outside the physical school building. Out-of-school education is also a term included in school legislation. Likewise, out-of-school education often uses informal education sources for formal education.

1.7.5 Science Centre

There are quite a number of terms used in the literature, such as science and technology centres (Association of Science-Technology Centers (ASTC), hands-on science centres (Bradburne, 1998; Wellington, 1990), hands-on science and technology centres (Pompea & Hawkins, 2002; Walton, 2000), interactive science centres (Ramey-Gassert, Walberg, & Walberg, 1994), and interactive science and technology centres (Quin, 1990; Rennie & McClafferty, 1995). In the most general sense, science centres can be defined as places where visitors are connected with science, inspire curiosity and support lifelong learning about science and provide first-hand experience (http://astc.org/sciencecenters/index.htm). In this study, science centre refers specifically to the Malaysia National Science Centre (Pusat Sains Negara, PSN).

1.7.6 Knowledge and understanding

The term ‘knowledge’ can be defined in a number of ways. Definitions such as, ‘the sum of what is known’ or ‘the body of truths or facts accumulated by humankind in the course of time’ (The Macquarie Dictionary, 1997) provide an all-encompassing view of knowledge. Hewson and Hewson (1983) describe knowledge in terms of conceptions which were composed of concepts, or units of information which were linked with one another. Knowledge and understanding includes learning facts or information (knowing ‘what’ or knowing ‘about’) and developing a deeper understanding, or grasping meaning more firmly, in relation to diverse specific fields’ (Hooper-Greenhill, 2007). In this study, knowledge refer to the appropriate collection of information related to the activities or programmes organised by MNSC. According to Lilia (2013), knowledge of the subject or content refers to the knowledge of the substantive structure of a discipline i.e. the concept, the theory and the principle of the field. Each knowledge element does not exist in isolation but rather is connected to other knowledge elements, and it is through these interconnections that understanding is constructed by the individual. When someone memorises information, then they have amassed knowledge. In this study, the ‘content’ knowledge of the subject under study (programmes and activities conducted by MNSC were referred). The students’ ‘perceptions of knowledge gained’ were considered in this study when they interact, engaged, provide solution and communicating the problems in the activity conducted by MNSC.

1.7.7 Attitudes and values

Attitude is defined as “feelings, beliefs, and values held about an object that may be the enterprise of science, school science, the impact of science on society or scientists themselves” (Osborne, Simon, & Collins, 2003). Attitudes and values are developed by learners as an integral part of their learning in both formal and informal environments. As new information is absorbed, attitudes to that information are developed, and these attitudes contribute to the formation of the values that inform the decisions people make about how to live their lives (Hooper-Greenhill, 2007). Visits to science centres, museums, archives and libraries can result in shifts or change in attitudes and can sometimes be seen to alter the values that people hold. With young learners, where attitudes can change frequently, and values are still to be firmly established, there are considerable opportunities to influence their development. It is highly possible that the effects on values and attitudes will not be apparent in the short term; and they may be forming without the learner's conscious awareness. Attitudes and values are given emphasis to produce virtuous individuals who are responsible and able to contribute towards the prosperity and development of the nation (Sharifah Maimunah & Lewin, 1993). This is crucial in order to prepare Malaysians as competent global citizens of the twenty-first century. The vision of building a strong Malaysian nation that is responsive to the challenges of the twenty-first century and at the same time holds strongly to religious and ethnic values had been the aspiration that was stressed time and again by Tun Dr Mahathir Mohamad (Rozita, 2007). Therefore, in this study, the researcher intends to explore participants' feelings and perceptions that they can show their opinions or attitudes when they engaged with the activity conducted by MNSC in non-formal settings.

1.7.8 Enjoyment

Enjoyment as an outcome of learning is likely to lead to the development of positive learner identities and to the desire to repeat the experience. When learning is enjoyable, it is easier, and may sometimes take people by surprise (Hooper-Greenhill, 2007). Creativity, invention and innovative ways of thinking and doing can result from visits to museums, archives and libraries. Where exploration and experimentation can be offered, creativity, inspiration and enjoyment may result (Hooper-Greenhill, 2007). Therefore, the enjoyment in this study referred to the positive action of the participants in doing the activities in out-of-school settings and their desired to repeat the experience.

1.7.9 Engagement

Engagement is by definition a two-way process, involving interaction and listening, with the goal of generating mutual benefit. Physical activities that allowed students to interact with, touch, and manipulate objects do not necessarily lead to mental engagement and subsequent learning. Learners need to partake in discussions and generate questions in order to mentally engaged in learning. Besides that, students also engaged mentally when they were asked questions. This was because questions require them to think about what they know and don't know about the subject matter, and generate an explanation that they were more likely to remember. It is important that the educator is aware of his students' interests and cognitive abilities because learning cannot take place if learners are not interested, or if the information presented is beyond or below the learners' level of comprehension.

1.7.10 Perception

Gerber (1982) defines perception as an active cognitive process in which an individual will become aroused against an object and state. This means that if the individual's perception of something is positive then they will be stimulated to do so and this will indirectly increase the excitement and effectiveness of the activities. According to Reid (2006), perceptions can either be positive or negative sentiments that will be formed through experience and will affect one's actions against other individuals, objects or things (Gokhale et al., 2009). Meanwhile, Ling et al., (2011) defines perception as a person's response to feeling, understanding, analyzing and translating something based on experiences. Knowledge can influence individual perceptions of a subject, circumstance and object; and it is not evaluated from the individual education level. Rather, it depends on the individual's experience and its concern for something that happens. However, 'knowledge' that someone's has is considered as an advantage to individuals as it can influence perceptions. Positive and broader evaluation of perceptions results from what they perceive to be important and valuable to them. In the context of this study, the perceptions on knowledge, attitudes and enjoyment from school visits to the Malaysia National Science Centre (MNSC) from the perspectives of students, teachers and science educators were examined.

Figure 1.2 shows the interconnectivity of the main concepts in this study to each other.

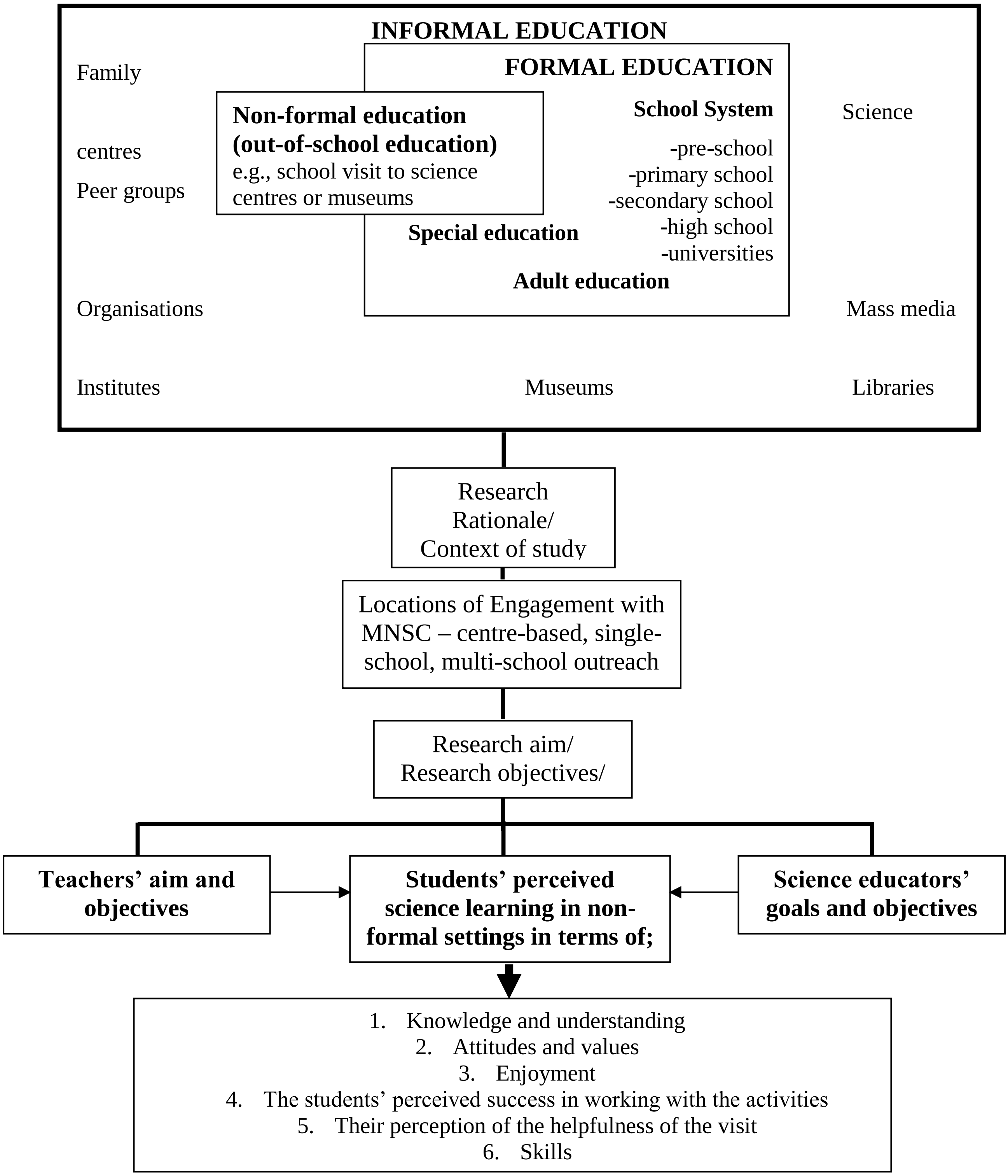


Figure 1.2. Flowchart of the context of the research

1.8 Summary

The current inadequate state of science, technology, engineering and mathematics education in Malaysia was an issue that needs to be addressed. In addition, from the latest report of international assessment (PISA and TIMMS study) and also from the local report, it shows that students' performance were declined. Although all the necessary effort has been made in formal schooling, it's still not solved this problem. From the literature, it has been shown that the combination of formal and informal learning techniques provides different and more effective ways of teaching science material and getting students excited about science. Thus, teachers should use the many informal educational opportunities offered by the national science centre which involve school group visits and other programs, to supplement formal educational activities. Therefore, the focus of this study was to examine the perceptions on knowledge, attitudes and enjoyment from school visits from the perspectives of students, teachers and science educators in the non-formal learning contexts.

This thesis consists of seven chapters. Following this first chapter, to situate this study within a larger scholarly context in terms of non-formal settings, programs and activities, the influences of the program towards science, several areas of literature are reviewed in Chapter 2. Chapter 3 presents the mixed methods, explanatory research approach that was utilized in the data collection and analysis process. Chapter 4 – Chapter 6 presents the findings from the data analysis from science educators, teachers and students respectively. Lastly, Chapter 7 of the thesis will close with the discussion, educational implications, and limitations of this study. Future research to enhance this study was presented in Chapter 7.

Chapter 2

Literature review

2.1 Introduction

The main objective of this chapter is to review of the relevant literature of this research. The background of the Malaysian context and the Malaysia education system is described, along with key aspects of education policy. This chapter discusses formal and informal science education; science centre and museums and the science learning using the non-formal approach. It also explains the importance of informal learning in complementing the formal science learning in Malaysia context.

The literature review then followed by the conceptual framework used in this research. In addition, the prior researches and studies relating to the research topic in this study were presented after the conceptual framework.

2.2 The Malaysia Context

Figure 2.1 shows the current Malaysia map. Malaysia is situated in Southeast Asia which divided into two main sections on either side of the South China Sea, called Peninsular Malaysia (West Malaysia) and East Malaysia. Consisting of a federation of thirteen states and three federal territories, Malaysia attained independence from Britain in 1957, and assumed its current name in 1963. Malaysia has a population of about 29 million as accounted by the World Data Bank in 2012 and comprises different ethnic groups including Malays, Chinese, Indians, indigenous people and other ethnic groups (World Development Indicators, 2012). Although the Malays form the largest ethnic group, modern Malaysian society is heterogeneous, with substantial Chinese and Indian minorities (Jasbir & Mukherjee, 1993). The population of Malaysia displays considerable ethnic, social, and culture diversity. The Chinese are primarily from the Hokkien, Teochew, Cantonese and Hakka dialect groups. The term Indians refer to those whose forefathers originated from countries such as South India, Pakistan, Bangladesh and Sri Lanka. The diversity within the population is complex, influenced not only by alliance to ethnical and religious groups, but also by language, education and social class.

Figure 2.1. Southeast Asia: Location of Peninsular Malaysia and East Malaysia

Source: The shaping of Malaysia by Amarjit Kaur and Metcalfe (1999)

Malaysia is a multi-ethnic and multicultural society (Gomes, 1999; Pong, 1993; Rozita, 2007). The today's pluralistic Malaysian society was the result of a complex process that involved domination from three successive colonial systems (Portuguese, Dutch and British) and also the influence of major world civilizations including the Indian and Chinese. The ethnically diverse society was the result of British colonial practice of separate education systems for different ethnic groups (Agadjanian & Hui, 2005; Rozita, 2007; Singh & Mukherjee, 1993). This had serious implications for the development of the Malaysian education system after independence in 1957. As education brings about improved status and economic mobility, this lead to unrest amongst especially the Malays, as the Chinese dominated economically at that time.

The country is tolerant to multiple religions whilst Islam remains the official religion. Malaysia's population is mainly divided into Malays who are Muslims (other races also becoming Muslims nowadays), Chinese who observe a syncretic religion combining Confucianism, Taoism and Buddhism, and Indians who are mostly Hindus by religious affiliation (Gomes, 1999). Malaysians may be different in terms of ethnicity, culture and religion, but there is no difference in their ‘primordial aspect’ as they are tied to everyday life and the same citizenship (Mansor, 1999). According to the author, a ‘primordial aspect’ is represented through prime needs such as the need for respect the elders and so on. A plural society allows for fragments of culture amongst the different ethnic groups that could be associated with each other (Gomes, 1999), and through modernisation, these fragments are integrated (Korff, 2001). This becomes the establishment of being a singular Malaysian citizen instead of being identified in the different ethnic groups.

There are a variety of mother tongue languages represented in Malaysian society. Although English is the second language, inherited through British colonisation, the official language is ‘Bahasa Melayu’ which translates as Malay language as in the country’s Federal Constitution. Nevertheless, other languages such as Mandarin and Tamil are still taught in schools and are considered ‘official’ languages for the respective ethnic groups the languages belong to. However, in Malaysian daily life there are a variety of other Chinese dialects such as Cantonese and other minority languages. This scene is further complicated with the mixing of languages between Malay or Chinese and English, which is known as ‘Manglish’ (Malaysian English).

2.3 Malaysia Education System

Education in Malaysia is compulsory and free through the secondary level (Agadjanian & Hui, 2005; Lee, 1997). According to the National Education Act of 1961, amended in 1996, education in Malaysia has been centralised particularly for primary and secondary school (Lee, 1999). The beginning of enrolment in the basic education system is at the age of seven. While in the past, the education system only provided for nine years of basic education, a recent reform in the early 1990s has extended the basic education from nine years to eleven years (Lee, 1999).

In the Education (National Curriculum) Regulations 1997, the National Curriculum is defined as:

> "an educational program that includes curricular and co-curricular activities which emphasizes all the knowledge, skills, norms, values, cultural elements and beliefs to help develop a pupil fully with respect to the physical, spiritual, mental and emotional aspects as well as to inculcate and develop desirable moral values and to transmit knowledge".

(National Curriculum) Regulations 1997

Malaysia's emphasis on education provides equal opportunity to all school-age children. Equality and right to education are fundamental liberties enshrined in the Federal Constitution. These aspirations are manifested in the National Philosophy of Education, which states that:

> "Education in Malaysia is an ongoing effort towards further developing the potentials of individuals in a holistic and integrated manner in order to produce individuals who are intellectually, spiritually, emotionally and physically balanced and harmonious, based on a firm belief in and devotion to God. Such an 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 a high level of personal wellbeing as well as being able to contribute to the betterment of the family, the society and the nation at large".

The educational system consists of three types: formal education, non-formal education and informal education. The next heading will discuss these types of educational system in Malaysian context.

2.3.1 Formal Education

Formal schooling in Malaysia begins at age seven, and education is compulsory and free through the secondary level. Malaysians go through 11 years of basic education which is divided into pre-school, primary school and secondary school (Lee, 1997, 1999). The Malaysian education system follows a 6-3-2 structure (six years of primary school, three years of lower secondary school, and two years of upper secondary school) (Lee, 1999). There are various systems of education available, with the national school (Sekolah Kebangsaan) being the major system, using the Malay language as the language of instruction. Apart from that, there are also vernacular school systems, also known as the national-type school (Sekolah Jenis Kebangsaan). Vernacular schools use the mother tongue as the language of instruction - Mandarin in Chinese schools and Tamil in Indian schools.

The national schools are fully funded by the government while vernacular schools are partially funded or fully sponsored by private organisations (Brown, 2007). Most of the independent private schools are Chinese schools. These schools run their own administrative system and educational curricula but are accountable to the Ministry of Education. Besides that, there are also state funded Islamic religious schools or Sekolah Agama Rakyat (SAR) and Islamic religious national schools or Sekolah Menengah Agama (SMA) (Hashim, 2006). SMA follows the national school system with extra emphasis on Islamic education and Arabic language (Rozita, 2007).

Higher education certificates and diplomas are for students from the age of 17 with Sijil Pelajaran Malaysia (SPM) qualifications (equivalent to GCSE 'O' levels in the UK) while the Bachelor degree is usually for students from the age of 19 or 20 onwards with post-secondary qualifications such as Sijil Tinggi Pelajaran Malaysia (STPM - Malaysian Higher School Certificate of Education examination) (equivalent to GCSE 'A' levels in the UK) or Pre-University/University Foundation qualifications (Kamogawa, 2003). There are plans by the government for those with diploma certificates to gain their degree, but these are for those mainly taking their bachelor degree through part time courses (Agadjanian & Hui, 2005).

Table 2.1. Types of formal education system in Malaysia

Type of Education	**Details**
Pre-school	• Education programme for pupils aged four to six • Curriculum is emphasis on the socialization process, personality development and the preparation of children for primary schooling.
Primary school	• Consists of six years of education (Year 1 to Year 6) • Year 6 students in national schools are required to undergo a standardized test; UPSR (Primary School Achievement Test or in Malay '*Ujian Pencapaian Sekolah Rendah*'). • National school - SK • Vernacular schools -SRJK (C) and SRJK (T)

Secondary school	• Consists of 5 years of schooling referred to as form 1 to form 5.
	• Form 1- Form 3 – lower secondary school, at the end of Form 3, undergo a standardized test; Penilaian Menengah Rendah (PMR) or lower secondary assessment examination
	• Form 4 – Form 5 – upper secondary school, at the end of Form 5, undergo a standardized test; Sijil Pelajaran Malaysia (SPM) or Malaysian Certificate Examination (MCE) (equivalent of the O-level)
	  ◦ Besides following the general education program, students begin to specialize in the sciences, arts, technical, vocational and religious disciplines.
	  ◦ Specific schools are designated for each discipline.
	  ◦ These schools are academic, technical and vocational.
	• SPM is the minimum qualification for students to progress to a tertiary education
	• Need to go through extra foundation year (Matriculation or Form Six) before entering the tertiary education

Post-secondary education	• Form Six – consists of two years of studies; (Lower Six and Upper Six). • At the end of Upper Six, need to sit for Sijil Tinggi Pelajaran Malaysia (STPM) or the Malaysian Higher School Certificate (HSC) (equivalent of the A-level) • Internationally recognize and generally taken by those desiring to attend a public and private universities. • Matriculation – one or two years programmed run by Ministry of Education. • Private colleges- British A Levels programmed or the equivalent of other national systems.
Higher education	**Tertiary education** • Public universities- are subsidised by the government. • UM, USM, IIUM, UKM, UMS UNIMAS, UPM, UTM, UUM, UPSI- open to all Malaysians • UiTM- are restricted; bumiputras only. **Post-graduate** • All public and most private universities in Malaysia offers Master's degrees either through coursework or research and Doctor of Philosophy Degrees through research.

Source: (Malaysia, 1995; Tan, 2012)

a) Science Teaching and Learning in Formal Education

Science subjects are taught in Malaysian Education system. Teaching of science in the primary school is compulsory according to the Schools' Regulations 1967 (Sharifah Maimunah & Lewin, 1993: 40). Thus in the 60s and 70s science subject was introduced since Year 1 in the primary level. However, in the 80s science subject was not taught as a core subject but students still learn science in subjects like man and environment where science, along with geography and history were one of the integrated elements. Recently, science education has again become one of the core subjects in Malaysia primary schools and since 2003, it has been taught to students as early as year 1 (7 years old).

The Malaysian science curriculum for primary schools is developed with eight objective to achieve:

1. Stimulate pupils' curiosity and develop their interest about the world around them
2. Provide pupils with the opportunities to develop science process skills and thinking skills
3. Develop pupils' creativity
4. Provide pupils with basic science knowledge and concepts
5. To provide learning opportunities for pupils to apply knowledge and skills in a creative and critical manner for problem solving and decision-making
6. Inculcate scientific attitudes and positive values
7. Foster the appreciation on the contributions of science and technology towards national development and well-being of mankind
8. Be aware the need to love and care for the environment

(Ministry of Education Malaysia, 2003: 2)

Still, whether this is enough to ensure that a positive behaviour towards science is taking place is up to the teachers own effort, since there is no formal evaluation of assessing whether the students practice and apply what they learn in school to their daily routine life. Science should be taught not only for the sake of passing exams or memorizing facts, but also must include the process of science, which effects the environment directly or indirectly.

2.3.2 Informal Education

Informal learning refers to learning that is not directed, taught, or evaluated by the teacher, such as free-choice activities at school, home, or museum. This definition was based on the Commission of the European Communities (2000) definition. The term informal learning was not well documented in Malaysia and the main focus of activities has been confined to programmes that teach basic information and communication technologies and numeracy skills to out-of-school youth, functionally illiterate adults and marginalized groups in rural areas (Ministry of Higher Education (MoHE) Malaysia, 2011).

2.3.3 Non-formal Education

Non-formal learning refers to purposeful teacher-planned learning activities that support the formal learning in the classroom but are not taught by the teacher or evaluated, such as learning on field trips at a science museum. This definition is based on the Commission of the European Communities (2000) definition. In Malaysia, non-formal learning opportunities generally take the form of workplace and on the-job training programmes. The government provides lifelong learning opportunities for people of all ages. There are several organizations and departments involved in encouraging non-formal learning, such as the Human Resource Development Council and the Department of Skills Development (Ministry of Higher Education (MoHE) Malaysia, 2011). Strategies of non-formal education in Malaysia include developing a range of life skills through distance learning, establishing workplace and community learning centres and promoting the joint sharing of resources with the formal school sector.

In defining the non-formal education, Coombs and Ahmed (1974) first defined non-formal education as “any organized, systematic, educational activity carried on outside the framework of the formal system to provide selected types of learning to particular subgroups in the population, adults as well as children" (p. 8). Schugurensky (2000) further described non-formal education as "all organized educational programs that take place outside a formal school system, and are usually short term and voluntary" (p. 2). Meanwhile, Braund and Reiss (2006: 1385) propose that school science teaching needs to be complemented by out-of-school science experiences (non-formal education) that draws on the actual world (e.g. through school group visits), the presented world (e.g. through science museums and centres, science books and magazines, etc.), and the virtual worlds that are increasingly available through using information and communication technologies (ICT). In this study, I will use Neill (2010) described non-formal education simply as the intentional, purposeful, and structured learning opportunities occurring outside of a formal education system, which is the definition that I will be using in this study. In order to grasp an idea of what is formal, informal and non-formal education, Figure 2.2 illustrated the link of out-of-school education as between formal and informal education.

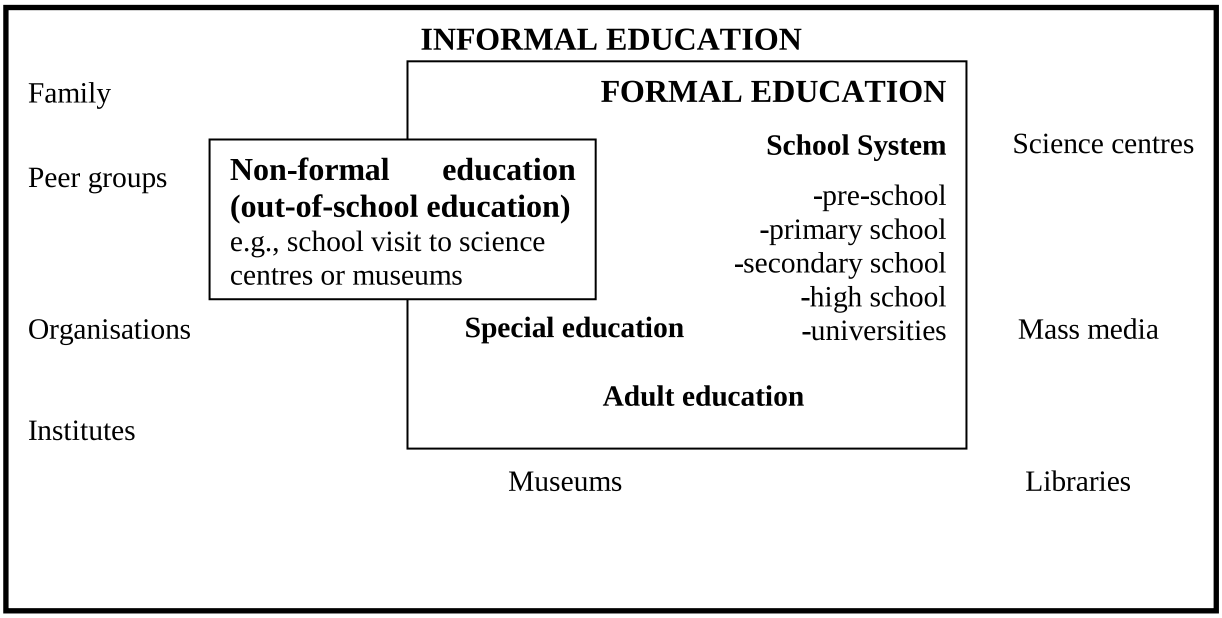


Figure 2.2. Out-of-school education as a link between formal and informal education

Source: Salmi (1993, 2003)

Non-formal education is targeted beyond the range of formal, yet is somehow related to formal education in its systematic application or delivery. While an organized and systematic learning activity can be seen by some cultures or for some populations as an “alternative” to formal education, it is usually viewed, in Western tradition, as a “supplement” to formal education (Brennan, 1997). This was among the reason why I preferred to use non-formal (or out-of-school) rather than informal setting in the study). This is because most learning takes place outside formal learning contexts, and informal learning carries with it connotations of ‘so many other features of a situation, such as dress, discourse, behaviour, diminution of social differences – that its colloquial application as a descriptor of learning contexts may have little to do with learning per se.’ Not only does the term ‘informal learning’ carry unwanted and confusing implications, but it is too wide to be of much use (Colley, Hodkinson, & Malcolm, 2003). Hence, the term non-formal learning was used in the study, involving out-of-school programs conducted by MNSC in three locations of engagement, centre-based, single and multi-school outreach.

2.4 The National Science Centre of Malaysia (MNSC)

The National Science Centre of Malaysia (MNSC) was officially opened on the 29th of November 1996 by the former Prime Minister of Malaysia, Tun Dr Mahathir Mohamad. It is perched on Bukit Kiara, Kuala Lumpur and boasts of a unique architectural landmark capped by a geodesic dome. It was established as an institution of informal learning of science with a mission to nurture Malaysians with an interest in life-long learning of science and technology. The centre houses many exhibits that are designed to captivate, stimulate, and excite visitors to acquaint with science and technology. The exhibits are located in different galleries based on two broad themes, namely the Basic Sciences and Technology (Loke et al., 2003). Besides that, the centre is equipped with a resource centre, three science laboratories, three fabrication workshops, two auditoriums, a multipurpose hall, a cafeteria and a souvenir shop. At the outdoor Science Wonderland, visitors can have the kinaesthetic experience with the giant outdoor exhibits, keep healthy while engaging with the exercise trails and discover nature in the Biodiversity area. The National Science Centre is definitely a wonderful choice for school group visits and family, as well as for tourists and local visitors alike.

The main objective of the centre is to promote public awareness, understanding and appreciation of science and technology. It is envisaged that the knowledge and experiences gained by participants of the in-reaching and out-reaching programmes of the centre will enable them to link science and technology to the society and the environment, to relate science to various aspects of their lives, such as religion, and to apply knowledge of science and technology to their day-to-day activities. In order to meet these objectives, the centre has delineated several strategies which include:

i) To provide a conducive environment and facilities to encourage fun learning of science;
ii) To provide interactive science and technology exhibits;
iii) To organise enjoyable science programmes and activities;
iv) To publish and disseminate literature on science and technology; and
v) To act as facilitators and advisers on informal science education.

Figure 2.3. The landscape of National Science Centre of Malaysia (MNSC)

Source: www.psn.gov.my

As previously pointed out by Bierbaum (1988), workshops and classes are common educational programs provided by museums or science centre. Despite the classroom structure of some programs offered to school groups at non-formal institutional settings, they remain non-threatening and non-evaluative because the educators leading these lessons will not grade or test the students' acquisition of the information at the conclusion of the lesson. Nor will the students and educators necessarily interact with one another under these conditions again, since most of these classes are one-time opportunities. In such a casual learning environment how can the educators effectively mediate and facilitate the learning process. Investigations into the mode of instruction by museum educators in such educational programs, and their impact on student learning may shed more light on the whole museum experience. Unfortunately, there is little literature pertaining to teaching and learning from the perspective of the educators at the non-formal institutional settings. However, if one contends that teaching is teaching regardless of where it is done, and it is the strategy that changes or is modified according to the audience and the setting, then the corpus of research about classroom practices can provide incredible insight to educators teaching at non-formal settings. As Schauble and Bartlett (1997) stated while reflecting on designing a new science gallery for the Children's Museum of Indianapolis, "studying forms of student learning often makes little sense without studying forms of teaching" (p. 790).

In view of the Malaysian government's current emphasis on the importance of science, technology, engineering and mathematics (STEM) learning, coupled with the declining enrolment of science among students, it is considered timely for the centre to play a vital and aggressive role in addressing the issue. As there is hardly any record in studies in this country that have explored the role of science centres in promoting public understanding and interest of science and technology, this current study aimed to pioneer research in this area.

2.5 Theoretical Framework

Theory is a set of systematic statements that can be generalized and empirically tested (Hair et al., 2007). A strong understanding of theories can help shape the framework of a good study concept. Basically, this study was based on Social Cognitive Theory pioneered by Albert Bandura (1986), Constructivist Theory by Piaget, and Sociocultural Theory by Vygotsky as the underpinning theories in this study.

The rational selection of Social Cognitive Theory as the basic framework in this study were based on three main objectives, namely the personal, environment and behavioural factors outlined in this theory were appropriate and correspond to the main variables in this study. The ability of this theory to determine the relationship and influence between the variables set forth in this study. In addition, Social Cognitive Theory has a strong model to explain and predict human behaviour through internal and external factors that have been translated through the Reciprocal Determinism Model (Bandura, 1986).

In addition, the Contextual Learning Model presented by Falk and Dierking (2000), which was one of the main models in the conceptual framework of this study, also based on Vygotsky's social learning theory and constructivism theory. Besides, the conceptual framework draws on the generic learning outcomes (GLOs). GLOs were chosen as part of the conceptual framework of this study as non-formal settings is a place for all participants to gain learning outcomes from learning through engagement with the activities conducted by MNSC. The generic learning outcomes (GLOs) were based upon the work of the Research Centre of Museums and Galleries at the University of Leicester (Hooper-Greenhill, 2007) which comprises of five generic learning outcomes which were; i) knowledge and understanding, ii) Enjoyment, inspiration and creativity, iii) Attitudes and values, iv) Skills, and v) Activity, behaviour and progression. However, in this study, only three outcomes were measured which; knowledge and understanding, enjoyment and attitudes, since the current research only look at what happen during the school visits to the non-formal settings and did not measure the post-visits (hence the construct of Action, Contribution and Progression and skills were not measured in the study).

The interaction experience that allows to apply learning in non-formal settings in this model involves interaction in socio-cultural, physical, and personal context. Social learning theories emphasize, students as an active learner, there also should be social interactions with peers or those who were more experienced so that students can develop meaningful learning experiences to themselves. In the context of this study, science educators who were competent and have more experienced play an important role in non-formal learning in controlling the visitor's social interaction to ensure that meaningful learning takes place. Hence, the following sections explained further in relation to social cognitive theory (Bandura, 1986), socio-cultural theory (Vygotsky, 1978), and constructivism theory (Jean Piaget) used as the main theory in the development of this conceptual framework.

2.5.1 Constructivist theory

Jean Piaget developed theory of constructivism which believes children learn by doing and they create their own learning experiences. Constructivist learning theory is based on the principle that learning is a contextualized and constructive activity carried out by the learner (Fosnot, 2005). This theoretical approach fits well with learning that occurs in non-formal settings, where learners have a great deal of control over their learning. Central to constructivism is the notion that the learner constructs his/her own version of reality in a non-linear manner. Any new information must be integrated somehow with existing understandings held by the learner. It is the role of the teacher not to provide learners with knowledge, but to provide experiences through which learners may construct meaning for themselves (Fosnot, 2005; Resnick, et al, 1991). Besides, constructivism also recognizes the physical setting as an important factor in knowledge formation (Duit & Treagust, 1998). Therefore, the constructivist theory was important in this research as the knowledge the visitors experiences emerges as a personal construction of their lived experiences and can be describes on how they learnt, in terms of building and incorporating new ideas into a framework of existing ideas.

2.5.2 Social-cognitive theory (Bandura, 1986)

The basic theories underlying non-formal science education are Social Cognitive Theory introduced by Bandura (1986). In this theoretical view, a person's behaviour is not driven by internal power, or is formed and controlled by external stimuli automatically, but behaviour, cognitive and personal factors operate and interact with each other in a natural environment. Behaviour in this perspective refers to one's ability to do something. Bandura (1977) also emphasizes the interaction between individuals and the environment. He believes that through this interaction process, individuals are constantly responding to the environment and actively forming and influencing the environment. The concepts interpreted in the Reciprocal Determinism Model by Bandura (1977), view individual behaviour as an interactive process of reciprocal interaction between personal factors (internal processes such as motivation, perception and cognitive), and environmental factors. This means that individuals not only control behaviours that can affect environmental and personal factors, but individual behaviour can also be influenced by environmental factors and personal factors.

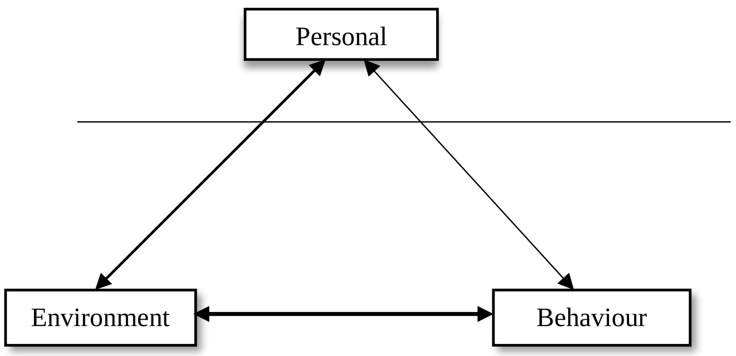


Figure 2.4. *Reciprocal Determinism Model*

Source: Bandura (1986)

Social Cognitive Theory imply humans as active creatures, making choices, using developmental processes to describe events and communicate with others. In fact, Bandura (1986) believes that individual functions were explained by behaviour, internal factors, and environment that interact with each other. Individual components include individual personality and cognitive factors that play an important role in the formation of individual behaviours such as expectations, beliefs, and personality traits that are unique to the individual. The environmental component consists of situations that occur in the physical environment of an individual to strengthen the stimulus. Social Cognitive Theory states that self-efficacy is influenced by three factors that are interdependent, namely personal, environmental, and behaviour factors (Bandura,

2001) as shown in Figure 2.4. Self-efficacy refers to individual beliefs about their ability to influence the motivation and the willingness of individuals to take on the responsibility to fulfil their goals.

The interesting features found in Social Cognitive Theory emphasize social influence but also the internal and external factors. Social Cognitive Theory not only describes how individuals acquire and maintain behaviour, but also consider the social environment contributing to the formation of such behaviour. However, the interaction between these three factors are different based on different environments and individuals. In some cases, one of the factors is stronger than other factors, and not necessarily all the factors occur simultaneously. According to Bandura (1977), these three factors cannot be separated to determine individual behaviour. It is clear here that; (1) the environment can control or affect individual personal factors and individual behaviours, or (2) individual personal factors can control or influence the environment and behaviour, or (3) individual behaviour can control or affect individuals and the environment.

The relationship between Social Cognitive Theory and the goal of this study was to see how the physical, personal and social context influences on the three main respondents, science educators, teachers and students in non-formal learning. Factors that influence the planning and implementation of non-formal science learning were given priority in this study. Teachers are always vulnerable with a wide range of teaching and learning strategies. Teachers are also exposed to the various planning options they need to do based on the present environment and situation. Likewise, science educators also have their specific plans in teaching and learning in non-formal settings. Hence, looking from different perspectives between science educators, teachers and lastly the main goal of this study is on how students' perceived learning in non-formal settings. In conclusion, Social Cognitive Theory provides an opportunity for this study to look at the strengths of the environmental factors in determining science educator, teacher and students' learning in personal context in non-formal settings. Not to forget, the relationships between all the three respondents in this study. The relationship between the theory and the chosen variable is appropriate to answer the research questions of the study, so this theory is used as the basis in the conceptual framework of this study.

2.5.3 Sociocultural theory (Vygotsky, 1978)

The social learning theory by Vygotsky emphasizes individual differences, creativity and cultural influences on learning. This theory also emphasizes students as active learners, it is necessary to have social interaction with peers or those who are more experienced so that students can form a meaningful learning. This is because students are thought to learn better when in an environment that needs a way of thinking that is much higher than the level of their existing development, which is called the zone of proximal development. Vygotsky also pointed out the idea that appreciation or internalization may exist as a result of discussion.

According to Vygotsky, what children learn and how they think are derived directly from the culture around them. The community is the source of all the concepts, ideas, facts, skills and attitudes. In his view adults look at things in a different way than children but this divergence is gradually getting closer as children begin to make their own judgment on the views of society and ultimately form their own views. Because students will only learn something through their surroundings, students cannot understand something without the help of teachers or science educators. Due to the lack of demonstrations and explanations from teachers or science educators, students find it difficult to master something (Razali et al., 2003). In this theory, Vygotsky presents some ideas about social learning models:

a) Zone of proximal development (ZPD)

The Zone of Proximal Development, or the ZPD, is one of the most significant concepts in Vygotsky's constructivist theory. Vygotsky formulated two levels of children's development to clarify how they transition from potential development to actual development, which is referred to as the ZPD – or "the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers" (Vygotsky, 1978, p. 86). Moving from one level to another may require assistance from adults or other knowledgeable persons; when such people use the ZPD knowledge to modify children's activities, children will bring their best learning ability into full play. This assistance is portrayed as "scaffolding" - which is the temporary support which helps the learner extend his or her current skills and knowledge to a higher level of competence. To apply ZPD in teaching and learning, teachers or science educators need to adhere to the following three principles; assessment, adjustment of assignments according to the level of student development or ability and the provision of instructional support. According to Vygotsky (1978), teachers can stimulate learning by giving students a lot of opportunities to respond, which includes skills and abilities that students can do alone and other skills that require the help of teachers or science educators

b) Scaffolding

The scaffolding concept was introduced as the provision of instructional support. This concept means a support for students to complete a task they cannot complete without the help of teachers or science educators. Scaffolding functions as a tool to help students learn new skills. Razali et al. (2003) provides several types of scaffolding that can be applied by teachers or science educators; modeling, giving explanations, asking questions, adapting instructional materials and being helpful and giving assistance. This strategy is able to bridge the relationship of teachers, science educators and students through collaboration and this will create a harmonious and balanced learning environment. Vygotsky's strategy is also expected to contribute to the unity through cooperative learning and recommended reciprocity (Vygotsky, 1978). This is because all students with no regard to religion and race are encouraged to mingle together while undergoing teaching and learning sessions. The concern of this research basically on science learning in non-formal settings, which involved science educators, teachers and the students themselves. Having discussed the theories underpinning the conceptual framework of this study, the two model; The Contextual Model of Learning (CML) by Falk and Dierking (1992) and the Generic Learning Outcomes

(GLOs) by (Hooper-Greenhill, 2007) shall form the conceptual framework for this research which also guided by the sociocultural and constructivist theory of learning.

2.5.4 The Contextual Model of Learning (CML)

In this study, the Contextual Model of Learning (CML) by Falk and Dierking (1992) were used as a conceptual framework. Falk and Dierking (1992) originally created the Interactive Experience Model with three overlapping contexts: personal, sociocultural, and physical. This model was revised in 2000 to include a fourth element, time and renamed the CML, (see Figure 2.5). In the CML, learning is the process/product of the visitor's interactions between these three contexts within a period of time. Falk and Dierking (2000) build upon Dewey's constructivism and Vygotsky's sociocultural theory, reasoning that a school group visits to non-formal settings can provide students with strong memories in two contexts: cognitive and sociocultural.

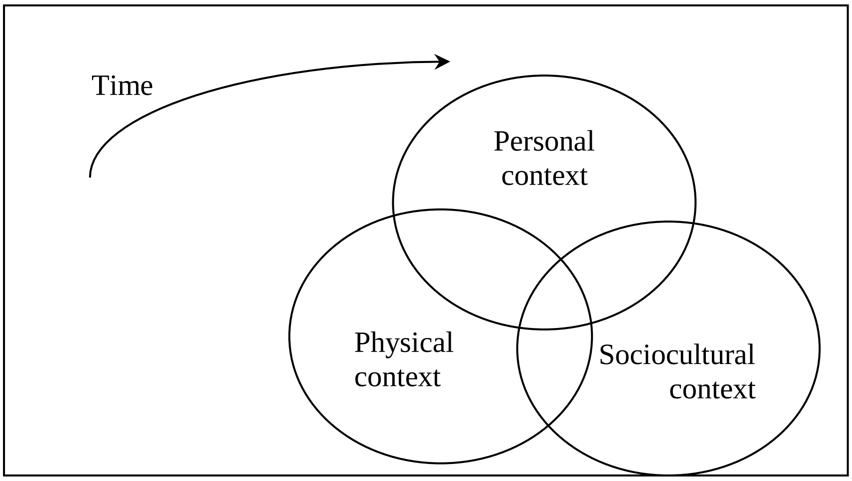


Figure 2.5. The Contextual Model of Learning (CML)

Source: (Falk & Dierking, 2000:12)

In the CML, visitors bring their personal context, including their prior knowledge and motivation to explore various exhibits. The non-formal settings present cultural content that the visitor usually experiences with other visitors - usually friends or family who are exploring the place together - thus creating a sociocultural context. According to Zhai and Dillon (2014), the sociocultural perspectives of learning highlight the importance of discourse during the process of knowledge construction. The physical context of the museum includes the building, as well as everything in it, including exhibits, bathrooms, gift shop, and café.

Kisiel (2003) examined the CML in relation to students visiting museums on field trips. He found eight factors that influence learning:

1. Motivation and expectations (visitors visit museums for a variety of reasons, and these reasons can shape the learning experience).
2. Prior knowledge, interests, and beliefs (visitors are drawn to exhibits where they have personal knowledge).
3. Control and choice (learning is optimal when the learner has control over which exhibits they visit).
4. Sociocultural mediation within groups (visitors within small groups mediate learning for each other).
5. Facilitated mediation by others (museum staff help make meaning with visitors).
6. Orientation and advanced organizers (visitors use a museum map or list of key concepts to guide learning).
7. Exhibit design (exhibits may engage a variety of learning styles).
8. Outside experiences that reinforce the museum experience (visitors continue the learning by finding books or websites that relate to the museum exhibit).

The CML builds on constructivist and sociocultural education theories and assumes that students are central to learning and that they are active learners responsible for acquiring their knowledge. It implies a child is always an active agent in the process of meaningful learning. Children learn, not only by receiving a transmission but by interpreting a message and the sharing of prior knowledge is essential for communication. For example, learning from activities or hands-on learning allows for meaningful grappling with the concepts under study (Cobern, 1996).The CML is the theory referred to most often in the literature and appears to be the accepted model for student learning in museums in the current research; therefore, it will be used as the basis for further discussion regarding learning in museums.

The concern of this research basically on science learning in non-formal settings, which involved science educators, teachers and the students themselves. How the students' perceived science learning in non-formal settings and what are the teachers' objectives when bringing the students to learn science in non-formal contexts. On the other side, in order to know about the students' and teachers' view, this research also want to know what the science educators' goals when teaching the students' in non-formal contexts. Researching what participants learn, as well as the goals, intentions and expectations, is a must to better understand and provide a better idea of effective science learning in non-formal settings. Thus, science learning in non-formal were investigated in this study include their responses towards science learning and also the sociocultural context.

The Falk and Dierking's Contextual Model of Learning (CML) was used as a theoretical construct for investigating learning within a free-choice setting. The CML was chosen as a framework in this study and it is hope that it can provide a better understanding on how complex combinations of factors will influenced the participants in this study, namely; science educators, teachers and students age 10-14 years old on science learning in non-formal settings.

The Contextual Model involves three overlapping contexts; the personal, the sociocultural and the physical context. Learning is the process or product of the interactions between these three contexts. According to (Falk & Storksdieck, 2005), the Contextual Model of Learning provides the large-scale framework with which to organize information on learning. For the purpose of this research, ten key factors that best suites the purpose of this research of science learning in the non-formal learning contexts.

The personal context looks at learning that occurs through motivation and expectations, prior knowledge, interest, beliefs and their choice of exhibits. The personal also engages the learner to stimulate their understanding and most important the learner is to take responsibility for their own learning. In the personal context pupils' learning flows from a set of emotional and motivation; the process of learning occur when they have expectation from the activity. The affective domain were operate at this time, an hence this often spark the interest to want to find out new things or go deeper into learning about something they already encountered (Braund & Reiss, 2004a). The impact of this engagement can provide an attitude to science learning. As learning is a very personal experience that depends on a number of conditions for success, for example the external environment. Therefore, the physical context has providing important factors to this success also. The orientation to the physical space (in this research includes the centre-based, single and multi-school outreach) plays a very important role in determining the success of science learning out-of-school classroom contexts. Besides that, the suitability of the activity and programs conducted also plays a very important role in the physical context.

Braund and Reiss (2004) stated that what we learn in any situation is often mediated through our gestures and by conversation with others. According to them, the way in which we act in and react to different learning situations is a product of our culture. Our culture and society and the ways in which we have been brought up impose a set of social norms which set expectations and give rise to rules about how we behave in different learning situations. These are key aspects of what Falk and Dierking call the sociocultural context. On the other side, factors affecting learning have been hypothesized to include such large-scale influences as the cultural value placed upon free-choice learning (Ogbu, 1995) as well as the cultural context of the museum within society (Hooper-Greenhill, 1992). Therefore, the sociocultural context was adapted in this study as it is beliefs the conversation we had with our peers and also with others outside our group circle (in this case of study the conversation with either science educator or the teacher) to influences on how we react and engage in a different learning situation in the non-formal settings.

2.5.5 The Generic Learning Outcomes (GLOs)

In the Generic Learning Outcomes by Hooper-Greenhill, there are five specific outcomes measured. The generic learning outcomes (GLOs) were based upon the work of the Research Centre of Museums and Galleries at the University of Leicester (Hooper-Greenhill, 2007). In this study, only three outcomes were used which were knowledge and understanding, enjoyment and attitudes, since the current research only look at what happen during the school visits to the non-formal settings and did not measure the post-visits (hence the construct of Action, Contribution and Progression and skills were not measured in the study).

According to Hooper-Greenhill, knowledge and understanding refer to 'learning facts or information (knowing 'what' or knowing 'about') and developing a deeper understanding, or grasping meaning more firmly, in relation to diverse specific fields Meanwhile enjoyment as an outcome of learning is likely to lead to the development of positive learner identities and to the desire to repeat the experience. When learning is enjoyable, it is easier, and may sometimes take people by surprise.

Attitudes and values were developed by learners as an integral part of their learning in both formal and informal environments. As new information is absorbed, attitudes to that information were developed, and these attitudes contribute to the formation of the values that inform the decisions people make about how to live their lives. Visits to museums, archives and libraries can result in shifts or change in attitudes, and can sometimes be seen to alter the values that people hold. With young learners, where attitudes can change frequently, and values are still to be firmly established, there are considerable opportunities to influence their development. It is highly possible that the effects on values and attitudes will not be apparent in the short term; and they may be forming without the learner's conscious awareness.

Attitudes to other people are part of basic values. Positive visits to museums, archives and libraries may result in increased tolerance for diversity and difference, perhaps based on new information about different ways to worship, learn or think. On the other hand, sometimes cultural visits may be used to confirm negative views about people and things. It is not always possible to change long- held views. Therefore, these part is crucial in order to prepare Malaysians as competent global citizens of the twenty-first century. The vision of building a strong Malaysian nation that is responsive to the challenges of the twenty-first century and at the same time holds strongly to religious and ethnic values had been the aspiration that was stressed time and again by Tun Dr Mahathir Mohamad (Rozita, 2007).

In adapting this theory, the perceptions of students, teachers and educators toward knowledge and understanding, attitudes and enjoyment were considered to be captured along the process. It's directly or indirectly involved with the personal, sociocultural and physical context throughout the experience in out-of-school settings. It is therefore the concern to investigate the impact of science learning in out-of-school settings. More specifically, this study examined the perceptions on knowledge, attitudes and enjoyment from school visits from the perspectives of students, teachers and science educators in non-formal learning, conducted by the Malaysia National Science Centre (MNSC) using three different locations of engagements: centre-based, single and multi-school outreach.

2.6 The conceptual framework of this study

According to Maxwell (2013), "the conceptual framework of a study is primarily…a tentative theory of the phenomena that you are investigating" (p. 39). The function of this underlying belief system is to inform the research design, including the questions asked, the data collection methods and focus of analysis. This study is guided by a sociocultural, social-cognitive, and constructivist theories and assumes that students are central to learning and that they are active learners responsible for acquiring their knowledge.

This study identifies three groups of people who attend, guide and support the learning activity as occupying distinct roles. While each group is inherently heterogeneous in terms of age and background, they are temporally unified in their role as student, science educator or teacher during the situated practice of a guided tour. By contrasting and comparing the perceptions of learning of these three groups, it is hoped that new insight will gained into this practice. What are the science educators' goals for science lessons taught at out-of-school settings? What are the teachers' objectives for conducting school visits to out-of-school settings? What do students' gained from their engagement with MNSC in term of students' responses to science?. Taking into consideration all the component and theories related to the science learning in thenon-formal settings, the conceptual framework used in this was illustrated in Figure 2.6.

This theoretical framework has been widely adopted and considered by many as a seminal work in understanding the factors associated with the learning that occurs in non-formal settings (Rennie, 2014). The concern of this research basically on science learning in non-formal settings, which involved the science educators, teachers and the students themselves. How the students' perceived science learning, and what are the teachers' objectives when bringing the students to learn science in non-formal contexts. On the other side, in order to know about the students' and teachers' view, this research also want to know what the science educators' goals when conducting the activity in the non-formal contexts. Researching what participants learn, as well as the goals, intentions and expectations, is a must to better understand and provide a better idea of effective science learning in non-formal settings. Thus, science learning investigated in this study include the responses towards science learning from three different contexts, personal, sociocultural and physical context.

In the personal context, pupils' learning flows from a set of emotional and motivation; the process of learning occur when they have expectation from the activity. The affective domain were operate at this time, an hence this often spark the interest to want to find out new things or go deeper into learning about something they already encountered (Braund & Reiss, 2004). The impact of this engagement can provide an attitudes to science learning. Motivation and personal interests are related to emotion or the affective domain, and greatly influence learning in informal contexts (Barriault, 2014). As learning is a very personal experience that depends on a number of conditions for success, for example the external environment. Therefore, the physical context has providing important factors to this success also. The orientation to the physical space (in this research includes the centre-based, single and multi-school outreach) plays a very important role in determining the success of science learning out-of-school classroom contexts. Besides that, the suitability of the activity and programs conducted also plays a very important role in the physical context.

Braund and Reiss (2004) stated that what we learn in any situation is often mediated through our gestures and by conversation with others. According to them, the way in which we act in and react to different learning situations is a product of our culture. Our culture and society and the ways in which we have been brought up impose a set of social norms which set expectations and give rise to rules about how we behave in different learning situations. These are key aspects of what Falk and Dierking call the sociocultural context. On the other side, factors affecting learning have been hypothesized to include such large-scale influences as the cultural value placed upon free-choice learning (Ogbu, 1995) as well as the cultural context of the museum within society (Hooper-Greenhill, 1992). Therefore, the sociocultural context were adapted in this study as it is beliefs the conversation we had with our peers and also with others outside out group circle (in this case of study the conversation with either science educator or the teacher) to influences on how we react and engage in a different learning situations in non-formal settings.

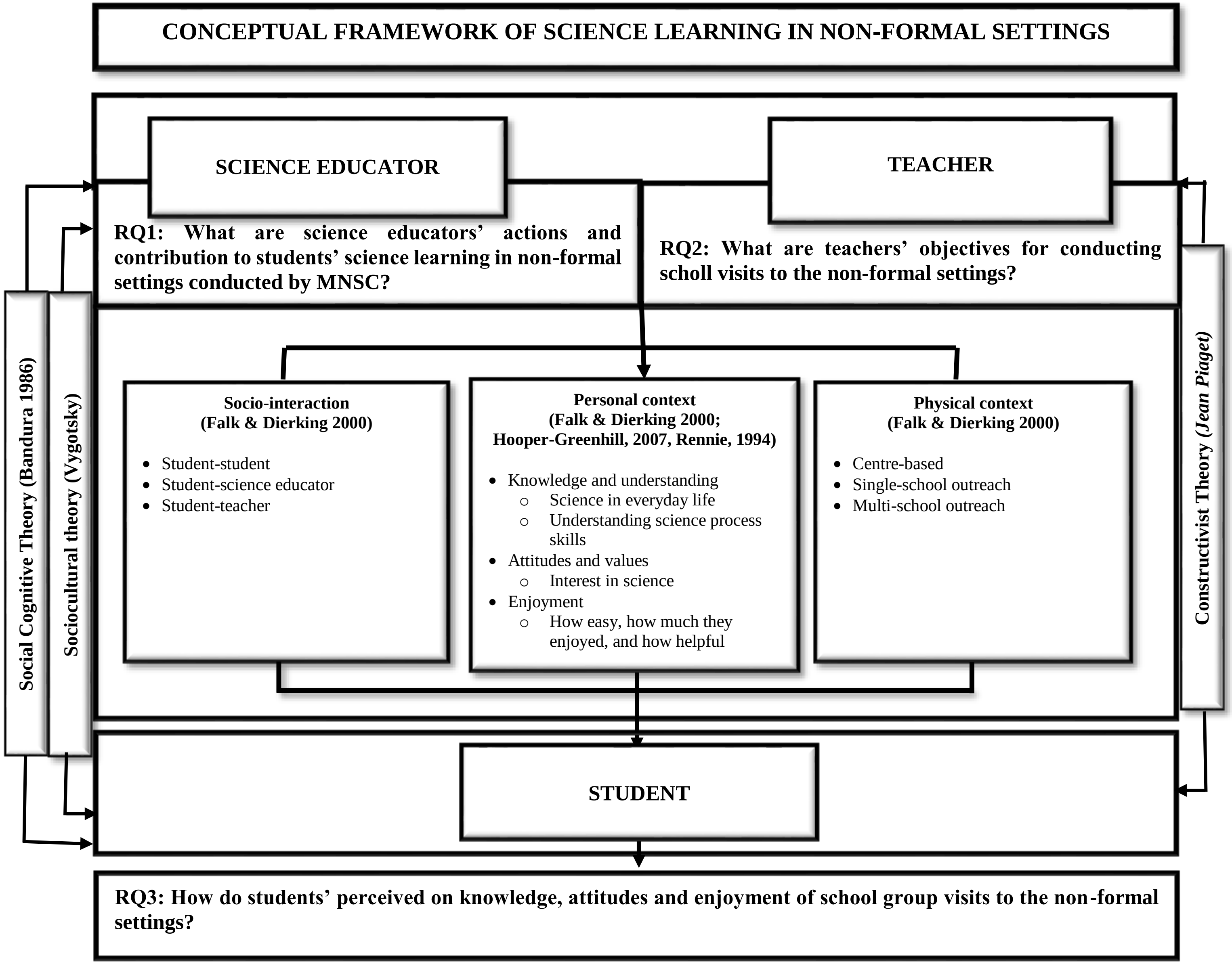


Figure 2.6. Conceptual framework of this study

2.7 Previous research on science learning in non-formal settings

In this heading, the global scenarios of school visits, the advantages of school group visits to non-formal settings and school group visits from the perspectives of science educator, teacher and students were discussed.

2.7.1 School group visits in non-formal settings

There are a wide range of learning environment or infrastructure available for school group visits (Falk, 2001; Rickinson et al., 2004; Tal, 2004; Tal & Morag, 2007). This visit usually involves teaching activities directly guided by teachers in an out-of-class setting (Rebar, 2009), enabling students to engage in out-of-classroom activities, build learning experiences in real context and support learning at school (Scarce, 1997; Tal & Morag, 2009), which is a connection to the ideas, concepts and content of science learning (Krepel & Duvall 1981). In recent years, science education reform trends in the world have focused on prioritizing hands-on activities and scientific thinking in improving student science interest (Falk & Dierking, 2011; Nabors et al., 2009; Pugh & Bergin, 2005). In line with these developments, non-formal settings have been experimenting with new ways to bring local and relevant current science to their audiences through programs and activities including science festivals, science and robotics competitions, exhibitions and forums (Selvakumar & Storksdieck, 2013).

Non-formal settings are believed to be capable of providing different learning opportunities and experiences to students. Among them are opportunities to develop knowledge and social skills development (Cox-Petersen et al., 2003; DeWitt & Hohenstein, 2010; Falk & Storksdieck, 2005; Olson et al., 2001; Pringle et al., 2003). As a result, the importance of learning beyond the classroom environment has been given special attention as one of the efforts to overcome the perceptions of science lessons that are usually considered to be difficult. This effort led to the collaboration between formal education institutions and informal learning institutions to enable students to achieve their own learning. This situation gives teachers an awareness of the benefits gained to produce effective teaching and learning. According to Yavuz and Kiyici (2013), almost all teachers emphasize the positive impact of an out-of-school learning environment in science and technology to address the academic concerns and academic level. This is seen as an important thing in building student confidence in science learning (Boxerman, 2013) and promoting student engagement in science learning (Bell et al., 2009; Olson et al., 2001). In addition, field-based studies also demonstrate that an out-of-school learning environment can benefit students in terms of success, motivation, attitudes, problem solving skills, and their interest in science (Braund & Reiss, 2006; Falk & Adelman, 2003).

2.7.2 The advantages of school group visits to non-formal settings

The findings of the previous study illustrate the focus on the importance of school visits to formal science education. Teachers use non-formal settings as a target for school visits to enable exploration of science learning that may not be possible in the classroom (Yerrick & Beatty-Adler, 2011). Non-formal science learning activities focus on exhibits to introduce and explain concrete and natural phenomena (Boxerman, 2013; DeWitt & Hohenstein, 2010; Falk & Storksdieck, 2005; Nabors et al., 2009; Orion & Hofstein, 1991; Suzuki, 2005). This activity contributes to the development of individual scientific concepts (Gelman & Kalish, 2006) where each activity provided representing scientific concepts and phenomena designed in line with current technological developments. In addition, teachers can also compare knowledge before and after school group visits (Anderson et al., 2003) to ensure the effect of learning experience in non-formal settings on the achievement of student science learning (Holmes, 2011).

In general, science centres and museums are an important resource in supporting the teaching and science learning. This is based on previous studies which state that school group visits to non-formal settings can help the science learning experience directly (Tran, 2004; Yerrick & Beatty-Adler, 2011) through previous knowledge (Bamberger & Tal, 2006, 2008; Falk, 2001; Falk & Dierking, 1997). By combining the concepts learned in formal classroom with science learning experience in non-formal settings, the learning process is seen to be active, easy to accept, meaningful and relevant to the student (Lee & Luykx, 2007). In addition, school group visits to the non-formal settings were also said to increase the level of intrinsic motivation (Hergenhahn &

Olson, 2005; Holmes, 2011; Pedretti, 2002; Salmi, 2003). This motivation can influence students' attitudes toward science (Abraham, 2002; Bell et al., 2009; Falk & Storksdieck, 2005; Feher, 1990; Knox et al., 2003; Markowitz, 2004; Michie, 1998; Roth & Li, 2003; Stake & Mares, 2001; Stroud, 2008; Weinburgh & Steele, 2000).

In addition, students are given the opportunity to determine their own learning and level of participation, what they need to learn, and the time they use to complete certain tasks (Falk & Dierking, 2002). They participate in activities that can stimulate their interest such as analyzing, hypothesis and experimenting experiments offered in these non-formal settings. Previous researchers point out that students are free to choose the desired learning experience through activities that have a diversity of interests, knowledge, and relevance to past experiences (Falk & Storksdieck, 2010; Csikszentmihalyi & Hermanson, 1995; Falk & Dierking, 1992; Griffin, 1998, 2004; Griffin & Symington, 1997; Pedretti, 2002). This is because each visitor has their own interpretation of their visit experience (Falk, 2004). School group visits also offer science-based learning based on the science-based leisure experience (Falk, 2009; Falk et al., 2007; Falk & Storksdieck, 2005) and 'learn science by doing science' (Dusenbery et al., 2008). Learning through school group visits exposes students to new learning experiences (Nabors et al., 2009) and is part of a science enrichment program (Tal, 2001). Science learning in non-formal settings only take a short time, requiring no continuity, depending on student curiosity, choice and control (Pedretti, 2002).

Previous research literatures showed that science centre has been recognized to have a huge impact in science and technology education. Zandstra (2012) in his study described the non-formal learning environment as exciting, fun and challenging. This is because non-formal settings are designed to trigger and stimulate visitor interest in science. Learning in non-formal settings environment typically offers free choice learning (Phipps, 2010; Zandstra, 2012), allowing students to build personal understanding (Bamberger & Tal, 2006), learning about science process skills (Allen, 2004; Falk & Storksdieck, 2005), learning across the school curriculum (Dillon et al., 2005; Falk & Dierking, 2000; Yerrick & Beatty-Adler, 2011), and build understanding and strengthen the science concepts (Dillon et al., 2005; Falk & Dierking, 2000; Guisasola et al., 2005; Tran, 2004). These advantages can influence the knowledge and achievement of students in science (Parker & Gerber, 2000; Romance & Vitale, 2001).

However, in order to optimize science learning in non-formal settings, school group visits need to be carefully planned. Griffin and Symington (1998) through their study explain that to produce meaningful learning in school group visits, the factors to consider are: (1) being able to take responsibility for carrying out learning activities, (2) actively involved in learning activities,) fully manipulate the activities offered, (4) make links between information obtained through exhibits with scientific ideas, (5) share learning content with teachers and peers, (6) confident in learning by asking questions and explaining to friends, and (7) ready to receive new information.

2.7.3 Research on science educator and their perceptions of teaching and learning in non-formal settings

In the science centre, they had different kinds of educational programs, including workshops and classes available to patrons, and structured science classes were among the most commonly offered programs. However, according to Tran (2002), research from the perspective of science educators in the non-formal settings and the educational programs the institutions provide, literature regarding learning and instruction was meagre.

In general, the role of the science educator is to assist a group to improve the effectiveness of decision-making and settlement by improving the process to ensure that the discussion process goes smoothly and perfectly (Wan Norjihan, 2003; Stewart, 2006). According to Hamdan et al. (2007) science educator is a facilitator that helps the group participants through an effective learning and communication process in achieving group goals. In this non-formal science study, science educators play a very important role in facilitating learning in a particular group; especially the groups of students who visit the non-formal institutions.

The role and function of science educator in non-formal science learning is more broad, encompassing as a (i) planners, (ii) science tour guides and expertise in a content area (Tran, 2008; Kamolpattana et al., 2015). Science educators need to be wise in planning learning at each visit or demonstration, having the skills as knowledge-driven guides to facilitate learning within the group effectively. To achieve objectives or learning outcomes, the science educator should help, guide and supervise the group to stay focused on learning at prescribed time (Hunter et al., 2005; Thomas, 2008; & Chin & Osborne, 2010). In addition, the science educator’s guidance is to increase student learning success in this non-formal context through the programs, exhibition materials and learning space provided (Cox-Petersen et al., 2003, Falk & Storksdieck, 2005, Thomas, 2010). In non-formal science learning at science centre for example, the science educator not only to oversee the exhibition tools but what is more important is to point out the visitors or students to an exhibition material and further explain the concept of science in question. Hence, the science educators plays an important role in ensuring that this non-formal learning can run smoothly and become a meaningful learning process.

Grenier (2011) argues that a professional science educator should have knowledge of the subject and the basic concepts of a field in order to integrate previous knowledge while performing the task. In the context of non-formal settings, the basic and the type of knowledge and skills are essential to enable the science educator to perform the task perfectly (Tran & King, 2007; Scott, 2006; Steward, 2006). In ensuring the effectiveness of this non-formal science learning, science educators and the learning environment provided by the organization involved play an important role. Competent science educators should provide and manipulate a conducive learning environment to promote effective learning. This is because in non-formal learning like at the science centre, visitors will respond with the physical context of the museum including large-scale aspects such as space, lighting, and weather as well as small-scale aspects such as exhibits and objects found there (Falk & Dierking, 2000; Falk & Starksdieck, 2005). In addition, science educator needs to have knowledge of the basic curriculum or science concepts and have the ability to disseminate the basic science concepts to build the potential of students to make decisions and overcome their own problems (Spencer & Spencer, 1993, 2008).

In addition, a science educator also needs to have good oral communication skills to ensure effective teaching and learning can take place in non-formal settings. Clear verbal communication is a good use of words, languages, and tones. In addition, every science educator should also encourage the involvement of all students and have good relationships with students to create trust and mutual understanding with each other where it will reduce students feel isolated and marginalized in the group (Hogan, 2002; Hunter & Thorpe, 2005; Paulsen, 2004; Thomas, 2005).

According to Stewart (2006), a science educator can use theoretical knowledge to manage the physical environment to ensure it is more conducive to promoting the involvement and creativity of group members. According to him, a good science educator is competent and understands information and acts quickly. In addition, this competency also refers to the ability of a science educator to train group members in improving skills and managing feedback received from visitors. Whereas, Kolb et al. (2008) stated that there are ten competencies under the five cluster categories of communication, task, and relationship/climate, organization and professional ethics as shown in Figure 2.7;

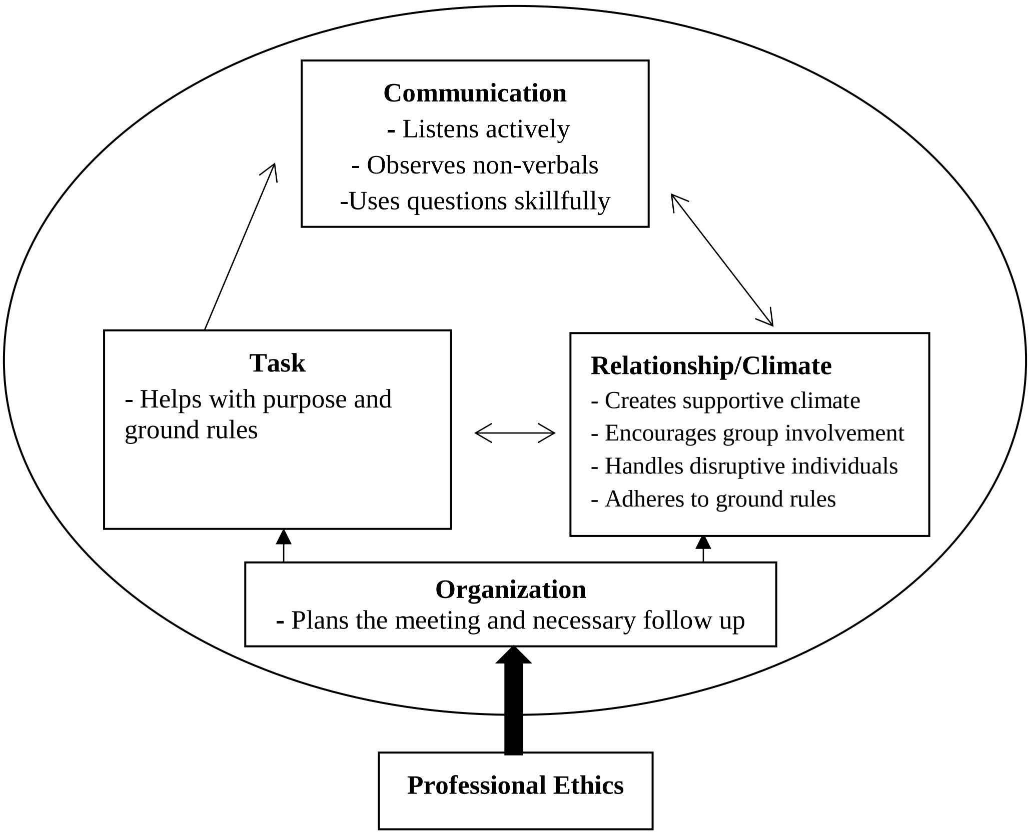


Figure 2.7. Framework of core facilitator competencies

Source: Kolb et al. (2008)

According to Kolb et al. (2008), communication, task and climate and change interconnected reflecting bilateral relations and interdependence with each other. For example, 'encouraging group engagement' is interconnected and influenced to complete assignments and communication among members in the group. A person who does not listen attentively, observe and attend to non-verbal communication, and use questions skillfully will have a difficult time fulfilling the responsibilities of a science educator. Likewise, a person who fails to attend to organizational issues throughout the facilitation and, specifically, to plan the meeting and perform necessary follow-up activities as contracted, will likely have a less than positive experience and outcome.

Based on the literature, studies that focus on science educators or instructors in non-formal science learning are still limited (Plummer & Small, 2013, Falk & Dierking, 2000) especially in Malaysia context. Accordingly, this study was conducted to focus on science educator's perceptions on science learning in the non-formal settings. This is very crucial as we know, in formal education at school, a teacher needs to comply with certain competencies, likewise in non-formal education, a science educator also needs to be competent in ensuring the objectives of a program achieve its goals. Therefore, this study was conducted in order to find out what are science educators' action and contribution to students' science learning in non-formal settings focusing on the activities conducted by MNSC in this current research.

2.7.4 Research on teacher and their perceptions of teaching and learning in non-formal settings

Based on the advantages of school group visits from teachers' perspectives, non-formal settings also offer benefits to teachers more than just a destination for school group visits. The institutional environment has the potential to provide pedagogical ideas to teachers, science knowledge that teachers need to master, and to improve teacher knowledge about the latest research developments (Selvakumar & Storksdieck, 2013). Among the studies carried out in relation to teacher education and professionalism development among teachers in a non-formal environment have been conducted by Kisiel (2012, 2013), Melber (2007) and Yerrick & Beatty-Adler (2011). In this regard, the study by Kisiel (2013) has shown a transformation from a study of teacher perceptions towards non-formal settings to help teaching science in the classroom. Basic awareness of the advantages of field trips in meeting the needs of students and affecting the involvement of teachers is often stated in the previous study (Kisiel, 2003, 2005). Basic awareness about the advantages of school group visits in meeting the needs of students and the involvement of teachers in school group visits is often stated in the previous study (Kisiel, 2003, 2005).

Kisiel's study findings (2013) show that teachers recognize non-formal science settings as a place to help science teachers in improving teaching quality, mastering content, teaching pedagogy and resources for teaching and learning activities. The emphasis on school group visits is also described from the perspective of teachers (Finkelstein, 2005; Schneider, 2003; Tal, 2001), teachers' motivation in field trips (Kisiel, 2005) and also science teaching strategies in a non-formal environment (Bamberger & Tal, 2006; Cox-Peterson et al., 2003; Tran, 2006). Kisiel (2013) and Dillon et al. (2005) emphasized that the benefits of out-of-school classroom learning are not limited to students but also lead to the relationship between teachers and students, personal development of teachers, and benefits in the science education curriculum.

In addition, Tran (2004) also explains that learning in non-formal settings is free, has a wide range of activities that is non-threatening to the student and have no specific assessment. This advantage can provide teachers with the opportunity to expose the program offered by non-formal settings to students to explore science concepts and understand the experiences they are experiencing in their daily lives. Based on the findings, the researchers conclude that (1) school group visits have the power in triggering curiosity, attracting attention and changing student learning routines in the classroom, (2) the knowledge and goals of teachers can affect students' science learning and behaviour, and (3) teachers and science educators can share their responsibilities in planning and implementing school group visits effectively. Thus, non-formal education science is not only beneficial to students but also to teachers in improving the quality of teaching and learning science.

2.7.5 Research on student and their perceptions of teaching and learning in non-formal settings

The function or role of the science centre has long been discussed internationally. Falk and Needham (2011) state that 70-80 percent of adults report that their children learn new things in science after visiting the science centre. It attracts children to learn more about science. Science centre has also increased students' curiosity and concern for science. A visit to the science centre has also encouraged children to engage in a variety of science-related activities to alter the behaviour related to science and technology. Falk and Needham (2011) also find that the science centre gives adults the opportunity to interact with children in matters related to science and technology.

Research by Rix and McSorley (1999) suggests that they found that although some students made cognitive gains on how the phenomena happened, the majority did not understand how or why it occurred. Students' inquiring behaviours were driven by 'what they need to do' in completing the activities rather than 'why was this happening?'. Students tended to 'play' with the apparatus and did not learn the intended science concept.

Conversely, studies have shown a significant negative impact on students' attitudes and attainment in science learning during the phase of transition from primary to secondary school (Braund, Crompton, Driver, & Parvin, 2003; Diack, 2009; Senturk & Ozdemir, 2014; Thurston et al., 2010) and the increased tendency to be negative about school were manifested in the middle of transition to secondary school.

The students' responses in this study refer to reinforcement of school knowledge within the visit to the science centre. Learning during a visit does not have to be about new things. It can occur when previous knowledge is consolidated by linking experiences together in a meaningful way (Rennie, 1994). Piaget certainly held that children's knowledge is constructed through interactions with their environment. Therefore, in this study, the responses will be captured based on students' reflection or their cognitive engagement with the content/activities displayed at the targeted exhibits at the science centre.

In Singapore, two studies were conducted by Lam-Kan (1985), Cheong and Lam-Kan (1987), and Finson and Enochs (1987) in the Singapore Science Centre. In order to assess the attainment of science concepts, the co-operation science test was used. It was found that by and large, students who interacted with the exhibit at the centre outperformed students who had no experience with the exhibition regarding the concepts that underlined the exhibits (Hofstein & Rosenfeld, 1996).

Besides, affective responses in this study specifically refer to on how students responded in term of how easy they found various aspects of activities, their enjoyment of what they did and how helpful they found the visit in terms of their wider views and understanding about science and scientist (Rennie, 1994).

a. How easy students' perceived success in working with the activities?
b. How much students enjoyed doing the activities?
c. What is students' perception of the helpfulness of the visit to the activity conducted by MNSC?

Assessments of the learning impact of a visit to a science centre need to consider the multiple outcomes of such a visit that are shaped by the sociocultural, personal and physical contexts of that learning experience (Barriault, 2014). When students view learning as "obligatory and extrinsic, it shares qualities with work" (Benton, 2013). Whereas when learning experiences are novel, fun and hands on, students reported finding the overall learning experience enjoyable.

With hands-on experience of a particular project, students have the freedom to explore, experiment with and observe previously unknown phenomena by themselves. Eventually, this exploration will help them to organize the information gathered and allow them to make decisions on the importance of information to their topic (Recht & Leslie, 1988; Balas, 1988; Schneider et al., 1996). It will provide students with another avenue of learning more about topics of personal interest to them, it will enable them to generate, analyse and assess the impact of their findings, and it will connect what they learn to experiences. Another factor that contribute to students' learning, is that participation in enrichment activities relevant to school science would improve science subject and help the students to organize the information and make decisions on the important information to the topic under study (Cheong and Lam-Kan, 1987).

2.8 Summary

This review of literature explains the background of my study, my interests and the important of science learning in non-formal settings. Although non-formal learning environments are often used in science teaching in the developed countries, they are still not being used at the desired levels in Malaysia. Therefore, this study examined the perceptions on knowledge, attitudes and enjoyment from school visits from the perspectives of students, teachers and science educators in the non-formal learning, conducted by the Malaysia National Science Centre (MNSC) using three different locations of engagements: centre-based (i.e. at the MNSC itself), single-school outreach (i.e. MNSC outreach at one school), and multi-school outreach (i.e. MNSC outreach for several schools gathered together at one school). As they were not many studies in the literature that present the effects of the usage of non-formal learning environments in science teaching especially in Malaysia context, therefore, it is hoped that the findings from this study will contribute to that matter especially literatures in Malaysia context. In this regard, it is vital to elicit the opinions of the teachers who are the executives of these visit activities, on the matter and the science educators, as the expert in this area of study – on how it will affect students' science learning during the visit to the centre.

Chapter 3

Research Methodology

3.1 Introduction

This study aims to examine the perceptions on knowledge, attitudes and enjoyment from school visits from the perspectives of students, teachers and science educators in the non-formal learning, conducted by the Malaysia National Science Centre (MNSC) using three different locations of engagements: centre-based (at the MNSC itself), single-school outreach (MNSC outreach at one school), and multi-school outreach (MNSC outreach for several schools gathered together at one school). The study gathered information from students and teachers visiting non-formal settings, and staff at MNSC (science educators), in order to identify the factors that make the visits as beneficial as possible. By identifying these factors, it would be beneficial for science learning as stated by National Science Education Standard (National Research Council, 1996: 45), which stated that museums and science centres "can contribute greatly to the understanding of science and encourage students to further their interests outside of school". Therefore, this chapter describes the research methodology; including research design, methods of data collection, the target audience, gaining access, an data analysis procedures.

3.2 Research design

The approach in this research was mainly 'naturalistic research' in that it was carried out in the natural settings, with three different locations of engagements: centre-based, single-school outreach, and multi-school outreach. The purposive sampling was chosen to explore the respondent's perceptions; either science educators at MNSC, or teachers or students involved in the programs conducted by MNSC. Study participants will be a convenience sample of MNSC visitors on the period of study (pilot study was conducted on September 2014 and main study data collection was conducted on February-May, 2015). Some information of visitors was known in advance as researcher was ask for permission from the person in charge in MNSC in order for the researcher to contact them. It should be noted that this procedure was occurred as all the procedure to conduct study in Malaysia was fulfilled. However, due to the context or environment of study, a convenience sampling case study turned out to be an opportunistic sampling. This was because the research depends on the school groups that visited the MNSC during the period of research under study. The convenience sampling was not entirely accurate, maybe because of last-minute cancellations of visits from any particular school groups, simply no shows or any other reasons that might appear. Therefore, in this study, the convenience sampling may end up being an opportunistic sampling.

A mixed methods approach using quantitative and qualitative methods sequentially was selected to address the research questions. The mixed methods approach uses in this study, both numerical and qualitative, in order to gain both a broad overview and an in-depth understanding of science learning in the non-formal settings. Quantitative and qualitative research methods offer different kinds of evidence and, in this research, they were used to complement each other. Mixed-methods research designs involve research studies that employ both quantitative and qualitative research methodologies to address the proposed research questions. Thus, mixed research methods combine the deductive and inductive inquiries of the scientific research methods as well as the use of a variety of data collection and analysis methods (Creswell, 2003, 2012; Kalaian, 2008). The two approaches used, allowing for a better depiction of the phenomena overall as well as the opportunity for triangulation of findings.

The type of mixed-method used in this study is triangulation mixed-methods designs. Using this design, the researcher simultaneously conceptualizes quantitative and qualitative research studies. Then, the researcher concurrently collects and analyses both quantitative and qualitative data. Finally, the researcher uses the results from the quantitative and qualitative studies to validate findings from both studies (Creswell, 2003, 2012; Kalaian, 2008). In this study, questionnaires were used to produce quantitative data (Form A and Form B), whereas observations and interviews generated qualitative data. The focus of the questionnaires was for the students and teachers; which were to capture whether school visits to non-formal settings has an influenced on students' responses to science and to identify the teachers' objectives for conducting school visits to non-formal settings. An in-depth interview intended to provide a more thorough picture of perceptions on knowledge, attitudes and enjoyment in non-formal settings from the science educators, teachers and students respectively. The science educators were only involved with the in-depth interview, which aims to identify their goals and objectives for science lessons taught at MNSC and how this affect teachers in planning their school visits and specifically on student's science learning in the non-formal settings.

Then, the data were analysed to draw conclusions. The triangulation, of data from these two approaches ultimately provide a more robust description of the school visit experience. The overall design of this study, which incorporated students, teachers and science educators interviews and observations, as well as survey questionnaire (for students and teachers only), make use of a two-pronged approach, not only provided a more holistic understanding of the real practicality of school group visits to non-formal settings, specifically in term of science learning, but also capitalized on the inherent strength of triangulated data.

3.3 Methods of data collection

Multi-methods were used to fulfil the aims of the study, three methods of data collection included questionnaires, non-participant observations and semi-structured interviews were used to examine the perceptions on knowledge, attitudes and enjoyment from school visits from the perspectives of students, teachers and science educators in the non-formal learning, conducted by the Malaysia National Science Centre (MNSC) using three different locations of engagements: centre-based, single- and multi-school outreach. The mixed methods using quantitative and qualitative methods concurrently to address the research questions. Therefore, for both of this design, the character would be the collection and analysis of numerical quantitative data followed by the collection and analysis of descriptive qualitative data or both can be done simultaneously. The diverse methods were used in this research were carefully chosen because they will be judged to be appropriate to generate the kind of information that were needed for the research questions being asked in this study (Creswell, 2003, 2012; Denscombe, 2002: 24, 2010: 132). The questionnaire survey provided a broad overview of students' and teachers' attitudes to science learning in non-formal settings, while the interview sessions provided a depth understanding of the questions raised in this study.

3.3.1 Questionnaires Survey

A significant advantage to using questionnaires in this research was that it allowed participants to remain anonymous, which was important in this study to encourage students and teachers to answer honestly, even when their opinions were negative. The questionnaires were used to collect general information from teachers and students in this study before conducting in-depth interviews to get a greater understanding about the questions raised. Gathering information by questionnaire had a number of advantages, as outlined by (Denscombe, 2003, 2010); questionnaires provide standardised answers, they encourage pre-coded answers, they eliminate the effect of personal interaction with the researcher, they allow the respondent time to think before responding and they can be given to many people simultaneously. Whereas, according to Munn and Driver (2004), by using questionnaires survey it can provide a standardised questions, an efficient use of time, the anonymity type for the respondent and the possibility of a high return rate. There can be disadvantages too, when using questionnaires, in that the pre-coded nature of the questions can prove to be restrictive for respondents. Low response rate and incomplete questionnaires can also be an issue (Denscombe, 2003, 2010). However as the questionnaires were followed by an interview, these disadvantages could be somewhat overcome (Driver, 1995). Two questionnaires were administered in this study, one questionnaire for teachers and one for students.

There were three types of questionnaires: structured, semi-structured and unstructured (Cohen, Manion, & Morrison, 2007). Researchers can select several types of questionnaire, from the highly structured to unstructured. Researchers have to design the questionnaires depending on their situation and then questionnaires need to be piloted and refined before conducting the research using the questionnaires. The structured questionnaire uses a pattern of clearly structured, sequenced and focused questions, – often using closed questions to collect and make a comparison of the results; this type of questionnaire is suitable for students in order to investigate their science learning in non-formal settings. This research study employed semi-structured questionnaires for students and teachers survey. The questionnaires were semi-structured in nature provides a series of questions, statements or items to ask the respondents, and the respondents were asked to give their comments in the way that they think best. There were a clear structure, sequence and focus, but the format was open-ended for respondents to give answers in their own words (Cohen et al., 2007; Creswell, 2003). The survey also provided demographic information, used to help determine the representativeness of the sample and provide contextual information.

According to the selection of the school participated in this study, the researcher asked the MNSC about the teachers and students which already planned to visit the MNSC from the appointment list. The appointment list is a list of schools whose requests for visiting MNSC were confirmed. Then, teachers were contacted by phone and consent was obtained to conduct a research when they were at the settings. For students, this research was concentrated on upper primary and lower secondary schools (10-14 years old age) students whose participate with the school visits to the MNSC during the research period. The range of age group of students were the main concern for researcher as these are crucial years when adolescents form interests and attitudes affecting choices for further education (Barmby et al., 2008). The researcher met briefly with the science educators of MNSC immediately before the school groups arrive at the settings. Upon arrival at the location, the selected teachers and their classes were greeted by science educators and researcher. Researcher's role at this moment was only to observe the behaviour during the school visit (students, teachers and science educators' behaviour respectively). Observations were recorded manually. The observations were carefully and unobtrusively conducted as possible. At the end of their visit, students and teachers were given a questionnaire to complete. At the end of the questionnaire, there was a question asked about whether further contact would be possible, for an in-depth interview. In order to ensure that the questionnaires is valid and reliable, a pilot study were conducted in September 2014 at MNSC. The purpose of pilot test study is to determine how well the questionnaires captured the desired information from the respondents and to ensure the practicality and suitability of the proposed study.

3.3.1.1 Questionnaires for teachers

Teacher questionnaire was developed to answer the research questions 'What are the teachers' objectives for conducting school visits to the non-formal settings'. A teacher's questionnaire (Form A) was adapted from Hooper-Greenhill et al., (2007) research study on Inspiration, Identity and Learning: The Value of Museum. The teacher's questionnaire was devised which asked general questions about the school and the teacher's use of science centre, before focusing on a number of very detailed questions which asked specific questions about each of the science learning outcomes (PART B: Question 6 – Question 14 in Appendix G).

Besides that, the questionnaire also was adapted from research study done by Kisiel (2003) about 'Revealing teacher agendas: An examination of teacher motivations and strategies for conducting museum fieldtrips'. The questions adapted in my research study, to answer the research questions raised in my research study (PART C: Question 14 – Question 22 in Appendix G).

The questionnaires in this study (the questionnaires for teachers (Form A) and for students (Form B)) were administered personally after the session so the researcher was able to establish rapport with participants and explain the purpose of the questionnaire and the meaning of the items where necessary. Whilst it is recognized that the presence of the researcher might be threatening and exert sense of compulsion on participants, students and teachers were reminded at the start that they should not put their name on their questionnaire and that they should answer honestly. They were also reminded that they would not see their researcher again and that (for the students) their teachers would not see their responses. One problem that has been identified with administering questionnaires like this is that participants might prefer or need more time to think than provided (Wellington, 2004), so teachers were offered the opportunity to return their own questionnaires by post after the sessions.

The teacher took 10-15 minutes to complete the questionnaires whereas the students completed the questionnaire in 5-10 minutes. This was more than sufficient for all the teachers and students to read, understand and give appropriate responses to the statements asked. Once the questionnaires were completed, teachers handed in the completed questionnaires to MNSC staff or the researcher before they leave the locations of engagement. Table 3.1. detailed out the constructs and the questionnaire used in this study.

Table 3.1. Details about the questionnaire used in the study

Construct	**Question**	**Sub-categories**
Knowledge and understanding	'To what extent do you think your pupils have gained facts and information during their museum visit?'	The sub-categories were facts that were subject-specific; interdisciplinary or thematic; about PSN or galleries; or about themselves and/or the wider world. A catch-all 'other' sub-category was also added.
Attitudes and Values	'To what extent do you think that the museum visit have enabled your pupils to feel more positive about any of the following?'	The sub-categories were: learning, museums and galleries, other people/communities, and themselves and their abilities.
Enjoyment, Inspiration, Creativity	'To what extent do you think your pupils have enjoyed or been inspired by their PSN visit?'	This had a number of sub-categories, covering the enjoyment of the experience as a whole, excitement because of new ways of learning, new interests aroused, inspiration to progress to further learning and inspiration to make something creative.
	'To what extent will you be using the museum experience to promote creativity?'	This construct also has a number of sub-categories, covering designing and making, exploring new ideas, dance/drama, creative writing and other forms of creative works.

3.3.1.2 Questionnaires for students

Student questionnaire was developed to answer the research questions 'What students gained from their visit to the non-formal settings in term of science learning outcomes? (e.g: Knowledge and understanding, skills, attitudes and values, enjoyment, inspiration and creativity, and action, behaviour and progression)'. A student's questionnaire (see Appendix H: Form B: Question 1 –Question 12) was adapted from Hooper-Greenhill et al., (2007) research study on Inspiration, Identity and Learning: The Value of Museum. The student's questionnaire was devised which asked general questions about the school and the student's use of science centres, before focusing on a number of very detailed questions which asked specific questions about each of the science learning outcomes. The questions were designed to generate information relating to each of the science learning outcomes. Students were asked to fill out the students' questionnaire immediately after completing the programs conducted by the MNSC. To answer $RQ_{3\text{-}1.2}$: Is there any differences on students perceptions between centre-based, single and multi-school outreach in term of attitudes; [how easy, enjoyed and helpfulness in doing the activities conducted by MNSC]?, 12 questions asking about the affect focused on three measurement variable; 1) students' perceptions that they have been successful in what they tried to do [5 likert scale ranging from very easy to very hard]; 2) they enjoyed what they did [5 likert scale ranging from not at all enjoyable to very enjoyable]; and 3) they thought it was helpful to their learning [5 likert scale ranging from not at all helpful to very helpful] were adapted from Rennie (1994) research study on Measuring affective outcomes from a visit to a science education centre (see Appendix H: Form B: Question 13 –Question 15).

3.3.2 Interviews

Quantitative approaches were useful in gaining a broad overview, but to explore the depth of a phenomenon, other methods which yield a more qualitative data were necessary (Hooper-Greenhill, 2007: 111). An interview was a purposeful conversation between two (or more) people that was directed by one in order to get information from the other (Cohen et al., 2007; Driver, 1995). According to authors, an interview was a flexible tool for data collection, suited to a wide range of research purposes.

In this study, semi-structured interviews were used. The name ‘semi-structured’ according to Driver (1995), means that the interviewer sets up a general structure by deciding in advance what ground was to be covered and what main questions were to be asked. This research puts emphasis on semi-structured interview intended to provide a more thorough picture of the effect of school visits specifically from the perspectives of students, teachers and the science educators in non-formal settings. The aims of using semi-structured interviews were as a complement to and a means of triangulation with the questionnaire surveys. It was hoped that the interviews would give a more holistic view of Malaysian patterns of use of non-formal settings in term of students’ responses to science.

The research questions focused on to examine the perceptions on knowledge, attitudes and enjoyment from school visits from the perspectives of students, teachers and science educators in the non-formal learning, conducted by MNSC using three different locations of engagements: centre-based, single and multi-school outreach. For this method, data were obtained through interviews with a smaller number of students, teachers and science educators. Observations of their school visit experiences at non-formal settings were conducted to examine just what happens during a school visit. Therefore, the purpose of the interviews was to supplement the initial questionnaire data and the observation data collected throughout the research, to provide answers to the research questions. The main advantage of interviews as a data collection method were that they provided a more ‘in- depth insight into the topic’ (Denscombe, 2003, 2010).

All interviews were semi-structured in nature as they provided the opportunity for participants, both teachers and students as well as science educators, to speak extensively on the subject at hand. Besides that, the character of semi-structured interviews which have prompts and probes function has an advantage of using this approaches in research study. Prompts enable the interviewer to clarify topics or questions, while probes enable the interviewer to ask respondents to extend, elaborate, add to, provide detail for, clarify or qualify their response, thereby addressing richness, depth of response, comprehensiveness and honesty that are some of the hallmarks of successful interviewing (Cohen et al., 2007; Driver, 1995). Denscombe (2010) outlined the benefits of semi-structured interviews as follows;

> the interviewer …has a clear list of issues to be addressed and questions to be answered…the interviewer is prepared to be flexible in terms of the order in which the topics are considered, and, perhaps more significantly to let the interviewee develop ideas and speak more widely on the issues raised by the researcher. The answers are open-ended, and there is more emphasis on the interviewee elaborating points of interest. (p. 175)

The data from three perspectives in this study were analysed to draw conclusions about the impact of the students' responses to science from the perspective of students, teachers and science educators. The use of qualitative inquiry within this investigation allowed for several school visit experiences to be examined in greater detail; in some cases, this will led to refinement of the factors identifies through the survey instrument. These cases were used to have a more clearly characterize different aspects of school visit to the students' learning, the teachers' aims and objective of conducting school visits and the science educators' aims and goals to students' learning during school visit to the non-formal settings. The methods that were used in this study hopefully will give and led to a more holistic description of these aspects as semi structured interviews also known suitable for gathering information and opinions an exploring people's thinking and motivations (Driver, 1995).

3.3.2.1 Teachers' interview questions

Semi-structured interviews were likely to have a mixture of closed and open questions, but in this research, open questions were used. The interview questions was adapted from Griffin (1998) study on 'School-museum integrated learning experiences in science : A learning journey'. Interview with individual or pairs of teachers enabled close discussion about the specific projects, including the aims of teachers, the learning outcomes for individual children, and the gathering of details of particular schools and communities (Hooper-greenhill, 2007: 79). They also enabled researchers to check and, if necessary, to modify their interpretation and understanding of particular matters. There were an interview with the teacher after the visit to the MNSC. These interviews mainly take place either at the settings or during the school of each individual teachers involved in this study. The respondent who were willing to be contacted after their school visit to the MNSC were contacted for an additional follow-up interview (see Appendix I: Guiding Questions for Teacher Interviews). The interview was conducted based on the respondents' time and availability.

3.3.2.2 Students' interview questions

Interview with students mainly aiming to look at a deeper understanding about 'why they visit the MNSC?', 'what are they supposed to do at MNSC?', 'what are they learnt from the visit?' and 'what they are going to do once they return to school?'. The interview questions were adapted from Griffin (1998) study on 'School-museum integrated learning experiences in science : A learning journey'. The advantage of using semi-structured interviews, it enabled researchers to check and, if necessary, to modify their interpretation and understanding of particular matters besides the questionnaire survey responses. There was an interview with students during the visit and after the visit to the non-formal settings. These interviews mainly take place either at the settings or during the school of each individual students involved in this study. The respondent who were willing to be contacted after their school visit to the MNSC or at single or multi-school outreach were contacted for an additional follow-up interview. The interview was conducted based on the respondents' time and availability (see Appendix J: Guiding Questions for Student Interviews).

3.3.2.3 Science educators' interview questions

Semi-structured, open-ended interview questions for science educators of MNSC was adapted from the research done by Tran (2002) which was to identified and captured 'The roles and goals of educators teaching science in non-formal settings'. The interview questionnaires were addressed to provide answers to the research question which; 'What are science educators' goals and objectives for science lessons taught at MNSC?', 'How do science centre's educators teach science lesson in non-formal learning?' and lastly 'to what extent science educators' objectives met from the visit?'. To answer these questions, semi-structured interview protocol were designed as attached in the Appendix K (see Appendix K: Guiding Questions for Science Educator Interviews).

These interviews mainly take place at MNSC of each individual educator involved in this study. Scheduling were arranged with staff supervisors/officer. The interviews were conducted based on the respondents' time and availability. The researcher was met briefly with the educator immediately before school visits/lesson to discuss the data collecting procedure. The educator was also be reminded that this was an exploratory study, and was not intended to evaluate or judge the educator's teaching practices nor would it effect their job.

Table 3.2 summarise the visual representations of data collection and methodologies that were used in this study.

Table 3.2. Visual representations of data collection and methodologies

Purpose	**Research Instrument**	**Item (s)/ Type /No.**	**Construct**	**Bil item (s)**	**Source (s)**
The effect on students' responses to science	Students' Questionnaire (Form B)	A1, A9	Enjoyment, inspiration, creativity	2	(Hooper-Greenhill et al., 2007)
		A4, A6, A7, A8	Attitudes and values	4	
		A2	Knowledge and understanding	1	
		A3	Skills	1	
		A5, A10, A11	Activity, behaviour and progression	3	
		B1-B5	General questions (Name,age, gender, race and name of school)	5	-
		1-12	Affective responses	12	(Rennie, 1994)
	Interview	Open-ended questions, semi-structured	To get in-depth data	-	(Griffin, 1998)
Investigate teachers' objectives	Teachers' Questionnaire (Form A)	A	General questions (Name,date, gender, race and name of school)		-
		B	Student gained from the visit to PSN		(Hooper-Greenhill et al., 2007; Kisiel, 2003)
		[5, 9]	Enjoyment, inspiration, creativity		
		[7]	Attitudes and values		
		[6]	Knowledge and understanding		
		[8]	Skills		
		[10,11]	Activity, behaviour and progression		
		[12]	General science learning		
		C14-C22]	Use of PSN, Information about specific class		
		D	Contact number for further follow up	-	
	Interview	Open-ended questions, semi-structured	To get in-depth data	-	(Griffin, 1998)
Investigate science centre's educators goals	Interview	Open-ended questions, semi-structured	How do you think children learn?	3	(Tran, 2002)
			What effect do these programs have on students?	2	
			What is the goal of this program?	4	

3.4 Data collection and timeframe for study

Pilot study was conducted in September 2014 at MNSC and the main study data were collected in February to May 2015 at three different locations of engagements: centre-based, single and multi-school outreach. The aim of the pilot study was to test the questionnaire with MNSC users to see if there were any unclear questions regarding the questionnaire or structure of the questionnaire design. Besides that, it purposes was to provide a method of training and experience in the quantitative and qualitative data collection, as I also not very familiar with the MNSC settings and scheduled. It also provided me an opportunity to try out the qualitative data collection through observation and interview techniques using semi-structured questions, field-note taking, devising observational schedules, and practice of interviewing by the use of digital recording and transcribing of the data. The main aim of pilot study in my research was not for analysing for their substantive results; instead, it was used to scrutinise for responses that had not been provided according to the instructions, or questions to which no answer had been given, in order to ensure the practicality to conduct a research.

Before conducting the pilot study, I sent a letter to the Director of Malaysia National Science Centre asking for permission to conduct both studies (for pilot and main data collection). Besides that, permissions also need to gain from the Economic Planning Unit (EPU) Prime Minister Office, the sponsor National University of Malaysia (UKM), the Education Planning and Research Department (EPRD) under the Ministry of Education (MOE), State Education Department (SOE) before the research can be conducted in Malaysia. After getting the permission from the mentioned ministry, the letter were sent to schools in order to get permission (the name of school was taken earlier from MNSC from the appointment list of schools whose requests for visiting MNSC were confirmed, in order to ensure getting approval from the school to involve in the research prior their visits to the non-formal settings based on their planned scheduled).

3.5 Pilot study

A pilot study is usually carried out in any study prior to the main data collection. Running a pilot study for me was important because it gave me an opportunity to observe my research instrument, to test the validity of the chosen instrument and to check whether the questions could be understood and implemented in the main study later. Yin (2009) explained that "a pilot study will help you to refine your data collection plans with respect to both the content of the data and the procedures to be followed" (p.92) and that a "pilot study can be so important that more resources may be devoted to this phase of the research than to the collection of data from any of the actual case" (p.92). Within this framework, it is crucial to make sure that all instruments are functioning well and can generate the data needed for the real study which means that, if we can fix the instrument and amend it prior to the main study, we can minimize errors and obtain data that are more accurate.

The pilot study was carried out in September 2014 (2-16 September 2014) in the activity area at level one and two of the Malaysia National Science Centre (MNSC) and at the outdoor science wonderland. The purpose of the pilot study was to provide a method of training and experience in the quantitative and qualitative data collection. For the quantitative data collection, pilot study can be used to devise the questionnaires for the participants (in Malay and English languages) as a benchmark for conducting main study data collection and practiced the numeric data analysis with the SPSS programme.

The pilot study also provided the opportunity to try out the qualitative data collection through observation and interview techniques using semi-structured questions, field-note taking, devising observational schedules, practice of interviewing by the use of digital recording and transcribing of the data. According to Robson (2011), some methods and techniques necessarily involve piloting such as in the development of a structured questionnaire or a direct observation instrument. An experiment or survey should be piloted on a small scale in virtually all circumstances (p. 405). Pilot studies helped to refine data collection with both content of the data and research methods in the current research.

The MNSC offers specific activities for school groups, known as 'the school offer'. These were comprised of the objectives, content and a brief description of workshops, activities and guided school tours offered by the Centre for each school level. For the purpose of this study, only selected galleries and exhibits were involve as it's cater the programs for primary and secondary school visits to the MNSC. During the pilot study period, three booked programs (primary school, aged 10-11 year old) were successfully observed by the researcher. Details of the programs involved in this study presented below;

3.5.1 Case study 1: Science Trail Program

Introducing the students about science concepts which have been translated into interesting exhibits. They were created based on the concepts of the national school curriculum for primary and secondary school students. The exhibits that involved with the science trail programs such as;

1. Aquarium - visitors can learn more about freshwater aquarium filled with 32 species of freshwater fish.
2. Wonderspark – highlights the three critical elements of nature; water, light and wind through exciting interactive exhibits.
3. Pathways to Science – visitors can engage themselves with the many hands-on exhibits in the different science disciplines of Biology, Physics, Chemistry, Earth Science and Astronomy. Visitors can learn more about the transformation of energy at the Energy Circuit exhibit.
4. Eureka – fun Science and Math zone with a creative corner for all to explore. This exhibit was designed to inspire visitors to think out of the box.
5. Flight – discover and learn about the science of the flight. Visitors can learn how to navigate a helicopter through interactive exhibits.
6. Thinking Machine – this gallery explores computers, communications, robotics and artificial intelligence. Visitors discover how they evolved, how they work and how they impact our lives.
7. Energy World – learn the importance of energy in our world. Discover the alternative energy resources.

The Science Trail Program allows children to learn about scientific knowledge and playing with the exhibits. Students need to complete the mission of science trail program. While doing these activities, students also playing and have fun at the same time they explored the scientific concept and process skills. For example, when the children need to complete the mission on the Wonderspark exhibits, students learnt about the three elements of nature; water, light and wind. Likewise, students learnt more about the transformation of energy at the Energy Circuit exhibit.

3.5.2 Case study 2: Science Wonders Program – Pasteur Laboratory

Involves the hands-on activities to enable the critical thinking and curiosity among the students towards science. In this program, students were make observations, experiments, collect and interpret data and make inferences about the data that they received. The researcher observed one school involved in this program during the pilot study period – experimenting on ‘Rock store carbon – Carbon Dioxide Gas’. In this program, science communicator act as a teacher and conducting the experiment. School teacher only helps to guide the students when necessary with the help of assistant from MNSC staff. Only simple experiment involved in this laboratory as the objective of the program was involved the students in doing the activities related to experimenting in chemistry and physics subjects.

3.5.3 Case Study 3: Science Wonderland - Nature Secrets Lab

An outdoor science, recreational park which brings a new dimension to learning using nature as a classroom. There were many activities that the students can participate in Science Wonderland Garden especially of the Herbs, Gardens, Rose Gardens, Aquatic Life, and Nature’s Secret Lab. The researcher observed one school involved in this program during the pilot study period – researcher observed the program they were doing in the ‘Nature Secrets Lab’ – studying about the butterfly and experimenting about the gas of carbon dioxide after participating in observing all parts of the Science Wonderland. Before starting the program, the science educator already mentioned what he expects the students to do and collecting two leafs in order for them to conducting an experiment at the Nature Secrets Lab.

3.5.4 Sample of the pilot study

The sample in the pilot study was 73 participants, including children's (age 10-14 years, total students 68 person), science teachers (6 person) and science educators (4 person), who participated in the scheduled programmed by MNSC on September 2014. The programs involved in this pilot study were; i) Science trail program; ii) Science wonderland (Nature Secrets Lab); and iii) Science Wonder (Pasteur Laboratory) – doing chemistry activities. In this study, the researcher puts emphasized to gain the data from the school group visit to the MNSC which had made booking to have a program at the MNSC. This findings was supported by the research done by Maite Morentin and Jenaro Guisasola on Primary and secondary teachers' ideas on school visits to science centres in the Basque Country which stated that learning improves when the visits was connected to school curriculum (Morentin & Guisasola, 2013). Therefore, the researcher makes a decision to ensure gaining the data from the school that made prior booking programme with the MNSC. In the pilot study, the researcher observed how the school group learnt, interact with the science educator, teachers and their peers. Table 3.3 shows the sample of the pilot study. I named the schools accordingly as School A, School B, and School C in this pilot study, in order to maintain confidentiality.

Table 3.3. Sample of the pilot study

School	Respondent	Types of data collected	Total
A	Teacher	Questionnaire, Observation & Interview	2
	Student	Questionnaire, Observation	28
	Teacher	Interview	
	Student		
B	Teacher	Questionnaire, Observation & Interview	2
	Student	Questionnaire, Observation	21
	Teacher	Interview	
	Student		
C	Teacher	Questionnaire, Observation & Interview	2
	Student	Questionnaire, Observation	18
	Teacher	Interview	
	Student		
MNSC	Science educator	Interview, Observation	NSC1, NSC2, NSC3, NSC3i
Total	**Student**		**68**
	Teacher		**6**
	Science educator		**4**
TOTAL			**73**

3.5.5 Findings from pilot study

3.5.5.1 Impact on students' responses to science from the visit to the Malaysia National Science Centre (MNSC)

Table 3.4. The students' perceptions to Malaysia National Science Centre (MNSC)

For students		Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
During my visit:		**(Frequency, Percentage) (n,%)**	**(Frequency, Percentage) (n,%)**	**(Frequency, Percentage) (n,%)**	**(Frequency, Percentage) (n,%)**	**(Frequency, Percentage) (n,%)**
1	I enjoyed myself	50 (73.5%)	18 (26.5%)	-	-	-
2	I learnt something new	31 (45.6%)	35 (51.5%)	2 (2.9%)	-	-
3	I did something new	31 (45.6%)	33 (48.5%)	4 (5.9%)	-	-
My visit today made me feel:		**(Frequency, Percentage) (n,%)**	**(Frequency, Percentage) (n,%)**	**(Frequency, Percentage) (n,%)**	**(Frequency, Percentage) (n,%)**	**(Frequency, Percentage) (n,%)**
4	More confident with science	21 (30.9%)	37 (54.4%)	7 (10.3%)	3 (4.4%)	-
5	Keen to find out more	38 (55.9%)	28 (41.2%)	2 (2.9%)	-	-
6	More interested in science	19 (27.9%)	40 (58.8%)	8 (11.8%)	1 (1.5%)	-
7	Studying science might be fun	27 (39.7%)	32 (47.1%)	8 (11.8%)	1 (1.5%)	-
8	Working in science might be interesting	17 (25.0%)	31 (45.6%)	17 (25.0%)	3 (4.4%)	-
9	National Science Centre (NSC) is a good place to learn about science	48 (70.6%)	19 (27.9%)	1 (1.5%)	-	-
10	I learn science in a different way to school in NSC	23 33.8%	34	8	3	-
11	When I get back to school, I think the experience from today will help me in science classes	30	36	2	-	-
12	I would recommend this place to my friends	48	18	1	1	-

From the questionnaire survey, almost all the pupils enjoyed their visit which comprise of 73.5% strongly agreed and 26.5% agreed that they enjoyed the visit (see Table 3.4Table 3.4. The students' perceptions to Malaysia National Science Centre (MNSC). 98.5% of the students agreed and strongly agreed that the national science centre was a good place to learn about science. Most of the participants concluded that the environment and resources in this activity are the most conducive and appropriate for learning. Students stated that they would recommend the centre to their friends once they get back to school (item 12: 70.6% strongly agreed and 26.5% agreed with the statement). All the items produce positive perceptions of the students from their visit to the centre except for the item 'Working in science might be interesting' which only 25% of the students strongly agreed with the statement and there were three person who disagreed with the statement.

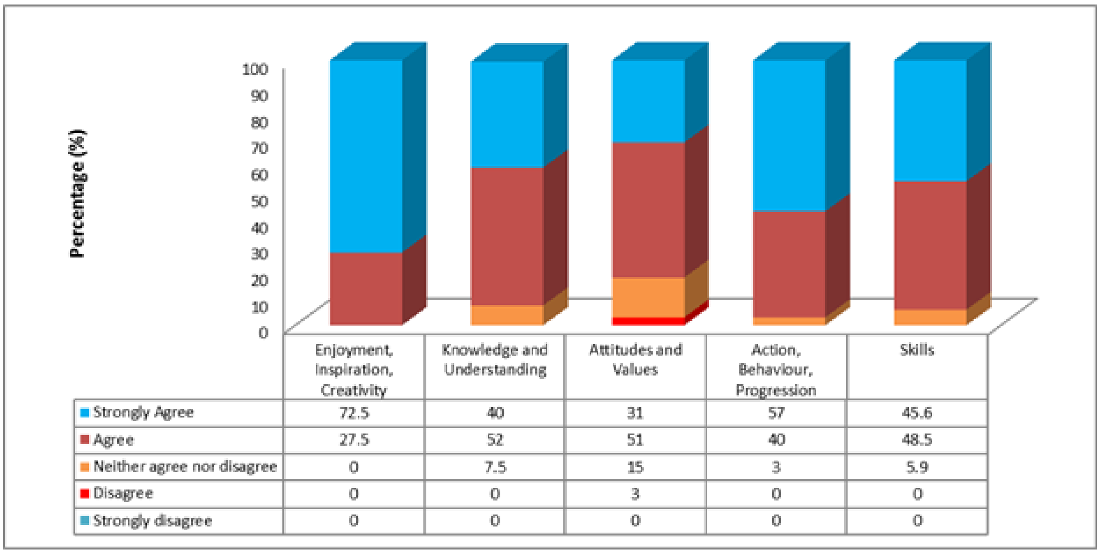


Figure 3.1. Overall impacts on students' responses to science from the visit to the MNSC

Figure 3.1 shows the overall impacts on students' responses to science from the visit to the Malaysia National Science Centre (MNSC). The strongest responses of the students were towards 'Enjoyment, inspiration and creativity' and 'Action, behaviour and progression'; 100.0% and 97.0% respectively. Students overall perception towards 'Skills' was about 94.1% and for the 'Knowledge and understanding' 92.0%. 'Attitudes and values' only received 82.0% of students' perception during their visit to the centre.

From the observation during the visit to the MNSC, researcher found that most of the participants engaged with the programmes and exhibits during their visit to MNSC. They had curiosity and enthusiasm to learn, to experiment and play with the exhibits in the centre. Most of the participants intended to join the activity because they were interested with the exhibits and excited to know more about nature; in this case during the visit at the Nature Secrets Lab and Aquatic Life and Aquarium. They want to do the experiment, asking the science educator and the assistance whenever they had problem with the experiment and they were very eager to know more about the topic that they were studying. They were really curious, for example when they were conducting an experiment regarding carbon dioxide gases. They were really curious how some materials produce gas, and some did not. They also make a comparison with their friends when there was a 'slow' reaction compared to their peers and started to ask the science educator and the assistance why this scenario happens.

> PB1: Teacher, look!!!how come their colour still not changed to yellow? My liquid become yellow already.
> PB2: Yeah, why it's still not change…
> SC2: Did you follow all the procedure that I showed before?
> PB2: Yes, I follow…
> SC2: Can you (PB1 and PB2) compare what's the different between the two?

[B10092014/11/Rock Store Carbon]

Science educator and the assistance were doing their best to help and describe why that scenario occurred. Besides that, when making concluding remarks, science educator pressing once again about what they had learnt today, trying to relate it with the everyday scenario in their life.

3.5.5.2 Teachers' objectives for conducting school visit to the MNSC

From teachers' questionnaire, the intention was to get a picture on students' responses to science from the teachers' views. The researcher want to investigate what were the teachers' objectives for conducting school visits to the centre and how does teachers' plan for the school visit in order to achieve the objectives?. Besides that, the researcher also want to know to what extent were the teachers' objectives met from the visit?.

3.5.5.3 Enjoyment, Inspiration, Creativity

There were two detailed questioned that asked teachers about Enjoyment, Inspiration, Creativity. One of the these addressed 'To what extent do you think your pupils had enjoyed or been inspired by visit to the MNSC?'. From the analysis, it shows that 83.33% of teachers (five teachers respond to this) agreed with the statement that the students 'excited by new ways to learn', 'new interests aroused' and 'inspired to learn more' from their visit to the centre. Half of the teachers thought it 'quite likely' that their pupils would be inspired to make something creative.

Table 3.5. To what extent do you think your pupils have enjoyed or been inspired by visit to the MNSC?

	Very likely	**Quite likely**	**Neither**	**Quite unlikely**	**Very unlikely**	**Don't know**
	Frequency (%)	**Frequency (%)**	**Frequency (%)**	**Frequency (%)**	**Frequency (%)**	**Frequency (%)**
Enjoyed the experiences	2 (33.33%)	4 (66.67%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Excited by new ways to learn	1 (16.67%)	5 (83.33%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
New interests aroused	1 (16.67%)	5 (83.33%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Inspired to learn more	1 (16.67%)	5 (83.33%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Inspired to create something creative	2 (33.33%)	3 (50.00%)	1 (16.67%)	0 (0.0%)	0 (0.0%)	0 (0.0%)

From the interview with the teachers, teachers do seem to view school visits as an educational opportunity; learn new things, with different ways compared to school science, and students can work with their friends to solve the problem arose. Teachers say that the visits were important as it will complement the concept and theories learnt at school. From the interview with the teacher, she believes;

> …the visit to science centre can be used to enrich the experience provided in school. The educational activity provided at the centre is almost always conducted by professional staff, assuming that the staff' knowledge makes the guided visit worthwhile…
>
> [B10092014/35/]

Many teachers believe that it was important for the visit to the centre and the programme conducted related and fit into the national curriculum. They were confirmed that the topic/programmes conducted at the centre related to science and technology curriculum but did not mention which topic when asked to describe in details. Teachers also frequently acknowledge the motivating influence such out-of-classroom experiences can have on their students and themselves.

> …teacher believes that visiting the science centre is important because it's contributes to the students' scientific knowledge and increase their motivation to learn science…
>
> [A03092014/42/]

Some teachers even express an awareness of the importance of content preparation prior to the visit, as well as follow-up to clarify remaining questions or reinforce concepts from the trip, but from the questionnaire survey and the interview itself, no one had done so. From the observation, among those who were aware of the importance of preparation and follow-up in supporting conceptual and affective gains, however, many report time constraints as their reasons for not implementing such practices. Observations of teachers' role during the school visits and doing the programmes indicates that teachers were involved in the activities or in helping the students to understand the explanations. Besides that, the teachers' role more on management and disciplines issues.

Finally, considering the analysis of teachers' answers to the questionnaire, all of them valued the exhibitions concerning their interest and relevance for science teaching and learning, and gave an overall evaluation of good or very good to all aspect questioned. However, concerning the type of contact they had with the science centre prior to the visit, all of them referred that they didn't visit the exhibits previously, neither alone or by previous school group. Teachers also referred that they didn't visit the webpage of the exhibition (only one person visit the webpage), although all of them considered that both aspects would be important for the visit preparation. Their objectives about the school visit were all related with the promotion of students' motivation to learn science and having fun when learning and the improvement of scientific knowledge about the topic addressed in the exhibits. However, they did not provide or specify which topic in national curriculum that related with what their students learnt in the centre today.

3.5.5.4 Science educators' action and contribution towards science learning

Observations of the programme involved in this pilot study were; i) Science trail programme; ii) Science wonderland (Nature Secrets Lab); and iii) Science Wonder (Pasteur Laboratory) – doing chemistry activities with four science educators. The structure of the guided visits observed mainly representing similar pattern of learning, but sometimes depending on the types of subject/topic concern. The main common feature was an introductory talk by the science educators, introducing what the students and teachers should expect from the visit. During these talks, the science educators used; i) experiment demonstration and models and artefacts (Nature Secrets Lab – real butterfly and moth to demonstrate; Pasteur Lab – different variety of rock); which they showed and sometimes let the students examine the object. Worksheet were mainly used at Pasteur Lab and Science Trail Programme. Science educators trying to use the most of the essence of the centre – their exhibits – was mostly used in order to complete the task in these programmes. Students were divided into small group and need to complete the task in Science Trail and Pasteur Lab. In this two programs, a very short, directed exploration observed, in which the students were requested to follow an observation sheet while exploring the exhibits. A whole group guided visits observed at the Nature Secrets Lab and Pasteur Lab and were directed by the science educators to do exactly as he demonstrated.

> 'Listen carefully, otherwise you would not know what to do'
>
> [SC1/03092014 & SC2/03092014 & SC3/11092014]

The above excerpt was a very common instruction used by the science educators. Nevertheless, because the students were full of curiosity and excitement with what they saw, they listen to the instructions and demonstrations, and once it's finished, they were trying to do it on their own. They were very happy to do the experiment. Science educators always trying to relate what they taught with what the students learnt at school and from their everyday life.

> …so, what are all of you learnt today,…we can see it from our daily life. We breathe every day. When we breathe, we deliver the oxygen to the body and we take away the carbon dioxide. That's why when you breathe out just now, the Bromothymol Blue (BTB) solution becomes yellow…
>
> [SC2/11092014]

DeWitt and Osborne (2010) stated that by relating the ideas they were likely to be familiar with from school and everyday life, it can help students develop their knowledge and understanding from their visit experiences. Observations of these three guided visits during pilot study (grade 4 and 5 – age 10 and 11 years old respectively) indicates that the main visitation pattern consisted of guide-centred and task-oriented activity. The science educators were considered on student age group they were guiding, when explained of the topics in questions, they were adapted the terminology to suit the student age group. Lower level of terminology was adapted if the student from lower primary school group visits.

> …we didn't know the age group of students that will attend our programme today because they didn't state it in the booking form. Normally if something like this happen, we will try our best to suit our clients' needs. We trying our best to deliver the content so that it could be reach for lower age group of students. We try to adapt and use the terminology that's understandable to them…
>
> [SC1/10092014]

Analysis of questions asked by science educators reveals that most of these questions required mainly lower-order thinking skills and some of the higher-order thinking skills. The questions were used as a means of forwarding the science educators explanation. Often, the science educators waited for the students to response before proceeding to the next explanation. Depending on the age level of group of students, the type of questions also varies. From observation, the science educators only asked questions that required yes/no answers or recalling previous simple knowledge. Science educators seems to appreciate the students more, as they entertained students till they satisfied with the answers provided.

3.5.6 Summary from pilot study

Data analysis from pilot study showed that the guided-visits, although well evaluated by both students and teachers, were mainly guide-directed and lecture-oriented, giving students and teachers very little choice and control over the learning agenda. Moreover, teachers showed a very passive role during the visit and reported limited plans for preparation and follow-up activities that would support the visit. Despite this scenario, the teachers who were interviewed preferred guided visits to non-guided visit as they stated that 'at least students learnt something at the centre, despite only playing with the exhibit'. One of the teacher during interview stated that 'I brought my students before, but with no booked programme. I think better for them to have a programme here, at least they learnt something'. Besides that, the teachers' interviewed and answered the questionnaire surveys recognized the potential of science centre for learning although they not very frequent or never use the MNSC education materials before.

The pilot phase revealed that many of the participants were unused to thinking about or talking about learning especially the students. When the researcher asked whether they learnt something from the visit today, at first, they replied they did not learnt, just played there. After researcher trying to link what they saw or played at the MNSC with the topic that they used to study, they realised and confirm that they learnt something from the visit and try to relate it with their study.

> R: What are you doing here today?
> PA1: Playing?
> R: Only playing? What's more do you do to? Are you learning something today?
> PA1: mmmmm…ooo yeah... I learnt about kinetic energy.
> R: So, what's are you learnt from there?
> PA1: I ride the bike. I cycled the bike and then it turns on the light.

[A03092014/11/PA2]

From the point of view from the teachers, they brought student to MNSC so that student will learnt something from the visit. The results show that most teachers who visit this centre with their class group scarcely prepare for the visit, i.e. they do not have a clear idea of how to use the science centre as a non-formal resource for learning about science although from the interview they did say that they bring their students to MNSC so that the students can learnt something from there.

Although non-formal learning environments were often used in science teaching in the developed countries, they were still not being used at the desired levels in Malaysia. They were not many studies in the literature that present the effects of the usage of non-formal learning environments in science teaching to the students. In this regard, it is vital to elicit the opinions of the teachers who were the executives of these visit activities, on the matter and the science educator, as the expert in this area of study – on how it will affect students' science learning during the visit to the centre.

It should be noted that during the interviews, I was not very confident and felt nervous because I only asking the teachers to participate in my study at the MNSC. Therefore, I had trying to use the limited time to ask the questions to the teachers but did not managed to ask in detail. This may or may not be relevant, but I must acknowledge that the time constraint often made me feel under pressure. In addition, the purpose of my pilot study also wants to see whether the research can be done or not at the MNSC. As far as I can say, the research can be done, but need to revise the research questions and research instrument so that it will fit the purpose of my study. Besides, it must be noted that the above results were obtained from a small sample size, they were not representative of all participants in the MNSC. To obtain more accurate results, the main study would have to be conducted with a larger sample group.

3.5.7 Implication to the main study

Yin (2009) advised that the researcher has to identify any necessary modifications for the post pilot study. I decided to make several changes to my work after the pilot study. I continue using the mixed-methods approach to collect my data but were made the following adjustments:

- I add in questions for students' questionnaire in term of easiness, enjoyment and helpfulness when involved in the activities conducted by the MNSC

- I add in/revise the questions for student's questionnaire
- I look at the interview questions that will be used in the main study. I need to ensure that the questions asked fit the purpose of the study.
- For main study data collection, regarding the procedure, to ensure the smoothness of my research, once I knew which school in the appointment list (getting earlier from the MNSC programs) that will visit the MNSC, I secured all contact information either by the contact information provided by the MNSC or browsing the internet. On doing this, I explained my intention and research requirements and if necessary, getting the consent form in advance before the school visits to the non-formal settings.

3.6 Main study data collection

This study aims to examine the perceptions on knowledge, attitudes and enjoyment from school visits from the perspectives of students, teachers and science educators in the non-formal learning, conducted by the MNSC. The study gathered information from students, teachers and educators in three different locations of engagement; centre-based, single and multi-school outreach, in order to identify factors that make the science learning in non-formal settings beneficial as possible. According to Silverman's (2005) as cited in (Samkange, 2012), methodology is a process of researching phenomena that is structured impeccably along the progression of preparing and developing a framework of the study that involves choosing a related case, usage of proper tools for data collection, and an appropriate data analysis procedure. Research method, on the other hand is the data collection technique (Bryman, 2012). This chapter will discuss in detail the methods employed in this research, particularly relating to main data collection of the study.

3.6.1 Selection sample for main study

According to Bryman (2012), the population in a research study is "the universe of units from which the sample is to be selected" (p.187). The aim of this study was to investigate the science learning in non-formal settings in three different locations of engagement; centre-based, single and multi-school outreach. More specifically, this study was examined the perceptions on knowledge, attitudes and enjoyment from school visits from the perspectives of students, teachers and science educators. Thus, the students of age 10-14 year old and teachers that accompanying them to the MNSC were chosen as the respondents in this study. No intervention took place beyond randomly selecting small groups for short interviews during the school visit and at their school after the visit. The data were collected in this study by distributing the questionnaires for students and teachers, audio recording my interviews with individual teachers, small groups of students and individual science educators as well as audio and video recording of selected activities which involves teachers, students and science educators.

In this study, the respondents comprise of 26 school group visits with the students from age 10 to 14 years old to the MNSC and the school that MNSC visited during their out-reach programmes (single and multi-school outreach). 10 to 14 year old students were selected as research samples; which were from upper primary (10-11 year old) and lower secondary (13-14 year old) school students. This type of sample was chosen because it did not disturb the class that have an exam. Altogether, 353 students were participated in the questionnaire survey, 18 small groups interview (consist of 83 of students). 40 teachers participated in the questionnaire survey and 17 among them were selected for interview session. Lastly, eight science educators were employed and interviewed in this study.

3.6.1.1 Student (P)

For students, this research was concentrated on upper primary and lower secondary schools (10-14 years old age) students whose participate with the school visits to the non-formal settings during the research period. The range of age group of students were the main concern for researcher as these were crucial years when adolescents form interests and attitudes affecting choices for further education (Barmby et al., 2008). During the main study, the researcher managed to conduct a total of 353 surveys to primary students' age 10 to 14 years old and conducting 18 small group interviews.

3.6.1.2 Teacher (T)

For teachers, the researcher managed to conduct a total of 40 surveys and managed to interview 17 science and technology teachers who either accompanying their school groups to the non-formal settings with three different locations of engagements: centre-based, single and multi-school outreach in Malaysia.

3.6.1.3 Science educator (SE)

The science educators from the Education Department of Malaysia National Science Centre were selected to participate in this study. Altogether, eight persons agreed to be interviewed. On contacting the science educators, as the researcher already conducted pilot study before, the process for main study much easier. Upon arrival in Malaysia, the researcher contacted and make an appointment to meet with the Science Officer. The researcher then explained the intention and research requirements for conducting the research. The officer gave a permission to observe the programmes conducted by MNSC's staff and regarding the outreach programmes, they allowed me to follow and evaluated their programmes and activities also due to their planning programmes were changing starting middle of March 2015. The researcher met briefly with the science educators of MNSC immediately before the school groups arrived at the MNSC.

3.6.2 Brief description of characteristic of selected school for main study

It was important to mention that, in this study, instead of the place of research only in MNSC, main study data collection involved three different locations of engagement which were; i) centre-based; ii) single-school outreach, and; iii) multi-school outreach. This was because not many scheduled booked programmes during the main study period. Although the researcher already conducted the pilot study and taken some precautions action, but the 'unexpected' things happen as the MNSC considering doing more outreach programmes starting the year 2015. During my period of conducting a pilot study, they never mentioned that this situation will occur. Therefore, to ensure that I will get ‘enough’ data for my study, I had collected the data while following the MNSC conducted their outreach programmes.

Hence, during my three months away to get the respondents for my data collection, I had included the programs in MNSC (centre-based) or outreach (single and multi-school) conducted by the Malaysia National Science Centre in order to examine the effect on students’ engagement with the activities conducted in term of science learning. The samples were selected from students and teachers, who were engaging in MNSC and outreach programmes conducted by MNSC, and the science educators at MNSC. The approach was the non-probability convenience sampling case study as the research be subject to the school group that visited the non-formal settings conducted by MNSC. However, due to the context or environment of the study, the samples that were used in current main study consisted of the students and teachers who were engaging in the centre-based and outreach programmes conducted by MNSC. Therefore, in this study, the non-probability convenience sampling ends up being an opportunistic sampling. Meanwhile, the third group of participants in my study was the science educators at MNSC. Figure 3.2 shows the composition of the groups.

As shown in Figure 3.2, twenty-six schools involved in the study. From there, the participants were assigned according to ‘how’ and ‘where’ the responses from the respondents of the study were collected. From the main student data collection, the type of how I collected the data according to centre-based and out-reach programmes were classified or grouped into ‘single-school’ and ‘multi-school’ outreach. For the ‘centre-based’, the respond of the respondent was collected at the MNSC. For the ‘single-school’ and ‘multi-school’, the data were collected during the outreach programmes conducted by MNSC at the selected school. ‘Single-school’ data collection means the outreach programmes were conducted at each selected school whereas the ‘multi-school’ based means that the students and teachers from various schools were gathered in one selected school by MNSC to perform the outreach programmes. I shall explain the reason for choosing and assigning each group of respondents in the following section.

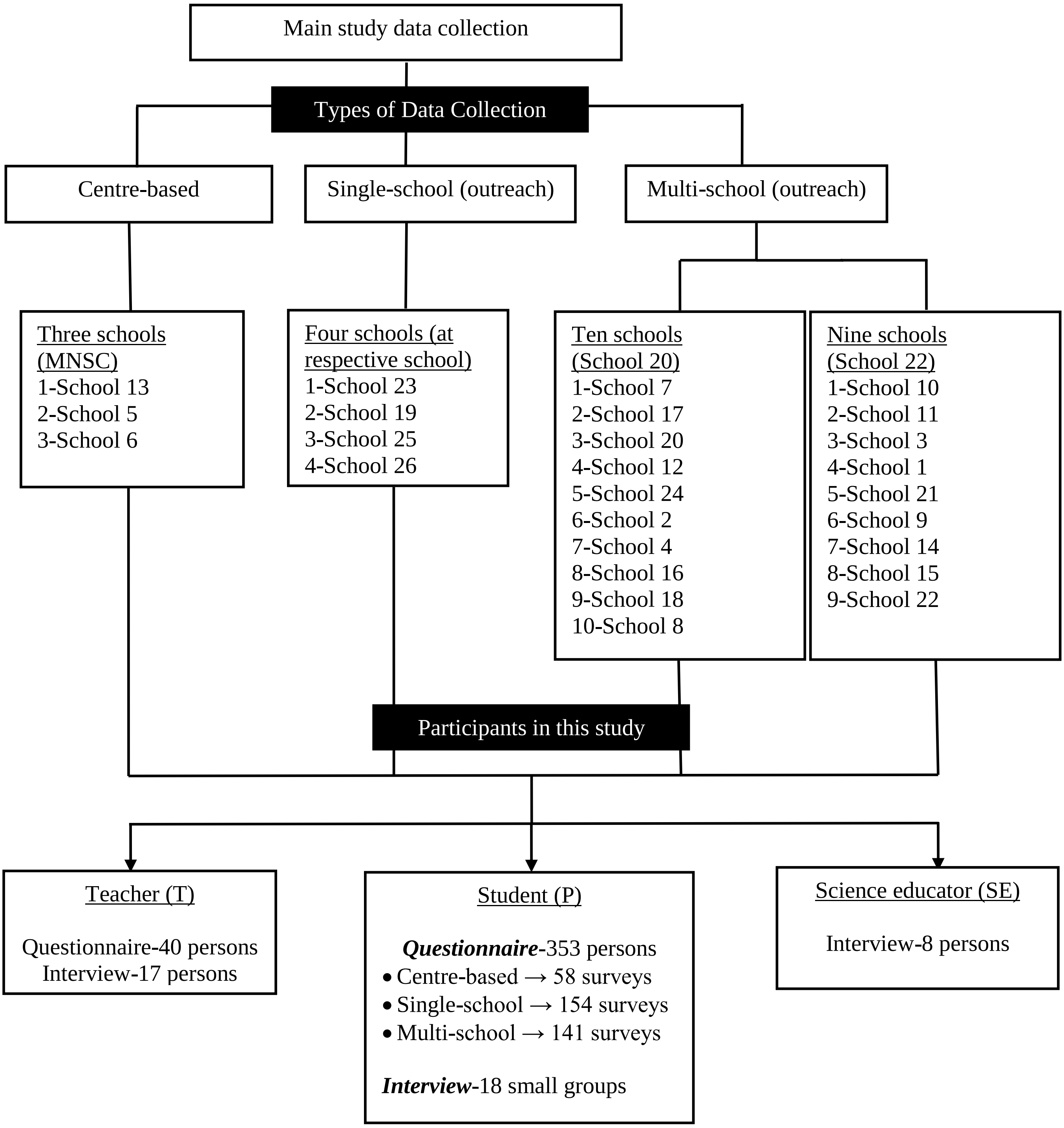


Figure 3.2. The sample selection in the main study

Regarding the classification of the school to each type, there were three schools under the centre-based type. Whereas, for the single-school type of data collection, four school were under this type of data collection. 19 schools were classified under the multi-school type of data collection, which divided into two locations of collecting the data. For the first school, ten schools were under this category (I will refer this type of data collection as School 20 to represent the 10 schools under this category) and the balance of nine schools under School 22.

For centre-based and single-school type of data collection, I did a follow-up interviews with the teachers and students. In the case of the multi-school out-reach, 6 out of 10 schools I contacted for follow-up interviews. Four schools from this type of data collection, I did interview with them during the day of the programmes due to the time constraints. Table 3.6 shows the profile of the interviews conducted in my study.

Table 3.6. Profile of interviews with their codes used in the study

Type of data collection / School	**Centre-based**		**Single-school**		**Multi-school**	
	Teacher	**Student**	**Teacher**	**Student**	**Teacher**	**Student**
School 13	T2	P2				
School 5	T5	P6				
School 6	T6	P7				
School 23			T3, T4	P3,P4,P5		
School 19			T1	P1		
School 26			T17	P18		
School 7					T7	P8
School 17					T8	P9
School 12					T9	P10
School 2					T10	P11
School 4					T11	P12
School 10					T12	P13
School 1					T13	P14
School 9					T14	P15
School 14					T15	P16
School 15					T16	P17

Notes:

Follow-up interview

During the programmes interview

3.6.3 Field notes

For observations, field notes were manually recorded on the students' behaviour when they engaged in the activities. The field notes record included: interactions between teachers and students; students' attention to displays; on- and off-task behaviours; indications of tiring or boredom; and indications of curiosity and interest. The purpose of taking field notes was that I can compare and contrast the findings and recorded any unique behaviour showed by my respondents.

3.7 Locations of engagement in the study

Three different locations of engagement involved in main study data collection which were; i) centre-based; ii) single-school outreach, and; iii) multi-school outreach. The next sub-heading discussed briefly about the description that fall into the category. These three locations of engagement were considered in this study with careful consideration that most of the programs conducted in the centre were similar to the programs conducted for outreach. For the single and multi-school outreach, the programs comprised mini exhibitions of selected items of interest from the MNSC. It came complete with staff and supplementary educational materials. The programs were combinations of exhibits, demonstrations, written educational materials and activities that regularly used in the science centre. The activities in the outreach programmes aims to disseminate awareness of science to various communities focusing on school students to encourage them to take a keener in science and its application.

3.7.1 Centre-based

For the 'centre-based', the responds of the respondent were collected at the Malaysia National Science Centre. This type of data collection was the one that I proposed after my pilot study to use in my main data collection process. However, due to 'unexpected' reasons, the locations of engagement divided by three locations instead of only at the MNSC (centre-based) was used in this study. In this type of data collection, once I knew which schools I needed to deal with, all contact information that was provided by MNSC were secured. According to the selection of the school participation in this study, the researcher asked the MNSC about the teachers and students which already planned to visit the MNSC from the appointment list. The appointment list is a list of schools whose requests for visiting MNSC were confirmed. Then, teachers were then contacted by phone and consent was obtained to conduct a research when they were at MNSC. On contacting the schools and teachers, the research intention and research requirements were explained and till they agreed to participate and become participants in the research. It should be noted that the respondents were free to withdraw at any time up to four weeks after the last phase of data collection if they feel uncomfortable with the research under study.

The researcher met briefly with the science educators of MNSC immediately before the school groups arrived at the MNSC. Upon arrival at the MNSC, the selected teachers and their classes were greeted by the science educators and researcher. Researcher's role at this moment was only to observe the behaviour during the school visit (students, teachers and science educators' behaviour respectively). Observations were recorded manually. The observations were carefully and unobtrusively conducted as possible. At the same time, a video recorded the interactions of students while they were engaged with the activities, digital photos also were recorded. Students and teachers were asked to fill in a questionnaire at the end of their visit. The teacher took 10-15 minutes to complete the questionnaires whereas the students completed the questionnaire in 5-10 minutes. This was considered more than sufficient for all the teachers and students to read, understand and give appropriate responses to the statements asked.

3.7.2 Single-school

For 'single-school' outreach, the data were collected during the outreach programmes conducted by MNSC at the selected school. 'Single-school' data collection means the outreach programmes were conducted at each of school respectively. In the single-school outreach, four schools involved in this type of engagement with the school code: School 19, 23, 25, and 26.

3.7.3 Multi-school

'Multi-school' outreach means that the students and teachers from various schools were gathered in one selected school by MNSC to carry out the outreach programmes. For multi-school outreach, the researcher did not contact the school in advance. This was because for this outreach programmes, the school location located in a Langkawi Island, Malaysia. In the multi-school outreach, the event called 'Kelana Sains' or 'Science Wanderer at Langkawi Island' were selected for this period of study (two multi-school outreach involving 19 schools altogether with school code School 20 (10 school gathered and involved in this type of engagement) and School 22 (9 school gathered and involved in this type of engagement) (refer Figure 3.2).

These three locations of engagement considered in this study with careful consideration that most of the programmes conducted in the centre were similar to the programmes conducted for outreach. For the single and multi-school outreach, the programmes comprised mini exhibitions of selected items of interest from the MNSC. It came complete with staff and supplementary educational materials. The programme was a combination of exhibits, demonstrations, written educational materials and activities that regularly used in the science centre.

3.8 Programmes and activities observed by different locations of engagement

In this study, the researcher carefully selected the respondents and programmes for the study. As mentioned before, it was quite hard to get the respondents following the initial proposal. This was because not many scheduled booked programmes during the main study period. Although the researcher already conducted the pilot study and taken some precautious action, but the 'unexpected' things happen as the MNSC considering doing more outreach programmes starting the year 2015. During my period of conducting pilot study, they not mentioned that this situation will occur. Therefore, to ensure that I get 'enough' data for my study, I had collected the data while following the MNSC conducted their outreach programmes which classified as single and multi-school outreach.

Figure 3.3 shows the main study data collection with the selected school engaged in the programmes and activities conducted by MNSC for three types of locations of engagement with MNSC classified in the study.

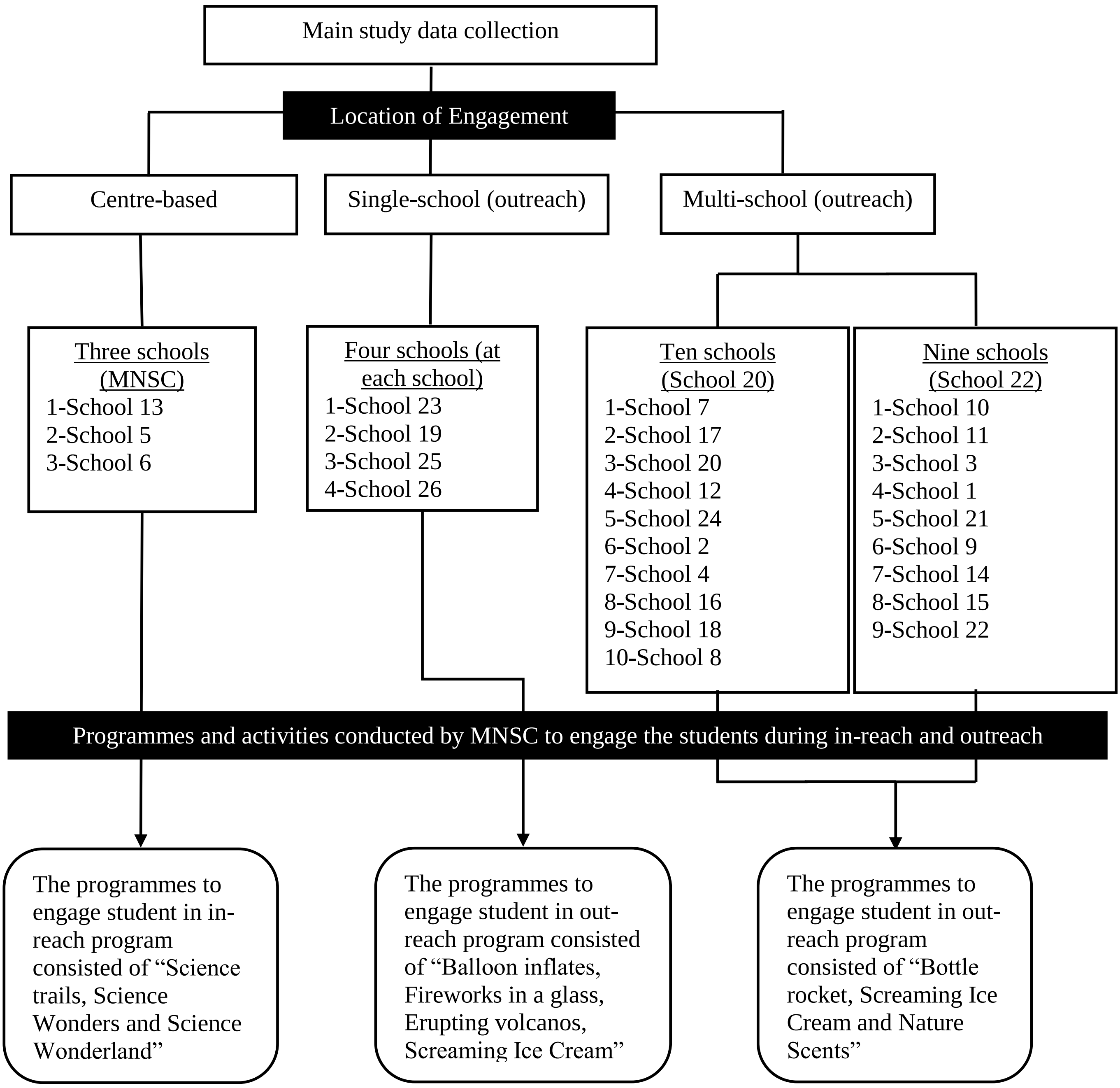


Figure 3.3. Types of data collection with the selected school engaging in the programmes and activities conducted by MNSC

3.9 Data analysis

The process of analysing data should be considered in each phase of research strategy. Sub-sections in this part describe about the process of analysing the data based on the methods described.

3.9.1 Analysis of quantitative data

Quantitative methods of data collection and analysis were utilised in the study and these methods allowed for breadth in the study and included teacher and student questionnaires regarding their school visits to non-formal settings. All quantitative data were analysed using Statistical Package for Social Sciences (SPSS) for Windows, version 21.0. Data were coded and transformed into different types of variables: nominal (binary), nominal (categorical), ordinal and scale. Then, data were manually and statistically searched for unexpected values, and original data were consulted in order to clarify any unusual set. Data then were used to generate descriptive statistics such as frequencies and percentages relating to dichotomous and Likert scale items, and cross tabulations to enable comparison between children in different types of locations of engagement.

3.9.1.1 Descriptive analysis

Descriptive statistics were used to describe the overall profile of the study such as gender, age of students and different locations of engagement. Moreover, this analysis was also used to explain and answer questions in the study. The descriptive statistical analysis used were frequency, mean and standard deviation.

3.9.1.2 Inferential analysis

Inferential analysis was used to observe the relationship that exists between the two variables studied (independent variables and the dependent variable). In this study, the independent variables were demographic factors such as the age of students, student gender and different locations of engagement with MNSC (centre-based, single-school and multi-school outreach). While the dependent variable in this study was the level of students' perceived responses to science in term of knowledge, attitudes and enjoyment during the engagements in non-formal settings. For the five-point Likert scale items, it was assumed that samples were not related, and that data collected on the outcome (ordinal) variable was not normally distributed. Therefore, non-parametric tests were used to identify differences by gender, age of students and different locations of engagements in non-formal settings.

The inferential statistics used in this study were Mann-Whitney U test and the Kruskal-Wallis. A Mann-Whitney U test was used to compare when the nominal variable has two categories was used (e.g., to compare between males and females students). The Kruskal-Wallis test was used to compare when the nominal variable has three or more categories (e.g. age group of students, ethnic origin/group, location of engagement with MNSC). For both statistical tests, the null hypothesis, H_o (there is no significant difference between groups) was tested at a significant level of $p \leq 0.05$.

3.9.2 Analysis of qualitative data

The qualitative methods of data collection included, open ended questions on questionnaires, individual interviews, observations, lesson observations and field notes to allow the researcher to investigate the impact of science learning during school visits to non-formal settings; which the respondent of this design were science educators at MNSC, or teachers and students visiting non-formal settings during the research period of study. Data were coded and categorised using constant comparative technique, this enabled the identification of similarities and differences, the grouping of data into categories and the development of propositional statements. The literature then interwoven with the data and used to confirm or refute findings.

3.9.2.1 Translation and transcription

The raw data gathered in the interviews were transcribed and, where necessary, translated into English. The interviews transcribed almost verbatim, including all 'urmms' and pauses, as far as possible. Even though the transcripts were verbatim, to make the meaning clearer, certain words were excluded in quotations used in the qualitative results if the words were repetitive, less meaningful or would cause confusion.

3.9.2.2 Coding strategy

The qualitative data gathered at each phase of the project were analysed initially, and then tracked individually through each case. All qualitative data were transcribed and the transcripts of interviews, observations and field notes were entered into Atlas.ti (Version 7.5.10). Atlas.ti was chosen as it can act both as a depository for all data and many simple and more complex searches can be automated. Due to the nature of the study and the large amount of data involved, Atlas.ti proved an excellent piece of software to store, code, cross code, perform many analytical tasks as well as providing a central place to hold all notes, comments and memos (Richards, 1999). It also became a way of ensuring reliability and trustworthiness in the analysis process. Coding took the format of broad to narrow analysis and then expanding out again to gain an overall view of the themes developed. At each stage of coding any ideas, thoughts, literature relationships were logged as memos/annotations and assigned/linked to the relevant data. Each code/category/theme were then carefully defined and recorded. Coding was the process whereby the collected data were divided into different sections and given names (Bryman, 2008). It was a “system of classification" (Bloomberg & Volpe, 2008, p.102) by which a researcher classifies the data according to the “interest or significance, identifying different segments of data, and labelling them to organise the information contained in the data” (p.102). Codes on the other hand were used in quantitative research as “tags that are placed on data about people or other units of analysis” (Bryman, 2008, p.691). Coding can be done manually or by using qualitative analysis software (Creswell, 2009).

For the use of this study report, the codes were used for classification and further analysis of the questions, terms, and interactions. Each pieces of data were marked indicating the sample of respondent, gender, ethnicity, grade level for school group (age of the individual respondent), date, school or MNSC, and program involved in the study; for example, [P83/F/M/11/09042015/School26/A7] stands for respondent number 83 for interview, female, Malay student, the student age is 11 year old, interview occurred at April 09, 2015, the respondent was from school 26 and the respondent involved with A7 activities which was PSN Trooperz (see Appendix L for details of the codes for programs used in this study). While, for Science Educators, as the respondent in this study were only eight people, SE1 to SE8 were assigned to identify the eight educators involved in this study (the abbreviation SE was used for science educator). For teachers, the abbreviation T was used for teacher followed by the code of the program that particular teacher involved during observed study period. For example, [T6/A5], T6 stand for teacher number six for interview and involved with A5 activity which was Nature Secrets.

3.9.3 Triangulation of data

Teddlie and Tashakkori (2009) defined triangulation as 'the combinations and comparisons of multiple data sources, data collection and analysis procedures, research methods, and/or inferences that occur at the end of a study' (p.27). Different methods of data collection provide different perspectives and produce data that potentially had inherent weaknesses regarding the overall aims of a particular research and/or practical obstacles the researcher may encounter (Denscombe, 2003). If researchers exclusively rely on one particular method of collecting data, their interpretation of what they were exploring may influence or get the wrong impression about their interpretation of what was being explored (Cohen et al., 2007). When different methods of data collection were used, each method can potentially look at something from different viewpoints, which in turn can be compared and contrasted by the researcher. Looking at things from different viewpoints can corroborate findings and improve the validity of the data.

In this study, the mixed methods approach was used as a triangulation to confirm and to verify quantitative results (from questionnaire surveys and observations) with qualitative findings (from interviews). Its objective was to supplement the questionnaire results in instances where the questions asked during the interviews differed from the questionnaires. It was hoped that by using this approach the multi-faceted nature of human experience (in this research as students, teachers and science educators of MNSC) in using non-formal settings in Malaysia could be revealed comprehensively.

3.9.4 Ethical considerations

The researcher was informed by core ethical principles and was guided by Education Ethics Committee as outlined by The University of York. Ethical Issues Audit Form need to fill in first for this study in order to get the approval by Education Ethics Committee (see Appendix D for full details of ethics proposal).

Before conducting research in Malaysia, a letter was sent to the Director of MNSC requesting for permission to conduct both studies. Besides that, permissions also required from the Economic Planning Unit (EPU) Prime Minister Office, the sponsor National University of Malaysia (UKM), the Ministry of Education, Selangor State Education Department before the research was conducted in Malaysia (see Appendix A - C for letter of approval). Confidentiality were adhered to throughout the study, as there was no need for the study to identify any of the students or the schools involved in the main study, everything were kept anonymous. During the group interviews and observations no names were recorded and whenever referring to the transcripts or field notes, pseudonyms were used at all times to ensure anonymity.

3.9.4.1 Informed consent for questionnaire survey

A covering letter were attached to the questionnaire to inform the respondents about the aims of the research and other issues such as the anonymity of their answers. The research participants were not asked for their names in the questionnaire and a respondent ID number were used as the identifier within the coding and analysis procedure. The questionnaires were kept in a secure place to which only the researcher had the access.

3.9.4.2 Informed consent for interviews

As for ethical procedure relating to the interviews, an information sheet and a consent form were given to MNSC users (see Appendix E and F). The information sheet provided information about the project and how the interview data will be used and outlined, informed interviewees on their right not to answer or to withdraw from the interview process and also guaranteed the anonymity of the results. If, after reading the information sheet, the respondents agreed to be interviewed; their consent will be obtained by asking them to sign the consent sheet.

3.9.4.3 Recording

The interviews were recorded using a digital voice recorder if getting permission from the interviewees and were transcribed into text file for analysis. Voice recording was chosen because the method made it possible to have continuous conversations, whereas writing notes would have disrupted the flow of the interview. In addition, it provided an accurate representation of what was said. Without voice recording, only the basics of any conversation could be captured and might possibly be misinterpreted. It was very convenient for the researcher to listen to the voice recordings repeatedly for data transcription purposes.

3.10 Summary

This chapter begins by presenting the methods of research used in this study. A combination of qualitative and quantitative methods was used to answer the research questions, to reinforce the findings and to interpret the responses. As stated, the purpose of this research were to examine the perceptions on knowledge, attitudes and enjoyment from school visits from the perspectives of students, teachers and science educators in the non-formal learning, conducted by the Malaysia National Science Centre using three different locations of engagements: centre-based (i.e. at the MNSC itself), single-school outreach (i.e. MNSC outreach at one school), and multi-school outreach (i.e. MNSC outreach for several schools gathered together at one school).

The methods of data collection included questionnaires, observations and semi-structured interviews which were used to gather information from students, teachers and science educators in the non-formal settings, in order to identify the factors that make the visits as beneficial as possible. The evidences from teachers' and students' questionnaires provided statistical data about the views of teachers and school students in Malaysia on the value of learning conducted by MNSC in the non-formal settings. This were deepened by qualitative data gathered through semi-structured interviews with teachers, students and science educators of MNSC. The evidences from these three clients of MNSC, it was hoped that it will provide an excellent overview of the outcomes and impact of science centre-based learning in Malaysia.

The findings of the study were reported in the subsequent chapters. Chapter 4 begins by reporting the results on the science educators' perceptions on teaching and learning in non-formal settings. Chapter 5 describes the teachers' perceptions of science learning in non-formal settings and the students' perceptions on learning in the non-formal settings was presented in Chapter 6.

Chapter 4

Science educators' perceptions of teaching and learning in non-formal settings

4.1 Overview

The findings of this study will be discussed in the following three chapters. In Chapter 4, the science educators' perceptions of teaching and learning in non-formal settings conducted by the MNSC using three different locations of engagements: centre-based, single, and multi-school outreach were covered. Teachers' perceptions on their students' visit to the non-formal settings were discussed in Chapter 5. Lastly, students' perceptions of science learning in non-formal settings was discussed in Chapter 6.

In this present chapter, the goals of science educators in teaching the lessons in the MNSC were discussed. Then their roles in teaching and facilitating learning at the centre and when conducting an outreach program were explored. Lastly, how do the educators teach the students in the non-formal settings together with their evaluation approach were summarized. This chapter then summarizing the findings from science educators' perceptions of students' learning in the non-formal settings regarding their engagement with the activities provided by the MNSC.

4.2 Sample Characteristics of Science Educators in the Study

Educators observed in this study were selected based on the availability of the educators during the research period of study. Eight educators out of twelve in the

Education and Outreach (E/O), the Department of National Science Centre of Malaysia (MNSC) were employed in this study. Pseudonyms were used to identify each educator. In this study, the abbreviation SE were used for science educator. SE1 to SE8 were assigned to identify eight educators involved in this study. The educators had varied teaching and experience in science centre (see Table 4.1). The highest level of education of the educator was a Masters' degree in sciences and one of them currently pursuing her Masters' degree in Early Childhood Education as she said she want to know better about childhood in order to better prepare for teaching in the non-formal learning.

> … you know lots of thing that we can study…the more we study, there were a lot more that we don't know…especially now I'm in charge of science learning [Education and Outreach (E/O) at science centre, I feels that it is my responsibility to know more about pupils or students…that's why currently I am pursuing my study in childhood education… [SE8].

Two of them (SE3 and SE6) had two Diploma in Microbiology and also a Diploma in Early Childhood Education. SE3 and SE6 had the longest experiences (21 years during the research period of study) in MNSC compared to the other six respondents of science educator in this study. Meanwhile, two of science educators in the research study only had Malaysian Certificate Examination (SPM) as a qualification to be an educator at MNSC which was the lowest qualification (in term of level of education) amongst all the respondents of the study. Their overall teaching experiences at MNSC ranged from 8 months to 21 years (from the time conducting the actual study data collection) with the less experience educator (8 months working at the MNSC) was recently graduated from university, and the post at MNSC was her first job.

Table 4.1. Education and teaching background, and job duties of educators teaching in non-formal settings (MNSC)

Educator	College degree	Experience/ In-formal Teaching background	Job duties
SE1	Diploma in Civil Engineering	11+ years; national science centre	Plan and prepare science activities, hands-on workshop, and science shows. Develop and present the ideas in department meeting, attend training for personal development
SE2	Malaysian Certificate Examination	Four years; national science centre	Assisting in planning and preparing science activities, hands-on workshop, and science show. Develop and present the ideas in department meeting, attend training for personal development
SE3	Diploma in Microbiology, Professional Diploma in Early Childhood Education	21 years in national science centre, before that at ASEAN Planti Project	Develop and implement programs for primary and secondary schools, run the science show, run the scheduled program for primary school students in laboratory at science center, teacher workshops
SE4	Master in Science	8months+, first job at science centre, recent graduate	Coordinate, manage, plan and prepare the activities for the education department, choose the appropriate education programs for selected groups, teach educational programs to public and organized groups, brochure and flyers, train and oversee education staff, purchase supplies on normal working days, and other management issues.
SE5	Malaysian Certificate Examination	Two years+	Roadshow, science show, explain exhibits to the guest. Ensure the safety of the visitors in exhibits, especially when running science show
SE6	Diploma in Microbiology, Professional Diploma in Early Childhood Education	21 years	Run programs for primary and pre-schools, execute the science show, run the scheduled program for primary school students in laboratory at science center

Educator	College degree	Experience/ In-formal Teaching background	Job duties
SE7	Master in Science	Three years+; national science centre; now education department - outreach; previously at exhibits	Oversee outreach programs, choose the appropriate education programs for selected groups, assigning the educator for specific tasks, teach educational programs to public and organized groups, run science show, train and oversee education staff, teacher workshops, and other management issues.
SE8	Master in Science (currently pursuing Master in Early Childhood Education)	Five years+; national science centre	Manage, plan and prepare the activities for the education department, train and oversee education staff, build displays and exhibits, revise and develop exhibit texts, purchase supplies on normal working days, and other management issues.

Overall, science educators interviewed in this study had no teaching experiences in formal schooling and only involved in non-formal teaching experiences at MNSC except for SE3, SE6 and SE8 who were currently pursuing her Masters' degree in Early Childhood Education. According to SE4, due to have no experience in formal schooling for teaching or do not have experience in teaching in non-formal settings, it become challenges for SE4. SE4 explained;

> … It is quite difficult for me at first as I need to handle the teaching and learning in non-formal settings, but I take it as a challenge and opportunities to me. [SE4].

Nevertheless, as SE4 still new at MNSC, she said she will learn from her seniors and attending workshops wherever relevance to her job scopes.

> …I actually went through a science communication workshop to prepare myself to handle this kind of program. In addition, I also attended the science show workshops and hands-on experiments…this is actually continual learning process and it will never end… [SE4].

SE4 believes that she will overcome the challenges over time with the addition of extra training in the field of non-formal settings.

As for SE1 as his background was in engineering and he had 11 years and plus experiences with MNSC, in order to improve his teaching in non-formal setting, he will go for training in order to better equip himself with the current scenarios in the contexts of non-formal learning. The educators will go for training conducted internally by MNSC or through outside training provider. Besides that, he also will do the research with the help of the internet to find out the recent project related to teaching in non-formal settings. According to SE1;

> … I will apply for the appropriate course and through MNSC consideration other than learning through the internet and feedback from students or teachers who take the program including through suggestions, opinions and critiques or guidance (or comment and advice) from people directly and indirectly involved in the teaching and learning.… [SE1].

To enhance their skills, they decided to pursue their education in Diploma in Childhood Education, in order to know better about their visitor/client [SE3; SE6]. This was true for SE8 also who was currently pursuing her Master's Degree in Childhood Education. According to SE8;

> "I love teaching, I want to know more about the students, and I am trying to pursue my study in Childhood Education so that from the study, I will get to know how to handle them better.. physically, emotionally, and intellectually…"[SE8].

Meanwhile, although she had the intentions to further study in education, as she was a recent graduate, SE4 told that she want to pursue the study in education (or will be majoring in the informal or non-formal education) when she is ready. This was because she said that as she was majoring in Science, she still does not feel confident enough compared to senior staff in the MNSC. Therefore, she said she would gain the experiences while working in the MNSC and will continue to further her study when she is ready. As for SE7, he said he has the intention to further study, but he will continue with his previous background which is Master's in Science as he loves the programs itself. In responses to the experience in teaching in non-formal settings, SE7 explained;

> "I love teaching, I love students…as long as I know the content, I can deliver the content better…"SE7].

SE7 was a bright educator and he believes that although he did not pursue his study in education, he can do it well with the addition of his experience with his work and the training provided by the MNSC.

4.3 Science Educators' goals in teaching the lesson in non-formal settings

In this part, to further understand the roles and how the science educator in non-formal settings teach their students, the science educator's goals were discussed. Eight of the educators were interviewed and observed during their availability during the research period of study. To better understand the roles of science educator at the MNSC, it is better first find out their goals of learning and teaching at MNSC.

An understanding of the opportunities, constraints, and strategies for educators teaching in non-formal settings could help to better understand and maximize the usage and all potential of science learning in the non-formal settings (Tran, 2002). The findings from the interviews showed that although the educators felt sharing information was a significant component of teaching as part of engaging in the activities and the programs that they conducted, they also felt that retention of knowledge was not the primary objective of their activities. This was supported by almost all the respondents who said that they were happy as long as the students having fun and understand what the information or key concepts that were shared in the activities. SE3 specifically said that;

> "teacher brings their students here especially for scheduled programs; they asked to attend the courses provided by MNSC,… because the time was limited (usually for the scheduled program it will last for 1-2 hours), I am happy enough if the students can follow what I am demonstrating and asking them to do…at least they get and understand the key or science concept from the activity that they engaged …" [SE3].

Besides that, most of the educators interviewed believe that science awareness and appreciation for science as an important goal of their teaching at the out-of-school settings.

> …obviously we [science educators at MNSC] want to impart some knowledge, but if we could get the kids to leave here saying, 'Science is really cool. This was

> something I am interested in; I love doing science in 'Pusat Sains Negara', … then we've done … regardless of whether they go out with a lot of knowledge or not…at least they get the key concept of science they engaged on that day…[SE3].

Similarly, SE3 teaching goals in non-formal settings were supported by the rest of science educators interviewed in the study. SE7 believes that in order to instill positive attitudes towards science, he believe that 'we need to create an environment that the student can feel science in their everyday lives. According to SE7;

> … since I am doing the education and outreach, my goals were to create a positive awareness towards science amongst student…to do that; I believed we need to create an environment that will support this… science in all their everyday lives…by doing that, I hope, they will gain confidence and interest in doing science, and thus creating a positive awareness towards science…[SE7].

SE7 said he was always promoting the 'slogan' 'science in everyday life' to the students. By saying that, he added that through the programs, activities or experiments that MNSC conducted, he tried to introduce the programs that were simply innovative and manageable to the students to do it by themselves at homes. He tried to expose the students with the experiments or activities that the students rarely see in school (out-of-school learning experiences). He added, at the centre, he does not only want to see on knowledge aspects, but it is more towards their skills and their interest in science. According to SE7, although students learnt in school about communication skill, work in a group and many more, they learnt it in more relaxed and fun in science centre or in the out-of-school settings as their progressed or achievement will not be measured, as there is no right or wrong, they can try it many time and at the same time it will teach them persistent value in doing things. Besides, he also said that sometimes the teachers also excited with the simple experiments and wanted to try it out with other students in their class who did not participated in engagement with MNSC when they were going back to school. Nonetheless, he believed that by doing this did not take away the MNSC responsibilities as an institution to provide information, although he thinks the percentage was not about the same weight as a formal institution as in school.

SE6 also shared the same feeling with SE3 and SE7. According to SE6;

> … normally, when I teach the students, I will relate what they learn with the topics that have in their school syllabus…so, of course, it will somehow will impart some knowledge there…but then, as the students who are engaged with us is varied, so I am quite happy if the students were having fun by doing simple science here…when I asked the students before their leaving, some of them saying, 'It is easy to do science. I will do it at home,…" [SE6].

SE6 believe by saying that, the student already showed some appreciation towards science. In addition to that, SE1 believed that his goals of teaching science to the students in the non-formal settings were to develop the appreciation towards science amongst students. Although from the leaflet they were already saying the range of age for a certain activity, but sometimes the teacher will bring their students with different age groups. Therefore, SE1 added depends on the situation, in this case, he tried his best to accommodate with the situations (use language suitable for younger students). Therefore, he satisfies if from the activity he conducted, the student can follow his instruction and finished up the activity. According to SE1,

> … They are not going to remember everything I tell them about potential or kinetic energy [e.g., of the science topic on Balloon Blast activities]…but at least through their participation in the activities, somehow they will remember when they were studying about this in their class…Maybe there's one piece that they could take back... All I am trying to do, I think, was to help them develop an appreciation for what they were doing now…[SE1].

On the other hand, SE4 felt that;

> ... "the content … is important, but it is not the top priority. It is more like an understanding of how important observation is, how important recording is, how important sharing is, how important tracking your numbers accurately and giving the right data. Those basic skills probably are as necessary. Moreover, the attitudes of respect towards living things,... those are the kinds of things to me that were as important as the content. I do think that we have a bigger responsibility being an educational science center to have [a certain amount of] content … that they can carry away…" [SE4].

According to SE8, her aims when students engaged with the activities by science educator either in centre-based or at single and multi-school outreach was to;

> "… my goal is always for each person to walk away with one new piece of information … because it could be important in the future. … if nothing else I'd like to establish an appreciation towards science that hopefully they will pass on to each person, and make a connection with their everyday lives… [SE8].

In summary, it could be listed that the goals of the science educators interviewed in this study were as i) Awareness and appreciation towards science; ii) General concept understanding of the science activities; and iii) Develop skills. Most of the science educators viewed their goals of teaching in the non-formal contexts as to create awareness and appreciation towards science and the students have the general knowledge of the activities that they were engaged with and at the same time they will develop their process skills.

4.4 Science Educators' roles in teaching and facilitating

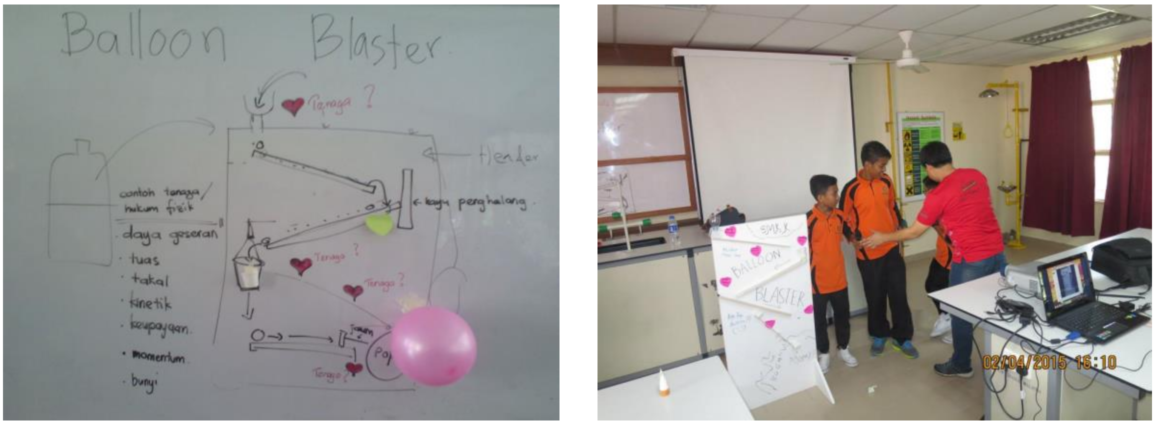
The role of non-formal science learning is beginning to form an important and complementary addition to formal education in engaging students in science learning (Mirrahimi et al., 2011). As such, according to Tran (2002; 2008), Tran and King (2009) and Kamolpattana et al. (2015), science educators played a significant role in what the students learned and experienced in non-formal settings. Science educators in this study had their own strong beliefs regarding science teaching and learning in non-formal settings especially in science centre and teaching science in non-formal contexts. Based on the interviews, their beliefs evolved from their personal experiences, past employment, their education background, personality and from their peers. Despite of that, the roles of science educators at MNSC on how children learn and the strategies to ensure meaningful learning were shared among the science educators and had similar philosophy among them; i.e., their role as a teacher and/or facilitator at MNSC.

4.4.1 Science educators role as a teacher and/or facilitator

Consistent with their belief that teaching was sharing of information (as described in the previous section heading 4.3), three of the educators suggested the role of the educator to be the provider of knowledge [SE3; SE4; SE8]. This belief was supported by the research done by Tran (2002) on her master thesis about 'The roles and goals of educators teaching science in non-formal settings' as she said that as 'they had the knowledge, and would share that knowledge with the students as the class progressed.' According to her, as the science educators knew the accepted information or interpretation of a concept, and they would correct the students' understanding if they disagreed. The implication of this was that the science educator act as a teacher and was at the center of the learning and teaching process, as in the classroom context. When interviewed about her roles in the MNSC and when doing outreach programs, SE4 stated that her role as a facilitator or science communicator. According to SE4;

> … What I can say is, I am more like a facilitator or science communicator…as I only have them for 30 to 45 minutes, or if the programs take a long time, it would be 60 minutes, 1 hour, 2 hours or even three days or a week programs. So, the way I look at it is I'm here to try and give them a new opportunities for new experiences and interactions with diverse of activities that science center offered such as engaged in balloon blast activities, science trails, science wonders, and many more,…and the information regarding those activities that they may or may not have had exposure to. So the way I see it, I am trying to share the information with them. Therefore, I feel like I am a facilitator or science communicator for that… [SE4].

According to SE4, although she feels that the role that she played at MNSC as a science facilitator or science communicator, but at the same time she would say that her role can also be imitated as a teacher. This was because most of the time, during the early stage of the teaching and learning process, she was in front of the class to communicate the knowledge and convey it to the students before proceeding it to another stage which merely instruction and facilitating the students throughout the program to do the activities. Therefore, during this time, she was at the center of the process of teaching and learning, similar to the traditional classroom before proceeding to facilitating the students in doing the activities and solving the problem provided.



(a) (b)

Figure 4.1. (a) Giving instruction and (b) facilitating students in doing the activity

> … I gave the overview of the activities …the science concept that they will learnt from this activity…after that I will facilitate their progress… [SE1].

For SE8, she believed her role in the non-formal learning was to expose the students with the information that the students were not familiar with in school and this might change the students' viewpoint. According to SE8;

> …my role here was definitely exposing them to information, and changing their viewpoint… We affect their education by dispelling myths; i.e., that science only can be learned in school… by exposing them to the science in their everyday life like the straightforward and easy experiments that we conducted here, by exposing them to things they were not going to be exposed to in school like the varieties of exhibits, the science of wheels which included the mobile exhibits that we used for single and multi-school outreach… [SE8].

As for SE1, he believed his role as a science educator at the MNSC and while doing outreach programs as a facilitator. According to him;

> … For me, it is really being a facilitator. Being someone that can point out things, and … call somebody to ask a question, "Why does this do this,' and it allows me to have a chance to explain it. … Making [information] available. Here it is, and what you can do with it… [SE1].

SE7 believes that his roles in teaching and learning and the out-of-school setting as being a facilitator, science communicator or the teacher itself. According to SE7;

> …being here, I can facilitate the students in the interactive exhibits although most of the exhibits here were in self-exploration and self-learning type of nature. For the scheduled programs, we try to facilitate and communicate the science ideas and concepts so that there was an interaction between the students with science educator, with their peers and at the same time with their teachers… as the students persistent in finding out the answer, for example in certain activities conducted, here come the roles of science educator to scaffold the students learning in the topic of study… [SE7]

> …I would say my role here are varied… sometimes my role is like being a facilitator…sometimes we were called science educator…and sometimes the students will call us teacher…whatever title that they call us is, my role and responsibility here is to share the things that we know with the visitors (or in this case is the students)…I would say my role has the characteristics of teacher, facilitator or science communicator…as we communicate and sharing the information, assisting the students in acquiring the knowledge and reinforce that information…we facilitate the learning process by engaging the students with the

> activities which involves touching, observing, experimenting and doing in order for them to generate their own understanding… [SE3].

Although the concept of science learning in the centre was self-exploration and self-learning in nature, SE6 believed that to ensure that the students will get advantage from their engagement with MNSC to have a 'human touch' at each exhibit (ideally). According to SE6;

> …There should be a facilitator to explain about the exhibits or the activities that they are engaged with…because we are lack in budgets, therefore not all the exhibits have explainer or facilitator…that's why we add the corner like 'let's experiment' and 'science show' so that there is an interaction between the students and science educator…will leave the 'hearts-on' on students… meaningful learning… [SE6]

Therefore, overall, the educators believe that their roles in teaching and learning in non-formal settings whether as a facilitator, science communicator or a teacher, with the objectives in the mind to facilitate, to convey the information, and scaffold the students when in doubt.

4.5 How do science educators' in non-formal settings teach science lesson?

For the upper primary lower secondary classes group targeted in this study, the classes focused on a particular concept, e.g. matter matters – fun with solid, liquid and gas, life cycles and stages of animal development and their characteristics (in this study the different between butterfly and moth), photosynthesis and respiration, acid and base, and energy (potential and kinetic energy). These programs encompass a broad range of topics, and most can be adapted to accommodate specific grades or age groups.

While teaching was not the only task for which these educators were responsible, it was their primary duty in the non-formal settings (see Table 4.1). The science educators teaching the classes that were available to any visitors, primarily school students from different grades and age groups, thus thousands of school children participated in such classes. Table 4.2 shows the total number of students participated in the programs conducted by MNSC in the month of January to Mei 2015 (in the period of the researcher conducting main study data collection).

Table 4.2 Total number of students participating in the education programs by MNSC from January – May 2015

Month	**Total number of students**
January	8,306
February	8,828
March	8,523
April	27,232
May	32,353
Total	**85,242**

Although science educators at MNSC only interacted with a class of students for 45-60 minutes (normal program), they had significant responsibilities on their shoulder as they were responsible for conducting the lesson, overseeing student progress, carrying out activities, and assessing student understanding during the class time (Tran, 2002). According to her finding from her research on 'The roles and goals of educators teaching science in non-formal settings', the classroom teacher or the accompanying teacher relinquished authority to the science educators during the lesson based on her observation. Therefore, she concluded from her research that the science educators were the primary instructor, and accountable for the management of student behaviour during their lesson (Tran, 2002). It's were the same with the current research, where once the school group arrived in the non-formal learning, the teacher hand-over the tasks to teach the children to the science educators.

In this section, data arising from observations and interviews generated insight into how the science educators at the MNSC teaching in the non-formal settings, focusing on the centre-based, single-school and multi-school outreach. In this study, the locations of engagement were categorized as a centre-based, single-school and multi-school outreach (for the details definition of locations of engagement, please refer to Chapter 3 with the sub-heading locations of engagement in the study). In brief summary, the respondents from the 'centre-based' were engaged with the activities conducted by the MNSC at the Malaysia National Science Centre (School code: School 5, 6, and 13). For the 'single-school' and 'multi-school', the data were collected during the outreach programs conducted by MNSC at the selected school. 'Single-school' data collection means the outreach programs have been carried out at each school respectively. Meanwhile, for the 'multi-school' outreach, the students and teachers from various schools were gathered in one selected school by MNSC to perform the outreach programs.

In the single-school outreach (four schools involved in this type of engagement with the school code: School 19, 23, 25, and 26) and multi-school outreach, the event called 'Kelana Sains' or 'Science Wanderer at Pulau Langkawi' were selected for this period of study (two multi-school outreach involving 19 schools altogether with school code School 20 (ten schools gathered and participated in this type of engagement) and School 22 (nine schools participated in this multi-school outreach) (please refer to Figure 3.4 in Chapter 3 for types of data collection based on locations of engagement in the study).

These three locations of engagement were considered in this study with careful consideration that most of the programs conducted in the center were similar to the programs conducted for outreach. For the single and multi-school outreach, the programs comprised mini exhibitions of selected items of interest from the MNSC. It came complete with staff and supplementary educational materials. The programs were a combination of exhibits, demonstrations, written educational materials and activities that regularly used in the science center.

In view on how the science educators teach in non-formal setting based on different locations of engagement, the structure of the teaching in these contexts; focusing on the classroom layout, the class instruction and the lesson plan implementation to teach were discussed in the next section. Considering the structure in these context, it was hopes that we can investigates whether there was significant different on the science educators' roles and approaches in these three different locations of engagement.

4.5.1 Class structure

The educational programs offered by the MNSC for the students in these three types locations of engagement included lectures and demonstrations as well as structured science classes for visiting groups of students. The science classes targeting school groups highlighted a topic or concept related to the area of science featured at that setting and were the primary education program examined in this study. Among others, the concepts that were investigated in this study comprised of the activities that the students were engaged with the science educators when they were doing the activities on a particular idea, e.g. matter matters – fun with solid, liquid and gas, life cycles and stages of animal development and their characteristics (in this study the different between butterfly and moth), photosynthesis and respiration, acid and base, and energy (potential and kinetic energy). These programs encompass a wide range of topics, and most can be adapted to accommodate specific grades or age groups and were used for these three types of locations of engagement which are on the centre-based, single and multi-school outreach.

To answer the question ‘How do science educators’ at MNSC teach science lesson?’, the physical descriptions of the class structure to deliver the instructions were discussed. The class structure comprised of the classroom layout, physical position in which science educator-led class and the general format of the lesson plan implementation. The physical layout of the settings itself, a position from which the educator orchestrated class in the out-of-school settings, and the design of the lesson plans were salient class environment characteristics identified in the twenty-one lessons observed in this study.

In this study, the layout for the teaching and learning in the non-formal settings for the three different locations of engagement in term of the uses of the room and the seating arrangement of the students during the lesson were summarize. Regardless of age group, and whether the class was taught at the science center or during the single or multi-school outreach (regardless whether during this outreach classes were taught indoors or out), the similar pattern that was found were the educators conducted the lesson at the front of the class. The design of the lesson plan for these classes ranged from a structured (matter matters), show-and-tell format (demonstrations) to an educator-led discovery process (e.g., science trails). Although there was minor variability in the classroom layout and lesson plan design among the twenty-six classes observed, the deviations were not unique to any locations of engagement with MNSC in the out-of-school settings.

4.5.1.1 Classroom layout

For all the three locations of engagement in this study, the students either sat in groups or addressed as a whole class. In addition, since teaching science classes to groups of school children was not the singular objective of these non-formal settings, there was often limited space for teaching these classes as reported in Tran (2002) study. However, in this recent study, I am only using one non-formal centre, Malaysia National Science Centre (MNSC) as non-formal institution learning conducting their programs to the school groups based on different locations of engagement; which were at the centre-based, single and multi-school outreach.

Considering that each location of engagement had different effects on the science teaching and learning in the non-formal contexts on children, this section discussed on how the differences in this context were applied in this study. Besides, considering that each class topic required different types of objects, animals, specimens, and/or equipment, and the classroom space was shared among the different types of classes offered, with the different age groups of students, materials specific to the class were brought out as needed. As explained previously in section 4.5 on how do science educators' at MNSC teach science lesson in these three locations of engagement, a careful consideration that most of the programs conducted in the center were similar to the programs conducted for outreach. For the outreach program either in single or multi-school outreach, the classroom layout that were used either in the hall, laboratory or in the classroom based. The mini exhibitions of selected items of interest from the MNSC were comprised and displayed at the hall in the selected schools so that the students can interact with the exhibits.

The students were arranged in a way to accommodate the needs of all. The seating arrangement of lessons conducted in a classroom in all three locations placed students in circles or small groups with the classroom teacher and assisting staff or 'explainer' sitting in the back of the room. The sketches of how the classroom differ in these three locations of engagement can be viewed graphically in the next section on class instruction style.

The similar pattern that was found in this study that the science educators conducted the science lesson at the front of the class for all three locations of engagement, regardless of the age groups, the number of students in the school groups, the size of classroom (either hall, laboratory or classroom based, or outside the classroom). Therefore, it can be concluded in this study that the classroom layout that was used not unique to only students engagement with the MNSC at the center-based but also similar when they were engaged in the single and multi-school outreach.

a) Centre-based

In the centre-based, there were eight rooms, labs, and halls that were used as classroom space for conducting classes, which includes any type of class or workshop that the institution offered. The space considered as a classroom in the centre such as i) Activity room; ii) Pasteur's Lab; iii) Watson and Ceick lab; iv) Conference room; v) Ibnu Sina' Auditorium; vi) Quantum Auditorium; vii) Multipurpose hall; and viii) Nature Secrets Lab. These space were primarily used for classes at the centre when conducting scheduled programs to the school groups visiting MNSC. As for the purpose of this study, the respondents were observed in three different classes which were at the Pasteur's lab, Ibnu Sina' Auditorium and lastly at the Nature Secrets lab.

As the classroom for the centre-based, there walls were decorated with objects, posters (Pasteur's lab) or animals (Nature Secrets lab) depending on the suitability of the decoration. The classrooms only contained chairs (and tables if needed for the lesson) and minimal posters or artwork on the walls. The classroom at the centre-based had storage closets along walls filled with supplies for other educational programs, reptiles, other education program materials stacked against corners and walls, and an oversized stuffed were laid back at the back of the class. The students were observed to be preoccupied with these materials during the free exploration portion of the lesson. At the Pasteur's lab and the Ibnu Sina' Auditorium, there were no windows in any of these classrooms. Only the exit sign and doors available in these classroom. Meanwhile, at the Nature Secrets lab, the classroom was decorated with diagrams, objects, specimens, and equipment related to butterfly and moth and their cycles and other animals and plants. During observation of the study, the science educator [SE7] was conducted the topic on ‘fun with butterfly and moth’, ‘fun with plants’ and ‘fun with photosynthesis and respiration’. The students observed in this study either sat in groups or addressed as a whole class by the SE7.

b) Single-school outreach

For the single-school outreach, the science educators in this study used the hall. The hall served as a multi-purpose room at single-school outreach. For the four single-school outreaches observed in this study, the arrangement of the classroom for the teaching and learning of the students’ engagement with MNSC in non-formal settings were similar to each other. As this hall was the standard hall for the respective school, there was no special arrangement relating to science classroom layout. Instead, the wall in the hall were filled with the decorations decided by the school admin. In School 23 for example, the walls were decorated with posters of the Yang di-Pertuan Agong, which is the monarch and head of state of Malaysia and his wife, Raja Permaisuri Agong. Following this poster, there were the vision and mission of the school. It is noted that there was no other poster relating to science learning in the classroom layout in the single-school outreach.

From the observation, the hall was empty and only has the chair at the back for teachers’ use and couches at the side of the hall to be used for closing event. As there was no tables or chairs, the students faced the front of the room lengthwise, with the science educators conducted the science lesson at the front of the class. All the materials needed for the science lesson were placed in front of the classroom and were distributed to the students when necessary. The students observed in this study either sat in groups to do the experiment and were addressed as a whole class by science educators when asking the questions to them. In this type of engagement, students did not use tables and chairs, nor did the educator had a large writing surface, for example, chalkboard or sketch pad, on which to write. Students either stood or sat on the ground, depending on the nature of the activity in which they were engaged.

c) Multi-school outreach

In the multi-school outreach, there were three types of space that were used as a classroom, which were hall, laboratory and classroom-based. Similar with single-school outreach, the hall served as a multi-purpose room at multi-school outreach but with the different size compared to the hall in the single-school outreach. This was because in order to accommodate many students from different school at one hall, the organizer was selected the school that was easy to reach, have big hall and can accommodate all the mini exhibits and the students from all the schools participated in the study at one time.

For the two multi-school outreaches observed in this study, the arrangement of the hall for the teaching and learning of the students' engagement with the MNSC in the non-formal settings were similar to each other. As this hall was the standard hall for the respective school, there was no special arrangement relating to science classroom layout. Instead, the wall in the hall were filled with the decorations decided by the school admin. In School 20 and School 22 for example, the walls were decorated with posters of the Yang di-Pertuan Agong, which is the monarch and head of state of Malaysia and his wife, Raja Permaisuri Agong. Following this poster, there were the vision and mission of the school. It is noted that there was no other poster relating to science learning in the classroom layout in the multi-school outreach.

The hall in the multi-school outreach were decorated with the mini exhibitions of selected items of interest from the MNSC. It came complete with staff and supplementary educational materials. The program was a combination of exhibits, demonstrations, written educational materials and activities that regularly used in the science centre. The participating students and teacher came to the hall to listen to the talk before proceeding to their scheduled programs either in the classroom, laboratory or the program conducted entirely outside.

For the laboratory-based and classroom-based layout in the multi-school outreach, the tables faced the front of the room and students sat on the chair as normal classroom and laboratory-based. The students were divided into group of 4-5 person. The science educators conducted the science lesson at the front of the class. All the materials needed for the science lesson were placed on their tables in the classroom and were distributed to the students when necessary. Although there was a large writing surface, the science educators only using the required space to write according to their usage, and based on observations, their usage were quite similar with the one that they did at the centre-based and single-school outreach.

The students observed in this study either sat in groups to do the experiment and were addressed as a whole class by the science educators when asking the questions to them. For this type of engagement, there was program that needed to do half in indoors (laboratory or classroom-based) and the other amount of time were conducted outside. For the first half of the time, they were taught indoors by listening to the instruction and make a preparation before proceeding to the outside for the application of the product that they produced. At the outside, students either stood or sat on the ground, depending on the nature of the activity in which they were engaging.

Since the centre was not in used, the availability of the resources for single and multi-school outreach was quite similar. The only different was for single-school, it only involved with one school at a time, but for multi-school outreach, the educators' need to cater all the schools' visits to that particular (school host) venue.

4.5.1.2 Class instruction style

Regardless of age group, and whether class was taught indoors or out, educators observed in the study conducted the lesson at the front of the class (see Figure 4.2 - Figure 4.4). The style on how the science educators taught in the class for example; SE3 and SE6 for example were involved in the three locations of engagement in this study. At the initial phase of the instruction, the educators led whole class discussion at the front of the class; this phase was to inform the students what they were experiencing and doing in this activity. As the lesson progressed and the students engaged in the activity, the science educators intermingled among the students [SE1 – SE8].

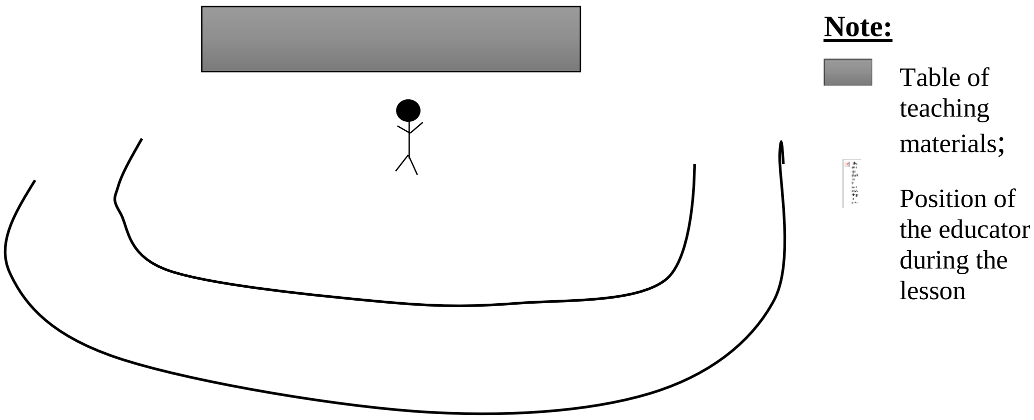
Most of the programs examined involved the students work in small groups, and each group had their own set of objects and equipment to manipulate and observe. This was in line with the previous studies showed that the role of the science educators was to assist a group to improve the effectiveness of decision-making and settlement by improving the process to ensure that the discussion process goes smoothly and impeccably (Wan Norjihan, 2003; Stewart, 2006). Regarding working in small group, Hamdan et al., (2007) stated that science educators play an important role in helping the group participants through an effective learning and communication process in achieving group goals. As such, it should be noted that in this non-formal science learning, science educators play a very important role in facilitating learning in a particular group; especially the groups of students who visit the non-formal institutions.

For some of the activities in the current research, the educators asked the students to present their products to the class [Balloon blast]. At the end of the lesson, the educators asked the students about what they were studying today? [SE3; SE1; SE6] to ensure that they learnt something from the lesson. Figure 4.2 - Figure 4.4 shows the classroom layout and the position of the educators during initial stage of instruction in the non-formal settings which were; (a) centre-based; (b) single-school outreach; and (c) multi-school outreach.

a) Centre-based

i) Hall – science trails

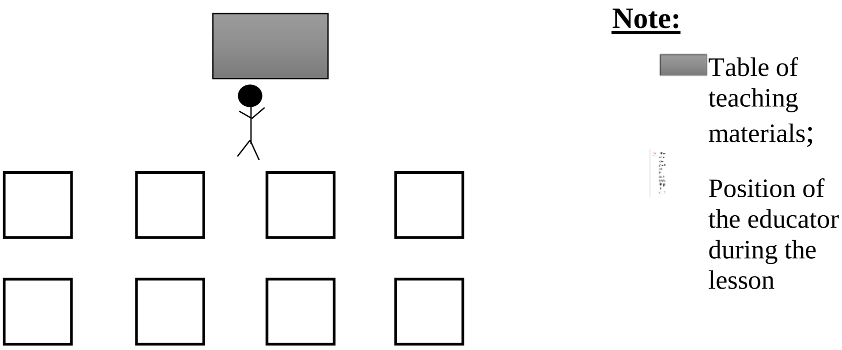
For science trails programs, the students were given the instruction in the hall before dividing the group into 4-5 person. Students sat in a semi-circle in the middle of the floor for their lesson at centre-based. The students were given the instruction in this hall before proceeding to complete their tasks in the program scheduled.



i. Hall

At the nature secrets lab, the students were brought to explore the plants in the garden and were asked to bring two green leaf before entering the lab. In the lab, the were asked to formed a group consisted 4-6 persons. The science educators taught the lesson in front of the class at the initial phase and intermingled among the students when they were engaged in group activities.

Whereas, at the pasteur's lab for science wonder programs, the classroom instruction style conducted by the educators were similar to the laboratory-based style in formal classroom, except for the experiment that were conducted at the centre-based were quiet straighforward and easy to follow. Similar to other type of instruction, the educators at the Pasteur's lab also taught the lesson in front of the class at the initial phase and intermingled among the students when they were engaged in group activities. The science educator at this class also did ask the students when necessary in order to ensure the students understand what being taught and what they had learnt today. Besides, she also did relate the activities that was conducted with the sylabus that the students learnt at school (as she did ask for their age group and school and their previous knowledge before). In addition to that, she also relates the impact of the experiment that they had conducted with their everyday life [the experiment that been observed was 'rock store carbon'].



ii. Laboratory based (nature secrets lab and science wonders program)

Figure 4.2. Arrangement of students and educator in lesson taught at centre-based (i) Hall; (ii) Laboratory-based

b) Single-school outreach

i) Hall – Let's Innovate

As there were no tables or chairs, the students faced the front of the room lengthwise, with the science educators conducted the science lesson at the front of the class. All the materials needed for the science lesson were placed in front of the classroom and were distributed to the students when necessary. Students either stood or sat on the ground, depending on the nature of the activity in which they were engaging.

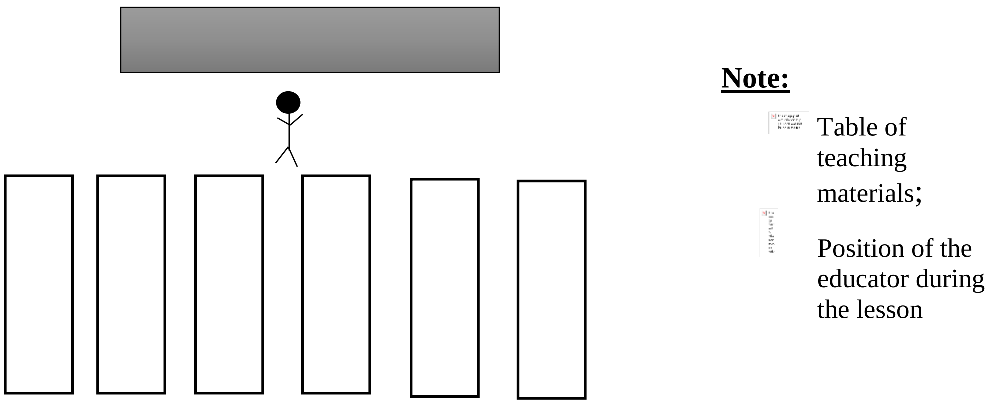
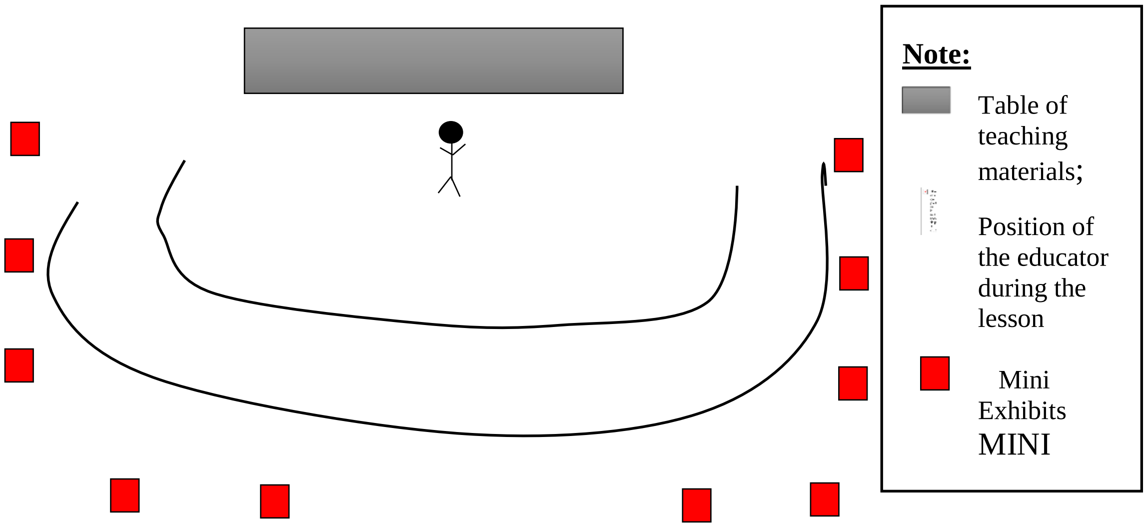


Figure 4.3. Arrangement of students and educators in lesson taught at single-school outreach (i) Hall

c) Multi-school outreach

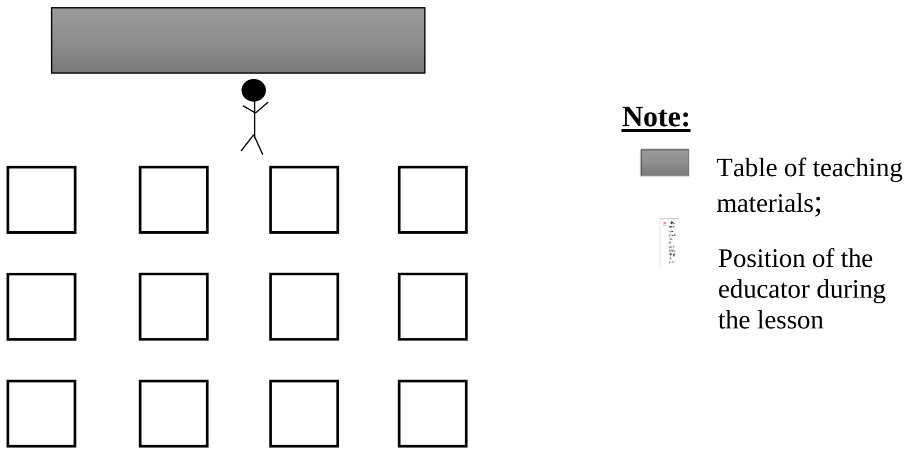
i) *Hall – Let's Innovate*

The hall in the multi-school outreach were decorated with the mini exhibitions of selected items of interest from the MNSC. It came complete with staff and supplementary educational materials. The programs were a combination of exhibits, demonstrations, written educational materials and activities that regularly used in the science centre.

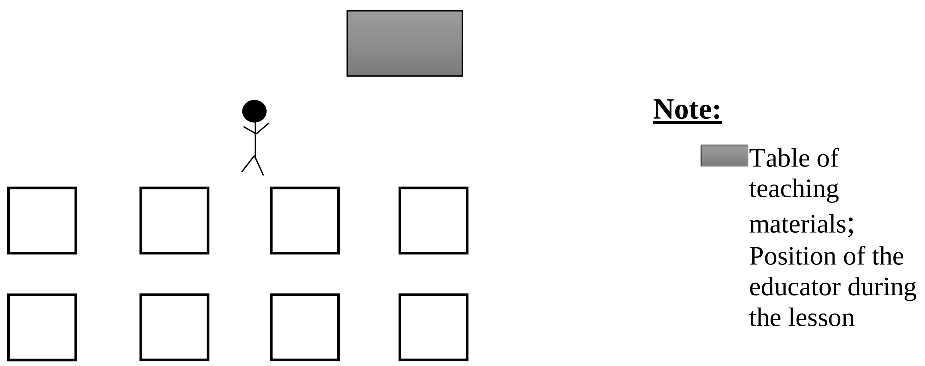


ii) *Laboratory-based and classroom-based (let's innovate programme)*

For the laboratory-based and classroom-based layout in the multi-school outreach, the tables faced the front of the room and students were sat on the chair as normal classroom and laboratory-based. The students were divided into groups of 4-5 person. The science educators conducted the science lesson at the front of the class. All the materials needed for the science lesson were placed on their tables in front of the classroom and were distributed to the students when necessary. The science educators taught the lesson in front of the class at the initial phase and intermingled among the students when they were engaged in group activities. The students observed in this study either sat in groups to do the experiment and were addressed as a whole class by the science educators when asking the questions to them. For this type of engagement, there was program that needed to do half in indoors (laboratory or classroom-based) and the other amount of time were conducted outside. For the first half of the time, they were taught indoors by listening to the instruction and make a preparation before proceeding to the outside for the application of the product that they produced. At the outside, students either stood or sat on the ground, depending on the nature of the activity in which they were engaging.



(a) Laboratory-based



(b) Classroom-based

Figure 4.4. Arrangement of students and educator in lesson taught at multi-school outreach (i) Hall; (ii)-(a) Laboratory-based; (ii)-(b) Classroom-based

4.5.1.3 Lesson plan implementation

The lesson plan format and teaching approach had strong similarities among the eight respondents of science educators interviewed in the study. The educators introduced the subject matter at the start of class, and communicated information to the students. Science educators' posed questions to encourage students to participate in the discussion. Dialogue about the concept, object, or organism, whether it was solely from the educator or in the form of student responses to questions posed by the educator, preceded student manipulation and interaction with the items.

In the activities observed in this study, all locations of engagement included physical activities in which students engaged with the activities (i.e; science trails, science wonders program, nature secret lab, let's innovate). To do the activity, students were divided into small groups in order to participate in the activities. Science educators facilitate the students in the middle of the activities. The lessons all ended with wrap up of the major ideas or concepts presented for the activity. The program conducted at multi-school outreach, 'bottle rocket' activities ran out of time, as the students asked many questions for the concepts that they did not understand, the lesson had to rush. Nevertheless, the educators managed to conclude the activity although it a bit rush.

The styles SE3 taught 'science wonder program – rock store carbon', involved students in the lesson, SE3 posed questions prior to her demonstrations, encouraged students to hypothesize the outcome, and called upon students to physically participate in order to help her illustrate the concept. While she provided the participation with a question to investigate the concept, the student participant was told what to do and how to do it. SE3 explained to the class what that student was going to do and why, and had the child demonstrate the concept to the class. In this activity, SE3 acts as a teacher and conducting the experiment. School teacher only helps to guide the students when necessary, and their main roles basically on managing the disciplines and times among their students.

Rather than showing through a demonstration of the concept and then telling about it, SE7's activity on 'science wonderland-nature secret lab' studying about the butterfly and experimenting with carbon dioxide gas after participating in observing all parts of the ‘science wonderland’. SE7’s class simply displayed the moth and butterfly to the students prior to or while the educator talked about the animals. SE7 showed the item to the whole class as they led a discussion about it. Students were given the opportunity to touch and examine the animals closer immediately after the animal was discussed. Students’ were asked to differentiate between moth and butterfly. The lesson plans for SE7 classes allotted free exploration of the animals, as well as stations of other activities related to the topic, after all educator led discussions. SE7 asked questions to encourage students to share what they knew about the item, to make closer observations, and to make connections between the items they were shown and what they already knew. The educators generally followed the student responses with an explanation or information about the featured item. Once all information about an item under study (in this case moth and butterfly) was shared by the educator and requested of the students, the educator moved on to the next experiment.

In the class observed, science educators mingled with the students during group work to help students doing the experiment, collect data, identify the problems, or keep them on task. Students also asked questions to science educator if there were any information that they did not understand. Students were asked to share their findings with the class (Balloon blast) and need to communicate why they chose to do the activity that way and the primary concepts involved in the study. Other groups were asked to evaluate the findings. These class formats and teaching approaches transcended age groups since they were used in classes for both age groups, upper elementary and lower secondary school. It also were used in different locations of engagement in this study. In all cases, the educator played a significant role in what the students learned and experienced. Accordingly, lessons plan taught at non-formal settings could range from show and tell format (science show, nature secret lab-moth and butterfly), to guided discovery (rock store carbon) and data collection (bottle rocket, rock store carbon, screaming ice-cream).

4.6 Evaluation of teaching and facilitation approach used

For years, science centre and museums have relied on evaluation as a way to monitor their success in terms of visitor opinions and perceptions of exhibits and programs offered. Evaluation in the context of non-formal science learning was important to ensure effective learning has taken place in the context of non-formal science learning settings. Bernhardsson and Lattke (2011) put an aspect of the evaluation of learning encompassing the ability of science educators to evaluate the basic knowledge of students and learning needs during the visit. Although the assessment in the context of non-formal learning is not as important as formal learning, but according to Bernhardsson and Lattke (2011), science educators should also evaluate learning outcomes in the activity conducted whether met the goals or objectives stated for the learning in the non-formal context. In addition, Kamolpattana (2015) recommends that cognitive aspects were emphasized in the evaluation of learning in non-formal settings. The study by Tran (2007) found that evaluation aspects is a very critical skill in non-formal learning. According to Tran, science educators need to have a quick assessment of the existing knowledge of the students before any learning activities were carried out.

As per research under study, science educators were asked on how they evaluate the effectiveness of their programs to the students in general. All science educators (SE1-SE8) said that he/she regarded the students understand the concept under study when they gave the respond and feedback when asked and through the evaluation form that MNSC prepared. SE3 stated;

> "as long as students understand the ideas and concepts that we talk today, for me it's more than enough…it's successful already…" [SE3].

In order to strengthen the students' understanding about the ideas or concepts they studied for the activity, SE3 applied asking questions and ended the lesson with wrap up of the major ideas or concepts presented for the activity. However, studies by Dillon et al. (2005); Kahn and Rockman (2002) found that no follow-up actions were taken by teachers to students after non-formal learning took place. In the context of non-formal learning also, science educators should always assist and guide as well as encourage students to develop ideas in new situations. This is in line with the Contextual Model by Falk and Dierking (2000) which states that learning is also influenced by the individual's desire to choose and control his or her learning. Students can apply concepts learned in various situations and develop existing ideas.

4.7 Summary

In this chapter, science educators' goals, roles and how they teach in the non-formal settings were discussed. The science educators at MNSC believes that their goals in teaching and learning science at the out-of-school settings as towards to i) Awareness and appreciation towards science; ii) General concept understanding; and iii) Develop skills. Most of the science educators viewed their goals of teaching in non-formal contexts as to create awareness and appreciation towards science and the students have the general knowledge of the activities that they were engaged with and at the same time they will develop their science process skills (this were observed when they did the activities/experiment).

While, the educators interviewed in the study believes that their roles in teaching and learning in the non-formal settings were either as a facilitator, science communicator or a teacher, with the objectives in the mind to facilitate, to convey the information, and scaffold the students when in doubt. 'How do science educators' at MNSC teach science lesson?', the physical descriptions of the class structure to deliver the instructions were discussed. The class structure comprised of the classroom layout, physical position in which science educator-led class and the general format of the lesson plan implementation. The physical layout of the settings itself, a position from which the educator orchestrated class in the out-of-school settings, and design of the lesson plans were salient class environment characteristics identified in the twenty-one lessons observed in this study.

In this study, the layout for the teaching and learning in the non-formal settings for the three different locations of engagement in term of the uses of the room and the seating arrangement of the students during the lesson were summarize. Regardless of age group, and whether the class was taught at the science centre or during the single or multi-school outreach, the similar pattern that was found were the educators conducted the lesson at the front of the class. The design of the lesson plan for these classes ranged from a structured (matter matters), show-and-tell format (demonstrations) to an educator-led discovery process (e.g., science trails). Although there was minor variability in the classroom layout and lesson plan design among the twenty-six classes observed, the deviations were not unique to any locations of engagement with MNSC in the out-of-school settings. It is hope from this awareness, those interested in teaching in traditional classrooms could better understand and use non-formal settings to supplement and complement their science curriculum.

In term of evaluation of teaching and facilitation approached used in the study, science educators believe that evaluation played an important role in monitoring the effectiveness and their success in conveying the objectives and roles towards the visitors specifically students in this research. They believe that they should evaluate the students in term of their basic knowledge and learning needs during the visit. Besides, after conducted the programs, they again evaluated the students whether they understand what they learnt from the engagement with the MNSC. The evaluation styles can take either by asking questions what they learnt and the major ideas or concept of knowledge that the learnt from the activity.

An understanding of the opportunities, constraints, and strategies of educators teaching in non-formal settings could help science teachers (formal and non-formal) and science teacher educators maximize upon all potential science learning and cognitive development opportunities. From this awareness, those interested in teaching in traditional classrooms could better understand and use non-formal settings to supplement and complement their science curriculum. Since this study involved three locations of engagement, it showed that the availability of the resources for single and multi-school outreach was quite similar. The only different was for single-school, it only involved with one school at a time, but for multi-school outreach, the educators' need to cater all the schools' visits to that particular (school host) venue. In term of science learning, there were variability of significant finding on students' learning across age group and locations under study which will be discussed in Chapter 6.

Chapter 5

Teachers' objectives of science learning in non-formal settings

5.1 Overview

In this chapter, teachers' perspectives on their students' learning were discussed. In this present chapter, the profile of teacher participants in this study were discussed followed by teachers' choice and objectives for conducting school group visits to non-formal settings. Then how do teachers' plan the school visit in order to achieve the objectives and lastly to what extent the teachers' objectives met from the visit. This chapter end by summarizing the findings from the teacher perspective on students' learning in the non-formal settings regarding their engagement with the activities provided by the science educators of MNSC.

5.2 Profile of teacher participant in questionnaire and interview in the study

The profile of teacher participants in this study is presented in Table 5.1. For the teacher questionnaire, there were 40 respondents who participated in this research and completed the questionnaire which consist of six people from centre-based, nine from single school outreach and 25 from multi-school outreach. Among the respondents, 11 or 27.5% of them were male teachers and 29 (72.5%) were female teachers. Whereas, for the interview session, 17 teachers from three different locations of engagement were selected to participated in the study. Among the participants, 12 or 70.6% of them were female teachers and five (29.4%) were male teachers.

Table 5.1. The number of teacher participated in the survey questionnaire and interview based on gender and different locations of engagement with MNSC

Source of data collection	Variable	Particular	Locations of engagement with MNSC			Total	Percentage (%)
			Centre-based	Single-school	Multi-school		
Survey	Gender	Male	2	1	8	11	27.5
		Female	4	8	17	29	72.5
		Total	6	9	25	40	100.0
Interview	Gender	Male	1	0	4	5	29.4
		Female	3	3	6	12	70.6
		Total	4	3	10	17	100.0

5.2.1 Teachers' choice

To better understand the type of school visit to non-formal place learning in Malaysia, teachers were asked to indicate the extent to which four different statements regarding school visit planning were accurate to their school. To answer this research question, one question was aimed at identifying teachers' choice on school visit planning were accurate to their school (see Appendix G: Teachers' questionnaire on Part C, Question No.13). The statements and the frequency of responses are shown in Table 5.2. Most of the teachers' responses indicated that they had 'no choice' in whether they want to lead a school visit or not (80.0%) and 'no choice' in to choose how many times they wish to go (87.5%).

Table 5.2. Teachers' choice to visit non-formal places

Statement	**Response**	
	Yes (n,%)	**No (n,%)**
Teachers can choose whether they want to lead a school visit or not	8 20.0%	32 80.0%
Teachers can choose where they wish to go	40 100.0%	0 0.0%
Teachers can choose when (date) they wish to go	40 100.0%	0 0.0%
Teachers can choose how many times they wish to go	5 12.5%	35 87.5%

Whereas, all of the teacher responses indicated that they had a choice to choose in where and when they would lead their school visit (100.0% person of the teachers agreed to the statements, n=40). The results here indicated that the decision to conduct a school visit was rely on the teacher's, as many have pointed to no restriction in choosing when and where to go, but had restriction in choosing how many times and whether they want to conduct the school visit. According to T5;

> "school visit were part of co-curriculum activity…so normally we will conduct it once or twice a year…as for science subject in school, we were advised to plan a visit to places related to science and technology, for example to science centre or planetarium…it's depends on us teacher to decide where and when to visit but normally will get what's available… we have no choice whether we want to lead the visit or not, as if we are teaching science subject in school, normally we will take the lead…no choice…" [T5/A5].

One teacher responded that their school held the visit because they want to prepare for class that had 'big' exam. Therefore, the school administrators asked the teacher to take a lead for school visit outside the school classroom.

> "exam at school now…so I were asked to bring the students out-of-school..atleast here these students can learnt something and not disturb the class who had the exam…" [T3/A2].

The results here indicated that the decision to conduct a school visit was only partially the teacher's, as many had pointed to restrictions in choosing when, where and even whether to go. It is likely, then, that this school context, as well as the personal context described earlier, play important roles in. determining the teacher's motives for leading the school visit in the first place.

5.2.2 Teachers' objectives for participating their students in the programs conducted by MNSC

To answer this research question, one question was aimed at identifying the teachers' objectives for participating their students in the programs conducted by MNSC. In this question, teacher was asked to 'tick ALL the objectives that apply' to them for participating their students in the programs conducted by MNSC with three different locations of engagement (see Appendix G: Teachers' questionnaire on Part C, Question No.14). Amongst the objective stated were; i) to connect with curriculum; ii) to expose students to new experiences; iii) to foster student interest and motivation; iv) to provide a learning experience; v) to provide a change of setting or routine; vi) to strengthen concept and theory; vii) to satisfy school expectation; and viii) no objective. Open-ended question below this question was made available in order for teacher to specify other kind of objectives that they think relevant to their objectives for conducting school group visits to non-formal settings.

Table 5.3 shows the findings for teachers' objective for participating their students in the programs conducted by MNSC. Based on Table 5.3, most of the teachers perceived score that their objectives for bringing their students outside the classroom was to expose the students with new learning environment outside of school classroom (82.5% of the teachers agreed with the statement) and to satisfy school expectations and requirement (75.0% of the teachers agreed with the statement).

An excerpt from T15 related to her objectives for bringing their students outside the classroom was to expose the students with new learning environment outside of school classroom;

> "it's good for MNSC to organised this event, as for students to go to KL to science centre or teacher conduct school visit to science centre is very difficult, far and need to handle many students" [T15/A6.$_2$]

> …"It is good being outside, and new environment to the student…besides the student will know that science not only learnt in school but other places too; i.e., science centre"… [T6/A5]

Often times, school visit to the non-formal settings were used by the teacher as a place for escape from school to give better place for student who will take the important exam.

> …"I bring the standard 5 students today to the science centre so that they experience learning in new place. Besides, it will give quiet places at school for students whose taking UPSR"… [T6/A5]

> …"I hope to show students that learning not only in school, they can get at other places for example in science centre also"… [T2/A2]

Whereas, 87.5% of the teachers ‘disagreed’ that their students’ engagement with the activity conducted by MNSC was part of to learn a theme that they currently teach at school. Only 12.5% of the teachers agreed that their objective was so that their student learn part of a theme that they were currently teach at school. Sometimes, they just bring the students outside of school environment and intend to follow guided tours. Initially they get the scheduled programs and inform the students what they expect the students will find in MNSC but the program did not tally with the theme they currently teach at school. Somehow, T16 indicated that his objective for bringing his students to the non-formal setting was to connect to the school curriculum in some way;

> “as today we learnt about balloon blast…we still didn’t learnt it in class…so yeah, the topic studied today not related to theme currently teach as school…but I hoped students can learnt something from the activities such as kinetic and potential energy” [T16/A6.2]

Among forty teacher participants in this study, only 12.5% of them stated that their objective was to experimentally complement the concept and theories studied in the class to their students.

> …“at MNSC, the science educator teach the student to do hands-on activities…indirectly, the students will involve in doing the experiment that sometimes not offered at school”… [T2/A2]

Other teachers explained that they take school visit;

> …“to allow the students to get hands-on experience with various elements and ideas taught during school visit…besides, I also feel some of my students... learn by doing, not reading”… [T9/A6.1]

Lastly, half of the teachers stated that their objective for bringing their students outside the classroom was to stimulate students’ motivation, interest and positive attitudes towards science (50.0% of the teachers agreed to the statement). Several teachers cited the importance of sparking student interest or generating intrinsic motivation in a particular topic or theme, or in learning in general.

> …“I hope that student learn something new here, something that they will not see in the classroom, they experience it themselves with the exhibits, to get them to think about what they are experiencing”… [T5/A4]

…"they can learn about science here…hope they will like science and technology"…[T6/A5]

Table 5.3. Teacher's objectives for participating their students in the programs conducted by MNSC

No.	Statement	Response	
		Yes (n%)	**No (n/%)**
i.	To learn part of a theme that I currently teach in class	5 (12.5%)	35 (87.5%)
ii.	To learnt something new compared to school classroom	21 (52.5%)	19 (47.5%)
iii.	To stimulate students' motivation, interest and positive attitudes towards science	20 (50.0%)	20 (50.0%)
iv.	To expose the students with the scientific experiments in the science centre.	10 (25.0%)	30 (75.0%)
v.	To expose the students with new learning environment outside of school classroom	33 (82.5%)	7 (17.5%)
vi.	To experimentally complement the concepts and theories studied in class	5 (12.5%)	35 (87.5%)
vii.	To satisfy school expectations and requirement	30 (75.0%)	10 (25.0%)
viii.	No objectives have been planned	21 (52.5%)	19 (47.5%)

5.2.3 Teachers' plan for non-formal programme to achieve the objectives

To answer this research question, one question was aimed at identifying the plan used by teachers on school visit in order to achieve the objectives for participating their students in the programs conducted by MNSC. In this question, teacher was asked to 'tick ALL the objectives that apply' to them for participating their students in the programs conducted by their locations of engagement with MNSC (see Appendix G: Teachers' questionnaire on Part C, Question No.16). Amongst the objective stated were; i) discussed with the students in the class about the visit; ii) prepare the worksheet in advance about the visit; and iii) no strategies have been planned. Open-ended question below this question was made available in order for teacher to specify other kind of plans. Table 5.4 shows the findings for teacher's plan for participating their students in the programs conducted by MNSC.

Table 5.4. Teacher's plan

No.	Statement	Response	
		Yes (n%)	No (n/%)
i.	Discussed with the students in the class about the visit	31 (77.5%)	9 (22.5%)
ii.	Prepare the worksheet in advance about the visit	0 (0.0%)	40 (100.0%)
iii.	No strategies have been planned	23 (57.5%)	17 (42.5%)

Based on Table 5.4, most of the teachers self-responses indicated that they discussed with their students in the class about the visit (77.5% of the teachers agreed with the statement) while only nine teachers did not discussed with their students in the class about the visit. All of the teachers stated that they did not prepare the worksheet in advance about the visit. This is because according to some of the teachers;

> …" normally we just come to the centre and the educators here normally already have the worksheet that they will teach/guide on that day"… [T5/A4]

The statements of teacher's plan (i) and (iii) contradict with each other as 57.5 % of the teachers agreed that no strategies have been planned for the visit, but at the same time they 77.5% of them stated that they discussed with their students in the class about the visit, which they already plan something for the visit (i.e., discussed with the students). The results here indicate that teachers basically discussed with their students in the class about the visit but did not prepare any worksheet for their students as they solely rely on science educators.

5.2.4 To what extent the teachers' objectives met from the visit - What do you think your pupils have gained from their engagement with MNSC?

To answer this question, the data from teachers' questionnaire survey were used. In this section, the analysis of teacher questionnaires that focused specifically on the extent to which teachers felt their pupils have achieved during their engagements with the activities conducted by MNSC in three different locations of engagement, either centre-based, single-school or multi-school outreach. The statements related to knowledge and understanding, attitudes and values and enjoyment were adapted from the research by Hooper-Greenhill (2007). The details of the extent to what teachers felt their students had achieved or would achieve upon engaging with the activities conducted by the MNSC were discussed in the next section.

5.2.4.1 Knowledge and understanding

The descriptive statistical results indicate that teachers felt their pupils have achieved during their engagements with the activities conducted by MNSC in term of 'knowledge and understanding' scales were positive as they were 'agreed' to the item 'to what extent do you think your pupils have gained facts and information by their engaging with the activities conducted by MNSC on subject specific facts; example in mathematics or science'' as 17 teachers response to this (42.5%) (see Table 5.5). Half of the teachers 'neither agreed nor disagreed' with the statement (20, 50.0%). Only one teacher felt that she/he 'strongly agreed' that their students have gained facts and information upon engaging with the activities conducted by the MNSC in term of subject-specific facts.

There were two teachers who 'strongly disagreed' that their student engagementd with the activity conducted by MNSC have gained fact and information (5.0%). The mean score and standard deviation was 3.42 and 0.636 respectively with the interpretation of the mean score is 'high' level of teachers expect their students have gained facts and information in term of subject-specific facts. For the inter-disciplinary or thematic facts, one teacher felt that students' engagement with the activity will not have gained facts and information, whereas the other remaining teacher fall in the scales either 'agreed' or 'neither agreed nor disagreed' with the statement.

Almost majority of the teachers think their pupils have gained facts and information by engaging with the activities conducted by MNSC in term of 'information about MNSC and galleries' (37, 92.5%). Only one teacher 'strongly disagreed with this statement and two teachers 'disagreed' with the statement that they think their pupils have gained facts and information by engaging with the activities conducted by MNSC in term of 'information about MNSC and galleries'. More than half of the teacher (25, 62.5%) think that their students have gained 'facts about themselves' during their engagement with activity conducted by the MNSC.

The overall mean score and standard deviation was 3.62 and 0.335 respectively with the interpretation of the mean score is 'high' level of teacher perceptions towards knowledge and understanding. The high means score and small standard deviations for the construct knowledge and understanding indicate that, in general, teacher perceived that their students' engagement to the non-formal settings improved their students' knowledge and understanding about MNSC, facts about themselves, inter-disciplinary or thematic facts and about subject-specific facts.

Table 5.5. 'To what extent do you think your pupils have gained **facts and information** by their engaging with the activities conducted by MNSC?'

8: To what extent do you think pupils have gained facts and information during their MNSC visit?							
a. Subject-specific facts (e.g. mathematics, science)							
Responses (n, %)							
Strongly agree (SA)	Agree (A)	Neither agree nor disagree (NAND)	Disagree (D)	Strongly disagree (SD)	Mean score	Std. deviation	Interpretation
1 (2.5%)	17 (42.5%)	20 (50.0%)	2 (5.0%)	0 (0.0%)	3.42	0.636	High
b. Inter-disciplinary or thematic facts (e.g. Science and technology)							
Responses (n, %)							
Strongly agree (SA)	Agree (A)	Neither agree nor disagree (NAND)	Disagree (D)	Strongly disagree (SD)	Mean score	Std. deviation	Interpretation
1 (2.5%)	18 (45.0%)	19 (47.5%)	2 (5.0%)	0 (0.0%)	3.45	0.639	High
c. Information about MNSC or galleries							
Responses (n, %)							
Strongly agree (SA)	Agree (A)	Neither agree nor disagree (NAND)	Disagree (D)	Strongly disagree (SD)	Mean score	Std. deviation	Interpretation
1 (2.5%)	37 (92.5%)	0 (0.0%)	2 (5.0%)	0 (0.0%)	3.97	0.276	High
d. Facts about themselves							
Responses (n, %)							
Strongly agree (SA)	Agree (A)	Neither agree nor disagree (NAND)	Disagree (D)	Strongly disagree (SD)	Mean score	Std. deviation	Interpretation
0 (0.0%)	25 (62.5%)	15 (37.5%)	0 (0.0%)	0 (0.0%)	3.62	0.490	High
Total perception towards knowledge and understanding					3.62	0.335	High

5.2.4.2 Enjoyment towards science

For the enjoyment construct, the descriptive statistical results indicate that teacher responses were very positive as all of the teacher rated ‘strongly agreed’ and ‘agreed’ with the statement that they think their students enjoyed the experiences they engaged with the MNSC which was (16, 40.0%) and (24, 60.0%) respectively. This indicated that the teachers strongly believe that their students enjoyed the experiences with MNSC. Slightly more than half of the teacher (21, 52.5%) ‘agreed’ that students excited by new ways to learn during their engagement with MNSC in doing the activities. 37.5% or 15 teachers think that their students excited by new ways to learn. Whereas, four teachers think that their students excited by new ways to learn during their engagement with the activities conducted by MNSC. The mean score and standard deviation was 4.28 and 0.64 respectively, with the interpretation of the mean score is ‘very high’ level.

For the statement ‘to what extent do you think new interest aroused when your pupils engaged with the MNSC’, slightly less than half of the teachers think that their student new interest aroused (19, 47.5%). 32.5% or 13 teachers ‘strongly agreed’ and 20.0% or eight teachers indicated as ‘agreed’ that the engagement with the MNSC build up the new interest among students.

The teachers’ shows positive responses to the statement that they think their students inspired to learn more upon engaging with the activity with the MNSC. This shows in Table 5.6 as (25, 62.5%) of the teacher rated as ‘agreed’ and (15, 37.5%) rated as ‘strongly agreed’ that they think the students inspired to learn during their engagement with the activities conducted by MNSC. Lastly, for the statement what the teacher thinks the students inspired to create something creative upon engaging with the MNSC, 95.0% of teachers ‘strongly agreed’ and ‘agreed’ that their students inspired to create something creative during their engagement with the MNSC. Only two teachers ‘neither agreed nor disagreed’ with the statement that they think the students inspired to create something creative upon engaging with MNSC. All in all, the mean score and standard deviation for the statement what the teacher think the students inspired to create something creative during their engagement with the MNSC was 4.30 and 0.560 respectively with the interpretation was very high.

Table 5.6. 'To what extent do you think your pupils have **enjoyed** or **been inspired** by their engagement with MNSC?'

7: To what extent do you think your pupils have enjoyed or been inspired by their engagement with MNSC?							
a. Enjoyed the experiences							
Responses (n, %)							
Strongly agree (SA)	Agree (A)	Neither agree nor disagree (NAND)	Disagree (D)	Strongly disagree (SD)	Mean score	Std. deviation	Interpretation
16 (40.0%)	24 (60.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	4.40	0.496	Very high
b. Excited by new ways to learn							
Responses (n, %)							
Strongly agree (SA)	Agree (A)	Neither agree nor disagree (NAND)	Disagree (D)	Strongly disagree (SD)	Mean score	Std. deviation	Interpretation
15 (37.5%)	21 (52.5%)	4 (10.0%)	0 (0.0%)	0 (0.0%)	4.28	0.640	Very high
c. New interests aroused							
Responses (n, %)							
Strongly agree (SA)	Agree (A)	Neither agree nor disagree (NAND)	Disagree (D)	Strongly disagree (SD)	Mean score	Std. deviation	Interpretation
13 (32.5%)	8 (20.0%)	19 (47.5%)	0 (0.0%)	0 (0.0%)	3.85	0.893	High
d. Inspired to learn more							
Responses (n, %)							
Strongly agree (SA)	Agree (A)	Neither agree nor disagree (NAND)	Disagree (D)	Strongly disagree (SD)	Mean score	Std. deviation	Interpretation
15 (37.5%)	25 (62.5%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	4.38	0.490	Very high
e. Inspired to create something creative							
Responses (n, %)							
Strongly agree (SA)	Agree (A)	Neither agree nor disagree (NAND)	Disagree (D)	Strongly disagree (SD)	Mean score	Std. deviation	Interpretation
14 (35.0%)	24 (60.0%)	2 (5.0%)	0 (0.0%)	0 (0.0%)	4.30	0.564	Very high
Total perception towards enjoyment					**4.24**	**0.573**	**Very high**

5.2.4.3 Attitudes and values

Table 5.7 shows 'to what extent do you think by engaging your pupils with the activities conducted by MNSC had enabled your pupils to feel more positive about themselves, their abilities, other people/communities, science subject and science centre/galleries'.

Table 5.7. 'To what extent do you think your pupils engaging with the activities conducted by MNSC have enabled your pupils to feels more **positive** about the following?'

7: To what extent do you think the PSN visit had enabled pupils to feel more positive about the following?							
a. Themselves							
Responses (n, %)							
Strongly agree (SA)	Agree (A)	Neither agree nor disagree (NAND)	Disagree (D)	Strongly disagree (SD)	Mean score	Std. deviation	Interpretation
8 (20.0%)	29 (72.5%)	3 (7.5%)	0 (0.0%)	0 (0.0%)	4.13	0.516	High
b. Their abilities							
Responses (n, %)							
Strongly agree (SA)	Agree (A)	Neither agree nor disagree (NAND)	Disagree (D)	Strongly disagree (SD)	Mean score	Std. deviation	Interpretation
6 (15.0%)	29 (72.5%)	5 (12.5%)	0 (0.0%)	0 (0.0%)	4.03	0.530	High
c. Other people/communities							
Responses (n, %)							
Strongly agree (SA)	Agree (A)	Neither agree nor disagree (NAND)	Disagree (D)	Strongly disagree (SD)	Mean score	Std. deviation	Interpretation
0 (0.0%)	24 (60.0%)	16 (40.0%)	0 (0.0%)	0 (0.0%)	3.60	0.496	High
d. Science subject							
Responses (n, %)							
Strongly agree (SA)	Agree (A)	Neither agree nor disagree (NAND)	Disagree (D)	Strongly disagree (SD)	Mean score	Std. deviation	Interpretation
6 (15.0%)	29 (72.5%)	5 (12.5%)	0 (0.0%)	0 (0.0%)	4.03	0.530	High
e. Science centre/Galleries							
Responses (n, %)							
Strongly agree (SA)	Agree (A)	Neither agree nor disagree (NAND)	Disagree (D)	Strongly disagree (SD)	Mean score	Std. deviation	Interpretation
6 (15.0%)	33 (82.5%)	0 (0.0%)	1 (2.5%)	0 (0.0%)	4.10	0.496	High
Total perception towards attitudes and values					3.98	0.442	High

72.5% or 29 teachers ‘agreed’ that engaging their students with the activities conducted by the MNSC had enabled their students to feel more positive about themselves. 20.0% of the teachers ‘strongly agreed that engaging their students with the activities conducted by the MNSC had enabled their students to feel more positive about themselves. Only three teachers or 7.5% ‘neither agreed nor disagreed’ with this statement. The mean score and standard deviation was 4.13 and 0.516 respectively with the interpretation of the mean score was ‘high’ level of teachers expect their students’ engagement with the activities had enabled students to feel more positive about themselves.

The teachers’ shows positive responses to the statement that ‘to what extent do you think by engaging your students with the activities conducted by MNSC had enabled your pupils to feel more positive about their abilities’. This shows in the Table 5.7 as (29, 72.5%) of the teacher rated as ‘agreed’ and (6, 15.0%) rated as ‘strongly agreed’ that they think by engaging their students with the activities conducted by MNSC had enabled their pupils to feel more positive about their abilities’. 12.5% or five teachers ‘neither agreed nor disagreed’ with the statement that by engaging their students with the activities conducted by MNSC had enabled their pupils to feel more positive about their abilities. The mean score and standard deviation was 4.03 and 0.530 respectively with the interpretation of the mean score was ‘high’ level of teachers expect their students’ engagement with the activities had enabled your pupils to feel more positive about their abilities.

For the statement that ‘to what extent do you think by engaging your students with the activities conducted by MNSC had enabled your pupils to feel more positive about other people/communities’. 24 or 60.0% of the teacher rated as ‘agreed’ and (16, 40.0%) rated as ‘neither agreed nor disagreed’ that they think by engaging their students with the activities conducted by MNSC had enabled their pupils to feel more positive about other people/communities’. Whereas, for the statement ‘to what extent do you think by engaging your students with the activities conducted by MNSC had enabled your pupils to feel more positive about science subject’, the teachers showed positive responses to the statement. A total of 95.0% of the teacher rated as ‘agreed’ (29, 72.5%) and rated as ‘strongly agreed’ (6, 15.0%) that they think by engaging their students with the activities conducted by MNSC had enabled their students to feel more positive about science subject'. Only 12.5% or five teachers 'neither agreed nor disagreed' with the statement that by engaging their students with the activities conducted by MNSC had enabled their pupils to feel more positive about science subject.

Lastly, for the statement 'to what extent do you think by engaging your students with the activities conducted by MNSC had enabled your pupils to feel more positive about science centre/galleries'. 33 or 82.5% of the teacher rated as 'agreed' and (6, 15.0%) rated as 'strongly agreed' that they think by engaging their students with the activities conducted by MNSC had enabled their pupils to feel more positive about science centre/galleries'. However, one teacher felt he/she 'disagreed' that he/she think by engaging their students with the activities conducted by MNSC had enabled their pupils to feel more positive about science centre/galleries'. The mean score and standard deviation for this statement was 4.10 and 0.496 respectively with the interpretation of the mean score is 'high' level of teachers expect their students' engagement with the activities have enabled your pupils to feel more positive about science centre/galleries.

The overall mean score and standard deviation was 3.98 and 0.442 respectively with the interpretation of the mean score was 'high' level of teacher perceptions towards attitudes and values. The high means score and small standard deviations for the construct attitudes and values indicate that, in general, teacher perceived that their students' engagement to the non-formal settings had enabled their students to feel more positive about themselves, their abilities, other people/communities, science subject and science centre/galleries'.

5.2.5 The important of science centre in science learning

The descriptive statistical results indicate that the teacher rated that science centre is not very important to their teaching in school (55.0%) and 40.0% of them rated as neither important nor not important. The results indicated that the science centre still not very familiar in supporting teaching and learning in classroom.

Table 5.8. Teacher perception on the important of science centre in science learning

Statement	Scale				
	Very important (n,%)	Important (n,%)	Neither (n,%)	Not very important (n,%)	Not at all important (n,%)
How important are science centre to your teaching?	0 0.0%	1 2.5%	16 40.0%	22 55.0%	1 2.5%

5.2.6 Successful school group visits

To answer this teacher was asked to 'rank four most successful of their students' engagement with MNSC during school visit' where 1 is for the most successful and 4 for the unsuccessful. Open-ended question below this question was made available in order for teacher to specify other kind of ideas of successful school visit. Figure 5.1 shows the diagram of successful school group visit in this study based on rank order.

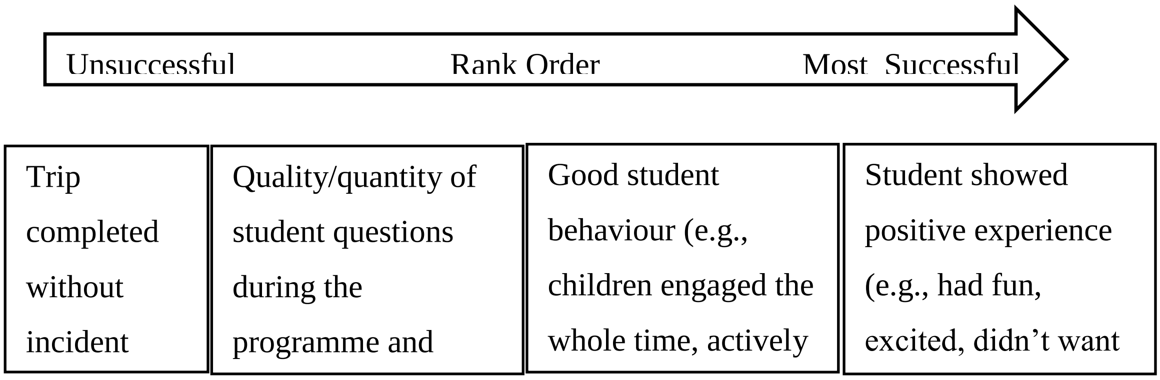


Figure 5.1. Successful school groups visit

Based on Figure 5.1, most of the teachers questioned indicated that they rank the visits as successful since the students showed positive experience with their engagement with MNSC (e.g., had fun, excited, didn't want to leave, etc) and successful when their students showed good student behavior (e.g., children engaged the whole time, actively engaged and enjoying themselves, etc). While Quality/quantity of student questions during the programme and activities conducted were indicated by the teacher as least successful.

The results here indicate that teachers describe their school visit as successful when their students showed positive experience such as having fun and did not want to leave after the programmed completed. However, the result from this question is only limited to identifying the successful school visit from teacher perception and not to quantifying the results.

5.3 Summary

In summary, there are potential benefits and challenges when engaging students in non-formal learning experiences such as partnerships between schools and science centres. Identifying different school visits out-of-school settings helps us gain a better understanding of different teacher intentions, objectives and plans used during these visits to out-of-school settings. The personal and school contexts of each teacher play a role in this kind of agenda that the teacher adopts. Learning outcomes are more likely to be realized when schools and science centre communicate and synchronize learning objectives and then work together to realize them. This requires clear consistent communication, reflection, and evaluation among all stakeholders involved including: students, teachers, science educators, and administrators to ensure that the relationship and especially learning take place during the implementation of out-of-school science program towards science.

Chapter 6

Students' Perceptions of science learning in non-formal settings

6.1 Introduction

This chapter discusses the students' perceptions of science learning in non-formal settings. More specifically, this chapter examined the perceptions on knowledge, attitudes and enjoyment from school visits to the MNSC from the perspectives of students. The presentation of the findings from this chapter will combine the data that were gathered from questionnaires focusing on the interpretation and presentation of the findings from the survey and also the qualitative part from the observations and interviews. The questionnaire was distributed to investigate how participating in activities offered by the MNSC influences school students' interest and engagement with science. The questionnaire was distributed to students' age 10 to 14 years old who were involved in the programs conducted by MNSC in different locations of engagement (centre-based, single and multi-school outreach) during the period of main study data collection. Interviews were conducted to gain a better understanding about students' perceptions on their engagement with MNSC in the non-formal settings in term of science learning.

The research question addressed in this chapter was "what do students' gained from their engagement with MNSC in term of students' responses to science in term of knowledge, attitude, enjoyment, the easiness, and helpfulness in doing the activities". In order to do that, the profile of respondents in this present study were discussed, followed by the section to answer the research question in this study. The descriptive analysis (e.g., percentage, mean score, standard deviation) were presented to answer the research question "what do students' gained from their engagement with MNSC in term of students' science learning" (see heading 6.2) followed by the inferential analysis (Mann-Whitney U test and the Kruskal-Wallis) (see heading 6.3) were presented to answer the research questions.

6.1.1 Profile of students' participants in questionnaire and interview in the study

The main samples in this present study consisted of 167 boys and 186 girls, yielding a total 353 sample size of students (see Table 6.1) from 26 schools in three different locations of engagement with MNSC to gather information for the questionnaire survey. When categorising into different locations of engagement, a total number of students' responses to the questionnaire survey at centre-based were 58 respondents or 16.4%, 154 respondents (43.6%) were responded at single-school outreach and 141 respondents or 39.6% were belong to multi-school data collection.

Meanwhile, majority of the respondent in this study were 11 years old student with 111 respondents in total (Standard 5 school children) followed by 14 years old (91 students or 25.8 in percentage). 79 and 72 respondents of 10 and 13 years old of students responded to the questionnaire in this study respectively. In term of locations of engagement, a total number of students' responses to the questionnaire survey at centre-based were 58 respondents or 16.4%, 154 respondents (43.6%) were responded at single-school outreach and 141 respondents or 39.6% were belong to multi-school data collection. The details of cross tabulation for the student participants in terms of age, gender, and by different locations of engagement in this study are shown in Table 6.1.

From 353 students involved in the questionnaire survey, a total of 18 small groups interviews were conducted which consist of 83 students. The interviews with the students were conducted as to strengthen the important point that calculated from the survey questionnaires and to support the findings from the quantitative analysis. The interview questions with the students mainly to look at a deeper understanding about their perceptions on their engagement with MNSC in non-formal settings in term of science learning, what were they supposed to do at the setting, what were they learnt, and what they were they going to do once they return to school.

Table 6.1. The number of student' participated in the survey questionnaire in this present study based on gender, age and by different locations of engagement with MNSC

Source of data collection	Variable	Particular	Location of engagement with MNSC			Total	Percentage (%)
			Centre-based	Single-school	Multi-school		
Survey	Gender	Male	28	70	69	167	47.3
		Female	30	84	72	186	52.7
		Total	58	154	141	353	100.0
	Age (Year old)	10	16	34	29	79	22.4
		11	42	36	33	111	31.4
		13	0	37	35	72	20.4
		14	0	47	44	91	25.8
		Total	58	154	141	353	100.0

6.2 Findings on students' perceptions of their engagement with MNSC in the non-formal settings in term of science learning

In this section, analysis of the students' survey was reported. The questionnaire was distributed to investigate how participating in activities offered by the MNSC influences school students' interest and engagement with science. This part of the questionnaire contained statements in order to gain students' opinions about their visit to the non-formal settings and engaging in the program conducted by MNSC using three different locations of engagements: centre-based, single, and multi-school outreach. The statements related to their knowledge and understanding, attitudes and values, enjoyment and how much they enjoyed doing the activity, how easy the activity, and how helpful the activity to them were covered. The details of students gained from their engagement in the activity conducted by MNSC in term of students' responses to science were discussed in the next section.

Three of the scales were adapted from Hooper-Greenhill's Generic Learning Outcomes (GLO), which were knowledge and understanding, attitudes and values and enjoyment. Whereas, a statements to measure affective gains were adapted from the research done by Rennie (1994). Specifically, the affective outcomes measured in this study referring to on how students responded in terms of how easy they found various aspects of the activities, their enjoyment of what they did, and how helpful they found the visit in terms of their wider views about science and scientist.

The measurement of affect focused on three related variables: the students' perceived success in working with the activities, their enjoyment, and their perceptions of the helpfulness of the visit. Three groups of four items were devised, each with a five-choice response format. The first group was directed at students' perceptions of their success during their working on the activities, and the response choices were 'very easy', 'easy', 'in between', 'hard' and 'very hard'. The second group of items asked about students' enjoyment of these experiences. Response choices ranged from 'not at all enjoyable' to 'very enjoyable'. The third group of items asked students' opinion of whether the experiences during the visit had been helpful to them in terms of school work and understanding about science and scientists. The response choices had end points of 'not at all helpful' and 'very helpful'. Sub-heading below describes the analysis of affective responses of students on their interaction and engagement with the activity.

For the purpose of the research study, the scale 'enjoyment' from Generic Learning Outcomes (GLO) and Rennie (1994) were combined and reported as 'enjoyment and how much they enjoyed doing the activity'.

6.2.1 Students' responses to science

In this section, the descriptive analysis of students' perceptions of knowledge and understanding, attitudes and values, enjoyment and how much they enjoyed doing the activity, how easy the activities, and how helpful the activity during their engagement with the activities conducted by MNSC were reported.

Table 6.2 shows the overall students' perception of knowledge, enjoyment, and attitudes and values upon engaging in the activities with the MNSC. The analysis of these part were obtained by which researcher computed the clean data of all the items to be in their specified constructs; i.e., 1) Enjoyment, Inspirations and Creativity; 2) Knowledge and understanding; 3) Attitudes and values; Skills (for example computed all items that can be; for example under the construct Attitudes and values (Item 4: more confident with science; Item 6: more interested in science ; Item 7: Studying science might be fun; and Item 8: working in science might be interesting) to get students' overall perceptions towards knowledge, enjoyment and attitudes and values upon engaging in the activities conducted by MNSC.

Table 6.2. The overall students' perception towards knowledge, enjoyment and attitudes and values during their engagement with the activities

Construct	**Frequency and percentage (%)**					**Mean score**	**Standard deviation**	**Level**
	MEAN SCORE							
	1.00-1.804 (SD)	**1.805-2.604 (D)**	**2.605-3.404 (NAND)**	**3.405-4.204 (A)**	**4.205-5.00 (SA)**			
Knowledge & understanding	1 (0.3%)	0 (0.0%)	16 (4.5%)	166 (47.0%)	170 (48.2%)	4.43	0.61	Very high
Enjoyment	1 (0.3%)	13 (3.7%)	3 (0.8%)	99 (28.0%)	237 (67.1%)	4.58	0.72	Very high
Attitudes and values	1 (0.3%)	13 (3.7%)	40 (11.3%)	175 (49.6%)	124 (35.1%)	4.16	0.78	High

*Level of interpretation of the mean score on students' perception
*SD – strongly disagree, *D – disagree, *NAND – neither agree nor disagree, *A – agree, *SA – strongly agree

The majority of the students' reported their perception towards statement of knowledge and understanding as 'agreed' (166, 47.0 %) and 'strongly agreed' (170, 48.2%) which made up 336 students responds in this scale in total or 95.2 in percentage. Out of 353 students, 16 students were reported as 'neither agreed nor disagreed' with the statements. Only one student reported rated 'strongly disagreed' with the statements to measure their perception towards construct of knowledge and understanding. The mean score and standard deviation for students' perception towards 'knowledge and understanding' were 4.43 and 0.61 respectively with the interpretation of the mean score is 'very high' level of students' perception towards construct of 'knowledge and understanding'. The high means and small standard deviations for the construct knowledge and understanding indicate that, in general, students perceived that their engagement to the non-formal settings improved their knowledge and understanding (refer to heading 6.2.1.1 for details about items in the construct knowledge and understanding).

Meanwhile, students' perception towards statements for 'attitudes and values' were more on the 'agreed' scale compared to 'strongly agreed' scale. For this construct, 175 out of 353 students rated 'agreed' with the statement to measure the 'attitudes and values' or 49.6 in percentage. 35.1% or 124 students rated as 'strongly agreed' with the statement to measure the 'attitudes and values'. In this construct, a big number of students reported as 'neither agreed nor disagreed' with 40 student or 11.3% made up in this group. Not many students reported as 'disagreed' with the students' response in this scale were 13 students or 3.7% and only one student or 0.3% reported as 'strongly disagreed' with the statement to measure students' perception on 'attitudes and values' while engaged in the activity. The mean score and standard deviation for students' perception towards 'attitudes and values' were 4.16 and 0.78 respectively with the interpretation of the mean score is 'high' level of students' perception towards construct of 'attitudes and values'. This data depicting that almost majority of the students (299, 84.7%) concerns with their attitudes responses when engaged with the activity conducted by the MNSC.

Whereas, to measure the students' perception towards enjoyment, the mean score and standard deviation for students' perception towards 'enjoyment' were 4.58 and 0.72 respectively with the interpretation of the mean score is 'very high' level of students' perception towards construct of 'enjoyment'. The high means and small standard deviations for the construct enjoyment indicate that, in general, students perceived that they enjoyed their learning in non-formal settings (refer to heading 6.2.1.3 for details about items in the construct enjoyment). 237 out of 353 students rated 'strongly agree' with the statement to measure the 'enjoyment' or 67.1 in percentage. 28.0% or 99 students rated as 'agree' with the statement to measure the 'enjoyment'. While three students reported as 'neither agree nor disagree', 13 student or 3.7% as 'disagree' and only one student or 0.3% reported as 'strongly disagree' with the statement to measure students' enjoyment while engaging in the activity. This data depicting that almost majority of the students (336, 95.1%) found that their engaging and involvement with the activity conducted by the MNSC had been enjoyable.

In order to examine more closely relationships with other variables, five scales were developed; which were the knowledge and understanding, attitudes and values, enjoyment and how much they enjoyed doing the activity, how easy the activity, and how helpful the activity to them were covered. This scale was covered in the study so that the researcher can capture what was students' expectations and responses towards their science learning in non-formal settings. The knowledge scale comprising items A2 and A10 (see Table 6.3 for the items in knowledge scale) had a Cronbach alpha reliability of .913. The enjoyment scale comprising items A1 and A9 (see Table 6.5 for the items in enjoyment scale) had a Cronbach alpha reliability of .942. Whereas, the attitudes and values scale comprising items A4, A6, A7, and A8 (see Table 6.4 for the items in attitudes and values scale) had a Cronbach alpha reliability of .949.

The next section discussed the detailed items of 'knowledge and understanding', 'attitudes and values', 'enjoyment and how much they enjoyed doing the activity', 'how easy the activity', and 'how helpful the activity' measured in this study.

6.2.1.1 Knowledge and understanding

The descriptive statistical results indicate that students responses to 'knowledge and understanding' scales were very positive as they were 'strongly agreed' and 'agreed' to the item 'During my visit, I learnt something new (or engaged in the activity at centre-based or during outreach programmes)' as 160 (45.3%) and 176 (49.9%) respectively (see Table 6.3). Only one student rated 'strongly disagreed' and 16 students (4.5%) as' 'neither agreed nor disagreed' that they learnt something new at centre-based or during outreach programmes. The mean score and standard deviation were 4.40 and 0.61 respectively. As mentioned before, the high means and small standard deviations for the construct knowledge and understanding indicate that, in general, students perceived that their engagement to the non-formal settings improved their knowledge and understanding towards science.

Table 6.3. Students' responses to the statement in the construct of 'knowledge and understanding'

A2: During my engagement with MNSC, I learnt something new							
Responses (n, %)							
Strongly agree (SA)	**Agree (A)**	**Neither agree nor disagree (NAND)**	**Disagree (D)**	**Strongly disagree (SD)**	**Mean score**	**Std. deviation**	**Interpretation**
160 (45.3%)	176 (49.9%)	16 (4.5%)	0 (0.0%)	1 (0.3%)	4.40	0.61	Very high
A10: My engagement with MNSC today made me feel I learn science in a different way to school							
Responses (n, %)							
Strongly agree (SA)	**Agree (A)**	**Neither agree nor disagree (NAND)**	**Disagree (D)**	**Strongly disagree (SD)**	**Mean score**	**Std. deviation**	**Interpretation**
117 (33.1%)	191 (54.1%)	40 (11.3%)	4 (1.1%)	1 (0.3%)	4.19	0.69	High
Perception towards knowledge and understanding					**4.43**	**0.61**	**Very high**

More than half of the students 'agreed' to the statement 'I learn science in a different way to school' with 191 (54.1%) responses to this. 33.1% or 117 students 'strongly agreed', 40 students (11.3%) 'Neither agreed nor disagreed', four person or 1.1% responses to 'disagreed' and only one student (0.3%) responses as 'strongly disagreed' with the statement. The mean score and standard deviation for the item 'My visit today made me feel: I learn science in a different way to school (or engaged in the activity at centre-based or during outreach programmes) was 4.19 and 0.69 respectively, with the interpretation of the mean score is 'high' level. All in all, the overall students' perception towards 'knowledge and understanding' were 'high' with the mean score 4.19 and standard deviation was 0.61.

6.2.1.2 Attitudes and values

Table 6.4 shows students' responses to the statement in the construct of 'attitudes and values'. There were four statements in this construct. For the statement 'My visit today made me feel more confident with science [or engaged in the activity at centre-based or during outreach programmes]', more than half of the students 'agreed' that their engagement in the activity made they feel more confident with science (194, 55.0%). 77 students or 21.8% 'strongly agreed' that their engagement in the activity made they feel more confident with science. Only one student rated 'strongly disagreed' (0.3%), 18.4% or 65 students rated 'neither agreed nor disagreed' and 16 students (4.5%) as 'disagreed' that their engagement in the activity made they feel more confident with science. The overall mean score and standard deviation were 4.16 and 0.78 respectively. The high means score and small standard deviations for the construct attitudes and values indicate that, in general, students perceived attitudes and values were positives during their engagement to the non-formal settings towards science.

More than half of the students 'agreed' that their engagement in the activity made they feel more interested in science (183, 51.8%). 101 students or 28.6% 'strongly agreed' that their engagement in the activity made they feel more interested in science. 15.3% or 54 students rated 'neither agreed nor disagreed', only two student rated 'strongly disagreed' (0.6%), and 13 students (3.7%) as 'disagreed' that their engagement in the activity made they feel more interested in science. The mean score and standard deviation were 4.01 and 0.89 respectively for the statement that their engagement in the activity made they feel more interested in science.

From Table 6.4, more than half of the students 'agreed' that their engaging in the activity made they feel studying science might be fun (189, 53.5%) and for 'strongly agreed', about 115 students or 32.6% 'strongly agreed' that their engagement in the activity made they feel studying science might be fun. Only one student rated 'strongly disagreed' (0.3%), 9.6% or 34 students rated 'neither agreed nor disagreed' and 14 students (4.0%) as 'disagreed' that their engagement in the activity made they feel more confident with science. The mean score and standard deviation were 4.14 and 0.77 respectively.

Table 6.4. Students' responses to the statement in the construct of 'attitudes and values'

A4: My engagement with MNSC today made me feel more confident with science							
Responses (n, %)							
Strongly agree (SA)	**Agree (A)**	**Neither agree nor disagree (NAND)**	**Disagree (D)**	**Strongly disagree (SD)**	**Mean score**	**Std. deviation**	**Interpretation**
77 (21.8%)	194 (55.0%)	65 (18.4%)	16 (4.5%)	1 (0.3%)	3.93	0.78	High

A6: My engagement with MNSC today made me feel more interested in science							
Responses (n, %)							
Strongly agree (SA)	**Agree (A)**	**Neither agree nor disagree (NAND)**	**Disagree (D)**	**Strongly disagree (SD)**	**Mean score**	**Std. deviation**	**Interpretation**
101 (28.6%)	183 (51.8%)	54 (15.3%)	2 (0.6%)	13 (3.7%)	4.01	0.89	High

A7: My engagement with MNSC today made me feel studying science might be fun							
Responses (n, %)							
Strongly agree (SA)	**Agree (A)**	**Neither agree nor disagree (NAND)**	**Disagree (D)**	**Strongly disagree (SD)**	**Mean score**	**Std. deviation**	**Interpretation**
115 (32.6%)	189 (53.5%)	34 (9.6%)	14 (4.0%)	1 (0.3%)	4.14	0.77	High

A8: My engagement with MNSC today made me feel working in science might be interesting							
Responses (n, %)							
Strongly agree (SA)	**Agree (A)**	**Neither agree nor disagree (NAND)**	**Disagree (D)**	**Strongly disagree (SD)**	**Mean score**	**Std. deviation**	**Interpretation**
78 (22.1%)	178 (50.4%)	92 (26.1%)	4 (1.1%)	1 (0.3%)	3.93	0.74	High
Perception towards attitudes and values					**4.16**	**0.78**	**High**

Lastly, for the statement that their engagement in the activity made they feel working in science might be interesting, about 50.4% or 178 students 'agreed' that their engagement in the activity made they feel working in science might be interesting, 98 students or 22.1% ‘strongly agreed’ that their engagement in the activity made they feel working in science might be interesting. Almost 100 of the students (92, 26.1%) ‘neither agreed nor disagreed’ that their engagement in the activity made they feel working in science might be interesting. Only one student rated ‘strongly disagreed’ (0.3%), and four students (1.1%) rated as ‘disagreed’ that their engagement in the activity made they feel working in science might be interesting. The mean score and standard deviation were 3.93 and 0.74 respectively.

6.2.1.3 Enjoyment and how much they enjoyed doing the activities?

For the enjoyment construct, the descriptive statistical results indicate that students’ responses were very positive as more than half of them (227, 64.3%) were ‘strongly agreed’ and (109, 30.9%) rated ‘agreed’ with the statement that they enjoyed themselves. Only one student rated ‘strongly disagreed’, four students (1.1%) as’ ‘neither agreed nor disagreed’ and 12 students or 3.4% were rated ‘disagree’ to the statement that they enjoyed themselves. The mean score and standard deviation were 4.56 and 0.71 respectively, with the interpretation of the mean score is ‘very high’ level.

Whereas, for the statement ‘National Science Centre is a good place to learn about science’, about 117 or 33.1% of the students rated as ‘strongly agreed’ and 162 or 45.9% of the students rated as ‘agreed’. 34 students (9.6%) ‘neither agreed nor disagreed’, 13 person or 3.7% responses to ‘disagreed’ and only one student (0.3%) responses as ‘strongly disagreed’ with the statement ‘National Science Centre is a good place to learn about science’. The mean score and standard deviation for the item ‘National Science Centre is a good place to learn about science’ was 4.23 and 0.79 respectively, with the interpretation of the mean score is ‘very high’ level. All in all, the overall students’ perception towards ‘enjoyment’ were ‘very high’ with the mean score 4.58 and standard deviation was 0.72. The high means score and small standard deviations for the construct enjoyment indicate that, in general, students enjoyed their engagement to the non-formal settings towards science.

Next, the descriptive analysis on how much students perceived they enjoyed doing the activities conducted by MNSC were reported. The responses to the items were scored 1 through 5, so that the higher score indicated the more positive response. The high means and small standard deviations for the Enjoyment items (Item 14a-14d) indicate that, in general, students agreed that the activities were enjoyable for them to do the activities. The most enjoyed feature of the visit was doing the activities with the mean score and standard deviation were (M=4.11, SD=.898) and the least enjoyed feature was working in groups (M=3.65, SD=.935), indicating that this social aspect is an important part of the affective experience students have at science centres.

As shown in Table 6.5, for the item ‘how much did you enjoy doing the activities?’, almost majority of the students’ reported their perception on how much you enjoyed doing the activities as ‘enjoyable (178, 50.4 %) and ‘very enjoyable’ (121, 34.3 %) which make up to 84.7 in percentage. This indicating that this social aspect was an important part of the affective experience students have at science centres. 13 students rated it as ‘not at all enjoyable’ doing the activities (13, 3.7 %). Only three students rated ‘not enjoyable’ doing the activities.

Whereas, to measure students’ perception on ‘how much did you enjoy working in groups?’, the mean score and standard deviation for students’ perception on ‘how much did you enjoy working in groups?’ were 3.65 and 0.935 respectively with the interpretation of the mean score was ‘high’ level of enjoyment of working in groups in working with the activities. 139 and 64 students rated ‘enjoyable’ and ‘very enjoyable’ working in groups respectively (139; 39.4%) (64; 18.1%). Only 22 students reported as working in groups in working with the activities conducted by the MNSC as ‘not enjoyable’ and ‘not at all enjoyable’ which made up 6.3% of the total respondents in this study. 36.3% or 128 students perceived that the level of enjoyment in working in groups were ‘in between enjoyable and not enjoyable’.

Table 6.5. Students' responses to the statement in the construct of 'enjoyment' and how much they enjoyed doing the activities?

A1: During my engagement with MNSC, I enjoyed myself							
Responses (n, %)							
Strongly agree (SA)	**Agree (A)**	**Neither agree nor disagree (NAND)**	**Disagree (D)**	**Strongly disagree (SD)**	**Mean score**	**Std. deviation**	**Interpretation**
227 (64.3%)	109 (30.9%)	4 (1.1%)	12 (3.4%)	1 (0.3%)	4.56	0.71	Very high

A9: National Science Centre is a good place to learn about science							
Responses (n, %)							
Strongly agree (SA)	**Agree (A)**	**Neither agree nor disagree (NAND)**	**Disagree (D)**	**Strongly disagree (SD)**	**Mean score**	**Std. deviation**	**Interpretation**
117 (33.1%)	162 (45.9%)	34 (9.6%)	13 (3.7%)	1 (0.3%)	4.23	0.79	Very high
Overall perception towards enjoyment					**4.58**	**0.72**	**Very high**

A14a. How much did you enjoy doing the activities?							
Responses (n, %)							
Not at all enjoyable	**Not enjoyable**	**In between**	**Enjoyable**	**Very enjoyable**	**Mean score**	**Std. deviation**	**Interpretation**
13 (3.7%)	3 (0.8%)	38 (10.8%)	178 (50.4%)	121 (34.3%)	4.11	.898	High

A14b. How much did you enjoy working in groups?							
Responses (n, %)							
Not at all enjoyable	**Not enjoyable**	**In between**	**Enjoyable**	**Very enjoyable**	**Mean score**	**Std. deviation**	**Interpretation**
14 (4.0%)	8 (2.3%)	128 (36.3%)	139 (39.4%)	64 (18.1%)	3.65	.935	High

A14c. How much did you enjoy using the equipment?							
Responses (n, %)							
Not at all enjoyable	**Not enjoyable**	**In between**	**Enjoyable**	**Very enjoyable**	**Mean score**	**Std. deviation**	**Interpretation**
13 (3.7%)	4 (1.1%)	42 (11.9%)	197 (55.8%)	97 (27.5%)	4.02	.879	High

A14d. How much did you enjoy the whole engagement with MNSC?							
Responses (n, %)							
Not at all enjoyable	**Not enjoyable**	**In between**	**Enjoyable**	**Very enjoyable**	**Mean score**	**Std. deviation**	**Interpretation**
13 (3.7%)	12 (3.4%)	36 (10.2%)	166 (47.0%)	126 (35.7%)	4.08	.961	High

*N – 353 students

Meanwhile, for item 'How much did you enjoy using the equipment?', more than half of the students' reported their perception on how much they enjoy using the equipment as ‘enjoyable’ (197, 55.8 %). 97 students rated they enjoyed using the equipment as ‘very enjoyable’ (27.5). The percentage of students who rated using the equipment as ‘very enjoyable’ and ‘enjoyable’ made up to 83.3% which is quite high in percentage. Only eight students rated it as ‘not enjoyable’ using the equipment or 1.1 in percentage and 14 students reported as ‘not at all enjoyable’ (3.7%). The mean score and standard deviation for students’ perception on ‘how much did you enjoy using the equipment?’ was 4.02 and 0.879 respectively with the interpretation of the mean score is ‘high’ level of students’ perception on ‘enjoyed using the equipment?’ in working in the activities conducted by MNSC.

The fourth items on ‘how much did students enjoy the whole engagement with MNSC’, almost majority of the students’ reported their perception on ‘how they enjoy the whole visit to the MNSC’ as ‘enjoyable’ (166, 47.0%) and ‘very enjoyable’ (126, 35.7%). Only 13 students rated it as ‘not at all enjoyable’ the whole visit to the MNSC or 3.7 in percentage and 12 students rated as ‘not enjoyable’. Out of 353 students, 36 students reported ‘in between enjoyable and not enjoyable’ the whole visit to the MNSC or 10.2 in percentage. The mean score and standard deviation for students’ perception on ‘how much did students enjoy the whole visit to the MNSC was 4.08 and 0.961 respectively with the interpretation of the mean score is ‘high’ level of students’ perception on they enjoyed the whole visit to the MNSC in general.

6.2.1.4 How easy students’ perceived success in working with the activities?

In this section, the descriptive analysis on how much students’ perceived success in working with the activities conducted by MNSC were reported. The responses to the items were scored 1 through 5, so that the higher score indicated the more positive response. The high means and small standard deviations for the Easiness items (Item 13a-13d) indicate that, in general, students agreed that the activities were easy to use, and they experienced success in using them. The highest mean for the item on how easy students’ perceived success in working with the activities was ‘using the equipment’ (M=3.49, SD=.823) followed by ‘get a result for the activity’ (M=3.44, SD=.858). The mean score for ‘how easy for you to understand the instruction’ was the lowest with the mean score 3.40 and standard deviation of .810. The details score on students' responses on how easy they perceived success in working with the activities was reported on Table 6.6.

As shown in Table 6.6, for the item 'how easy was it for you to understand the instructions?', almost majority of the students' reported their perception towards how easy they understand the instructions in working in the activities as 'in between easy and hard' (162, 45.9 %) and 'easy' (166, 40.8 %). Only 19 students rated it as very easy to work in the activities (19, 5.4 %). Out of 353 students, 13 and 15 students reported 'very hard' and 'hard' to understand the instruction. Whereas, to measure students' perception on 'how easy was it for you to use the equipment?', the mean score and standard deviation for students' perception on 'how easy was it for you to use the equipment?' were 3.49 and 0.823 respectively with the interpretation of the mean score is 'high' level of easiness of using the equipment in working with the activities. 178 and 19 students rated 'easy' and 'very easy' respectively. Only 30 students reported as using the equipment in working with the activities conducted by the MNSC as 'hard' and 'very hard' which made up 8.5% of the total respondents in this study. 35.7% or 126 students perceived that the level of easiness of using the equipment in working with the activities were 'in between easy and hard'.

Meanwhile, for the item 'how easy was it for you to: get a result for the activity?', almost majority of the students' reported their perception on how easy they get a result for the activity as 'in between easy and hard' (158, 44.8 %) and 'easy' (135, 38.2 %). 31 students rated it as 'very easy' to work in the activities or 8.8 in percentage. Out of 353 students, 13 and 16 students reported 'very hard' and 'hard' to get a result for the activity. The mean score and standard deviation for students' perception on 'how easy they get a result for the activity' were 3.44 and 0.858 respectively with the interpretation of the mean score is 'high' level of students' perception on 'how easy they get a result' in working in the activities conducted by MNSC.

Lastly, for the fourth items on how easy students' perceived success in working with the activities, 'how easy was it for you to understand what the activity was all about?', almost majority of the students' reported they perception on how easy was it for you to understand what the activity was all about as 'in between easy and hard' (158, 44.8

%) and ‘easy’ (138, 39.1 %). Only 27 students rated it as ‘very easy’ to understand what the activity was all about or 7.6 in percentage. Out of 353 students, 13 and 17 students reported ‘very hard’ and ‘hard’ to understand what the activity was all about. The mean score and standard deviation for students’ perception on ‘how easy they understand what the activity was all about’ were 3.42 and 0.846 respectively with the interpretation of the mean score is ‘high’ level of students’ perception on they easily understand what the activities conducted by MNSC was all about.

Table 6.6 The details score on students’ response on how easy they perceived success in working with the activities

A13a. In the activities you did, how easy was it for you to: understand the instructions?

Responses (n, %)							
Very hard	**Hard**	**In between**	**Easy**	**Very easy**	**Mean score**	**Std. deviation**	**Interpretation**
13 (3.7%)	15 (4.2%)	162 (45.9%)	144 (40.8%)	19 (5.4%)	3.40	.810	High

A13b. In the activities you did, how easy was it for you to: use the equipment?

Responses (n, %)							
Very hard	**Hard**	**In between**	**Easy**	**Very easy**	**Mean score**	**Std. deviation**	**Interpretation**
13 (3.7%)	17 (4.8%)	126 (35.7%)	178 (50.4%)	19 (5.4%)	3.49	.823	High

A13c. In the activities you did, how easy was it for you to: get a result for the activity?

Responses (n, %)							
Very hard	**Hard**	**In between**	**Easy**	**Very easy**	**Mean score**	**Std. deviation**	**Interpretation**
13 (3.7%)	16 (4.5%)	158 (44.8%)	135 (38.2%)	31 (8.8%)	3.44	.858	High

A13d. In the activities you did, how easy was it for you to: understand what the activity was all about?

Responses (n, %)							
Very hard	**Hard**	**In between**	**Easy**	**Very easy**	**Mean score**	**Std. deviation**	**Interpretation**
13 (3.7%)	17 (4.8%)	158 (44.8%)	138 (39.1%)	27 (7.6%)	3.42	.846	High

*N – 353 students

6.2.1.5 How helpful –what is students' perception of the helpfulness of their engagement to the activity conducted by MNSC?

In this section, the descriptive analysis on 'what is students' perception of the helpfulness of their engagement visit to their general activity' conducted by MNSC were reported. Students perceived the engagement to be reasonably helpful in advancing their ideas about what scientist do and what MNSC does in general terms, but not necessarily in terms of school work and understanding about science in their community. The low means of the helpful items (Item 15a and 15b) indicate that, in general, students agreed that their engagement in the activities were not really helpful in terms of their school work and understanding their community better. The means of the other two items were positive, with the mean so above three. The most helpful feature of the engagement in term of getting an idea of what MNSC does, as they involved with the activities conducted by the MNSC and interacting with them themselves.

Table 6.7 shows the details score on students' response on how helpful of the engagement to their general activity. For the item 'how helpful was the engagement with MNSC in terms of your school work?', almost majority of the students' reported their perception on 'how helpful was the engagement with MNSC in terms of your school work?' not reasonably helpful as they rated 'not at all helpful' (157, 44.5 %) and 'not helpful' (128, 36.3 %). The percentage of the students who response negatively for this item was made up to 80.8% of the total respondents in this study. Only 25 students rated it as 'helpful' in term of their school work (25, 7.1 %). Out of 353 students, 43 students reported 'in between helpful and not helpful' the activities they engaged conducted by the MNSC to their school work. The mean score and standard deviation for students' perception on 'how helpful was the engagement with MNSC in terms of their school work' was 1.82 and 0.905 respectively with the interpretation of the mean score is 'low' level of students' perception on 'how helpful was the engagement with MNSC in terms of their school work'.

Table 6.7 The details score on students' response on how helpful of the engagement with MNSC to the activity conducted by MNSC?

A15a. How helpful was the engagement with MNSC in terms of your school work?							
		Responses (n, %)					
Not at all helpful	**Not helpful**	**In between**	**Helpful**	**Very helpful**	**Mean score**	**Std. deviation**	**Interpretation**
157 (44.5%)	128 (36.3%)	43 (12.2%)	25 (7.1%)	0 (0.0%)	1.82	.905	**Low**

A15b. How helpful was the engagement with MNSC in terms of understanding about science in your community?							
		Responses (n, %)					
Not at all helpful	**Not helpful**	**In between**	**Helpful**	**Very helpful**	**Mean score**	**Std. deviation**	**Interpretation**
19 (5.4%)	101 (28.6%)	97 (27.5%)	136 (38.5%)	0 (0.0%)	2.99	.943	Medium

A15c. How helpful was the engagement with MNSC in terms of getting an idea about what scientist do?							
		Responses (n, %)					
Not at all helpful	**Not helpful**	**In between**	**Helpful**	**Very helpful**	**Mean score**	**Std. deviation**	**Interpretation**
4 (1.1%)	12 (3.4%)	185 (52.4%)	151 (42.8%)	1 (0.3%)	3.38	.614	Medium

A15d. How helpful was the engagement with MNSC in terms of getting an idea about what MNSC does?							
		Responses (n, %)					
Not at all helpful	**Not helpful**	**In between**	**Helpful**	**Very helpful**	**Mean score**	**Std. deviation**	**Interpretation**
3 (0.8%)	11 (3.1%)	70 (19.8%)	266 (75.4%)	3 (0.8%)	3.72	.576	High

*N – 353 students

Whereas, to measure students' perception on 'how helpful was the engagement with MNSC in terms of understanding about science in your community?', the mean score and standard deviation for students' perception on 'how helpful was the engagement with MNSC in terms of understanding about science in your community?' was 2.99 and 0.943 respectively with the interpretation of the mean score is 'medium' level of helpfulness of their engagement with the activities to their understanding about science in their community. 136 or 38.5% students rated their engaging with the activities as 'helpful' to their understanding about science in their community. Only 19 students reported as engaging with the activities to their understanding about science in their community conducted by MNSC as 'not at all helpful' or 5.4 in percentage. 28.6% or 101 students perceived that the level of helpfulness of their engagement with the activities conducted by the MNSC in terms of understanding about science in their community 'not helpful'. 97 or 27.5% students rated their engagement with the activities as 'in between helpful and not helpful' to their understanding about science in their community.

Meanwhile, for the item 'how helpful was the engagement with MNSC in terms of getting an idea about what scientist do?', more than half of the students' reported their perception on how helpful the engagement with MNSC was in terms of getting an idea about what scientist do as 'in between helpful and not helpful' (185, 52.4 %). 151 students or 42.8% rated it as 'helpful'. Only one student rated it as 'very helpful' or 0.3 in percentage. Whereas, 16 students or 4.5% rated it as 'not at all helpful' and 'not helpful' their engagement in the activities conducted by MNSC in term of getting an idea about what scientist do.

Lastly, for the items 'how helpful was the engagement with MNSC in terms of getting an idea about what MNSC does?', almost majority of the students' reported their perception on how helpful was the engagement with MNSC in terms of getting an idea about what MNSC does as 'helpful' (266, 75.4 %) and 'very helpful' (3, 0.8 %) which made up to 76.2% of the total respondents in the study. Only 14 students rated it as 'not at all helpful' and 'not helpful' or 3.9% indicating that their engagement with the activities did not helpful in getting an idea about what MNSC does. Out of 353 students, 70 students reported as 'in between helpful and not helpful' that their engagement with the activities helpful in getting an idea about what MNSC does. The mean score and standard deviation for students' perception on 'how helpful was the engagement with MNSC in terms of getting an idea about what MNSC does' was 3.72 and 0.576 respectively with the interpretation of the mean score was 'high' level of students' perception on how helpful the engagement with MNSC was in terms of getting an idea about what MNSC does.

6.3 Inferential analysis on students' perceptions of their engagement with MNSC in non-formal settings in term of science learning

In this section, the inferential analysis was presented. The inferential analysis used in this study were Mann-Whitney U test and the Kruskal-Wallis test. Mann-Whitney U test was used to compare when the nominal variable has two categories were used (e.g., to compare between males and females students). The Kruskal-Wallis test was used to compare when the nominal variable has three or more categories (e.g. age group of students and location of engagement with MNSC). For both statistical tests, the null hypothesis, H_o (there is no significant difference between groups) was tested at a significant level of $p \leq 0.05$. In these analyses, the comparison between males and females, age group, ethnic origin/group and locations of engagement were conducted to find if there is any different between the groups.

6.3.1 Students' responses to science in terms of knowledge and understanding, attitudes and enjoyment

Students were asked for their views on whether their engagement with MNSC help them in term of their responses to science in terms of knowledge, attitude and enjoyment. Two statements were used to construct a scale rating relating to students' cognitive responses to science in term of 'knowledge and understanding' with their engagement with MNSC:

- I learnt something new (item 2)
- I learn science in a different way to school with MNSC (item 10)

Cronbach's α for the two items is 0.717, indicating they were a reliable measure of the same construct. According to Pallant (2007), the reliability values above .7 were considered acceptable.

Four items were used to construct a scale to measure students' 'attitude' towards science learning with MNSC:

- More confident with science (item 4)

- More interested in science (item 6)
- Studying science might be fun (item 7)
- Working in science might be interesting (item 8)

Cronbach's α for items 4, 6, 7 and 8 is 0.910, indicating they were a reliable measure of the same construct. The removal of any of the items resulted in a lower value of alpha.

Two items were used to measure students' enjoyment towards their engagement with MNSC:

- I enjoyed myself (item 1)
- Science centre is a good place to learn about science (item 9)

Cronbach's α for the two items is 0.817, indicating they were a reliable measure of the same construct. The next section shows student responses to science in terms of knowledge and understanding, attitudes and enjoyment by their gender, school age group, and location of engagement with MNSC.

6.3.1.1 Do males and females differ in term of their levels of 'knowledge and understanding, attitudes and enjoyment' during their engagement with the activities conducted by MNSC?

The Mann-Whitney U test to measure students' level of 'knowledge and understanding, attitudes and enjoyment' during their engagement with the activities conducted by MNSC by gender is presented in Table 6.8. The significance level was .764, .346 and .510 for knowledge and understanding, attitudes and enjoyment respectively. This were more than the alpha level of .05, so there were no significant difference at $p<.05$ perceived levels of 'knowledge and understanding' ($U = 15257$, $p=.764$), 'attitudes' ($U = 14654$, $p=.346$) and 'enjoyment' ($U = 14928$, $p=.510$)' between males and females students during their engagement with the activities conducted by MNSC.

Therefore, there was no difference between males and females students in terms of their perceived levels of ‘knowledge and understanding’, attitudes’ and enjoyment’ during their engagement with the activities conducted by MNSC.

Table 6.8. Mann-Whitney U test to measure students’ perceived level of ‘knowledge and understanding, attitudes and enjoyment’ during their engagement with the activities conducted by MNSC by gender

Construct / Gender	Knowledge & Understanding	Attitude	Enjoyment
Mann-Whitney U	15257.000	14654.000	14928.000
Asymp. Sig. (2-tailed)	.764	.346	.510

N = 353

6.3.1.2 Is there a significant difference in ‘knowledge and understanding, attitudes and enjoyment’ levels across age group?

The Kruskal-Wallis test to measure the significant difference in ‘knowledge and understanding, attitudes and enjoyment’ levels across age group is presented in Table 6.9. The significance level was .118 for knowledge and understanding and .695 for attitudes and values. Since the value were more than alpha level of .05, there were no significant differences for the ‘knowledge and understanding ($\chi2$ (3, N=353) = 5.880, p = .118)’ and ‘attitude ($\chi2$ (3, N=353) = 1.446, p = .695)’ scale at p>.05 but there was a significant difference for the ‘enjoyment’ ($\chi2$ (3, N=353) = 8.866, p = .031) at p<.05. The details of significant different for enjoyment were showed in the next sub-heading.

Table 6.9. The Kruskal-Wallis test to measure the significant difference in ‘knowledge and understanding, attitudes and enjoyment’ levels across age group

Construct / Age group	Knowledge & Understanding	Attitude	Enjoyment
Chi-Square (χ^2)	5.880	1.446	8.866
df	3	3	3
Asymp. Sig.	.118	.695	*.031*

df – degree of freedom

Knowledge and understanding

There were no significant differences between students in ‘knowledge and understanding’ with engagement with MNSC across age group.

Attitudes

There were no significant differences between students in ‘attitudes’ with the engagement with the MNSC across age group.

Enjoyment

The only significant difference was detected in term of students’ ‘enjoyment’ with the engagement with MNSC across age group. As stated above, there was a significant difference for the ‘enjoyment’ ($\chi 2$ (3, N=353) = 8.866, p = .031) at $p<.05$. Further analysis for the items 1 and 9 in the ‘enjoyment’ scale shows a significant difference between students in different year group. Students in all year groups responded positively (96.2%, 97.3%, 95.8%, and 91.2% respectively agreed or strongly agreed with the statement ‘I enjoyed myself’ when engaging with MNSC, those in age 11 (Standard 5) were 97.3% positive with this statement (71.2 strongly agreed compared with 65.8%, 69.4%, and 50.5% in age 10, 13 and 14 respectively. Despite the positive responses, there are students’ who were ‘disagreed’ with the statement that ‘I enjoyed myself’ when engaging with MNSC across all level age group in the study (3.8%, 2.7%, 4.2% and 3.3% respectively for the age 10, 11, 13 and 14 years old). The finding seems to be supported by the research in TIMSS study (2007) report, which found student interest in science was strong in grade 4 (10 years old) but had waned significantly by grade 8 (14 years old). The positive attitudes of older student in this study was significantly lower than that of the lower graders for these variables.

Similarly, students in all year group responded positively (88.6%, 91.9%, 90.2%, and 74.8% respectively agreed or strongly agreed with the statement ‘science centre is a good place to learn about science’. Although students in the age group of 11 responded positively (91.9% strongly agreed and agreed with the statement), students age 13 was more positive as they 'strongly agreed' or 56.9 in percentage agreed with the statement 'science centre is a good place to learn about science'. In these two statements to measure students' perception towards enjoyment, students in age 11 was found to be positively response to the statements in 'enjoyment' scale. Table 6.10 shows the direction of student response to the statement in 'enjoyment' scale.

Table 6.10. Student response to item 1 'I enjoyed myself' and item 9 'science centre is a good place to learn about science' across age group

Agreement / Age/Level	SA (n,%)	A (n,%)	N (n,%)	D (n,%)	SD (n,%)
Item 1: 'I enjoyed myself'					
10 / Standard 4	52 65.8	24 30.4	0 0.0	3 3.8	-
11 / Standard 5	**79** **71.2**	29 26.1	0 0.0	3 2.7	-
13 / Form 1	50 69.4	19 26.4	0 0.0	3 4.2	-
14 / Form 2	**46** **50.5**	37 40.7	5 5.5	3 3.3	-
Total	**227** **64.3**	**109** **30.9**	**5** **1.4**	**12** **3.4**	**0** **0.0**
Item 9: 'science centre is a good place to learn about science'					
10 / Standard 4	27 34.2	43 54.4	6 7.6	3 3.8	-
11 / Standard 5	39 35.1	63 56.8	6 5.4	3 2.7	-
13 / Form 1	41 56.9	24 33.3	4 5.6	3 4.2	-
14 / Form 2	36 39.6	32 35.2	18 19.8	4 4.4	1 1.1
Total	**143** **40.5**	**162** **45.9**	**34** **9.6**	**13** **3.7**	**1** **0.3**

χ^2 (3, N=353) = 8.866, p = .031

SA	Strongly agree
A	Agree
N	Neither agree nor disagree
D	Disagree
SD	Strongly disagree
χ^2.	Chi squared statistic
p	probability
N	number of cases

To sum up, when combine students' response for the scale for 'enjoyment' across age group, students in higher age group were less positive compared to students in lower age group. Secondary school student (age 13 and 14) responded 95.8% and 91.2% strongly agreed and agreed with the statement 'I enjoyed myself' when engaging with MNSC compared to 96.2% and 97.3% for students in primary school (age 10 and 11). The response pattern was similar for the statement 'science centre is a good place to learn about science' but the percentage for higher age group (age 14) was too low (74.2% only). This was such an interesting finding from this study and the finding also supported by (Salmi, 2003) study stated that 'science centre visits had a positive effect on students in all age groups, but were most positive among primary school pupils'. Since it is not a shocking information that primary pupils' shows greater and positive interest in science than secondary school students.

6.3.1.3 Is there a significant difference in 'knowledge and understanding, attitudes and enjoyment' levels between locations of engagement?

The Kruskal-Wallis test measured the significant difference in 'knowledge and understanding, attitudes and enjoyment' between locations of engagement are presented in Table 6.11. The significance level was .001 (rounded) for all the three constructs. This is less than the alpha level of .05, so there was significant difference at $p<.05$ perceived levels of 'knowledge and understanding', attitudes and enjoyment between locations of engagement. The Kruskal-Wallis test shows there were significant differences between locations of engagement for the three scales measured in the study for the knowledge and understanding, attitudes and enjoyment with MNSC. The details of significant different for enjoyment were showed in the next sub-heading.

Table 6.11. The Kruskal-Wallis test to measure the significant difference in 'knowledge and understanding, attitudes and enjoyment' levels between locations of engagement with MNSC

Construct / **Ethnic origin/group**	**Knowledge & Understanding**	**Attitude**	**Enjoyment**
Chi-Square (χ^2)	48.833	51.471	104.598
df	2	2	2
Asymp. Sig.	.000	.000	.000

df – degree of freedom

Table 6.12 – Table 6.14 shows the statistical test results for students' perception to the statement in 'knowledge and understanding, attitudes and enjoyment' scale between locations of engagement in the present study.

Knowledge and understanding

There were significant differences between students in term of 'knowledge and understanding' across location of engagement with MNSC. Further analysis for the items 2 and 10 (see Table 6.12) in the scale 'knowledge and understanding' shows students' responses in term of their perception toward the statement 'I learnt something new' and 'I learn science in a different way to school' across location of engagement with MNSC.

Students engagement with MNSC in centre-based responded positively as a total of 100.0% strongly agreed or agreed with the statement 'I learnt something new' whilst followed by multi-school and single-school with 98.5% and 90.2% respectively. Whereas, for the statement 'I learn science in a different way to school (item 10)' with MNSC by locations of engagement with MNSC, engagement by locations at centre-based and multi-school shows positive response with 91.4% and 91.5% respectively. Both of the statements in 'knowledge and understanding' scale shows similar pattern, which students in the single-school engagement with MNSC shows adequate response, whilst centre-based and multi-school shows high response to the statements. In multi-school outreach, students mixed with other students from other schools when doing the activities conducted by MNSC, hence nurturing their sense of competition in a positive way. That's maybe one of the reason why students in multi-school outreach responded positively towards the statement 'I learnt something new' and 'I learn science in a different way to school' by locations of engagement with MNSC.

Table 6.12. Student response to item 2 'I learnt something new' and item 10 'I learn science in a different way to school' by locations of engagement with MNSC

Agreement / Location of engagement	SA (n,%)	A (n,%)	N (n,%)	D (n,%)	SD (n,%)
Item 2: 'I learnt something new'					
Centre-based	27 46.6	31 53.4	-	-	-
Single-school	41 26.6	98 63.6	14 9.1	1 0.6	-
Multi-school	**92** **65.2**	47 33.3	2 1.4	-	-

SA	Strongly agree
A	Agree
N	Neither agree nor disagree
D	Disagree
SD	Strongly disagree
χ^2.	Chi squared statistic
p	probability
N	number of cases

Total	160 45.3	176 49.9	16 4.5	1 0.3	-
Item 10: 'I learn science in a different way to school'					
Centre-based	8 13.8	**45** **77.6**	5 8.6	-	-
Single-school	32 20.8	94 61.0	27 17.5	1 0.6	-
Multi-school	**77** **54.6**	52 36.9	9 6.4	3 2.1	-
Total	**117** **33.1**	**191** **54.1**	**41** **11.6**	**4** **1.1**	**-**

χ^2 (3, N=353) = 48.833, p = .000

Attitudes

There were significant differences between students in term of their 'attitudes' across location of engagement with MNSC ($\chi 2$ (3, N=353) = 51.471, p = .000)) at $p<.05$. Further analysis for the items 4, 6, 7, and 8 (see Table 6.13) in the scale of 'attitudes' shows students' responses in term of their perception toward the statement during their engagement with MNSC by their locations.

Table 6.13. Student response to item 4 'more confident with science', item 6 'more interested in science', item 7 'studying science might be fun' and item 8 'working in science might be interesting' by locations of engagement with MNSC

Agreement / Location of engagement	SA (n,%)	A (n,%)	N (n,%)	D (n,%)	SD (n,%)
Item 4: 'more confident with science'					
Centre-based	6 10.3	38 65.5	14 24.1	-	-
Single-school	15 9.7	82 53.2	43 27.9	13 8.4	1 0.6
Multi-school	56 39.7	74 52.5	8 5.7	3 2.1	-
Total	**77** **21.8**	**194** **55.0**	**65** **18.4**	**16** **4.5**	**1** **0.3**
Item 6: 'more interested in science'					
Centre-based	5 8.6	39 67.2	14 24.1	-	-
Single-school	35 22.7	78 50.6	27 17.5	1 0.6	13 8.4
Multi-school	61 43.3	66 46.8	13 9.2	1 0.7	-
Total	**101** **28.6**	**183** **51.8**	**54** **15.3**	**2** **0.6**	**13** **3.7**
Item 7: 'studying science might be fun'					

SA	Strongly agree
A	Agree
N	Neither agree nor disagree
D	Disagree
SD	Strongly disagree
χ^2.	Chi squared statistic
p	probability
N	number of cases

Centre-based	6 10.3	44 75.9	8 13.8	-	-
Single-school	29 18.8	95 61.7	17 11.0	13 8.4	-
Multi-school	80 56.7	51 36.2	9 6.4	1 0.7	-
Total	**115** **32.6**	**190** **53.8**	**34** **9.6**	**14** **4.0**	**-**
Item 8: 'working in science might be interesting'					
Centre-based	4 6.9	43 74.1	11 19.0	-	-
Single-school	17 11.0	78 50.6	57 37.0	1 0.6	1 0.6
Multi-school	57 40.4	57 40.4	24 17.0	3 2.1	-
Total	**78** **22.1**	**178** **50.4**	**92** **26.1**	**4** **1.1**	**1** **0.3**

χ^2 (3, N=353) = 51.471, p = .000

Table 6.13 shows student response to item 4 'more confident with science' upon their engagement with MNSC by their locations of engagement. Students in multi-school responded positively to the statement that MNSC made them feel 'more confident with science' (39.7% strongly agreed and 52.5% agreed) followed by centre based (10.3% strongly agreed' and 65.5% agreed) and single-school (9.7% strongly agreed and 53.2% agreed) engagement with MNSC. Student response to item 6 'more interested in science' upon engaging with MNSC by their locations of engagement shows students in multi-school responded positively to the statement that MNSC made them feel 'more interested in science' (46.8% agreed and 43.3% strongly agreed with the statement) followed by students' engagement in centre-based (67.2% agreed and only 8.6% strongly agreed with the statement) and lastly by students' engagement in single-school (50.6% agreed and 22.7% strongly agreed).

On the other hand, student response to the statement 'studying science might be fun' (item 7) by engaged with MNSC by their locations. Again, students in multi-school responded positively to the statement that engagement with MNSC made them feel 'studying science might be fun'. Whereas, student response to the statement 'working in science might be interesting' (item 8) was highly rated by students in centre-based (74.1% agreed and 6.9% strongly agreed with the statement) compared to multi and single-school (80.8% and 61.6% respectively agreed or strongly agreed with the statement). The statements in 'attitudes scale shows similar pattern, which students in the single-school engagement with MNSC showed the lowest response, whilst centre-based and multi-school shows higher response to the statements.

Enjoyment

There were significant differences between students in their perception toward 'enjoyment' across locations of engagement with MNSC ($\chi2$ (3, N=353) = 104.598, p = .000) at p<.05. Further analysis for item 1 'I enjoyed myself' and item 9 'science centre was a good place to learn about science' (see Table 6.14) in the scale of 'enjoyment' shows students' responses in term of their perception toward the statement during their engagement with MNSC by their locations of engagement.

Table 6.14 shows 100.0% of the students' in centre-based and multi-school agreed and strongly agreed to the statement 'I enjoyed myself' upon engagement with MNSC. Similarly, students' in multi-school and centre-based agreed and strongly agreed to the statement 'science centre is a good place to learn about science' (99.8% and 93.1% respectively agreed or strongly agreed with the statement, Item 9). Yet, only 72.1% of students' engagement with MNSC in single-school agreed or strongly agreed with the statement 'science centre is a good place to learn about science'.

Table 6.14. Student response to item 1 'I enjoyed myself' and item 9 'science centre is a good place to learn about science' by locations of engagement with MNSC

Agreement / Location of engagement	SA (n,%)	A (n,%)	N (n,%)	D (n,%)	SD (n,%)
Item 1: 'I enjoyed myself'					
Centre-based	39 67.2	19 32.8	-	-	-
Single-school	72 46.8	65 42.2	5 3.2	12 7.8	-
Multi-school	**116** **82.3**	25 17.7	-	-	-
Total	**227** **64.3**	**109** **30.9**	**5** **1.4**	**12** **3.4**	**-**
Item 9: 'science centre is a good place to learn about science'					
Centre-based	10 17.2	44 75.9	4 6.9	-	-
Single-school	28 18.2	83 53.9	29 18.8	13 8.4	1 0.6

SA	Strongly agree
A	Agree
N	Neither agree nor disagree
D	Disagree
SD	Strongly disagree
χ^2.	Chi squared statistic
p	probability
N	number of cases

Multi-school	**105** **74.5**	35 24.8	1 0.7	-	-
Total	**143** **40.5**	**162** **45.9**	**34** **9.6**	**13** **3.7**	**1** **0.3**

χ^2 (3, N=353) = 104.598, p = .000

To sum up, students' engagement in single-school responded lower to all the statements in the 'enjoyment' scale compared to students' engagement in centre-based and multi-school. This was maybe because although the out-of-school program conducted by MNSC, yet the students still learnt in the environment near the school area (physical factor) and engage with their peers only which was the same experience compared to students' experience at centre-based and multi-school outreach. Therefore, this research supports that physical context have an impact in determining the success of science learning in out-of-school classroom context (Falk and Dierking, 2000).

6.3.2 *Students'* **responses** *to science [in term of how easy]*

Students were asked for their views on whether their engagement with MNSC help them in term of how easy the activities for them. Four statements were used to construct a scale rating relating to students' 'easiness' with their engagement with MNSC:

- In the activities you did, how easy was it for you to:
    - Understand the instruction? (item 13a)
    - Use the equipment? (item 13b)
    - Get a result for the activity? (item 13c)
    - Understand what the activity was all about? (item 13d)

Cronbach's α for the four items is 0.974, indicating they were a reliable measure of the same construct. According to Pallant (2007), the reliability values above .7 were considered acceptable and the values above .8 were preferable.

6.3.2.1 Do males and females differ on how easy students' perceived success in working with the activities?

Table 6.15 shows the significance level was .001 (rounded). This is less than the alpha level of .05, so there were significant differences between males and females students in terms of their perceived levels of 'easiness' during their engagement with the activities conducted by MNSC. Girl (M_d = 4.00, n = 186) perceived success in working with the activities better than boy (M_d = 3.25, n = 167), U = 12270, z = -3.525, p = .000, r = .19 at $p<.05$. The effect size r = .19 indicating a small effect size between girl and boy (Cohen, 1988).

Table 6.15. Mann-Whitney U test to measure students' level of 'easiness' during their engagement with the activities conducted by MNSC by gender

Construct / **Gender**	**Easiness**
Mann-Whitney U	12270.000
Z	-3.525
Asymp. Sig. (2-tailed)	.000

N = 353

Effect size
r = z / √ N
r = -3.525 / √ 353
r = 0.19

Table 6.16. The median score by gender to measure students' level of 'easiness' during their engagement with the activities conducted by MNSC

Gender	**N**	**Median**
Boy	167	3.25
Girl	186	4.00

N = 353

Further analysis for the items 13a, 13b, 13c, and 13d (see Table 6.17) in the scale of 'easiness' shows students' responses in term of their perception toward the statement during their engagement with MNSC by gender.

Table 6.17. Student response to item 13a, 13b, 13c and 13d on how easy they perceived they 'understand the instruction, to use the equipment, to get a result for the activity and to understand what the activity is all about' by gender

Agreement / Gender	VE (n, %)	E (%)	IB (%)	H (%)	VH (%)
Item 13a: 'how easy for you to understand the instruction'					
Boy	8 4.8	53 31.7	88 52.7	12 7.2	6 3.6
Girl	11 5.9	91 48.9	74 39.8	3 1.6	7 3.8
Total	**19** **5.4**	**144** **40.8**	**162** **45.9**	**15** **4.2**	**13** **3.7**
Item 13b: 'how easy for you to use the equipment'					
Boy	8 4.8	69 41.3	70 41.9	15 9.0	5 3.0
Girl	11 5.9	109 58.6	56 30.1	3 1.6	7 3.8
Total	**19** **5.4**	**178** **50.4**	**126** **35.7**	**18** **5.1**	**12** **3.4**
Item 13c: 'how easy for you to get a result for the activity'					
Boy	15 9.0	46 27.5	87 52.1	13 7.8	6 3.6
Girl	16 8.6	89 47.8	71 38.2	3 1.6	7 3.8
Total	**31** **8.8**	**135** **38.2**	**158** **44.8**	**16** **4.5**	**13** **3.7**
Item 13d: 'how easy for you to understand what the activity is all about'					
Boy	8 4.8	51 30.5	89 53.3	14 8.4	5 3.0
Girl	19 10.2	87 46.8	70 37.6	3 1.6	7 3.8
Total	**27** **7.6**	**138** **39.1**	**159** **45.0**	**17** **4.8**	**12** **3.5**

VE	Very easy
E	Easy
IB	In between
H	Hard
VH	Very hard

**Note for item 13b: the equipment refers in this study depends on the activity they involved and not the same for everyone*

Based on Table 6.17, girls find it easier in terms of to 'understand the instruction, use the equipment, get the result for the activity and understand what the activity was all about' compared to boys. Therefore, girls' perceptions were positive compared to boys in terms of to 'understand the instruction, use the equipment, get the result for the activity and understand what the activity was all about'.

6.3.2.2 Is there a significant difference on how easy students' perceived success in working with the activities across age group?

The Kruskal-Wallis test to measure the significant differences on how easy students' perceived success in working with the activities across age group are presented in Table 6.18. The significance level was .002. This is less than the alpha level of .05, so there were significant differences across age group of students in terms of how easy they perceived success in working with the activities ($\chi 2$ (3, N=353) = 14.724, p = .002) at $p<.05$. Students in upper primary school recorded a higher median score (M_d = 3.750 for 11 year old; M_d = 3.500 for 10 year old) compared to lower secondary school student (M_d = 3.375 for 13 year old; M_d = 3.000 for 14 year old) (see Table 6.19).

Table 6.18. The Kruskal-Wallis test to measure the significant difference in term of how easy students' perceived success in working with the activities across age group

Scale / **Age group**	**Easiness**
Chi-Square (χ^2)	14.724
df	3
Asymp. Sig.	.002

df – degree of freedom

Table 6.19. The median score by age group to measure students' level of 'easiness' during their engagement with the activities conducted by MNSC

Age Group	**N**	**Median**
10 / Standard 4	79	3.500
11 / Standard 5	111	3.750
13 / Form 1	72	3.375
14 / Form 2	91	3.000

N = 353

Further analysis for the items 13a, 13b, 13c, and 13d (see Table 6.24) in the scale of 'easiness' shows students' responses in term of their perception toward the statements during their engagement with MNSC by age group.

Table 6.20. Student response to item 13a, 13b, 13c and 13d on how easy they perceived they 'understand the instruction, to use the equipment, to get a result for the activity and to understand what the activity is all about' by age group

Agreement / Age group	VE (n, %)	E (n, %)	IB (n, %)	H (n, %)	VH (n, %)
Item 13a: 'how easy for you to understand the instruction'					
10 / Standard 4	-	40 50.6	32 40.5	4 5.1	3 3.8
11 / Standard 5	5 4.5	57 51.4	45 40.5	1 0.9	3 2.7
13 / Form 1	14 19.4	19 26.4	36 50.0	-	3 4.2
14 / Form 2	-	28 30.8	49 53.8	10 11.0	4 4.4
Total	**19 5.4**	**144 40.8**	**162 45.9**	**15 4.2**	**13 3.7**
Item 13b: 'how easy for you to use the equipment'					
10 / Standard 4	-	45 57.0	27 34.2	4 5.1	3 3.8
11 / Standard 5	5 4.5	66 59.5	38 34.2	1 0.9	3 2.7
13 / Form 1	14 19.4	25 34.7	30 41.7	-	3 4.2
14 / Form 2	-	42 46.2	33 36.3	13 14.3	3 3.3
Total	**19 5.4**	**178 50.4**	**126 35.7**	**18 5.1**	**12 3.4**
Item 13c: 'how easy for you to get a result for the activity'					
10 / Standard 4	2 2.5	38 48.1	32 40.5	4 5.1	3 3.8
11 / Standard 5	7 6.3	59 53.2	41 36.9	1 0.9	3 2.7
13 / Form 1	19 26.4	14 19.4	36 50.0	-	3 4.2
14 / Form 2	3 3.3	24 26.4	49 53.8	11 12.1	4 4.4
Total	**31 8.8**	**135 38.2**	**158 44.8**	**16 4.5**	**13 3.7**
Item 13d: 'how easy for you to understand what the activity is all about'					
10 / Standard 4	2 2.5	36 45.6	34 43.0	4 5.1	3 3.8
11 / Standard 5	8 7.2	52 46.8	47 42.3	1 0.9	3 2.7
13 / Form 1	14 19.4	22 30.6	33 45.8	-	3 4.2
14 / Form 2	3 3.3	28 30.8	45 49.5	12 13.1	3 3.3
Total	**27 7.6**	**138 39.1**	**159 45.0**	**17 4.8**	**12 3.4**

VE	Very easy
E	Easy
IB	In between
H	Hard
VH	Very hard

**Note for item 13b: the equipment refers in this study depends on the activity they involved and not the same for everyone [refer Appendix M)*

Based on Table 6.20, student in age of 10 and 11 years old responded positively compared to 13 and 14 years old student. As mentioned earlier, students' in lower age group responded positively compared to students' in higher age group. This is because during this time students are the most enthusiastic about learning science (Roberson, 2010).

6.3.2.3 Is there a significant difference on how easy students' perceived success in working with the activities between locations of engagement?

The Kruskal-Wallis test to measure the significant difference on how easy students' perceived success in working with the activities between locations of engagement are presented in Table 6.21. The significance level was .001 (rounded). This is less than the alpha level of .05, so there were significant differences between students in different locations of engagement in term of how easy they perceived success in working with the activities ($\chi 2$ (3, N=353) = 18.740, p = .000) at $p<.05$. Students' engagement in single-school with MNSC recorded a higher median score (M_d = 4.00) followed by students' engagement in centre-based (M_d = 3.75) and lastly students in multi-school (M_d = 3.00) (see Table 6.22).

Table 6.21. The Kruskal-Wallis test to measure the significant difference in term of how easy students' perceived success in working with the activities between locations of engagement

Scale / Locations of engagement	Easiness
Chi-Square (χ^2)	18.74
df	2
Asymp. Sig.	.000

df – degree of freedom

Table 6.22. The median score by between different locations of engagement to measure students' level of 'easiness' prior to engagement with the activities conducted by MNSC

Locations of engagement	N	Median
Centre-based	58	3.75
Single-school	154	4.00
Multi-school	141	3.00

N = 353

Further analysis for the items 13a, 13b, 13c, and 13d (see Table 6.23) in the scale of 'easiness' shows students' responses in term of their perception toward the statement during their engagement with MNSC between different locations of engagement.

Table 6.23. Student response to item 13a, 13b, 13c and 13d on how easy they perceived they 'understand the instruction, to use the equipment, to get a result for the activity and to understand what the activity is all about' between different locations of engagement

Agreement / Locations of engagement	VE (n, %)	E (n, %)	IB (n, %)	H (n, %)	VH (n, %)
Item 13a: 'how easy for you to understand the instruction'					
Centre-based	1 1.7	33 56.9	20 34.5	4 6.9	-
Single-school	18 11.7	77 50.0	36 23.4	10 6.5	13 8.4
Multi-school	-	34 24.1	106 75.2	1 0.7	-
Total	**19** **5.4**	**144** **40.8**	**162** **45.9**	**15** **4.2**	**13** **3.7**
Item 13b: 'how easy for you to use the equipment'					
Centre-based	1 1.7	32 55.2	21 36.2	4 6.9	-
Single-school	18 11.5	77 50.0	34 22.1	13 8.4	12 7.8
Multi-school	-	69 48.9	71 50.4	1 0.7	-
Total	**19** **5.4**	**178** **50.4**	**126** **35.7**	**18** **5.1**	**12** **3.4**
Item 13c: 'how easy for you to get a result for the activity'					
Centre-based	1 1.7	34 58.6	19 32.8	4 6.9	-
Single-school	30 19.5	66 42.9	34 22.1	11 7.1	13 8.4
Multi-school	-	35 24.8	105 74.5	1 0.7	-
Total	**31** **8.8**	**135** **38.2**	**158** **44.8**	**16** **4.5**	**13** **3.7**
Item 13d: 'how easy for you to understand what the activity is all about'					
Centre-based	2 3.4	29 50.0	23 39.7	4 6.9	-
Single-school	25 16.2	65 42.2	40 26.0	12 7.8	12 7.8
Multi-school	-	44 31.2	96 68.1	1 0.7	-
Total	**27** **7.6**	**138** **39.1**	**159** **45.0**	**17** **4.8**	**12** **3.4**

VE	Very easy
E	Easy
IB	In between
H	Hard
VH	Very hard

**Note for item 13b: the equipment refers in this study depends on the activity they involved and not the same for everyone [refer Appendix M)*

Based on Table 6.23, students' engagement in single-school responded more positively towards the statement how easy they perceived success in working with the activities in 'easiness' scale (agreed or strongly agreed with the statement) followed by students' engagement in centre-based and lastly by students in multi-school.

6.3.3 S*tudents'* responses *to science? [in term of enjoyment]*

Students were asked for their views on whether their engagement with MNSC help them in term of how they enjoyed the activities. Four statements were used to construct a scale rating relating to students' 'enjoyment' with their engagement with MNSC:

- How much did you enjoy?
    - Doing the activities? (item 14a)
    - Working in groups? (item 14b)
    - Using the equipment? (item 14c)
    - Your whole engagement with MNSC? (item 14d)

Cronbach's α for the four items is 0.918, indicating they were a reliable measure of the same construct. According to Pallant (2007), the reliability values above .7 were considered acceptable and the values above .8 were preferable.

6.3.3.1 Do males and females differ on how much students enjoyed doing the activities?

Table 6.24 shows the significance level was .001 (rounded). This is less than the alpha level of .05, so there were significant differences in terms of their levels of 'enjoyment' during their engagement with the activities conducted by MNSC by gender. A Mann-Whitney U test revealed there were significant differences between males (M_d = 4.00, n = 167) and females (M_d = 4.00, n = 186) students in terms of their levels of 'enjoyment' during their engagement with the activities conducted by MNSC (U = 11997, z = -3.78, p = .00, r = .20). The test statistics are presented in Table 6.24.

Table 6.24. Mann-Whitney U test to measure students' level of 'easiness' during their engagement with the activities conducted by MNSC by gender

Scale / Gender	'How enjoyed'
Mann-Whitney U	11997.00
Z	-3.78
Asymp. Sig. (2-tailed)	.000

N = 353

Effect size
r = z / √ N
r = -3.784 / √ 353
r = 0.20

Despite the fact that there were significant different between boy and girl, the median score by both gender was the same (M_d = 4.00 for boy and girl). This may be due to small effect size r = .20 indicating a small effect size between girl and boy (Cohen, 1988). Nevertheless, the mean rank score shows that girl responded higher than boy in terms of their levels of 'enjoyment' during their engagement with the activities conducted by MNSC (see Table 6.25).

Table 6.25. The median and mean rank score by gender to measure students' level of 'enjoyment' during their engagement with the activities conducted by MNSC

Construct / Gender	N	Mean Rank	Median
Boy	167	155.84	4.00
Girl	186	196.00	4.00

N = 353

Further analysis for the items 14a, 14b, 14c, and 14d (see Table 6.26) in the scale of 'enjoyment' shows students' responses in term of their perception toward the statement during their engagement with MNSC by gender.

Based on Table 6.26, girls find it more enjoyable in terms of 'doing the activities, working in groups, using the equipment and their whole engagement to MNSC' compared to boys (agreed or strongly agreed with the statements). This might also because girls tend to give positive feedback compared to boys.

Table 6.26. Student response to item 14a, 14b, 14c and 14d on how much did you enjoy 'doing the activities, working in groups, using the equipment, and your whole engagement with MNSC' by gender

Agreement / Gender	VE (n, %)	E (n, %)	IB (n, %)	NE (n, %)	NAAE (n, %)
Item 14a: 'how much did you enjoy doing the activities'					
Boy	46 27.5	83 49.7	29 17.4	3 1.8	6 3.6
Girl	75 40.3	95 51.1	9 4.8	-	7 3.8
Total	**121** **34.3**	**178** **50.4**	**38** **10.8**	**3** **0.8**	**13** **3.7**
Item 14b: 'how much did you enjoy working in groups'					
Boy	23 13.8	62 37.1	69 41.3	7 4.2	6 3.6
Girl	41 22.0	77 41.4	59 31.7	2 1.1	7 3.8
Total	**64** **18.1**	**139** **39.4**	**128** **36.3**	**9** **2.5**	**13** **3.7**
Item 14c: 'how much did you enjoy using the equipment'					
Boy	35 21.0	89 53.3	34 20.4	4 2.4	5 3.0
Girl	62 33.3	108 58.1	9 4.8	-	7 3.8
Total	**97** **27.5**	**197** **55.8**	**43** **12.2**	**4** **1.1**	**12** **3.4**
Item 14d: 'how much did you enjoy your whole engagement with MNSC'					
Boy	49 29.3	81 48.5	28 16.8	4 2.4	5 3.0
Girl	77 41.4	86 46.2	8 4.3	8 4.3	7 3.8
Total	**126** **35.7**	**167** **47.3**	**36** **10.2**	**12** **3.4**	**12** **3.4**

VE	Vey enjoyable
E	Enjoyable
IB	In between
NE	Not enjoyable
NAAE	Not at all enjoyable

6.3.3.2 Is there a significant difference on students' enjoyment doing the activities across age group?

The Kruskal-Wallis test to measure the significant difference in term of students' enjoyment doing the activities across age group is presented in Table 6.27. The significance level was .001. This is less than the alpha level of .05, so there were significant differences in term of students' enjoyment doing the activities across age group. The Kruskal-Wallis test revealed a statistically significant different between students in different age group in term of students' enjoyment doing the activities with MNSC ($\chi 2$ (3, N=353) = 16.338, p = .001) at p<.05. 13 years old student recorded a highest median score (M_d = 4.250) compared 10, 11 and 14 years old students (M_d = 4.000 for each group) (see Table 6.28).

Table 6.27. The Kruskal-Wallis test to measure the significant difference in term of students' enjoyment doing the activities across age group

Scale / Age group	Enjoyment
Chi-Square (χ^2)	16.338
df	3
Asymp. Sig.	.001

df – degree of freedom

Table 6.28. The median and mean rank score by age group to measure students' level of 'enjoyment' during their engagement with the activities conducted by MNSC

Age Group	N	Mean Rank	Median
10 / Standard 4	79	175.82	4.00
11 / Standard 5	111	185.61	4.00
13 / Form 1	72	205.71	4.25
14 / Form 2	91	144.81	4.00

N = 353

Further analysis for the items 14a, 14b, 14c, and 14d (see Table 6.29) in the scale of 'enjoyment' shows students' responses in term of their perception toward the statement during their engagement with MNSC by age group.

Based on Table 6.29, 13 year old student find it more enjoyable in terms of 'doing the activities, working in groups, using the equipment and their whole engagement to MNSC' compared to 10, 11, and 14 years old students (agreed or strongly agreed with the statements). Students' around this transition year found science is not boring yet compared to older group of students (Roberson, 2010).

Table 6.29. Student response to item 14a, 14b, 14c and 14d on how much did you enjoy 'doing the activities, working in groups, using the equipment, and your whole engagement with MNSC' by age group

Agreement / Age group	VE (n, %)	E (n, %)	IB (n, %)	NE (n, %)	NAAE (n, %)
Item 14a: 'how much did you enjoy doing the activities'					
10 / Standard 4	28 35.4	41 51.9	7 8.9	-	3 3.8
11 / Standard 5	35 31.5	67 60.4	6 5.4	-	3 2.7
13 / Form 1	36 50.0	27 37.5	6 8.3	-	3 4.2
14 / Form 2	24.2	47.3	20.9	3.3	4.4
Total	**121** **34.3**	**178** **50.4**	**38** **10.8**	**3** **0.8**	**13** **3.7**
Item 14b: 'how much did you enjoy working in groups'					
10 / Standard 4	12 15.2	31 39.2	30 38.0	3 3.8	3 3.8
11 / Standard 5	19 17.1	57 51.4	30 27.0	2 1.8	3 2.7
13 / Form 1	19 26.4	22 30.6	28 38.9	-	3 4.2
14 / Form 2	14 15.4	29 31.9	40 44.0	27 4.4	4.4
Total	**64** **18.1**	**136** **38.4**	**128** **36.3**	**9** **2.5**	**16** **4.7**
Item 14c: 'how much did you enjoy using the equipment'					
10 / Standard 4	21 26.6	46 58.2	9 11.4	-	3 3.8
11 / Standard 5	30 27.0	71 64.0	7 6.3	-	3 2.7
13 / Form 1	30 41.7	33 45.8	6 8.3	-	3 4.2
14 / Form 2	16 17.6	47 51.6	21 23.1	27 4.4	6 3.3
Total	**97** **27.5**	**197** **55.8**	**43** **12.2**	**4** **1.1**	**12** **3.4**
Item 14d: 'how much did you enjoy your whole engagement with MNSC'					
10 / Standard 4	29 36.7	39 49.4	6 7.6	2 2.5	3 3.8
11 / Standard 5	35 31.5	65 58.6	4 3.6	4 3.6	3 2.7
13 / Form 1	39 54.2	25 34.7	5 6.9	-	3 4.2
14 / Form 2	23 25.3	38 41.8	21 23.1	6 6.6	6 3.3
Total	**126** **35.7**	**167** **47.3**	**36** **10.2**	**12** **3.4**	**12** **3.4**

**Note for item 14c: the equipment refers in this study depends on the activity they involved and not the same for everyone [refer Appendix M)*

VE	Vey enjoyable
E	Enjoyable
IB	In between
NE	Not enjoyable
NAAE	Not at all enjoyable

6.3.3.3 Is there a significant difference in students' enjoyment doing the activities between locations of engagement?

The Kruskal-Wallis test to measure the significant difference in term of how students enjoyed working with the activities with MNSC between different locations of engagement is presented in Table 6.30. The significance level was .035. This is less than the alpha level of .05, so there were statistically significant differences between students in different locations of engagement in term of how students enjoyed working with the activities with MNSC ($\chi 2$ (3, N=353) = 6.730, p = .035) at p<.05.

Table 6.30. The Kruskal-Wallis test to measure the significant difference in term of how students enjoyed working with the activities with MNSC between different locations of engagement

Scale / **Locations of engagement**	**Enjoyment**
Chi-Square (χ^2)	6.730
df	2
Asymp. Sig.	.035

df – degree of freedom

Despite the fact that there was significant different difference in term of how students enjoyed working with the activities with MNSC between different locations of engagement, the median score for the three locations of engagement were the same (M_d = 4.00 for centre-based, single-school and multi-school engagement). Nevertheless, the mean rank score shows that student in multi-school (mean rank = 185.18) were responded positively (higher score) compared to student in single-school (mean rank = 181.07) and centre-based (mean rank = 146.28) of engagement with MNSC (see Table 6.31).

Further analysis for the items 14a, 14b, 14c, and 14d (see Table 6.32) in the scale of 'enjoyment' shows students' responses in term of their perception toward the statement after their engagement with MNSC between different locations of engagement.

Table 6.31. The median and mean rank score between different locations of engagement to measure students' level of 'enjoyment' after their engagement with the activities conducted by MNSC

Locations of engagement	N	Mean Rank	Median
Centre-based	58	146.28	4.000
Single-school	154	181.07	4.000
Multi-school	141	185.18	4.000

N = 353

Table 6.32. Student response to item 14a,14b, 14c and 14d on how much you enjoy 'doing the activities, working in groups, using the equipment and your whole engagement with MNSC' between different locations of engagement

Agreement / Location of engagement	VE (n, %)	E (n, %)	IB (n, %)	NE (n, %)	NAAE (n, %)
Item 14a: 'how much did you enjoy doing the activities'					
Centre-based	3 5.2	48 82.8	7 12.1	-	-
Single-school	77 50.0	39 25.3	22 14.3	3 1.9	13 8.4
Multi-school	41 29.1	91 64.5	9 6.4	-	-
Total	**121** **34.3**	**178** **50.4**	**38** **10.8**	**3** **0.8**	**13** **3.7**
Item 14b: 'how much did you enjoy working in groups'					
Centre-based	2 3.4	38 65.5	14 24.1	4 6.9	-
Single-school	25 16.2	48 31.2	63 40.9	5 3.2	8.4
Multi-school	37 26.2	53 37.6	51 36.2	-	-
Total	**64** **18.1**	**139** **39.4**	**128** **36.3**	**9** **2.5**	**13** **3.7**
Item 14c: 'how much did you enjoy using the equipment'					
Centre-based	4 6.9	44 75.9	10 17.2	-	-
Single-school	51 33.1	63 40.9	24 15.6	4 2.6	12 7.8
Multi-school	42 29.8	90 63.8	9 6.4	-	-
Total	**97** **27.5**	**197** **55.8**	**43** **12.2**	**4** **1.1**	**12** **3.4**
Item 14d: 'how much did you enjoy your whole engagement with MNSC'					
Centre-based	7 12.1	46 79.3	4 6.9	1 1.7	-
Single-school	67 43.5	40 26.0	24 15.6	11 7.1	12 7.8
Multi-school	52 36.9	81 57.4	8 5.7	-	-
Total	**126** **35.7**	**167** **47.3**	**36** **10.2**	**12** **3.4**	**12** **3.4**

VE	Vey enjoyable
E	Enjoyable
IB	In between
NE	Not enjoyable
NAAE	Not at all enjoyable

Based on Table 6.32, students' engagement in multi-school find it more enjoyable in terms of 'doing the activities, using the equipment and their whole engagement to MNSC' compared to students in centre-based and single-school. Meanwhile, students in centre-based engagement with MNSC responded more positively towards item 14b 'how much did you enjoy working in groups' compared to students in single and multi-school location of engagement MNSC. As for students in multi-school outreach, the fact that they mixed with students from other schools may inspire or risen their enthusiastic level to compete with other students. As for the centre-based, this is new environment to students, and hence they enjoyed working in small groups to solve the activities conducted by MNSC.

These findings seems parallel with the findings from the interview. The girl interviewed (from multi-school outreach) stated that she's happy because got to mingle and interact with friends from other schools instead of only from her usual classroom routine. According to her;

> "…here I engaged with different people…I got new friends…I enjoyed working with them all especially in my own group…we got to compete among the group to solve the problem..really happy…"
>
> [P60/F/M/14/30032015/School24/A6-bb]

When probes, she said why she mentioned that compared to school science;

> …"being here (School 20 – non-formal settings at multi-school outreach), I fell fresh…I got to do the activity with my own group here…we completed the assignment…although we did not won, but we learnt something (how to do make the balloon blast)…we tried many times here…"

6.3.4 S*tudents'* responses *to* science*? [in term of how helpful]*

Students were asked for their views on whether their engagement with MNSC help them in term of how helpful the activities for them. Four statements were used to construct a scale rating relating 'how helpful' their engagement with MNSC:

- How helpful was your engagement with MNSC in terms of:
    - Your school work? (item 15a)

- Understanding about science in your community? (item 15b)
- Getting an idea about what scientist do? (item 15c)
- Getting an idea about what MNSC does? (item 15d)

Cronbach's α for the four items were 0.660, which slightly lower than the value considered as acceptable by Pallant (2007). Pallant considered the reliability values above .7 were considered acceptable and the values above .8 were preferable. Despite of that, this scale was used in this study considering the researcher already conducted pilot study for the instruments and there was no problem relating this scale during pilot study period.

6.3.4.1 Do males and females differ in terms of their perception towards the helpfulness of their engagement to the activity conducted by MNSC?

The Mann-Whitney U test revealed the significance level was .527. This is more than the alpha level of .05, so there was no significant differences between males and females students in terms of how helpful their engagement with MNSC in helping with their 'school work, understanding about science in community, getting an idea about what scientist do and getting an idea about what MNSC does' (U = 14933.5, p = .00) at p>.05. The test statistics is presented in Table 6.33. Therefore, from this study, males and females students did not find their engagement with MNSC were helping them with their school work, understanding about science in community, getting an idea about what scientist do and getting an idea about what MNSC does. They found some enjoyment when engage with the MNSC but it didn't help them in their school work. From the interviewed session, it's happen that they were saying that they topic that MNSC covered still did not learnt in school classroom, hence the activities that they did were not helpful in any ways to their school work.

Table 6.33. Mann-Whitney U test to measure students' level of 'how helpful' their engagement with MNSC by gender

Construct / **Gender**	**Knowledge & Understanding**
Mann-Whitney U	14933.500
Asymp. Sig. (2-tailed)	**.527**

N = 353

6.3.4.2 Is there a significant difference on how helpful students' perceived success in working with the activities across age group?

The Kruskal-Wallis test to measure the significant difference in term of how helpful students' perceived success in their engagement with MNSC across age group is presented in Table 6.34. The Kruskal-Wallis test revealed the significance level was .001 (rounded). This is less than the alpha level of .05, so there were statistically significant differences between students in different age group in term of how helpful students' perceived success in their engagement with MNSC ($\chi2$ (3, N=353) = 20.644, p = .000) at p<.05.

Table 6.34. The Kruskal-Wallis test to measure the significant difference in term of how helpful students' perceived success in their engagement with MNSC across age group

Scale / Age group	Helpfulness
Chi-Square (χ^2)	20.644
df	3
Asymp. Sig.	.000

df – degree of freedom

11 and 13 years old student recorded a higher median score (M_d = 3.250 for each age group). The youngest and oldest student age group recorded the same lower median score compared to 11 and 13 years old student, by 0.5 score different (M_d = 2.750 for each group of 10 and 14 year old) (see Table 6.35).

Further analysis for the items 15a, 15b, 15c, and 15d (see Table 6.36) in the scale of 'helpfulness' shows students' responses in term of their perception toward the statement after their engagement with MNSC by age group.

Table 6.35. The median and mean rank score by age group in term of how helpful students' perceived success in their engagement with MNSC

Age Group	N	Mean Rank	Median
10 / Standard 4	79	147.99	2.750
11 / Standard 5	111	200.61	3.250
13 / Form 1	72	199.94	3.250
14 / Form 2	91	155.23	2.750

N = 353

Based on Table 6.36, 10 and 14 years old student found it not helpful or not at all helpful with the statement that their engagement with MNSC help in their school work (88.6% and 87.9% respectively responded negatively to the statement). For item 15b, 15c and 15d, 11 and 13 years old student responded positively to the statement compared to 10 and 14 years old student. For item 15b, 42.3% and 50.0% of student age 11 and 13 perceived that their engagement with MNSC help them understand about science in their community. 50.4% of 11 years old student and 54.2% of 13 years old student responded helpful or very helpful to the statement that their engagement with MNSC help them in getting idea about what scientist do.

Table 6.36. Student response to item 15a,15b, 15c and 15d on 'school work, understanding about science in community, getting an idea about what scientist do and getting an idea about what MNSC does' by age group

Agreement / Age group	VH (n, %)	H (n, %)	IB (n, %)	NH (n, %)	NAAH (n, %)
Item 15a: 'how helpful was your engagement with MNSC in terms of your school work'					
10 / Standard 4	-	3 3.8	6 7.6	35 44.3	35 44.3
11 / Standard 5	-	16 14.4	20 18.0	34 30.6	41 36.9
13 / Form 1	-	4 5.6	8 11.1	29 40.3	31 43.1
14 / Form 2	-	2 2.2	9 9.9	30 33.0	50 54.9
Total	**-**	**25 7.1**	**43 12.2**	**128 36.3**	**157 44.5**
Item 15b: 'how helpful was your engagement with MNSC in terms of understanding about science in your community'					
10 / Standard 4	-	19 24.1	27 34.2	25 31.6	8 10.1
11 / Standard 5	-	47 42.3	33 29.7	29 26.1	2 1.8
13 / Form 1	-	36 50.0	18 25.0	13 18.1	5 6.9
14 / Form 2	-	34 37.4	19 20.9	35 38.5	3 3.3
Total	**-**	**136 38.5**	**97 27.5**	**102 28.9**	**18 5.1**
Item 15c: 'how helpful was your engagement with MNSC in terms of getting an idea about what scientist do'					
10 / Standard 4	-	24 30.4	50 63.3	3 3.8	2 2.5
11 / Standard 5	1 0.9	55 49.5	51 45.9	4 3.6	-
13 / Form 1	-	39 54.2	33 45.8	-	-

VH	Vey helpful
H	Helpful
IB	In between
NH	Not helpful
NAAH	Not at all helpful

14 / Form 2	-	33 36.3	51 56.0	5 5.5	2 2.2
Total	**1** **0.3**	**151** **42.8**	**185** **52.4**	**12** **3.4**	**4** **1.1**
Item 15d: 'how helpful was your engagement with MNSC in terms of getting an idea about what MNSC does'					
10 / Standard 4	2 2.5	52 65.8	21 26.6	3 3.8	1 1.3
11 / Standard 5	1 0.9	87 78.4	20 18.0	3 2.7	-
13 / Form 1	-	63 87.5	9 12.5	-	-
14 / Form 2	-	64 70.3	20 22.0	5 5.5	2 2.2
Total	**3** **0.8**	**266** **75.4**	**70** **19.8**	**11** **3.1**	**3** **0.8**

($\chi 2$ (3, N=353) = 4.527, p = .004)

Likewise, for item 5d, 79.3% of 11 years old student and 87.5% of 13 years old student responded helpful or very helpful to the statement that their engagement with MNSC help them getting an idea about what MNSC does. In summary, it showed that all age groups of students did not find that their engagement with MNSC will help their school work, in understanding about science in community, in term of getting an idea about what scientist do and lastly getting an idea about what MNSC does. It shows that students did not find that their engagement in non-formal settings will help in any way about their school science and science in the community. It shows that non-formal science learning still lacking in Malaysia context.

6.3.4.3 *Is there a significant difference on how helpful students' perceived success in working with the activities between locations of engagement?*

The Kruskal-Wallis test to measure the significant difference in term of how helpful students' perceived success in their engagement with MNSC between locations of engagement are presented in Table 6.37. The Kruskal-Wallis test revealed the significance level was .012. This is less than the alpha level of .05, so there were statistically significant differences between students in different locations of engagement in term of how helpful students' perceived success in their engagement with MNSC ($\chi 2$ (2, N=353) = 8.810, p = .012) at $p<.05$.

Table 6.37. The Kruskal-Wallis test to measure the significant difference in term of how helpful students' perceived success in their engagement with MNSC between different locations of engagement

Scale / Locations of engagement	Helpfulness
Chi-Square (χ^2)	8.810
df	2
Asymp. Sig.	.012

df – degree of freedom

Students' engagement in single-school with MNSC recorded a higher median score (M_d = 3.250) followed by students' engagement in centre-based (M_d = 3.000) and lastly students in multi-school (M_d = 2.750) (see Table 6.38).

Table 6.38. The median and mean rank score between different locations of engagement in term of how helpful students' perceived success in their engagement with MNSC

Locations of engagement	N	Mean Rank	Median
Centre-based	58	196.07	3.000
Single-school	154	187.36	3.250
Centre-based	141	157.84	2.750

N = 353

Further analysis for the items 15a, 15b, 15c, and 15d (see Table 6.39) on the scale of 'helpfulness' shows students' responses in term of their perception toward the statement after their engagement with MNSC between different locations of engagement. Based on Table 6.39, majority of students find their engagement with MNSC not at all helpful in their school work (87.1% in single-school, 86.5% in multi-school, and 50.0% in centre-based responded negatively to the statement). They responded positively to the statement that their engagement with MNSC helpful in term of understand about science in their community (item 5b) and getting an idea about what MNSC does (Item 5d) .Whereas, for the statement that their engagement with MNSC help them in getting an idea about what scientist do, most of the student find it in between whether it help or not help in getting an idea about what scientist do (52.4% of overall students in three different locations of engagement responded in between).

Table 6.39. Student response to item 15a,15b, 15c and 15d on 'school work, understanding about science in community, getting an idea about what scientist do and about what MNSC does' between different locations of engagement

Agreement / Location of engagement	VH (n, %)	H (n, %)	IB (n, %)	NH (n, %)	NAAH (n, %)
Item 15a: 'how helpful was your engagement with MNSC in terms of your school work'					
Centre-based	-	15 25.9	14 24.1	9 15.5	20 34.5
Single-school	-	-	20 13.0	72 46.8	62 40.3
Multi-school	-	10 7.1	9 6.4	47 33.3	75 53.2
Total	**-**	**25 7.1**	**43 12.2**	**128 36.3**	**157 44.5**
Item 15b: 'how helpful was your engagement with MNSC in terms of understanding about science in your community'					
Centre-based	-	16 27.6	19 32.8	20 34.5	3 5.2
Single-school	-	89 57.8	34 22.1	25 16.2	6 3.9
Multi-school	-	31 22.0	44 31.2	57 40.4	9 6.4
Total	**-**	**136 38.5**	**97 27.5**	**102 28.9**	**18 5.1**
Item 15c: 'how helpful was your engagement with MNSC in terms of getting an idea about what scientist do'					
Centre-based	1 1.7	26 44.8	29 50.0	-	2 3.4
Single-school	-	74 48.1	66 42.9	12 7.8	2 1.3
Multi-school	-	51 36.2	90 63.8	-	-
Total	**1 0.3**	**151 42.8**	**185 52.4**	**12 3.4**	**4 1.1**
Item 15d: 'how helpful was your engagement with MNSC in terms of getting an idea about what MNSC does'					
Centre-based	3 5.2	38 65.5	16 27.6	-	1 1.7
Single-school	-	100 64.9	41 26.6	11 7.1	2 1.3
Multi-school	-	**128 90.8**	13 9.2	-	-
Total	**3 0.8**	**266 75.4**	**70 19.8**	**11 3.1**	**3 0.8**

VH	Vey helpful
H	Helpful
IB	In between
NH	Not helpful
NAAH	Not at all helpful

According to the student during the interview, "science seems to be something which is enjoyable and exciting, particularly when it has the element that it is something 'to play with'; unfortunately, the activities done here will not help with our school work

[P66/M/C/11/02042015/School1/A6.2-bb]". This view was further confirmed by a girl from school 10:

> "… engaging in the activity conducted by the MNSC make me have more interest in science, love science more but unfortunately it is not help in doing our school work".
>
> [P59/F/M/11/02042015/School10/A6.2-ic]

6.4 Summary

In this present chapter, students' perceptions towards science learning in non-formal settings were described. Findings shows that overall students' perception towards knowledge and enjoyment are very high upon engaging with the activities provided by MNSC and their perceptions towards attitudes and values at high level only. This regarded that students perceived knowledge gained and enjoyment the most as part of their opportunity engaged in non-formal learning activities.

In term of gender, the Mann-Whitney U test showed there were no difference between males and females students in terms of their perceived levels of 'knowledge and understanding', attitudes' and enjoyment' during their engagement with the activities conducted by MNSC.

Based on age group, there were no significant differences for the 'knowledge and understanding and 'attitude scale but there was a significant difference for the 'enjoyment' as students in higher age group were less positive compared to students in lower age group.

For different locations of engagement, the Kruskal-Wallis test shows there were significant differences between locations of engagement for the three scales measured in the study for the responses on knowledge and understanding, attitudes and enjoyment with MNSC which multi-school showed all higher positive responses towards knowledge and understanding, attitudes and enjoyment. Students' engagement in single-school responded lower to all the statements in the 'enjoyment' scale compared to students' engagement in centre-based and multi-school. This was maybe because although the out-of-school program conducted by MNSC, yet the students still learnt in the environment near the school area (physical factor) and engage with their peers only which was the same experience compared to students' experience at centre-based and multi-school outreach. Therefore, this research supports that physical context have an impact in determining the success of science learning in non-formal context (Falk and Dierking, 2000). Overall, the findings from this study can be used to look at the different factors affecting science learning in non-formal settings.

Chapter 7

Conclusions and recommendations

7.1 Introduction

This last chapter discusses and interprets the results of the research and presents significant findings, including the impacts of non-formal settings programs specifically on students' knowledge, attitudes and enjoyment towards science from the perspective of students, teachers and science educators. This discussion also centres these results in the existing research and provides recommendations for further research. In general, 7.3 section will discuss the findings from science educators' perception, 7.4 section about teachers' perceptions and 7.5 discussions about students' perceptions. Later, the summary of the three findings will be summarised.

7.2 Addressing the main findings

To recall, the overall aim of this study was to investigate science learning in non-formal settings. More specifically, this study examined the perceptions on knowledge, attitudes and enjoyment from school visits to the Malaysia National Science Centre (MNSC) from the perspectives of students, teachers and science educators. Three main objectives of this study were to;

1. Investigate science educators' actions and contributions to students' science learning in non-formal settings conducted by MNSC.

2. Investigate teachers' objectives for conducting school group visits to the non-formal settings; and
3. Investigate on how students perceived on knowledge, attitudes and enjoyment of school group science learning in non-formal settings conducted by MNSC.

Accordingly, the main conclusions drawn from the data collected were discussed in the context of these three objectives.

7.3 Findings of science educators' actions and contributions to students' science learning during non-formal programme conducted by MNSC

In this section, the findings of this study were divided into science educators' goals, roles, teaching approach and types of evaluations conducted and implemented in the non-formal settings. The report were write in such style so that we will get the general overview on how the practices of non-formal educators' in Malaysia specifically.

7.3.1 Science Educators' goals and roles in teaching in non-formal settings

In this recent study, the science educators' goals in teaching in non-formal setting includes as to create an awareness and appreciation towards science, to give a general concept and understanding of the science activities and to develop student's skills. Most of the science educators viewed their goals of teaching in the out-of-school contexts as to create awareness and appreciation towards science and the students have the general knowledge of the activities that they were engaged with and at the same time they will develop their process skills.

In this recent study, although there were three types of engagements which; centre-based, single-school and multi school outreach, and the roles of science educators were about the same which is as a leading instructional figure in the settings. They instructed class much like a formal educator in the classroom in that they created and used lesson plans to guide their instruction and incorporated physical activities and used verbal behaviours to engage students mentally. Similar to classroom teachers, non-formal educators desired cognitive and affective gains in science from their students, and believed that physical activities and mental participation were necessary to learning.

However, there were conditions that make the teaching in both settings different from one another.

At non-formal settings, the following circumstances proved as characteristics that distinguished them from science teaching in formal classrooms. Lessons taught by the educators were short, one-time student learning opportunities. Consequently, non-formal educators spent extensive time, resources, and effort in the development and implementation of their science classes in order to maximize their impact.

In the recent study with three different locations of engagement, formal assessments of student learning were not part of the lessons. As interviewed in the recent study, science educators normally will give an assessment of the lesson at the end of the teaching period, such as giving a question to ensure students understand what they learnt from the activities [SE3, SE8]. The lack of evaluations and judgements in these classes led to a certain amount of scope in their lesson plan design. However, non-formal educators informally assessed student prior knowledge and comprehension of the lesson, which influenced content discussed, amount of activities accomplished, and pace of the class. While there were no tests, there were also no follow-up afterwards. Thus, the educators targeted creation of worthwhile memories via physical activities as a way to encourage students to continue their interest and pursuit of scientific knowledge. Although they did not teach the same students every day, they capitalized upon repetition of the same lesson plan to improve their instruction. Thus, the lesson plans may improve and be refined over time with the same science educator, and this increased the little time they did spend with a group of students.

While non-formal educators had no control over the knowledge of school groups, they learn to assess student prior knowledge at the beginning of the lesson, and then made accommodations to the pace and cognitive level of their discussion accordingly. This was consistent with the fundamental principles of David Ausubel's work (1968) that centered on determining learner knowledge in order to make teaching relevant and productive for the learner.

> *"If I had to reduce all of educational psychology to just one principle, I would say this: The most important single factor influencing learning is what the learner already knows. Ascertain this and teach him accordingly"*
>
> (Ausubel, 1968)

Since students participating in science classes at non-formal settings arrived with such varying backgrounds, non-formal educators felt it was essential to establish their audiences' baseline knowledge promptly. Just as research identified the value of assessing student understanding preceding instruction in formal settings, non-formal educators discovered the advantages of establishing prior knowledge immediately through experience with thousands of students each year. Consequently, science class programs were created with generalizations to accommodate the majority, but had the flexibility to adapt to the individuality of each participating school group.

Furthermore, much like classes in formal school rooms, science educators followed lesson plans created for the classes, and content discussed within the lesson plans were usually correlated with school curriculum i.e., to support learning at school (Scarce, 1997; Tal & Morag, 2009), which is a connection to the ideas, concepts and content of science learning (Krepel & Duvall 1981). The lesson plan was used as an outline to guide the science educators through the lesson in an organized and timely manner. Like a classroom teacher, time to talk about and explore a science topic was limited. Considerable forethought and planning was needed in order to maximize on the intended goals. Regular delivery of the same class structure and activities to students of varying ages and knowledge enabled educators to refine their presentations of that class. From the observations from three different locations of engagement, the science educators used the same modules and quickly trying to adapt with the learning environment, students' age groups, variability of students' knowledge and experience and many other factors that may affect the effectiveness of their delivery. The science educators realized that each class of students arrived with their own needs, knowledge, and personality unique to that group of students.

As a way to improve their teaching, the educators used the lesson plan repetition to improve their teaching of that subject matter, to enhance interaction with a particular age group, and as a way to make their teaching more versatile. The educators were knowledgeable enough and able to deal with any emergency situations that happen when conducting the program in the non-formal contexts. Since they taught the same lesson plan regularly, they were able to shorten a lesson seamlessly, or elaborate on material briefly if something happen, as for SE1 in this study, the program conducted at multi-school outreach, 'bottle rocket' activities ran out of time, as the students asked many questions for the concepts that they did not understand, the lesson had to rush. Nevertheless, the educators managed to conclude the activity although it a bit rush.

Much like a classroom teacher, these non-formal educators had a limited amount of time to present, explore, and discuss the scientific content and concept of their lesson. In the traditional classroom, formal teachers have the added advantage of working with the same students over an entire school year. Thus, they have a better ability to guess of the students' prior knowledge and can follow up on student understanding or misunderstanding (Bernhardsson & Lattke, 2011). Science educators in non-formal settings did not have the opportunity to improve their interactions with the same students. However, repeated delivery of the same lesson plan afforded them the chance to improve upon the presentation of that lesson plan so that they maximized on the little time they had with a given group of students.

As mentioned by SE1, he contributed to improve of the materials used in the centre by looking at the new programs or activities through youtube or any other resources before discussed it with his colleagues. After that they will discussed the appropriateness and how to use it during teaching in the non-formal settings and evaluate the effectiveness of the programs. The nature of these educational institutions, gave non-formal settings access to resources not necessarily available to classroom teachers.

In non-formal settings, teaching was a significant component of science educators' job duties. The educators were not teaching all day and every day, thus there was time for reflection on class presentations and communicating with colleagues. Depending on the institution, multiple educators at one institution were teaching the same lesson plan or subject matter with the same parameters and criteria. Consequently, they could share strategies, or work on improving their approaches with the help of colleagues undergoing similar experiences. In addition, their personal interests were in science and nature, and the settings in which they worked specialized in this. As a result, materials and resources that further supported their interests surrounded them.

Facilitation and quality of the teaching generally is harder than it looks. The key to the long-term impact of this will be training of the science educators. Professional development in science was continually encouraged and made available to non-formal educators. SE8 for example were on ongoing study for her to better understand the teaching and learning in the out-of-school settings. As for SE1, he always trying to improve his approaches in teaching and updates with the latest information in this digital era by always looking up for professional development.

More commonly, continued science education arose from the non-formal educators' personal interest and curiosity coupled with the resources and time available for them to pursue such inquiries at work. The non-formal settings were locations intended to educate, encourage inquiry, and nurture curiosity in a more casual, self-paced format. Thus, the non-formal educators were immersed in an environment that allowed for their continuing education in science. However, there was no report of such professional development in education and pedagogy.

In non-formal settings, science educators incorporated physical opportunities in their lessons as a way to establish a more memorable lesson as an impact of active participation. The intention of using physical participations in the non-formal settings was to create memories that associated science with enjoyment and doable activities. Their belief that physical activities generated a lasting memory of the events that took place in the lesson, and the content and concepts presented was supported by research on teaching and learning in formal classrooms (Glasson, 1989; Renner et al., 1985), as well as explorations at non-formal settings (Flexer & Borun, 1984; Rix & McSorley, 1999; Wright, 1980). Besides, Duit and Treagust (1998) also recognizes the physical setting as an important factor in knowledge formation in non-formal context.

However, sensory experiences in all these lessons were brief and controlled by the science educator. Sensory operations invariably took place after the educator led a dialogue about the object, animal, or equipment. The items were either held up to the group or brought around to each individual student in a circle for closer examination and touchable opportunity. In one class (nature secret labs – moth and butterfly), small group of students was given a set of specimens (leaf) with which to work to studied about stomata. Meanwhile the educator led the exploration of each specimen, speeding through the lesson in order to "cover" all of the specimens in the box. Although the sensory opportunities were potentially hands-on because students were able to touch the item, they were also "minds-on" as they did allot time and opportunity for students to interact with, explore, or inquire about the items. This is because, in recent years, science education reform trends in the world have focused on prioritizing hands-on activities and scientific thinking in improving student science interest (Falk & Dierking, 2011; Nabors et al., 2009; Pugh & Bergin, 2005). Having said that, science learning in the non-formal settings not only hands-on in nature, but also minds-on to the students. However, there is need to keep in mind that even though students were given opportunities to make observations, they were brief and rushed. There was no time for students to generate questions and plan their own investigations. The same constraints that bound overall design of the lesson plans could also be responsible for these brisk tactile experiences. Nonetheless, if the overall purpose of the physical activity was to simply create a memory, touching a moth, butterfly, or different kind of rocks could leave a lasting impression upon the students.

7.3.2 Science educators' teaching approach in non-formal settings

In this research study, $RQ_{1\text{-}2}$: How do science educators teach science lesson in non-formal settings? was discussed. The type of questions asked were predominantly Yes/No or Fill-in-the-blank questions that prompted memory recall. In addition, these science educators rarely pursued student comments or questions with requests for elaboration or clarification if any only a brief elaboration due to time constraint. Their purpose for asking questions was primarily to mentally engage students in the lesson with the idea that such teacher behaviour would prompt students to reflect on the subject-matter and learn something from the activities. This activity contributes to the development of individual scientific concepts (Gelman & Kalish, 2006) where each activity provided representing the basic scientific concepts. It is considered enough for these science educators as long as students follow the instruction and managed to complete the task at the end of the lesson as long as the students can follow the lesson, they definitely learnt something

Science educators make an assumption that students generated connections between concepts and content (Krepel & Duvall 1981) w if provided the necessary information and prompts, which was consistent with their belief that teaching was sharing of information, and the educator played the role of information provider in the learning process. In three different locations of engagement observed in this study, most of science educators placed at the centre of the teaching and learning process and this is not necessarily unique to non-formal science educators as it could be driven by the constraint that bound the learning in out-of-school settings. Consequently, these science educators focused on disseminating information via experiences that hopes will create worthwhile memories to the students.

Meanwhile, for the lesson plan design and implementation, the science educators introduced a content area and led a discussion, showed an item related to the discussion, and then moved on to the next item once dialogue and display by the teacher were complete (moth and butterfly, rock store carbon, stoma). Science educators were the content expert (Tran, 2008; Kamolpattana et al., 2015) in non-formal settings. Students were usually allowed to touch and examine the item closer to further reinforce what was said, but this did not necessarily take place immediately following discussion about the item. Nevertheless, the educator remained at the focal point of the entire lesson.

The initial topic and inquiries of the lesson in non-formal settings, in which students were participating were not necessarily driven by student interest as their teacher already agreed for a scheduled program and tours. This was contradicting with Falk and Dierking (2002), whose stated that “students are given the opportunity to determine their own learning and level of participation, what they need to learn, and the time they use to complete certain tasks”. The classroom teachers determined the subject- matter of the lesson when they scheduled the class based on their needs and perception of student interest. Meanwhile, the non-formal educators decided on the experiences and activities they desired to convey in order to arrive at the general goals they had set forth prior to meeting the students. Thus, these science classes offered in non-formal settings were not designed as student-centred programs, despite the fact it involved hands-on activities. As the teacher determined the subject-matter of the lesson when they scheduled the class to out-of-school setting, they had a choice in determining which programs that will met their objectives. In the single and multi-school outreach in this study, the teacher had no choice as they science educators already planned the scheduled for the activity. Therefore, in fulfilling school needs, the collaborations between the science educator and teacher were very important to accommodate the needs of the target audience (students) been met.

The findings from the interview analysis with science educators also found that as a science educator, the role that a science educator should take is to have the subject knowledge about the program they were taught to students, and science educators were also required; (i) associating science knowledge with the contextual knowledge of the student; (ii) knowing the latest development of the expert components and (iii) lifelong learning. In science learning, linking science knowledge with contextual knowledge of students allows one to build their own understanding and indirectly active learning has taken place in their minds (Guess, 2004). This contextual learning method combines content with the daily experience of individuals, communities and work environment. This method provides concrete learning involving hands-on and mind-on activities. Therefore, in non-formal learning, it is important that science educator be able to link science knowledge with student experience. This finding is supported by Contextual Model by Falk and Dierking (2000) as well as Falk and Storksdieck (2005) which states that contextual learning is based on the free-choice based learning concept. This finding is in line with the finding by Kamolpattana et al. (2015) which states that science educators need to intelligently associate the subject’s knowledge with everyday life.

7.3.3 Evaluation

This section discussed 'RQ1-3: To what extent science educators' objectives met from the visit?'. As mentioned in section 4.6 in Chapter 4, for years, science centre and museums have relied on evaluation as a way to monitor their success in terms of visitor opinions and perceptions of exhibits and programs offered. As per research under study, science educators were asked on how they evaluate the effectiveness of their programs to the students in general and the responses were they only evaluate their teaching based on the responds from students when they were asked and through questionnaire survey of the effectiveness of their teaching (but the researcher did not saw any evaluation form distributed during the study period). Therefore, an evaluation plan of the impact of the programs must be considered for future research.

The future research on this aspect is important as although the assessment in the context of non-formal learning is not as important as formal learning, but according to Bernhardsson and Lattke (2011), science educators should also evaluate learning outcomes in the activity conducted whether met the goals or objectives stated for the learning in the non-formal context. As interviewed in the recent study, science educators normally will give an assessment of the lesson at the end of the teaching period, such as giving a question to ensure students understand what they learnt from the activities [SE3, SE8]. The lack of evaluations and judgements in these classes led to a certain amount of scope in their lesson plan design. The study by Tran (2007) found that evaluation aspects is a very critical skill in non-formal learning. According to Tran, science educators need to have a quick assessment of the existing knowledge of the students before any learning activities were carried out.

7.3.4 Summary of Science Educators' action and contribution to students' science learning during out-of-school programme conducted by MNSC

All in all, the findings from science educators' perceptions towards students' science learning in the out-of-school settings can be shown as Figure 7.1.

Goals	**Roles**	**Evaluation**
• Nurturing and interest and appreciation for science • science in daily life • develop skills • remember content	• teacher • facilitator • science communicator	• informally • ask at the end of the lesson • ask to fill in the form

Figure 7.1. Summary of the findings from science educators' perspectives

In summary, it could be listed that the goals of the science educators interviewed in this study are as i) Awareness and appreciation towards science; ii) General concept understanding of the science activities; and iii) Develop skills. The majority of the science educators viewed their goals of teaching in the out-of-school contexts as to create awareness and appreciation towards science and the students have the general knowledge of the activities that they were engaged with and at the same time they will develop their process skills.

The science educators believe that their roles in teaching and learning in the out-of-school settings as a facilitator, science communicator or a teacher, with the objectives in the mind to facilitate, to convey the information, and scaffold the students when in doubt. In the class observed, science educators mingled with the students during group work to help students doing the experiment, collect data, identify the problems, or keep them on task. Students also asked questions to science educator if there were any information that they did not understand. Students were asked to share their findings with the class (Balloon blast) and need to communicate why they chose to do the activity that way and the primary concepts involved in the study. Other groups were asked to evaluate the findings. From interviews, science educators stated that they only evaluate their teaching in the non-formal settings based on visitor opinions and perceptions of exhibits and programs offered.

7.4 Teachers' role in students' engagement in the activities

There were potential benefits and challenges when engaging students in non-formal learning experiences such as partnerships between schools and science centres. A first step for getting teachers involved in the use of science museum visits as a learning instrument is to know what teachers think about school visits to science museums and their role in these visits (Morentin & Guisasola, 2013). Therefore, identifying different school visits to out-of-school settings helps us gain a better understanding of different teacher intentions, objectives and plans used during these visits to out-of-school settings. In this study, three different locations of engagement were observed.

From the observations from this study, the decision to conduct a school visit is only partially the teacher's, as many have pointed to restrictions in choosing when, where and even whether to go. It is likely, then, that this school context, as well as the personal context play important roles in. determining the teacher's motives for leading the school visit in the first place. One of the challenges in supporting teachers' roles in school visits to out-of-school settings, may be prompting them, to consider their purpose for the visit. As demonstrated by Griffin and Symington (1997), teachers may not be aware of their reason for conducting the visit until asked. Simply encouraging teachers to consider why they were taking their students on the visits, either as part of their reservation form or as a separate checklist item included with the preparation materials, may provide some beneficial results to the visit to their students in general. In this study, from the questionnaire survey, amongst the objective stated by the teachers were; i) to connect with curriculum; ii) to expose students to new experiences; iii) to foster student interest and motivation; iv) to provide a learning experience; v) to provide a change of setting or routine; vi) to strengthen concept and theory; vii) to satisfy school expectation; and viii) no objective were stated by the teachers.

Teachers were asked what they planned in order to achieve the target objectives. Unfortunately, most of the teacher (40 out of 40) did not prepare the worksheet in advance about the visit to the out-of-school settings, since they said the centre will prepare it for them. However, 31 of the teachers stated that they discussed with students in the class about the visit since the teacher already decided which programs they were to follow in the out-of-school setting; since they were responsible in organising the visits in order for students to benefit from social and personal experiences related to science. Their task finishes, however, once the visit is organised and the science educator is seen to be taking care of the students. More than half of the teacher (57.5%) did not plan any strategies for the visit. However, although they did not plan any specific activities for the visit, they believe that the visit is connected with what is taught in class. According to DeWitt and Osborne (2010), by relating the ideas they are likely to be familiar with from school and everyday life, it can help students develop their knowledge and understanding from their visit experiences. In this study, the teacher acknowledges the opportunities to see the experiments offered by MNSC and the possibility of students performing them.

To sum up, teachers' views on their students' participation were positive even though teachers were not 100% committed to the programme. They evaluated the students' gained facts and information by engaging with the activities conducted by MNSC as high especially in terms of information about MNSC, fact about themselves, subject specific facts (e.g., mathematics, science) and inter-disciplinary or thematic facts (e.g., science and technology). They also evaluated the students' responses to science as very high especially in terms of their courage and determination to complete the tasks. Furthermore, they also rated that their students really enjoyed when doing the activities at the out-of-school settings as the students enjoyed the experiences, excited by new ways to learn and they amazed by the students inspired to create something creative while doing the activities with MNSC. The teachers believed their students serious engagement with the activities conducted by MNSC had polished their interest in science and revealed the talent and courage they have within themselves and has a sense of belonging in communities. The students seem to acknowledge their abilities in doing the activities provided by MNSC; i.e., they need to do the experimental part in the activities by themselves in the non-formal settings. Hence, it can be concluded that the teachers believed that participating in the activities conducted by MNSC in the non-formal settings is beneficial yet demanding for students, teachers and science educators' cooperation. Figure 7.2 shows the summary of the finding from teachers' perspectives.

Objectives	Plan the visit	Perceptions on student learning

• to expose the students with new learning experience
• environment out-of-school classroom
• to satisfy school expectations and requirement
• as a place for escape from school
	• discussed with the students in the class about the visit (77.5%)	• knowledge
		• enjoyment
		  • enjoyed by the experience
		  • excited by new ways to learn (90.0%)
		• attitudes

Figure 7.2. Summary of the findings from teachers' perspectives

7.5 Students' engagement in the activities

Students' perceptions towards science learning in non-formal settings were described to answer the research questions, RQ_{3-1}: What do students' gained from their engagement with MNSC in term of students' responses to science?. Finding showed that the overall students' perception towards knowledge and enjoyment were very high upon engaging with the activities provided by MNSC and their perceptions towards attitudes and values at high level only. This regarded that students perceived that they gained knowledge and enjoyment the most as part of their opportunity in engaging with non-formal settings learning activities. It was very important in the regard that an enjoyable and successful visit experience is an important outcome because it can predispose the learner to engage in further cognitive learning (Rennie, 1994). Motivation and willingness to engage in further instruction were most likely to be the important affective outcomes of a visit. In terms of other affective outcomes relating to science, a short visit is more likely to raise students' awareness about science, scientists and future careers than to result in a fundamental change of attitude with respect to these things, although this may also occur.

For the research question, $RQ_{3-2.1}$: Is there any differences on impact on students between centre-based, single and multi-school outreach in term of attitudes; [is there any differences on impact of students between different locations of engagement and attitudes towards science?]. In general, students agreed that the activities were easy to use, and they experienced success in using them. Students also found that the most helpful feature of the engagement in term of getting an idea of what MNSC does, as they involved with the activities conducted by MNSC and interacting with their peers. The previous research done by Davidson, Passmore, & Anderson (2010) and (Dunlop et al., (2018) demonstrated how students placed high value and importance on social interactions with their peers and the current research also showed similar patterns.

Males and females students in terms of their perceived levels of 'knowledge and understanding', attitudes' and enjoyment' during their engagement with the activities conducted by MNSC showed there were no significant difference. Whereas, based on age group, there were no significant differences for the 'knowledge and understanding and 'attitude scale but there was a significant difference for the 'enjoyment' as students in higher age group were less positive compared to students in lower age group (Barmby et al., 2008; Salmi, 2003; Senturk & Ozdemir, 2014).

The physical context showed an important contribution towards science learning in non-formal settings. Between different locations of engagement, the Kruskal-Wallis test shows there were significant differences between locations of engagement for the three scales measured in the study for the cognitive responses (knowledge and understanding, attitudes and enjoyment) with MNSC which multi-school showed all higher positive responses towards knowledge and understanding, attitudes and enjoyment. Students' engagement in single-school responded lower to all the statements in the 'enjoyment' scale compared to students' engagement in centre-based and multi-school. This was maybe because although the out-of-school program conducted by MNSC, yet the students still learnt in the environment near the school area (physical factor) and engage with their peers only which was the same experience compared to students' experience at centre-based and multi-school outreach. Therefore, this research supports that physical context have an impact in determining the success of science learning in out-of-school classroom context (Duit & Treagust, 1998; Falk and Dierking, 2000).

Through this research, I have come to understand that it is critical to recognize that students' perceived knowledge, attitudes and enjoyment are parts of an entwined and complex web of factors that influence their academic achievement. The components I set out to understand - knowledge, attitudes and enjoyment - are not separate from each other but rather nested within and overlapping with many other influential factors such as social context, physical context, personal context, school community, student-teacher relationships, student-science educator relationship, student self-perceptions, societal expectations. The exact effects of a program or the individual factors that promote success of a student cannot be identified in isolation from other influences. Therefore, to be successful, initiatives promoting student success must employ a holistic approach that addresses the complexity of students' lives and that adapts any initiatives accordingly. Overall, the findings from this study can be used to look at the different factors affecting science learning in out-of-school settings.

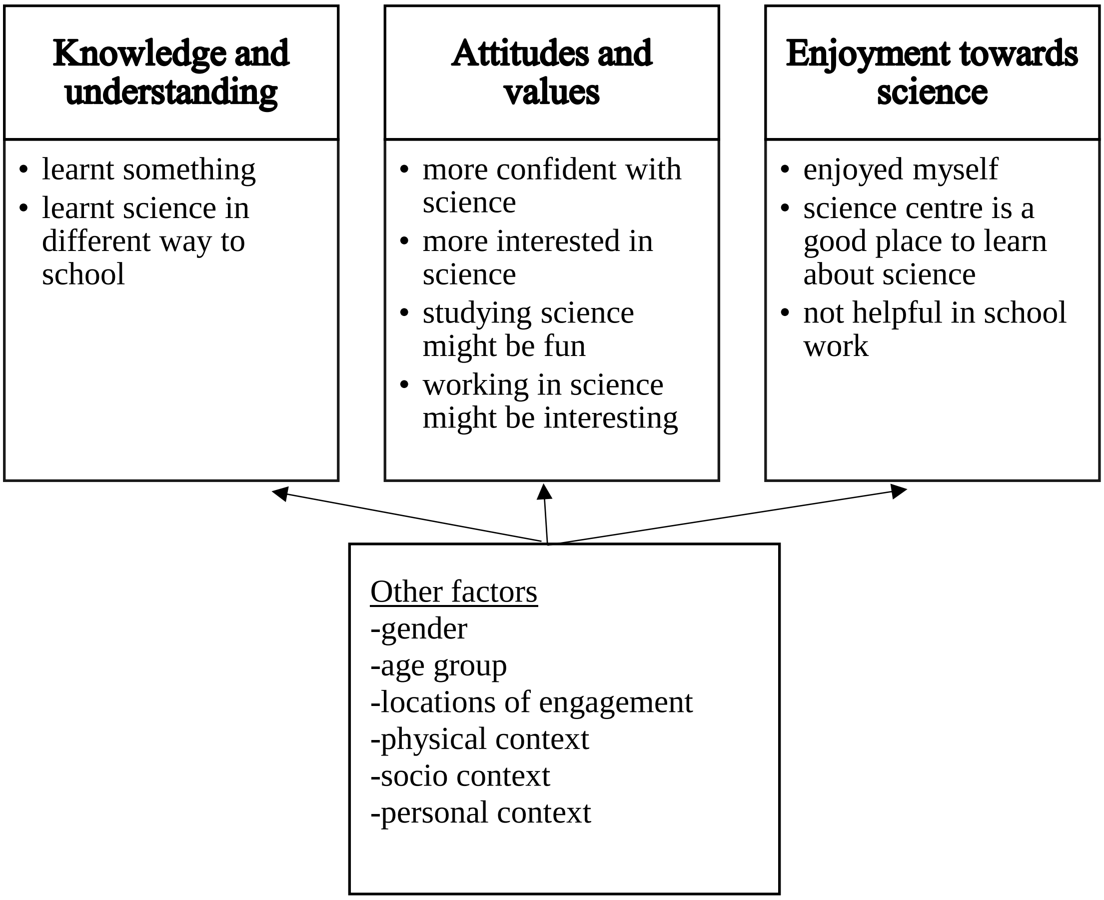


Figure 7.3. Summary of the findings from students' perspectives

7.6 Implications of the research

7.6.1 Science Educator

Another implication is that if science educators want to have a strong influence on student learning, they need to work closely with teachers to ensure there have a clear, explicit learning goals, that the science educator knows how the school visit fits in with classroom activities, and what the students want and expect from the trip. The findings from the current study showed that the science educators believe that their teachings were related to the science curriculum in schools, but only sometimes what they teach is not parallel with students' age (cases where they did not know students' age in advance).

The empirical study of this chapter is an effort to add to the existing knowledge of the competencies of science educators, specifically in the non-formal context. In non-formal science education, the role of the science educator is very important, as it can encourage and facilitate science centre's visitors to explore science and thus develop scientific literacy. Being scientifically literate is one of the ways to empower society to deal effectively with the economic and environmental impacts of globalization. The findings on the SE's roles, goals identified in this study will help science educators to improve their skills and knowledge in non-formal settings. SEs should be encouraged to reflect on their competency achievement and evaluate the extent of their proficiency in conducting daily tasks, so that they can do their job effectively. This could be done as part of an in-service training or a professional development course.

7.6.2 Teacher

The main implication of these findings is that, to maximize the learning potential of school visits to the non-formal settings, teachers need to have clear, explicit learning goals that are tied to classroom-learning activities. This confirms previous research on the importance of classroom pre- and post-trip learning (see, e.g., Anderson, Lucas, Ginns, & Dierking, 2000; Falk &Dierking, 1992). The results from this study suggest, at least in these two cases, that classroom teachers have an important role in shaping their students' visit's experiences, not only what students do, but how they view the school group visit, what they value and focus on, what they see as the purpose of the visit, and what they remember about it.

7.6.3 Student

The main concerns of this study is towards students' learning during school visit to non-formal learning. Students' desires for social interaction should be harnessed to enhance engagement in learning activities on school visits. This could be brought about by allowing students to be in groups with their friends and could be focused by having students discuss what they saw, learned, and enjoyed with each other (Griffin, 2004). Besides, research showed that students placed high value and importance on social interactions with their peers (Davidson et al., 2010; Dunlop et al., 2018).

7.7 Contribution to knowledge

From the responses received, this study can contribute to our understanding of several aspects of knowledge of this whole issue. The findings of this study are expected to benefit teachers and science educators and students in general. Among the contributions and suggestions of further studies are as follows:

7.7.1 Contribution in the field of research

This study has significant contributions in strengthening the implementation of non-formal science learning in Malaysia's education system. The findings of this study have introduced a new approach in non-formal learning inquiry by combining theoretical approaches with non-formal science learning models. Based on these findings, a non-formal science learning framework is recommended and can be used by teachers as well as science educators as a guide for student learning during the course of school visits to the non-formal settings. The framework can be used as a guideline to stakeholders (teacher, schools administrator, science educator) in planning activities, learning management and learning models in non-formal settings. This framework can also be used in the development of professionalism of science educators as well as science teachers in the effort of empowering non-formal science learning as a complement to formal science learning in the classroom. This study has also triggered new perceptions related to non-formal science learning through formal school visits that have been solely lacking in Malaysia context. This study contributes to new knowledge and pioneered the support system required by students in school in fulfilling the diversity of student learning styles especially in non-formal science education. Although the participation in non-formal programs conducted by science centre whether at centre-based, single and multi-school outreach has promoted increased student understanding of science at the upper primary and lower secondary level. The participation has also promoted interest in the topic. Although a single-session programme is likely to have less impact on long-term learning than a similar programme with extended exposure times for students, it appears that these types of programmes should not be dismissed lightly. Even a one-hour hands-on programme can contribute significantly to learning, as in this research, the activity conducted as appeared in Appendix M.

7.8 Limitations of the Study

The study used intact school groups that were visiting the science centre; and the schools that were already contacted the centre to follow the scheduled tour provided by the centre; hence, there was no random sampling but opportunistic sampling. Since intact groups were used, boys and girls were not represented in equal numbers. There were a higher number of girls in the study. Also, students were not homogenous, coming from varying socio-economic groups, age groups, ethnic origin/group, schools, and ability levels.

Although in this study, interview was used as research tool, but it was not in-depth. Therefore, to get a greater meaning from the study, an in-depth interview is encouraged. The study would have benefitted from further qualitative data such as in-depth interviews to assess deep student learning from their engagement with MNSC. This study, however, was in an initial phase to evaluate the usefulness of non-formal learning programme in stimulating interest in and understanding of science learning activities among students age 10-14 years old.

However, the constraints of classes in non-formal settings, e.g. short lessons, one-time interactions with the students, and not knowing students' prior knowledge antecedent to developing and delivering the lesson, might require some modifications of these approaches. In addition, this study involved three different locations of engagement in the study. Therefore, it might have many invisible constraints that need to cover. Nonetheless, the potential of science learning in non-formal settings to supplement or enriching the science learning in formal classroom is there. To take advantage of this possibility, an understanding of the teaching strategies of science educators are using in non-formal settings must first be established together with teachers' objectives for conducting school group visits.

It is must be cautioned that these findings should not be generalised as they are limited by the contextual, educational and cultural differences. But rather it can be relatable to other non-formal institutions in Malaysia if having the same concepts under study. Having said that, within the limitations of time, manpower and fund allocated, the researcher has tended her best efforts to provide as accurate as possible in interpreting the perceptions on knowledge, attitudes and enjoyment towards science in non-formal settings from the perspective of students, teachers and science educators.

7.9 Future Considerations and Recommendations

Researching the learning in non-formal settings were challenging because the outcomes are rather broad (Smith-palmer, Schnepf, Sherman, Sullenger, & Macdonald, 2015). The response to non-formal learning is unique to the individual's own personal experience and varies by context. In this study, a variety of research tools were used in order to cover the varied responses of the participants (survey questionnaire, interview and observation). However, further research is needed into ways to successfully collect data from young children, as in this study, it only involved a limited times of data collection period. A more thorough research tools need to be develop as young students often influenced by their peers, as well as the way a question is posed.

Future work could also incorporate a greater focus on understanding what conditions foster the long term learning of science in non-formal settings. Specific focus could be placed on ways to bridge the gap between the theoretical understanding of learning and the practical application in these non-formal settings where we continue to ask ourselves how can be even better designed and implemented to facilitate science learning in non-formal context. If further study is conducted, there should be specific criteria for selecting the sample of the schools (the students), and maybe should introduced the control schools. As for this research, the initial plan to conduct the research at MNSC, but due to technical problem, the locations of engagement of this research rather split to three categories, centre-based, single-school and multi-school outreach.

The actual collection of data for this study was conducted in the three different locations of engagement, at the MNSC (centre-based), single and multi-school outreach, on February - May 2015, spanning a period of only three months. A more extensive study over a longer period of time (longitudinal study) and covering a wider spectrum of programmes, galleries, and visitors would provide further support for the generalizability of the findings. As the present study is a combination of questionnaire survey and interview (it only examines the perceptions of visitors only once during a particular visit). Follow-up studies or a longitudinal study to investigate any changes in the students' knowledge, attitudes and enjoyment towards science would provide further information on the impact of their engagement.

Another study that could be given due consideration is to evaluate the actual learning that has taken place after visiting the centre. A quasi-experimental design involving pre and post-tests could probably be used to determine the effectiveness of the programs and activities in conveying specific scientific concepts.

According to evidences that we obtained from this study, further recommendations are needed for the following stages:

i. An awareness should be raised among all teachers and pre-service teachers about non-formal learning/teaching.

ii. Besides formal education, new strategies and educational policies should be developed, implemented and generalized about non-formal education in every stage of education, and an awareness should be raised in public about science learning in non-formal settings.

iii. There should be established a bridge between schools and the non-formal settings in Malaysia.

iv. Although the current study focused on three important key players in non-formal settings, but the focus was too broad (as the science educators, teachers and students had their own agenda when involved in school group visits). Therefore, for further research, the researcher should choose for example only one dependent variable that want to focus on (for example the motivations by the three key players) towards science learning in non-formal settings.

v. Identifying the competencies is a beginning to the professionalization of science educators. Competencies can also be acquired by the science educators in non-formal settings (at their workplace). Thus, future studies might measure the gap between acquired and expected competencies for science educator, so that planning for in-service training can be more effective. Identifying competencies at the micro-level related to the various tasks of science educators is also important. This would enable science educators to follow a more focused professional development programme.

vi. An evaluation plan to measure the effectiveness of the programs must also be considered.

vii. A comprehensive framework for implementation of science learning in non-formal settings from all the stakeholders (science educator, teacher, administrator, principal, ministry, community, parents, students) should be established.

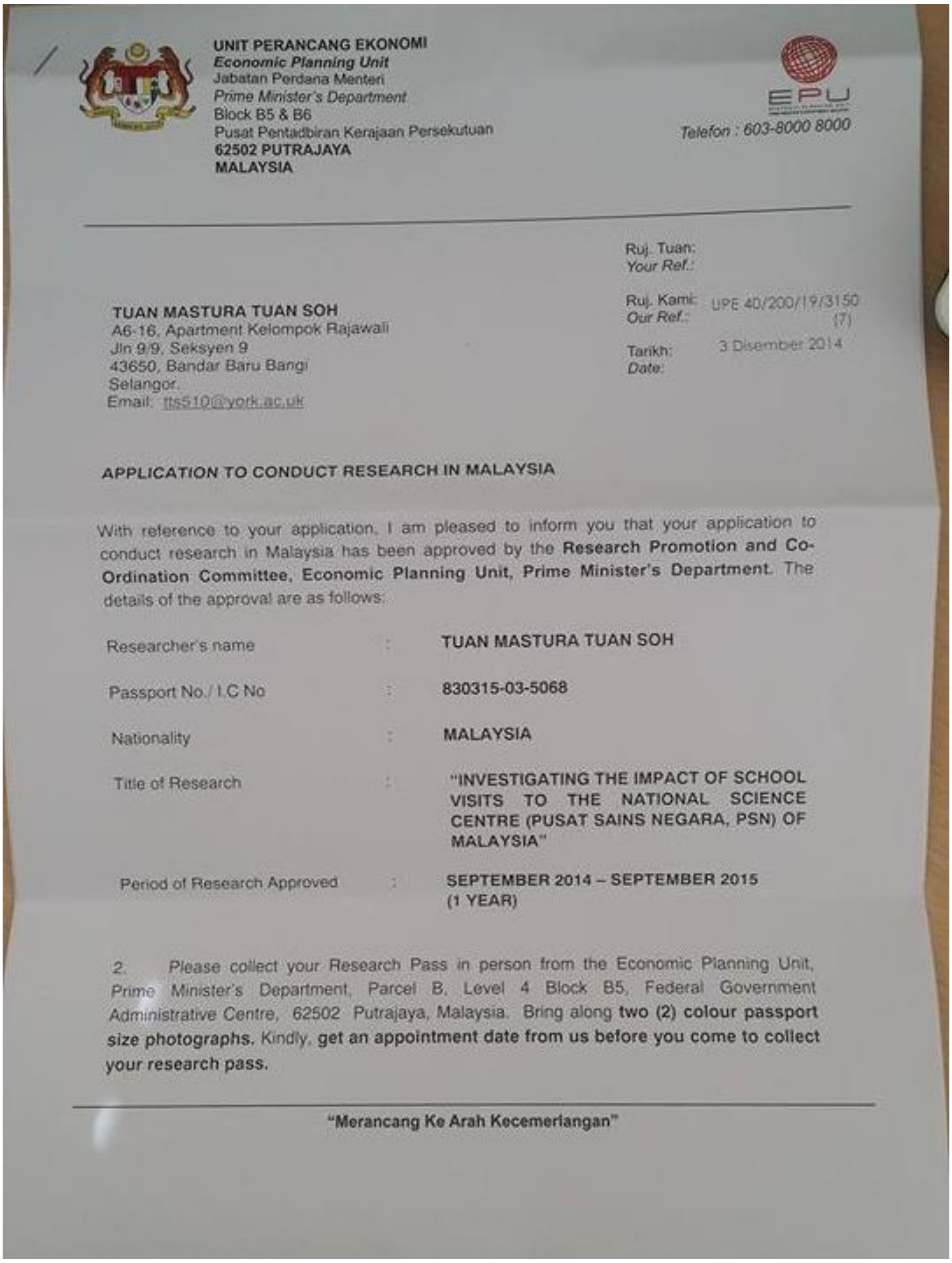
7.10 Concluding comments

The findings of this research indicate that the students' perceived science learning in non-formal settings in term of knowledge, attitude, and enjoyment were positive. The teachers believed their students' active engagement with the activities conducted by MNSC had polished their interest in science and revealed the talent and courage they have within themselves and has a sense of belonging in communities. The students seem to acknowledge their abilities in doing the activities conducted by MNSC; i.e., they need to do the experimental part in the activities by themselves in the non-formal settings. Hence, it can be concluded that the teachers believed that participating in the activities conducted by MNSC in non-formal settings is beneficial yet demanding for students, teachers and science educators' cooperation. The majority of the science educators viewed their goals of teaching in the out-of-school contexts as to create awareness and appreciation towards science and the students have the general knowledge of the activities that they were engaged with and at the same time they will develop their process skills.

Therefore, from the findings in this study, it was clear that this activity in non-formal settings benefited people for all stages; students, teachers and science educators in general. In summary, there are potential benefits and challenges when engaging students in non-formal learning experiences such as partnerships between schools and science centre. From literature, non-formal learning experiences have the potential to create a more rich and vibrant learning environment for students that is closer to the real work of scientists. Other potential benefits include increasing scientific literacy through a broader definition of cognitive learning goals, as well as increasing student enthusiasm for science through a conscious focus on affective learning goals. Learning outcomes are more likely to be realized when schools and science centre communicate and synchronize learning objectives and then work together to realize them. This requires clear consistent communication, reflection, and evaluation among all stakeholders involved including: students, teachers, parent volunteers, administrators, science educators, and museum partnership coordinators. This represents a revealing insight into the views of the three main respondents in this study, science educator, teacher and student in science learning in out-of-school settings.

APPENDIX A.

<u>APPROVAL LETTER FROM ECONOMIC PLANNING UNIT AND RESEARCH DIVISION (EPRD) OF MALAYSIA</u>



UNIT PERANCANG EKONOMI
Economic Planning Unit
Jabatan Perdana Menteri
Prime Minister's Department
Block B5 & B6
Pusat Pentadbiran Kerajaan Persekutuan
62502 PUTRAJAYA
MALAYSIA

Telefon : 603-8000 8000

Ruj. Tuan:
Your Ref.:

Ruj. Kami: UPE 40/200/19/3150 (7)
Our Ref.:

Tarikh: 3 Disember 2014
Date:

TUAN MASTURA TUAN SOH
A6-16, Apartment Kelompok Rajawali
Jln 9/9, Seksyen 9
43650, Bandar Baru Bangi
Selangor.
Email: tts510@york.ac.uk

APPLICATION TO CONDUCT RESEARCH IN MALAYSIA

With reference to your application, I am pleased to inform you that your application to conduct research in Malaysia has been approved by the **Research Promotion and Co-Ordination Committee, Economic Planning Unit, Prime Minister's Department**. The details of the approval are as follows:

Researcher's name	:	**TUAN MASTURA TUAN SOH**
Passport No./ I.C No	:	**830315-03-5068**
Nationality	:	**MALAYSIA**
Title of Research	:	**"INVESTIGATING THE IMPACT OF SCHOOL VISITS TO THE NATIONAL SCIENCE CENTRE (PUSAT SAINS NEGARA, PSN) OF MALAYSIA"**
Period of Research Approved	:	**SEPTEMBER 2014 – SEPTEMBER 2015 (1 YEAR)**

2. Please collect your Research Pass in person from the Economic Planning Unit, Prime Minister's Department, Parcel B, Level 4 Block B5, Federal Government Administrative Centre, 62502 Putrajaya, Malaysia. Bring along **two (2) colour passport size photographs.** Kindly, **get an appointment date from us before you come to collect your research pass.**

"Merancang Ke Arah Kecemerlangan"

3. I would like to draw your attention to the undertaking signed by you that you will submit without cost to the Economic Planning Unit the following documents:

a) A brief summary of your research findings on completion of your research and before you leave Malaysia; and

b) Three (3) copies of your final dissertation/publication.

4. However, you are required to avoid using samples from exam classes.

5. Lastly, please submit a copy of your preliminary and final report directly to the State Government where you carried out your research. Thank you.

Yours sincerely,

(MUNIRAH BT. ABD MANAN)
For Director General,
Economic Planning Unit.
E-mail: munirah@epu.gov.my
Tel: 88882809
Fax: 88883798

ATTENTION

This letter is only to inform you the status of your application and **cannot be used as a research pass.**

APPENDIX B.

APPROVAL LETTER FROM NATIONAL SCIENCE CENTRE OF MALAYSIA (MNSC)

MOSTI

PUSAT SAINS NEGARA
NATIONAL SCIENCE CENTRE
KEMENTERIAN SAINS, TEKNOLOGI DAN INOVASI
MINISTRY OF SCIENCE, TECHNOLOGY & INNOVATION
PESIARAN BUKIT KIARA
BUKIT KIARA
50662 KUALA LUMPUR

PUSAT SAINS NEGARA
Telefon: 03-20921150
Telefax: 03-20921250
http://www.psn.gov.my

Ruj. Kami: *Our Ref.:* PSN. 6304 Jld. 23 (12)

Tarikh: *Date:* 2 September 2014

Tuan Mastura Tuan Soh

Puan,

KEBENARAN MENJALANKAN KUTIPAN DATA BAGI KAJIAN TESIS PH.D MENGENAI PEMBELAJARAN DI LUAR BILIK DARJAH

Berhubung perkara tersebut di atas, adalah dimaklumkan bahawa Pusat Sains Negara dengan ini memberi kebenaran kepada puan untuk melaksanakan kutipan data bagi penyelidikan puan.

2. Walau bagaimanapun, pihak puan perlu mematuhi apa-apa jua prosedur/sistem sedia ada yang digunapakai oleh Pusat Sains Negara sebagai sebuah badan Kerajaan. Dengan ini, PSN mengucapkan selamat maju jaya dalam melaksanakan kajian puan.

Sekian, terima kasih.

'BERKHIDMAT UNTUK NEGARA'

Saya yang menurut perintah,

(PROF. MADYA DR. IRMAWATI RAMLI)
b/p Pengarah Pusat Sains Negara

APPENDIX C.

Support Letter from University of York

THE UNIVERSITY of York

Professor Judith Bennett
Salters' Professor of Science Education

DEPARTMENT OF EDUCATION
The University of York
YORK YO10 5DD
England

Telephone 01904 323471
Fax 01904 323444
International +44 1904 + number
e-mail judith.bennett@york.ac.uk

TO WHOM IT MAY CONCERN

10 November 2014

Dear Sir/Madam,

Ms Tuan Mastura Tuan Soh [Student ID: 109006574]

Ms Tuan Mastura Tuan Soh is currently enrolled on the PhD programme in the Department of Education at the University of York and I am one of her supervisors. As part of her research, Ms Mastura would like to carry out data collection at the National Science Centre in Malaysia from February to April 2015 in order to find out how participating in activities offered by the centre affects school students' interest and engagement with science.

I support her application for approval to collect data, and I hope you will agree to the request.

Yours faithfully,

Judith Bennett

Professor Judith Bennett

APPENDIX D.

Ethical Issues Audit Form from University of York

UNIVERSITY of York

Education Ethics Committee
Ethical Issues Audit Form

This questionnaire should be completed for each research study that you carry out as part of your degree. Once completed, please email this form to your supervisor. You should then discuss the form fully with your supervisor, who should approve the completed form. **You must not collect your data until you have had this form approved by your supervisor (and possibly others - your supervisor will guide you).**

Surname / Family Name:	Tuan Soh
First Name / Given Name:	Tuan Mastura
Programme:	PhD In Education Sciences
Supervisor (of this research study):	Prof Dr Judith Bennett and Dr Lynda Dunlop
Topic (or area) of the proposed research study:	
Investigating the impact of school visits to the National Science Center (Pusat Sains Negara, PSN) of Malaysia	
Where the research will be conducted:	
Pusat Sains Negara (PSN) @ National Science Centre of MALAYSIA and follow-up interview in the school involved in the study	
Methods that will be used to collect data:	
Questionnaire Survey, Semi-Structured Interview, Observations	
If you will be using human participants, how will you recruit them?	
Through PSN, ideally in advance of their visit.	

Supervisors, please read *Ethical Approval Procedures: Students*. Note: If the study involves children, vulnerable participants, sensitive topics, or an intervention into normal educational practice, this form must also be approved by the programme leader (or Programme Director if the supervisor is also the Programme Leader); or the TAP member for Research Students. It may also require review by the full Ethics Committee (see below).

First approval: by the supervisor of the research study (after reviewing the form):
Please select one of the following options.

I believe that this study, as planned, meets normal ethical standards	☒
I am unsure if this study, as planned, meets normal ethical standards	☐
I believe that this study, as planned, does not meet normal ethical standards and requires some modification	☐

Supervisor's Name (please type)	Prof Dr Judith Bennett and Dr Lynda Dunlop
Date:	16 June 2014

Supervisor - If the study involves children, vulnerable participants, sensitive topics, or an intervention into normal educational practice (see *Ethical Approval Procedures: Students*), please email this form for second approval to the Programme Leader (or Programme Director if the supervisor is also the Programme Leader); or the TAP member for Research Students. For this second approval, other documents may need to be sent in the same email e.g. the proposal (or a summary of it) and any informed consent and participant information sheets.

If the study has none of the above characteristics, the supervisor should email this completed form to the Programme Administrator.

Second approval: by the Programme Leader; or Programme Director; or TAP member for Research Students:

Please select one of the following options:

I believe that this study, as planned, meets normal ethical standards	☒
I am unsure if this study, as planned, meets normal ethical standards	☐
I believe that this study, as planned, does not meet normal ethical standards and requires some modification	☐

Name of Programme Leader; or Programme Director; or TAP member (please type):	Dr Jeremy Airey (TAP member)
Date:	26 June 2014

The supervisor should now email this completed form to the Programme Administrator, unless approval is required by the full Ethics Committee (see below).

Approval required by the full Education Ethics Committee?

Note to Programme Leader, Programme Director, or TAP member: If the study involves a) deception, or b) an intervention and procedures could cause concerns, or c) if the topic is sensitive or potentially distressing, review by the full Education Ethics Committee is required. Please forward to the Research Administrator (education-research-administrator@york.ac.uk).

FOR COMPLETION BY THE STUDENT

Data sources

1 If your research involves collecting secondary data only **go to SECTION 2**.

2 If your research involves collecting data from people (e.g. by observing, testing, or teaching them, or from interviews or questionnaires) **go to SECTION 1.**

SECTION 1: For studies involving people

3 Is the amount of time you are asking research participants to give reasonable?**YES**

4 Is any disruption to their normal routines at an acceptable level?**YES**

5 Are any of the questions to be asked, or areas to be probed, likely to cause anxiety or distress to research participants?**NO**

6 Are all the data collection methods used necessary?**YES**

7 Are the data collection methods appropriate to the context and participants?**YES**

8 Will the research involve deception?**NO**

9 Will the research involve sensitive or potentially distressing topics? (The latter might include abuse, bereavement, bullying, drugs, ethnicity, gender, personal relationships, political views, religion, sex, violence. If there is lack of certainty about whether a topic is sensitive, advice should be sought from the Ethics Committee.)**NO**

If YES, what steps will you take to ensure that the methods and procedures are appropriate, not burdensome, and are sensitive to ethical considerations?

10 Does your research involve collecting data from vulnerable or high risk groups? (The latter might include participants who are asylum seekers, unemployed, homeless, looked after children, victims or perpetrators of abuse, or those who have special educational needs. If there is a lack of certainty about whether participants are vulnerable or high risk, advice should be sought from the Ethics Committee. Please note, children with none of the above characteristics are not necessarily vulnerable, though approval for your project must be given by at least two members of staff; see above).**NO**

If YES, what steps will you take to ensure that the methods and procedures are appropriate, not burdensome, and are sensitive to ethical considerations?

11 Are the research participants under 16 years of age?**YES**
If NO, go to question 12.

If YES, and you intend to interact with the children, do you intend to ensure that another adult is present during all such interactions?**NO**

If NO, please explain, for example:
i) This would seriously compromise the validity of the research because [***provide reason***]

Please see the other reasons.

ii) I have/will have a full Disclosure and Barring Service check (formerly Criminal Records Bureau check).**NO**

iii) Other reasons:

Will conduct interview with 10-15 year old students pertaining their visit to the National Science Centre of Malaysia. Before conducting the interview, will get the permission from teacher and students to conduct the research (Note: Research in Malaysia doesn't need to apply for a full Disclosure and Barring Service) and the research will be carried out in public.

Payment to participants

12 If research participants are to receive reimbursement of expenses, or any other incentives or benefits for taking part in your research, please give details, indicating what or how much money they will receive and, briefly, the basis on which this was decided:

-

If your study involves an INTERVENTION i.e. a change to normal practice made for the purposes of the research, go to question 13 (this does not include 'laboratory style' studies i.e. where ALL participation is voluntary):
If your study does not involve an intervention, go to question 20.

13 Is the extent of the change within the range of changes that teachers (or equivalent) would normally be able to make within their own discretion?Choose an item.

14 Will the change be fully discussed with those directly involved (teachers, senior school managers, pupils, parents – as appropriate)?Choose an item.

15 Are you confident that *all* treatments (including comparison groups in multiple intervention studies) will potentially provide some educational benefit that is compatible with current educational aims in that particular context? (Note: This is *not* asking you to justify a non-active control i.e. continued normal practice)Choose an item.
Please **briefly** describe this / these benefit(s):

16 If you intend to have two or more groups, are you offering the control / comparison group an opportunity to have the experimental / innovative treatment at some later point (this can include making the materials available to the school or learners)?Choose an item.
If NO, please explain:

17 If you intend to have two or more groups of participants receiving different treatment, do the informed consent forms give this information?Choose an item.

18 If you are randomly assigning participants to different treatments, have you considered the ethical implications of this?Choose an item.

19 If you are randomly assigning participants to different treatments (including non-active controls), will the institution and participants (or parents where participants are under 16) be informed of this in advance of agreeing to participate?Choose an item.

If NO, please explain:

General protocol for working in institutions

20 Do you intend to conduct yourself, and advise your team to conduct themselves, in a professional manner as a representative of the University of York, respectful of the rules, demands and systems within the institution you are visiting?
YES

21 If you intend to carry out research with children under 16, have you read and understood the Education Ethics Committee's *Guidance on Working with Children Under 16*?
YES

Informed consent

22 Have you prepared Informed Consent Form(s) which participants in the study will be asked to sign, and which are appropriate for different kinds of participants?**YES**

If YES, **please attach the informed consent form(s).**
If NO, please explain:

23 Please check the details on the informed consent form(s) match each one of your answers below. Does this informed consent form:

a) inform participants in advance about what their involvement in the research study will entail?
YES

b) inform participants of the purpose of the research?
YES

c) inform participants of what will happen to the data they provide (how this will be stored, who will have access to it, whether and how individuals' identities will be protected during this process)?
<u>YES</u>

d) if there is a possibility that you may use some of the data publicly (e.g. in presentations or online), inform the participants how identifiable such data will be **<u>and</u>** give them the opportunity to decline such use of data?**<u>YES</u>**

e) give the names and contact details (e.g. email) of at least two people to whom queries, concerns or complaints should be directed? One of these people should be on the Education Ethics Committee and not involved with the research.
<u>YES</u>

f) in studies involving interviews or focus groups, inform participants that they will be given an opportunity to comment on your *written record* of the event?
<u>YES</u>

If NO, have you made this clear this on your consent form?Choose an item.
If NO, please explain why not:

g) inform participants how long the data is likely to be kept for?**<u>YES</u>**

h) inform participants if the data could be used for future analysis and/or other purposes?
<u>YES</u>

i) Inform participants they may withdraw from the study during data collection?**<u>YES</u>**

j) provide a date/timescale by which participants will be able to withdraw their data and tell the participants how to do this? (NB. If your data is going to be completely anonymised, any withdrawal of data needs to happen before this.)**<u>YES</u>**
**NA if your data will be anonymous at point of collection*
If your answer was NO to any of the above, please explain here, indicating which item(s) you are referring to (a-j):

24 Who will be asked to sign an Informed Consent Form? Please <u>select all</u> that apply:

CATEGORY	
Adult research participants	☒
Research participants under 16	☒
Teachers	☒
Parents	☐
Head/Senior leadership team member	☐
Other (please explain)	☐

25 In studies involving an **intervention** with under 16s, will you seek informed consent from parents?
If NO, please explain:

Because it's not an intervention

If YES, please delete to indicate whether this is 'opt-in' or 'opt-out'
If 'opt-out', please explain why 'opt-in' is not being offered:

SECTION 2
Data Storage, Analysis, Management and Protection

26 I am accessing data from a non-publicly available source (regardless of whether the data is identifiable) e.g. pupil data held by a school or local authority, learners' work.**YES**

If YES, I have obtained written permission, via an informed consent document, from a figure of authority who is responsible for holding the data. This informed consent a) acknowledges
responsibility for releasing the data and b) confirms that releasing the data does not violate any informed consents or implicit agreements at the point the data was initially gathered.
YES

27 I have read and understood the Education Ethics Committee's *Guidance on Data Storage and Protection* **YES**

28 I will keep any data appropriately secure (e.g. in a locked cabinet), maintaining confidentiality and anonymity (e.g. identifiers will be encoded and the code available to as few people as possible) where possible.**YES**

29 If your data can be traced to identifiable participants:
a) who will be able to access your data?

The researcher and both of my supervisors

b) approximately how long will you need to keep it in this identifiable format?

Until the estimated viva date: September 2016

30 If working in collaboration with other colleagues, students, or if under someone's supervision, please discuss and complete the following:

We have agreed:
a) [*Tuan Mastura Tuan Soh*] will be responsible for keeping and storing the data
b) [*Tuan Mastura Tuan Soh, Prof Dr Judith Bennett and Dr Lynda Dunlop*] will have access to the data
c) [*Tuan Mastura Tuan Soh, Prof Dr Judith Bennett and Dr Lynda Dunlop*] will have the rights to publish using the data

Reporting your research

31 In any reports that you write about your research, will you do everything possible to ensure that the identity of any individual research participant, or the institution which they attend or work for, cannot be deduced by a reader?**<u>YES</u>**

If NO please explain:

<u>Conflict of interests</u>

32 If the Principal Investigator or any other key investigators or collaborators have any direct personal involvement in the organisation sponsoring or funding the research that may give rise to a possible conflict of interest, please give details:

-

<u>Potential ethical problems as your research progresses</u>

33 If you see any potential problems arising during the course of the research, please give details here and describe how you plan to deal with them:

-

Student's Name (please type):	Tuan Mastura Tuan Soh
Date:	16 June 2014

Please <u>email</u> this form to your supervisor. They must approve it, and send it to the Programme Administrator by email.

NOTE ON IMPLEMENTING THE PROCEDURES APPROVED HERE:

If your plans change as you carry out the research study, you should discuss any changes you make with your supervisor. If the changes are significant, your supervisor may advise you to complete a new 'Ethical issues audit' form.
For Taught Masters students, on submitting your MA dissertation to the programme administrator, you will be asked to sign to indicate that your research did not deviate significantly from the procedures you have outlined above.

For Research Students (MA by Research, MPhil, PhD), once your data collection is over, you must write an email to your supervisor to confirm that your research did not deviate significantly from the procedures you have outlined above.

APPENDIX E.

Information Sheet

Investigating the impact of school visits to the National Science Center of Malaysia

Tuan Mastura Tuan Soh

February 2015

Project overview

The project is a research study which is being conducted as part of a PhD degree at the University of York, United Kingdom. This information sheet is for people considering participating in the project, and gives you some information about the project and what it involves. Please take time to read the following information carefully and discuss it with others if you wish. Please feel free to contact me if you would like more information (see details on reverse of this page).

What is the purpose of this study?

This study aims to investigate the impact of school visits to the National Science Center.In order to do this, I would like to talk to teachers, students and others working in science education, including staff at PSN) to gather information on their views of the visits.

Why is the study being done?

Science centres are increasingly recognized as an educational resource. School visits to science centres have increased markedly over the last decade, and students are the most important visitor group during the school year. This reflects the important role played by science in the primary and secondary education curriculum. The study plans to gather information from students and teachers visiting PSN, and staff at PSN, in order to identify the factors that make the visits as beneficial as possible. The main focus of the research places emphasis on three key points: the first to identify and explore whether the school visit to the PSN will have an impact on students' science learning; the second to investigate the teachers' objectives for conducting school visits to the PSN; and the third to investigate science educators actions and contributions to students learning during school visits to the PSN.

Why have I been invited to participate?

You have been invited to take part in this study because you are either a science educator at PSN, or you are a teacher or student visiting the science centre (PSN). Your contribution to this study will enhance the understanding of how schools use science centre and how the collaboration between teachers' and science educator at PSN will have an impact on students' understanding of science ideas.

Do I have to take part?

It is up to you to decide whether or not to take part. If you decide to take part, I will need you to sign a consent form for this study. You will be free to withdraw at any time up to four weeks after the last phase of data collection. This decision will not affect you or your rights in any way.

What will I have to do?

The research design involves gathering information in a variety of ways in order to help understand the impact of school visits to the PSN. This would involve observations, surveys and conducting in-depth interviews with students, teachers and science educators. For more details, kindly refer to the information;

If you are a teacher

Please could teacher for each class visiting today complete this Form A (10-15 minutes to complete).

There is a question at the end of the teachers' questionnaire that ask about whether further contact would be possible, for an in-depth interview.

The participants for in-depth interviews will be asked to sign a consent form to take part in an interview. The questions are open-ended in nature and there will be no right or wrong answers. Each interview would take approximately 20 minutes.

Please hand the envelope with the completed Form A and Form B to the PSN staff or me (the researcher) **BEFORE YOU LEAVE THE PSN**.

If you are a student

Please could each student visiting the PSN today complete this Form B (5-10 minutes to complete).
There is a question at the end of the students' questionnaire that ask about whether further contact would be possible, for an in-depth interview.
The participants for in-depth interviews will be asked to sign a consent form to take part in an interview. The questions are open-ended in nature and there will be no right or wrong answers. Each interview would take approximately 20 minutes.
Please hand the questionnaire to the teacher once completed.

If you are a science centre educator

The science educators at PSN involved with school visits will be asked to participate in the study.
The researcher will meet briefly with the science educator immediately before the lesson to discuss data collection procedure.
An interview will be conducted in order to gain a better understanding from the perspectives of science educators regarding students' science learning during school visits to the PSN.
The participants for in-depth interviews will be asked to sign a consent form to take part in an interview. The questions are open-ended in nature and there will be no right or wrong answers. Each interview would take approximately 20 minutes.

What are the possible benefits of taking part?

I am hoping that the data collected will produce information about, and contribute to, science learning outside the classroom. Your contribution will help to shape the experiences of future groups visiting PSN.

What are the possible disadvantages of taking part?

The questionnaire/interview will take some of your time. Every effort has been made to keep any inconvenience to a minimum. This study should not pose any other disadvantages to you.

Will my taking part in the study be kept confidential?

The use of any information that identifies you during the course of the research will be kept strictly confidential. This information will be kept in a secure place (password protected file) and only a PhD student and both supervisors will have access to the data and information collected in this study before it is anonymized. The data and information collected during this study will be anonymized within 4 weeks of collection before analyzing stage. For interview transcripts record, the participants will be given an opportunity to comment on transcripts for verification purposes.

What happens when the research stops?

The anonymized data may be presented at conferences and in journal articles. The data will only be used for academic and research purposes. Data will be kept until the research end in September 2016. We can also send participants a summary of the study results on request.

What should you do if you have questions or concerns?

The study has been reviewed by and received ethics clearance through the ethics committee in the Department of Education at the University of York. If you have any questions about this research, please feel free to contact me, or the faculty supervisor Prof. Judith Bennett (judith.bennett@york.ac.uk) and co-supervisor Dr. Lynda Dunlop (lynda.dunlop@york.ac.uk). If you have any concern about the conduct of this research, you may contact the chair of the Education Ethics Committee, Dr. Emma Marsden (emma.marsden@york.ac.uk).

Researcher

Tuan Mastura Tuan Soh [Student ID: 109006574]
Candidate, PhD., Science Education, Department of Education, University of York, UK
Email: tts510@york.ac.uk; Tel: +447778308664

Thank you for taking the time to read this information. Your thoughts are immensely valuable.

APPENDIX F.

UNIVERSITY of York

CONSENT FORM FOR DOCTORAL RESEARCH PROJECT

Project Title: Investigating the impact of school visits to the National Science Center (Pusat Sains Negara, PSN) of Malaysia

Name of Researcher: Tuan Mastura Tuan Soh [Student ID: 109006574]

I confirm that I have read and understood the information sheet dated ___/___/20___ for the above project which I may keep for my records and have had the opportunity to ask any questions I may have.

I agree to take part in the above study and am willing to have my involvement in the interview recorded.

______________________	______________________	______________________
Name of Participant	Signature	Date
______________________	______________________	______________________
Name of Researcher	Signature	Date

Department of Education
The University of York
Heslington YO10 5DD
York United Kingdom
Tel: +44 (0) 1904 323460
Fax: +44 (0) 1904 323459

(For researcher use only)

APPENDIX G.

FORM A: TEACHER QUESTIONNAIRE

My Name is Tuan Mastura Tuan Soh. I am a doctoral research student at the University of York. I am conducting a survey about your aims for conducting visit to the National Science Centre (Pusat Sains Negara, PSN). The following questions are designed to find out your aims and objectives for conducting school visits to the science centre.

Please fill in the blank or please √ tick the boxes].

A. YOUR SCHOOL AND THE NATIONAL SCIENCE CENTRE

1. Your Name : ____________________
2. Your Age : ____________________
3. Ethnicity : ☐ Male ☐ Female
4. Ethnicity : ☐ Malay ☐ Chinese ☐ Indian ☐ Others (please specify) ________
5. Your school : ____________________
6. Age of your pupils/total : ☐ / ☐

B. WHAT DO YOU THINK YOUR PUPILS HAVE GAINED FROM THEIR ENGAGEMENT WITH SCIENCE CENTRE?

7. To what extent do you think your pupils have **enjoyed** by their engagement with science centre? (please tick one box for each)

	Very likely	Quite likely	Neither	Quite unlikely	Very unlikely	Don't know
Enjoyed the experiences	☐	☐	☐	☐	☐	☐
Excited by new ways to learn	☐	☐	☐	☐	☐	☐
New interests aroused	☐	☐	☐	☐	☐	☐
Inspired to learn more	☐	☐	☐	☐	☐	☐
Inspired to create something creative	☐	☐	☐	☐	☐	☐
Other kinds of enjoyment (please specify)						

____

8. To what extent do you think pupils have gained **facts and information** during their engagement with science centre? (please tick one box for each)

	Very likely	Quite likely	Neither	Quite unlikely	Very unlikely	Don't know
Subject-specific facts (e.g. mathematics, science)	☐	☐	☐	☐	☐	☐
Inter-disciplinary or thematic facts (e.g. Science and technology)	☐	☐	☐	☐	☐	☐
Information about PSN or galleries	☐	☐	☐	☐	☐	☐
Facts about themselves	☐	☐	☐	☐	☐	☐
Other kinds of facts (please specify)						

9. To what extent do you think their engagement with science centre have enabled pupils to feel more **positive** about the following? (please tick one box for each)

	Very likely	Quite likely	Neither	Quite unlikely	Very unlikely	Don't know
Themselves	☐	☐	☐	☐	☐	☐
Their abilities	☐	☐	☐	☐	☐	☐
Other people/communities	☐	☐	☐	☐	☐	☐
Science subject	☐	☐	☐	☐	☐	☐
Science Centre/Galleries	☐	☐	☐	☐	☐	☐
Anything else (please specify)						

10. For each of the following potential outcomes from the **engagement** with science centre, please could you rate the importance of each one in your view: (please tick one box for each)

	Very likely	Quite likely	Neither	Quite unlikely	Very unlikely	Don't know
Knowledge and understanding	☐	☐	☐	☐	☐	☐
Attitudes and values	☐	☐	☐	☐	☐	☐
Enjoyment	☐	☐	☐	☐	☐	☐

C. YOUR USE OF NATIONAL SCIENCE CENTRE AND THE DECISION TO PLAN SCHOOL VISIT

11. Is this your first visit (as a teacher) to science centre with a class? Yes ☐ No ☐

12. If **NO**, how many times have you visited science centre? ____________

13. Please consider the following statements and indicate whether they are accurate for **your** school.

a. Teachers can choose **whether** they want to lead a school visit or not Yes ☐ No ☐

b. Teachers can choose **where** they wish to go Yes ☐ No ☐

c. Teachers can choose **when** (date) they wish to go Yes ☐ No ☐

d. Teachers can choose **how many times** they wish to go Yes ☐ No ☐

14. Why do you take your class to visit science centre today? (Please tick **ALL** that apply)

☐ To learn part of a theme that I currently teach in class.

☐ To learnt something new compared to school classroom.

☐ To stimulate students' motivation, interest and positive attitudes towards science.

☐ To expose the students with the scienctific experiments in the science centre.

☐ To expose the students with new learning environment outside of school classroom.

☐ To experimentally complement the concepts and theories studied in class.

☐ To satisfy school expectations and requirement.

☐ No objectives have been planned.

☐ Other kind of objectives (please specify)

15. Is the work done with the science centre today directly linked to the curriculum? Yes ☐ No ☐

If **YES**, what curriculum areas of the school work are linked with this science centre visit today? (Please tick **ALL** that apply)

- ☐ Living things – e.g., Animal, plant, food chain, food web
- ☐ Force – e.g., push, pull, friction,
- ☐ Energy – e.g., kinetic, light, heat, electricity, etc
- ☐ Material –e.g., properties of material, etc
- ☐ Other kind of areas (please specify)

---

16. What strategies you use to make sure your school visit to science centre successful? (Please tick **ALL** that apply)

- ☐ Discussed with the students in the class about the visit.
- ☐ Prepare the worksheet in advance about the visit.
- ☐ No strategies have been planned.
- ☐ Other kind of strategies (please specify)

---

17. How do you know if this school visit is successful? (Pease rank four most successful to you where 1 is the most successful and 4 is the least successful)

- ☐ Student showed positive experience (e.g., had fun, excited, didn't want to leave, etc)
- ☐ Good student behaviour (e.g., children engaged the whole time, actively engaged and enjoying themselves, etc)
- ☐ Quality/quantity of student questions during the programme and activities conducted.
- ☐ Trip completed without incident.

Other kind of idea of successful school visit (please specify)

---

18. Does your school make regular visits to informal organisations? Yes ☐ No ☐

19. How important are museums to your teaching?	**Very important** ☐	**Important** ☐	**Neither** ☐	**Not very important** ☐	**Not at all important** ☐
20. How satisfied are you with the science centre provision today?	**Very satisfied** ☐	**Satisfied** ☐	**Neither** ☐	**Dissatisfied** ☐	**Very dissatisfied** ☐
21. To what extent has the experience of this visit increased your own confidence to use science cetre as part of your teaching?	**Very likely** ☐	**Quite likely** ☐	**Neither** ☐	**Quite unlikely** ☐	**Very unlikely** ☐

22. Would you be willing to be contacted later in my research? Yes ☐ No ☐

D.	**Contact phone number :**	**E-mail address:**

Thank you very much for your time. Please return the form to the PSN staff/researcher.

(For researcher use only)

APPENDIX H.

FORM B: STUDENT QUESTIONNAIRE

My Name is Tuan Mastura Tuan Soh. I am a doctoral research student at the University of York. I am conducting a survey about your visit to the National Science Centre. The following questions are designed to find out your opinions about **YOUR ENGAGEMENT** with science

Part A: Your Opinions about Your Engagement with Science Centre

For students		Strongly Agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
During my engagement with MNSC:						
1	I enjoyed myself					
2	I learnt something new					
3	I did something new					
My engagement with MNSC today made me feel:						
4	More confident with science					
5	Keen to find out more					
6	More interested in science					
7	Studying science might be fun					
8	Working in science might be interesting					
9	Science centre is a good place to learn about science					
10	I learn science in a different way to school in science centre					
11	When I get back to school, I think the experience from today will help me in science classes					
12	I would recommend this place to my friends					
In the activities you did, how **easy** was it for you to:		**Very easy**	**Easy**	**In between**	**Hard**	**Very hard**
	a. understand the instructions?					
	b. use the equipment?					
	c. get a result for the activity?					
	d. understand what the activity was all about?					
How much did you **enjoy**		**Not at all enjoyable**	**Not enjoyable**	**In between**	**Enjoyable**	**Very enjoyable**
	a. doing the activities?					
	b. working in groups?					
	c. using the equipment?					
	d. the whole engagement with MNSC?					

How **helpful** was the engagement with MNSC in terms of	Not at all helpful	Not helpful	In between	Helpful	Very helpful
a. your school work?					
b. understanding about science in your community?					
c. getting an idea about what scientist do?					
d. getting an idea about what MNSC does?					

Please identify three things about science that you have learnt in science centre today;

1

2

3

Part B: General Questions

1. Your Name: ______________________________
2. Your Age: ______________________________
3. Gender ☐ Boy ☐ Girl
4. Ethnicity ☐ Malay ☐ Chinese ☐ Indian ☐ Others (please specify) ______________
5. Your School: ______________________________

APPENDIX I.

INTERVIEW PROTOCOL

GUIDING QUESTIONS FOR TEACHER INTERVIEW

INTERVIEW WITH TEACHER BEFORE THE VISIT		
No	**Question**	**Comment**
1	What is the purpose of this visit?	
1.1	What objectives do you have?	
2	Is the visit part of a theme you are doing at school?	
3	If not, why are you doing this visit at this time?	
4	What have you discussed with the class about the visit?	
4.1	Have you done pre-visit work with the class?	
5	What do you expect the students to do during the visit?	
5.1	Do they have worksheets? (May I have a copy?)	
5.2	If so, do you expect them to do anything else?	
5.3	Will there be time to look around without the worksheets?	
6	What do you expect the students to gain from the visit?	
7	Will you do anything with the class following the visit?	
7.1	If so, what will you do?	
INTERVIEW WITH TEACHER AFTER THE VISIT		
No	**Question**	**Comment**
1	Toward what extend do you think your objectives for the visit were achieved?	
2	How did / could you assess this?	
3	How satisfied are you with the outcomes of the visit?	
4	Do you feel there are ways in which the use of the visit could be made more effective? (Discussion about this.)	
5	What have you done with your class since the visit?	Post-visit

APPENDIX J.

GUIDING QUESTIONS FOR STUDENT INTERVIEW

	INTERVIEW WITH STUDENTS DURING THE VISIT	
No	**Question**	**Comment/Note**
1	What are you doing here?	Install the video recording at the targeted exhibits/ programmes
2	What are you learning about?	
3	Have you done any work in class about this, before the visit?	
4	What have you discovered so far?	
5	Tell me what this display is about? How the exhibit work?	
6	What do you think this exhibit trying to show you?	
7	What do you not understand about this display / topic?	Take photos during the school group doing activities and programmes
8	Are there other things you would like to know about this topic? If so, what are they?	
9	How do you think you might be able to find the answers to these questions?	
10	Would you like to be able to find these answers back at school after the visit?	
	INTERVIEW WITH STUDENTS AFTER THE VISIT	
No	**Question**	**Comment/Note**
1	Did you enjoy your visit to the PSN? Why / why not?	(show clip or photos of them)
2	What did you like most about the visit? Least?	
3	What did you find out while you were there? What are you remember from your visit to PSN?	
4	Did you get the opportunity to learn what you were interested in? Why do you think this was / was not so?	
5	What was happening in the clip or photos? How the exhibit work?	
6	What do you think this exhibit trying to show you?	
7	Did you enjoy when you looking at/learning at this exhibit? Why?	
8	Did you come away with any questions about what you saw there?	
9	What have you done back at school since the visit?	
10	If you had the opportunity to plan a visit like this, what would you do?	
11	Questions about their views about the particular topic covered.	

APPENDIX K.

GUIDING QUESTIONS FOR SCIENCE EDUCATOR INTERVIEW

Semi-structured, open-ended interview protocol

<table>
<tr><td colspan="2">INTERVIEW WITH SCIENCE EDUCATORS IMMEDIATELY AFTER THE SCHOOL GROUP VISIT/TEACHING SESSION</td></tr>
<tr><td>Part A: Introduction – General</td><td>Comment</td></tr>
<tr><td>Thank you for agreeing to participate in this interview. It should take approximately 20 minutes. As I mentioned in the information sheet, the purpose of this interview is for me to gain a better understanding of your experiences as a science educator at PSN for attending school group visits. There are three sections of this interview: your role as an educator at PSN (the general ideas) and the educator's role during school group visit and Part C is for concluding remark. You may stop me at any time to ask for clarification.

First, what were your reasons for becoming science educators at PSN?

In this first section, I’m interested in your general ideas about your role in PSN.

How long have you been working here? What year you’ve been working here?
How about you prior qualification?
How about your prior experiences?
What do you do as a science educator at PSN?
Can you tell me about a day in your life as a science educator at PSN?

What kinds of things do you do?
What types of decision do you have to make?
What kinds of daily experiences did you most value?

Now, we will proceed with school group visits. How many schools normally do you attend for a day? A week? A month?
What is your role as the educator for school group visits?
What are your general perceptions about school group visits to PSN? (Including their purposes and outcomes related to, a visit to a science centre)
How do you think students learn at PSN?

What did you want them to learn?
What else did you hope to achieve?
What do you do to achieve your set goals?

What can you as educators do to facilitate that school group will benefit from the visit in term of cognitive and affective science learning? –relate with the programme/exhibits they involved during their school visit to PSN (Force and energy, living things or materials)

What did they learnt?
How do you know whether they understand or not? (to evaluate whether your teaching/facilitating was successful or not)
What would you do differently next time?

If the students didn’t pay attention during the visit, what can you do to hinder this?
What kind of preparation/training did you receive in order to teach this and other programs like this?
How often do you teach these programs?
What was your involvement in developing the program? If minimal, what would you do differently?
</td><td>Qs about observed programme/activities

Qs about observed programme/activities</td></tr>
</table>

<table>
<tr><th colspan="3">Part B: School group visit</th><th>Comment</th></tr>
<tr><td>Educator’s Goal</td><td>Educator's Role-Teaching and Facilatating</td><td>Evaluation of Teaching and Facilitation approach used</td><td></td></tr>
<tr><td>• What are you trying to communicate when you teach this program? (Is there any curriculum related to formal schooling, etc)
• What are you goals for teaching/facilitating the programmes?
• (relate to their teach lesson, e.g., force and energy, living things or materials)</td><td>• What approach do you use to accommodate children in school groups come to PSN with a wide range of interests and backgrounds? Do you use any unique style for the particular school group?
• How do you find students’ cognitive and affective response during school visits to PSN in term of age group? How do they differ?
• How do you adapt your teaching style to accommodate the differences between the age group, school, performances, SES etc.
• What approach do you use to accommodate different students learning style?
• Is there any kind of materials (eg: worksheet) in order for you to support students’ science learning at PSN? (If YES, may I have a copy?)
• How do educators’ and teachers collaborate in order to ensure students ‘learn’ during school visits to PSN?</td><td>• What effect do you think you as the educator with whom these students interact have on their learning experience?
• How do you think your teaching approach affects the students and their experience?
• How do you as the educator at PSN evaluate the effectiveness of your programs to the students?
• How do you know children learnt what you wanted them to learn? (relate to their teach lesson, e.g., force and energy, living things or materials)
• To what extent do you think you set objectives met?
• What do you think about your approach to teach/facilitate them? (As they come from a diverse background of students; eg: age, gender, school location, etc)
• Does PSN collect evaluation data of school group visits? If YES, can I ask for access to this data?</td><td></td></tr>
<tr><th colspan="3">Part C: Wrap-up</th><th>Comment</th></tr>
<tr><td colspan="3">Thank you for answering all of these questions!
• Is there anything else that you’d like to share with me that you think is important for me to know about your time as a science educator at PSN?
• Is there anything else that you’d like to share with me that you think is important for me to know about science learning in informal institutions?</td><td>These questions create the opportunity for participants to bring up ideas that are not yet on my radar.</td></tr>
</table>

APPENDIX L.

<u>List of the interview schedules</u>

Bil	Date	Program/ Agenda	School code	Location of engagement	Total of respondents				
					Questionnaire		Interview		
					Student(s)	Teacher(s)	Student(s)/ (person/group)	Teacher(s) (person)	Science Educator (person)
1	5 February 2015	Science Trails	School 13	Centre-based	22	**2**	6	1	
2	26 February 2015	**-let's innovate** -screaming ice cream -science of survivals – nature scents	School 19	Single-school	24		5		
3	12 March 2015	**-let's innovate** -balloon inflates -fireworks in a glass -erupting volcanoes	School 23	Single-school	42	**4 org**	15	2	
4	19 March 2015	Science wonders	School 5	Centre-based	18	2	6	1	
5	21 March 2015	Nature Secrets	School 6	Centre-based	18	2	6	1	
6	29-30 March 2015	Langkawi-Outreach program **-let's innovate** -screaming ice cream -science of survivals – nature scents -balloon blast -bottle rockets -hoopster -UFO -paper tower	**School 20** 1. School 7 2. School 17 3. School 20 4. School 12 5. School 24 6. School 2 7. School 4 8. School 16 9. School 18 10. School 8	Multi-school	67	13	5 GROUP (20 PERSONS)	5	1
7	1-2 April 2015	Langkawi-Outreach program **-let's innovate** -screaming ice cream -science of survivals – nature scents -balloon blast -bottle rockets -hoopster -UFO -paper tower	**School 22** 1. School 10 2. School 11 3. School 3 4. School 1 5. School 21 6. School 9 7. School 14 8. School 15 9. School 22	Multi-school	74	13	4 GROUP (16) persons)	5	1
8	26 March 2015	**-let's innovate**	School 25	Single-school	46		4		

Bil	Date	Program/ Agenda	School code	Location of engagement	Total of respondents				
					Questionnaire		Interview		
					Student(s)	Teacher(s)	Student(s)/ (person/group)	Teacher(s) (person)	Science Educator (person)
		-screaming ice cream -science of survivals – nature scents							
9	09 April 2015	**-let's innovate** -screaming ice cream -science of survivals – nature scents	School 26	Single-school	42		5		
			TOTAL		**353**	**40**	**83**	**17**	**8**

Bil	Date	Program/ Agenda	Code for the programme
1	26 February 2015	Meet the scientist	A1-
2	5 February 2015	Science Trails	A2
3	12 March 2015	Science activities and visit to the bus exhibits (science on the wheel)	A3
4	19 March 2015	Science wonders	A4
5	21 March 2015	Nature Secrets	A5
6	29-30 March 2015	Langkawi-Outreach program	A6.1
7	1-2 April 2015	Langkawi-Outreach program	A6.2
8	09 April 2015	PSN Trooperz	A7

APPENDIX M.

<u>Programs and activities conducted during main study data collection</u>

In order to ensure that the programmes that the researcher had observed shared the similarity between the activities, the researcher only observed and conducted survey and interview to the programmes that have the 'sense' similar to 'scheduled booked programmes' during center-based programmes. For the center based data collection, three programmes were evaluated to investigate the impact of engaging in the center-based or outreach programs conducted by the Malaysia National Science Center (Pusat Sains Negara, PSN) in term of science learning. The programmes evaluated at 'centre-based' type were; i) Science trails; ii) Science Wonders Program – Pasteur Laboratory; and iii) Science Wonderland - Nature Secrets Lab. Diagram 1 below shows the activities of this type of data collection.

(a)

(b)

Diagram 1. Diagram (a) and (b) displays the example of exhibits usage for centre-based data collection

The programmes evaluated for the single-school type of data collection consists of 'Let's Innovate' programmes. In 'Let's Innovate' programmes, the activities that were conducted such as 'Balloon inflates, Fireworks in a Glass, Erupting Volcanos, Screaming ice cream, Science of Survival'. Besides that, for the outdoor programme, 'Bottle Rocket' was conducted. The slight different between single-school and multi-school types of data collection were at the activities carried out under the 'Let Innovative' programmes. In the multi-school type of data collection, the activities conducted were 'Screaming ice cream, Ballon Blast, Nature Scents, Hoopster, UFO, Paper Tower'. In this study, the data were collected following these type of activities as it has similar kind of activities for every outreach that MNSC conducted. Therefore, to get the similar kind of responses and the programmes, the researcher managed to focus on this types of programmes to avoid biassed. Other than that, the researcher needs to control on how she had collected her data to make meaning and to answer the research questions. Diagram 2 and Diagram shows the diagram of school groups with the activities that they are engaging in the outreach programmes conducted by MNSC.

(c)

(d)

Diagram 2.Diagram (c) and (d) shows the school groups with their ‘Ballon inflates’ and ‘Erupting volcanoes’ designs during single-school data collection

(e)

(f)

Diagram 3. Diagram (e) and (f) shows the school groups with their bottle rocket designs during multi-school data collection

Table 1. The classification of programmes and activities carried out during the main study based on the locations of engagement with the MNSC.

Type Particular	**Centre-based collection**	**Single school-out-reach based collection**	**Multi-school out-reach based collection**
Program/ Activities	**Science Trail Program** Introducing the students about science concepts which have been translated into interesting exhibits. They are created based on the concepts of the national school curriculum for primary and secondary school students. The exhibits that involved with the science trail programs such as; 1. Aquarium - visitors can learn more about freshwater aquarium filled with 32 species of freshwater fish. 2. Wonderspark – highlights the three critical elements of nature; water, light and wind through exciting interactive exhibits. 3. Pathways to Science – visitors can engage themselves with the many hands-on exhibits in the different science disciplines of Biology, Physics, Chemistry, Earth Science and Astronomy. Visitors can learn more about the transformation of energy at the Energy Circuit exhibit. 4. Eureka – fun Science and Math zone with a creative corner for all to explore. This exhibit was designed to inspire visitors to think out of the box. 5. Flight – discover and learn about the science of the flight. Visitors can learn how to navigate a helicopter through interactive exhibits. 6. Thinking Machine – this gallery explores computers, communications, robotics and artificial intelligence. Visitors discover how they evolved, how they work and how they impact our lives. 7. Energy World – learn the importance of energy in our world. Discover the alternative energy resources. The Science Trail Program allows children to learn about scientific knowledge and playing with the exhibits. Students need to complete the mission of science trail program. While doing these activities, students also playing and have fun at the same time they will explore the scientific concept and process skills. For example, when the children need to complete the mission on the	**Bottle rocket (outdoor)** For this outdoor activity, it offers students the opportunity to explore rocketry and to extend their classroom knowledge to practical applications. A water rocket is a rocket model that uses water as a driving force. Water would be forced out using compressed air. Caused by the movement of water, then thrust forward will be produced at the same time based on Newton's Third Law. These activities indirectly give students the experience of creating an experimental method of science. The objective of this activity was to expose students to design the best water rockets based on the factors influencing the launching of a rocket that carried water through the demonstration. Before conducting the experiment in groups of 4-5 students, they will be given some demonstration that requires their observation. Based on these observations, the students have to design a water rocket that can reach the maximum target (furthest distance). The idea of this activity that the students should ponder is 'How do I get the longest time aloft?'. A simple rocket can be built of an empty Coke or lemonade or F&N plastic bottle and etc. Students were given 30 minutes to design the rocket and then they would launch it to test its effectiveness. In order to test the rocket's effectiveness, the rocket will partly fill with water and pressurised air, the rocket can be blasted high up or horizontal in the air. The pressurised air expels the water, which in turn creates the thrust to accelerate the rocket, counteracted by air resistance and the weight of the rocket. Concept or theory that would be exposed to the students in this activity is based on Newton's Third Law. Science concepts or science ideas that are introduced in this activity are as thrust, air resistance, stability, air pressure, compressed air, launch angle, volume and so on. **Note:** Newton's third law of motion states that for every action force, there is a reaction force having the same magnitude but act in the opposite direction.	

	Wonderspark exhibits, students will learn about the three elements of nature; water, light and wind. Likewise, students can learn more about the transformation of energy at the Energy Circuit exhibit.		
	Science Wonders Program – Pasteur Laboratory Involves the hands-on activities to enable the critical thinking and curiosity among the students towards science. In this program, students will make observations, experiments, collect and interpret data and make inferences about the data that they receive. The researcher observed one school involved in this program during the pilot study period – experimenting on 'Rock store carbon – Carbon Dioxide Gas'. In this program, science communicator acts as a teacher and conducting the experiment. School teacher only helps to guide the students when necessary with the help of assistant from MNSC staff. Only simple experiment involved in this laboratory as the objective of it want to in doing chemistry and physics activities.	**Let's Innovate (Balloon inflates, Fireworks in a Glass, Erupting Volcanos, Screaming ice cream, Science of Survival)** A hands-on experiment that can be done in our daily life. Basically, in doing this hands-on experiment, the educators want to expose the students with the simple experiment that can be done in their daily life. The ideas and apparatus needed for every experiment are very basic and would not need any extra preparation. The objectives of the activity, for example, "Balloon inflate" is to study the three phases of matter (solid, liquid and gas) by comparing and contrasting the properties of these different phases and by mixing materials to create different phases (e.g., mixing a liquid and a solid to produce gas) The concepts of science that were exposed to the student during experimenting this activity included; "the three phases of matter' solid, liquid and gas, desity and etc". The programmes conducted during this outreach includes "Balloon inflates, Fireworks in a glass, Erupting volcanos, Screaming ice cream, Science of survival"	**Let's Innovate (Screaming ice cream, Balloon Blast, Nature Scents, Hoopster, UFO, Paper Tower)** Kembara Sains @ Langkawi (outreach program) is a programmes by National Science Centre in an effort to bring the Science, Technology and Innovation (STI) closer to the society. The program provides opportunities for students to experience, interact and carry out activities through exhibits and hands-on activities. The location of the program is divided into two zones, the East Zone and West Zone to ensure access can be made to all primary and secondary schools. The objectives for this Kembara Sains @ Langkawi are as follows: a) to give a new experience to students and teachers around Langkawi for STI program offered by the MNSC. b) to increase the awareness and the appreciation of student on learning STI. c) to promote a program offered by the MNSC. The programmes conducted during this outreach includes "Screaming ice cream, Balloon Blast, Nature Scents, Hoopster, UFO, Paper tower"
	Science Wonderland - Nature Secrets Lab An outdoor science, a recreational park which brings a new dimension to learning using nature as a classroom. There are many activities that the students can participate in Science Wonderland Garden especially of the Herbs, Gardens, Rose Gardens, Aquatic Life, and Nature's Secret Lab. The researcher observed one school involved in this program during the pilot study period – researcher observed the program they are doing in the 'Nature Secrets Lab' – studying about the butterfly and experimenting with the gas of carbon dioxide after participating in observing all parts of the Science Wonderland. Before starting the program, the science communicator already mentioned what he expects the students to do and collecting two leafs in order for them to conducting an experiment at the Nature Secrets Lab.		

<u>Screaming ice cream</u>

Form 2: Water and solution
Standard 5:

Aims/objectives:

1. Kesan bendasing (garam) terhadap takat didih dan takat beku ais
2. Aktiviti ini menunjukkan, apabila garam ditambah ke dalam ais, suhu ais menjadi rendah…proses pembekuan berlaku…haba dibebaskan → tenaga kinetic menjadi rendah
3. Fasa menarik minat pelajar terhadap sains
4. Jika mahu membuat eksperimen
   Bandingkan antara bekas yang ditambah garam dan satu lagi tanpa garam
   Pemboleh ubah dimanipulasi: kehadiran garam
   Pemboleh ubah dimalarkan: kuantiti ais, isipadu air kotak
   Pemboleh ubah bergerak balas: keadaan air selepas digoncang

Materials:

1/2 cup milk	1/2 cup whipping cream or heavy cream
1/4 cup white sugar	1/4 teaspoon vanilla extract
2 cups ice	1/2 to 3/4 cup sodium chloride (NaCl) aka table salt or rock salt
1-quart Ziploc bag	1-gallon Ziploc bag
Thermometer	Measuring cups and spoons

Bowls, cups, spoons or cones to serve your ice cream treat

<u>Procedure:</u>

Add 1/4 cup sugar, 1/2 cup milk, 1/2 cup cream, and 1/4 teaspoon vanilla to the quart Ziploc bag. Zip that bag up so nothing leaks!
Put the 2 cups of ice into the gallon Ziploc bag.
Use the thermometer to measure the temperature of the ice in the gallon Ziploc bag. Make sure to record this number so you can record
Add 1/2 to 3/4 cup salt (sodium chloride) to the gallon Ziploc bag of ice.
Place the sealed quart bag inside the gallon bag of ice and salt. Seal the gallon bag securely.
Rock the gallon bag from side to side. Hold it at the seal so that the cold ice doesn't freeze your hands instead of your ice cream. You can also use gloves or a cloth to protect your hands, just remember it will be colder than 0 degrees Celsius!
Continue to rock the bag for 10-15 minutes or until the contents of the quart bag have solidified, or until you can't wait for ice cream anymore.
Open the gallon bag and use the thermometer to measure and record the temperature of the ice and salt mixture. Notice how much colder it is than the ice on its own.
In bowls or cones serve and most importantly enjoy your homemade ice cream!


Balloon inflates

Form : States of matter: Gas
Standard :primary/secondary

Materials:

One small empty plastic soda or water bottle
Small balloon
Funnel or piece of paper
½ cup of vinegar
Baking soda

Procedure:

1. Carefully pour the vinegar into the bottle
2. This is the tricky part: Loosen up the balloon by stretching it a few tes and then use the funnel to fill it a bit more than halfway with baking soda. If you don't have a funnel you can make one using the paper and some tape.
3. Now carefully put the neck of the balloon all the way over the neck of th bottle without letting any baking soda into the bottle.
4. Ready? Lift the balloon up so that the baking soda falls from the balloon into the bottle and mixes with the vinegar. Watch the balloon inflates!

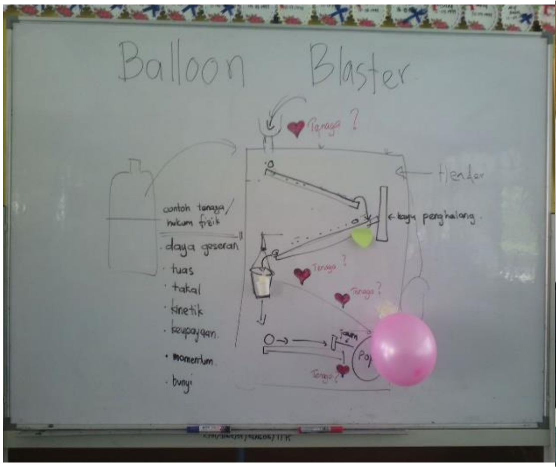
Balloon Blast

Form : States of matter: Gas
Standard :primary/secondary

Materials:

Balloon
Thread
Pin
Selotape
Ball
Straw
Plastic cup
Clip
Ruler

Procedure:



Erupting volcanos

Form :
Standard :

Materials:

A container
Food coloring
Baking soda
Drinking glass
Vinegar

Procedure:

1. Put the drinking glass into a container.
2. Put the baking soda inside the drinking glass
3. Adding the food coloring into the baking soda
4. Now for the eruption! Add the provided vinegar into the container and watch your container come alive!

Fireworks in a glass

Materials:

1 clean and clear glass
Vegetable oil
Food coloring
¾ cup of water
Mentos tablet

Procedure:

1. Pour the water into the bottle
2. Use a measuring cup or funnel to slowly pour the vegetable iol into the bottle until it's almost full. You may have to wait a few minutes for the oil and water to separate.
3. Add 10 drops of food coloring to the bottle. The drops will pass through the oil and then mix with the water below.
4. Break a mentos tablet in half and drop the half tablet into the bottle. Watch it sink to the bottom and let the blobby greatness begin!
5. To keep the effect going, just add another tablet piece. For a true lave lamp effect, shine a flashlight through the bottom of the bottle.

Hoopster
Materials:

A regular plastic drinking straw
3 x 5 inch index card or stiff paper
Tape
Scissors

Procedure:
1. Cut the index card or stiff paper into 3 separate pieces that measure 1 inch (2.5cm) by 5 inches (13cm)
2. Take 2 of the pieces of paper and tape them together into a hoop as shown. Be sure to overlap the pieces about half an inch (1cm) so that they keep a nice round shape once taped.
3. Use the last strip of paper to make a smaller hoop, overlapping the edges a bit like before.
4. Tape the paper loops to the ends of the straw as shown below. (notice that the straw is lined up on the inside of the loops)
5. That's it! Now hold the straw in the middle with the hoops on top and throw it in the air similar to how you might throw a dart angled slightly up. With some practice you can get it to go farther than many paper airplanes.

The cornstarch and water experiment

Form : State of matters
Standard : Primary school

Materials:

Cornstarch
Water
Food coloring
A large bowl

Procedure:
1. Everyone should roll up their sleeves and prepare for some gooey fun.
2. This is easy. Pour the cornstarch into the bowl. Don't rush to add water – take time to feel the cornstarch. Cornstarch does not feel like any other powder. It has a texture that can be

compared to that of whipped cream. The grains of cornstarch are so small that they will fill into grooves of your fingerprints and make the prints stand out.

3. After you've taken-in the feel of the powder, it is time to add water (you should add the food coloring to your water before adding it to the powder). There are no exact formulas regarding how much water to add, but it will end up being about ½ cup (120 ml) of water per cup (235 ml) of cornstarch. The secret is to add the water slowly and mix as you add it. Don't be shy here – dig in with your hands and really mix it up. This is usually when you notice that this is not your average liquid. Add enough water so that the mixture slowly flows on its own when mixed. The best test is to reach in and grab a handful of the mixture and see if you can roll it into a ball between your hands – if you stop rolling it and it 'melts' between your fingers – success!

<u>Stomata on a leaf peel</u>

Materials required:

A fresh leaf found around nature secret lab
Glass slide
Cover slip
Watch glasses
Nail varnish/glycerine
Water/lactophenol blue solution
Dropper
Forceps

Procedures/ Methods:

1. Pluck a fresh leaf from a tree around nature secret lab (guided by facilitator).
2. Fold the leaf and carefully tear along the bruised area of the lower side of the leaf.
3. We can see a colourless narrow border along the torn edge.
4. Carefully pull out the thin membranous transparent layer from the lower epidermis using a forceps.
5. Put the epidermis into a watch glass containing distilled water.
6. Take few drops of Lactophenol Blue solution using a dropper and transfer this into another watch glass.
7. Using a brush transfer the epidermis into the watch glass containing the Lactophenol Blue solution.
8. Keep the epidermis for 30 sec in the Lactophenol Blue solution to stain the peel.
9. To remove excess stain sticking to the peel, place it again in the watch glass containing water.
10. Place the peel onto a clean glass slide using the brush.
11. Take a few drops of nail varnish/glycerine using a dropper and pour this on the peel.
12. Using a needle, place a cover slip over the epidermis gently.
13. Drain out the excess glycerine using a blotting paper.
14. Take the glass slide and place it on the stage of the compound microscope.
15. Examine the slide through the lens of the compound microscope.

Observations:

- The epidermis is made of uniseriate layers of cells that have distinct cell walls, a nucleus and cytoplasm, and are closely packed.
- The epidermal layers are broken at places. These openings are the stomata.
- Each **stoma is guarded by a pair of bean shaped cells that are guard cells.**

Precautions:

- The epidermal peel should be taken from a freshly-plucked leaf.
- Take the epidermal layer from the lower surface of a leaf, as it has more stomata.
- Always use a clean glass slide.

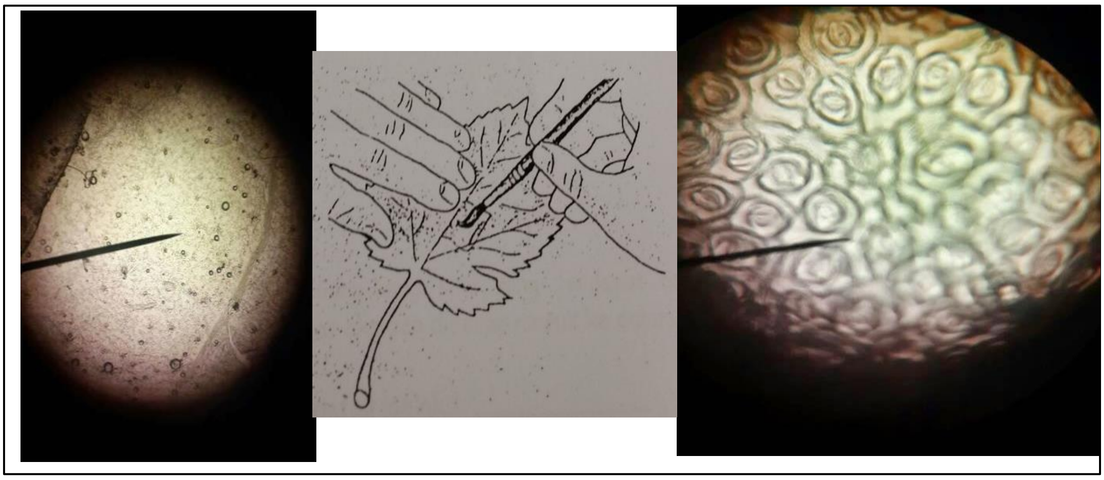


Diagram 4. The pictures of stomata taken straight away from the lens of the microscope

Abbreviation List

CML	Contextual Model of Learning
GLOs	Generic Learning Outcomes
MNSC	Malaysia National Science Centre
MOE	Ministry of Education
PSN	Pusat Sains Negara
S&T	Science and technology
SPM	Sijil Pelajaran Malaysia (equivalent to GCSE ‘O’ levels in the UK)
STEM	Science, Technology, Engineering and Mathematics
STPM	Sijil Tinggi Pelajaran Malaysia (Malaysian Higher School Certificate of Education examination / equivalent to GCSE ‘A’ levels in the UK)
T&L	Teaching and learning
UPSR	Primary School Achievement Test or in Malay ‘*Ujian Pencapaian Sekolah Rendah*’

REFERENCES

Abraham, L.M. 2002. What do high school science students gain from field-based research apprenticeship programs? The clearing house. *Journal of Educational Psychology, 75*(5): 229-232.

Agadjanian, V., & Hui, P. L. (2005). Preferential policies and ethnic differences in post-secondary education in Peninsular Malaysia. *Race Ethnicity and Education*, *8*(2), 213–230.

Ahmad Nurulazam Md Zain, Mohd Ali Samsudin, Robertus Rohandi, & Azman Jusoh. (2010a). Improving Students ' Attitudes Toward Science Using Instructional Congruence. *Journal of Science and Mathematics*, *33*(1), 39–64.

Ahmad Nurulazam Md Zain, Mohd Ali Samsudin, Robertus Rohandi, & Azman Jusoh. (2010b). Using the Rasch Model to Measure Students' Attitudes toward Science in "Low Performing" Secondary Schools in Malaysia. *International Education Studies*, *3*(2), 56–63.

Allen, S. (2004). Designing for learning: studying science museum exhibits that do more than entertain. *Science Education*, *88*(1): 17-33.

Amarjit Kaur., & Metcalfe, I. (1999). *The Shaping of Malaysia: Studies in the Economist of East and South-East Asia*. (P. Nolan & M. Falkus, Eds.). London: MacMillan Press Ltd.

Anderson, D., Lucas, K.B., Ginns, I.S. & Dierking, L.D. (2000). Development of knowledge about electricity and magnetism during a visit to a science museum and related post-visit activities. *Journal of Research in Science Teaching*, *84*: 658-679.

Anderson, D., Thomas, G.P., & Ellenbogen, K. (2003). Learning science from experiences in informal contexts: the next generation of research. *Asia-Pacific Forum on Science Learning and Teaching*, *4*(1): 1–6.

Ausubel, D. (1968). *Educational psychology: A cognitive view*. New York: Hot, Rinehart and Winston.

Balas, A.K. (1998). Science Fairs in Elementary School. *ERIC Digest*. Columbus, OH: ERIC Clearinghouse for Science Mathematics and Environmental Education.

Bamberger, Y., & Tal, T. (2006). Learning in a personal context: levels of choice in a free choice learning environment in science and natural history museums. *Science Education*, *91*: 75-95.

Bamberger, Y., & Tal, T. (2008). Multiple outcomes of class visits to natural history museums: the students' view. *Journal of Science Education in Technology*, *17*: 274-284.

Bandura, A. (1977). Self-efficacy: toward a unifying theory of behavior change. *Psychological Review*, *84*: 191–215.

Bandura, A. (1986). *Social foundations of thought and action: a social cognitive theory*. Englewood Cliffs: Prentice-Hall.

Bandura, A. (2001). Social cognitive theory: an argentic perspective. In Fiske S.T. (Eds.). *Annual review of psychology*, *52*, 1–26.

Barmby, P., Kind, P. M., & Jones, K. (2008). Examining Changing Attitudes in Secondary School Science. *International Journal of Science Education*, *30*(8), 1075–1093.

Barriault, Chantal Lise. (2014). *Visitor engagement and learning behaviour in science centres, zoos and aquaria*. Ph.D. Curtin University, Science and Mathematics Education Centre.

Bell, P., Lewenstein, B., Shouse, A. W., & Feder, M. A. (2009). *Learning Science in Informal Environments: People, Places, and Pursuits*. (P. Bell, B. Lewenstein, A. W. Shouse, & M. A. Feder, Eds.). Washington, D.C.: The National Academies Press.

Bennett, J. (2003). *Teaching and Learning Science: A Guide to Recent Research and Its Application*. London: Continuum.

Benton, G. M. (2013). The Role of Intrinsic Motivation in a Science Field Trip. *Journal of Interpretation Research*, *18*(1), 71–82.

Bernhardsson, N., & Lattke, S. (2012). Core competencies of adult learning facilitators in Europe. *Findings from a transnational delphi survey conducted by the project "Qualified to Teach".*

Bevan, B., Dillon, J., Hein, G.E., Macdonald, M., Michalchik, V., Miller, D., Root, D., Rudder, L., Xanthoudaki, M., & Yoon, S. (2010). *Making Science Matter: Collaborations Between Informal Science Education Organizations and Schools*. A CAISE Inquiry Group Report. Washington, D.C.: CAISE.

Bierbaum, E. G. (1988). Teaching science in science museums. *Curator*, *31*(1), 26-35.

Bishop, G. (1989). *Alternative strategies for education*. London: Macmillan.

Blackford, J. (2009). *School-museum partnership : Bridging formal and informal science learning in the elementary school*. Unpublished Master Thesis. Portland State University

Bloomberg, L.D., & Volpe, M.F. (2008). *Completing your qualitative dissertation: A roadmap from beginning to end*. USA: Sage Publications Inc.

Boxerman, J.Z. (2013). Echoes from the field: an ethnographic investigation of outdoor science field trips. Unpublished PhD thesis. Northwestern University.

Bozdogan, A. E., & Yalcin, N. (2009). Determining the Influence of a Science Exhibition Center Training Program on Elementary Pupils ’ Interest and Achievement in Science. *Eurasia Journal of Mathematics, Science and Technology Education*, *5*(1), 27–34.

Bradburne, J.M. (1998). Dinosaurs and white elephants: The science centre in the 21st century. *Museum Management and Curatorship*, *17*(2), 119–137.

Braund, M., Crompton, Z., Driver, M., & Parvin, J. (2003) Bridging the key stage 2/3 gap in science. *School Science Review, 85*(310), 117-123.

Braund, M., & Reiss, M. (2004a). *Learning Science Outside the Classroom*. In M. Braund & M. Reiss, (Eds.). Abingdon, UK: Taylor & Francis.

Braund, M., & Reiss, M. (2004b). The nature of learning science outside the classroom. In M. Braund & M. Reiss (Eds.), *Learning Science Outside the Classroom* (1st Ed., pp. 1–12). London: Routledge: Taylor & Francis Group.

Braund, M., & Reiss, M. (2006). Towards a More Authentic Science Curriculum: The contribution of out-of-school learning. *International Journal of Science Education*, *28*(12), 1373–1388.

Brennan, B. (1997). Reconceptualizing non-formal education. *International Journal of Lifelong Education*, 16(3), 185–200.

Brown, G.K. (2007). Making ethnic citizens: The politics and practice of education in Malaysia. *International Journal of Educational Development*, *27*(3), 318–330.

Bryman, A. (2008). *Social research methods*. New York: Oxford University Press.

Bryman, A. (2012). *Social research methods* (4th Ed.). Oxford University Press.

Chetty, P.S. (2005). *Informal Learning at Science Centres*. University of Johannesburg.

Cheong, A.C.S., & Swee, L.-K.K. (1987). The Contributions of Enrichment Activities Towards Science Achievement. *Singapore Journal of Education*, *8*(1), 63–75.

Chin, C., & Osborne, J. (2010). Students’ Questions and Discursive Interaction : Their Impact on Argumentation During Collaborative Group Discussions in Science. *Journal of Research in Science Teaching*, *47*(7), 883–908.

Cobern, W.W. (1996). Constructivism and non-western science education research. *International Journal of Science Education*, *4*(3), 287–302.

Cohen, J. (1988). Statistical power analysis for the behavioral sciences. *Statistical Power Analysis for the Behavioral Sciences*.

Cohen, L., Manion, L., & Morrison, K. (2007). *Research Methods in Education* (6th Ed.). London & New York: Routledge: Taylor & Francis Group.

Colley, H., Hodkinson, P., & Malcolm, J. (2003). *Informality and Formality in Learning: a report for the Learning and Skills Research Centre*. Leeds.

Commission of the European Communities. (2000). *A Memorandum on Lifelong Learning*. *Commission staff working paper*. Brussels.

Coombs, P. H. (1976). Nonformal Education : Myths, Realities, and Opportunities. *Comparative Education Review*, *20*(3), 281–293.

Coombs, P. H., & Ahmed, M. (1974). *Attacking rural poverty: How non-formal education can help*. Baltimore: John Hopkins University Press.

Cox-Peterson, A.M., Marsh, D.D., Kisiel, J., & Melber, L.M. (2003). Investigation of guided school tours, student learning, and science reform recommendations at a museum of natural history. *Journal of Research in Science and Teaching*, *40*(2): 400-418.

Creswell, J.W. (2003). *Research design: Qualitative, Quantitative, and Mixed Methods Approaches* (2nd Ed.). London: Sage Publications.

Creswell, J.W. (2009). *Research Design: Qualitative, quantitative, and mixed method approaches* (3rd Ed.). USA: Sage Publications Inc.

Creswell, J.W. (2012). *Educational Research: Planning, conducting and evaluating quantitative and qualitative research* (4th Ed.). Boston: Pearson.

Csikszentmihalyi, M., & Hermanson, K. (1995). Intrinsic motivation in museum: what makes visitors want to learn. In. Falk J.H. &. Dierking, L.D. (Eds.). *Public institutions for personal learning: establishing a research agenda*, p. 67–77. Washington DC: American Association of Museums.

Davidson, S.K., Passmore, C., & Anderson, D. (2010). Learning on zoo field trips: The interaction of the agendas and practices of students, teachers, and zoo educators. *Science Education*, *94*(1), 122–141.

Denscombe, M. (2002). *Ground Rules for Good Research: A 10 Point Guide for Social Researchers*. Buckingham, Philadelphia: Open University Press.

Denscombe, M. (2003). *The good research guide for small-scale social research projects* (2nd Ed.). Maidenhead, Philadelphia: Open University Press.

Denscombe, M. (2010). *The good research guide for small-scale social research projects* (4th Ed.). Open University Press.

DeWitt, J.E. (2008). What is This Exhibit Showing You? Insights from Stimulated Recall Interviews with Primary School Children. *Journal of Museum Education, 33*(2), 165–173.

DeWitt, J., & Hohenstein, J. (2010). School trips and classroom lessons: an investigation into teacher–student talk in two settings. *Journal of Research in Science Teaching, 47*(4): 454-473.

DeWitt, J., & Osborne, J. (2010). Recollections of Exhibits: Stimulated-recall interviews with primary school children about science centre visits. *International Journal of Science Education*, *32*(10), 1365–1388.

Diack, A. (2009). A smoother path: Managing the challenge of school transfer. *Perspective in Education, 2,* 39-51.

Dillon, J., Morris, M., O'Donnell, L., Reid, A., Rickinson, M., & Scott, W. (2005). *Engaging and Learning with the Outdoors – The Final Report of the Outdoor Classroom in a Rural Context Action Research Project*.

Driver, E. (1995). *Using semi-structured interviews in small-scale research: A teacher's guide*. Glasgow: The Scottish Council for Research in Education (SCRE).

Duit, R., & Treagust, D.F. (1998). Learning in science – From behaviourism towards social con- structivism and beyond. In B. J. Fraser & K. Tobin (Eds.), *International handbook of science education* (pp. 3–25). Dordrecht, The Netherlands: Kluwer.

Dunlop, L., Clarke, L., & Mckelvey-martin, V. (2018). Free-choice learning in school science : a model for collaboration between formal and informal science educators. *International Journal of Science Education, Part B,* 1–16.

Dusenbery, P.B., Harold J.B., McLain, B., & Curtis, L. (2008). Space weather outreach: an informal education perspective. *Advance in space research, 42*: 1837-1843.

Eraut, M. (2000). Non-formal learning and tacit knowledge in professional work. *British Journal of Educational Psychology*, *70*, 113–136.

Eshach, H. (2007). Bridging In-school and out-of-school Learning: Formal, Non-Formal, and Informal Education. *Journal of Science Education and Technology, 16*(2), 171–190.

Fadzil, H.M., & Saat, R.M. (2014). Enhancing STEM Education during School Transition: Bridging the Gap in Science Manipulative Skills. *EURASIA Journal of Mathematics, Science & Technology Education*, *10*(3), 209–218.

Falk, J.H. (2001). *Free-choice science education, how we learn science outside of school.* New York: Teachers College Press.

Falk, J.H. (2004). The director's cut: toward an improved understanding of learning from museums. *Science Educations, 88*(1): 83-96.

Falk, J.H., & Adelman, L.M. (2003). Investigating the impact of prior knowledge and interest on aquarium visitor learning. *Journal of Research in Science Teaching, 40*(2): 163-176.

Falk, J.H., & Dierking, L.D. (1992). *The museum experience*. Washington, DC: Whalesback Books.

Falk, J.H., & Dierking, L.D. (1997). School field trips: assessing their long-term impact. *Curator*, *40*: 211–218.

Falk, J.H., & Dierking, L.D. (2000). *Learning From Museum: Visitor Experiences and the Making of Meaning*. Walnut Creek, CA: Alta Mira Press.

Falk, J.H., & Dierking, L.D. (2002). *Lessons without limit: How free-choice learning is transforming education*. Walnut Creek, CA: Alta Mira Press.

Falk, J. H., & Dierking, L.D. (2010). The 95 Percent Solution: School is not where most American learn most of their science. *American Scientist*, *98,* 486–493.

Falk, J.H., & Dierking, L.D. (2011). *The museum experience*. Walnut Creek, CA: Left Coast Press.

Falk, J.H., & Needham, M.D. (2011). Measuring the impact of a science center on its community. *Journal of Research in Science Teaching 48*(1): 1–12.

Falk, J., & Storksdieck, M. (2005). Using the contextual model of learning to understand visitor learning from a science center exhibition. *Science Education*, *89*(5), 744–778.

Falk, J.H., & Storksdieck, M. (2010). Science learning in a leisure setting. *Journal of Research in Science Teaching*, *47*(2): 194-212.

Feher, E. (1990). Interactive museum exhibits as tools for learning: exploration with light. *International Journal of Science Education*, *12*: 35–39.

Field, A. (2009). *Discovering statistics using SPSS* (3rd Ed.). Sage Publications.

Finkelstein, D. (2005). *Science museums as resources for teachers: an exploratory study on what teachers believe*. Dallas: National Association for Research in Science Teaching Annual Conference.

Finson, K.D., & Enochs, L. (1987). Students attitudes towards science- technology society resulting from a visit to a semi-technology museum. *Journal of Research in Science Teaching 24*, 593-609.

Flexer, B., & Borun, M. (1984). The impact of a class visit to a participatory science museum exhibit and a classroom science lesson. *Journal of Research in Science Teaching*, *21*(9), 863-873.

Fosnot, C.T. (2005). *Constructivism: Theory, perspectives, and practice*. (2nd Ed.). New York: Teachers College Press.

Garrity, J., Pastore, K., & Roche, A. (2010). *An Evaluation of the Effectiveness of Science Field Trips and Hands-On Classroom Activities at the Maria Mitchell Association, Nantucket, MA*. Degree of Bachelor of Science, Worcester Polytechnic Institute.

Gelman, S.A., & Kalish, C.W. (2006). Conceptual development. In. Kuhn D. & Siegler R. (Eds.). *Handbook of child psychology: cognition, perception and language*. New York: Wiley.

Gerber, R.V. (1982). An International Study of Children's Perception and Understanding of Type used on Atlas Maps. *The Cartographic Journal*, *19*(2), 115–121.

Glasson, G.E. (1989). The effects of hands-on and teacher demonstration laboratory methods on science achievement in relation to reasoning ability and prior knowledge. *Journal of Research in Science Teaching*, 26(2), 121-131.

Gokhale, A., Brauchle, P., & Machina, K. (2009). Development and Validation of a Scale to Measure Attitudes toward Science and Technology. *Journal of College Science Teaching*, 66–75.

Gomes, A. (1999). Peoples and Cultures. In A. Kaur & I. Metcalfe (Eds.), *The Shaping of Malaysia: Studies in the Economist of East and South-East Asia* (pp. 78–98). London: MacMillan Press Ltd.

Grenier, R.S. (2011). Taking the lead: a qualitative study of expert docent characteristics. *Museum Management and Curatorship, 26*(4): 339-353.

Griffin, J.M. (1998). *School-Museum integrated learning experiences in science : A learning journey*. Doctor of Philosophy. Unpublished PhD Thesis. University of Technology, Sydney.

Griffin, J. (2004). Research on students and museums: Looking more closely at the students in school groups. *Science Education*, *88*: 59-70.

Griffin, J., & Symington, D. (1997). Moving from task-oriented to learning oriented strategies on school excursions to museums. *Science Education*, 81,763-779.

Griffin, J., & Symington, D. (1998). Thinking about learning strand 1: visitor behavior. In. Stocklmayer, S. & Hardy, T. (Eds.). *Learning science in informal contexts*, p.7–15. Australia: Questacon, The National Science and Technology Centre.

Guest, G. 2004. Discussion of Constructivism. UWE, Bristol. Retrieved from http://www.aes.org.uk/sci_tutors/. [26 March 2016].

Guisasola, J., Morentin, M., & Zuza, K. (2005). School visits to science museums and learning sciences: a complex relationship. *Physics Education*, *40*(6), 544–549.

Hair, J.F. Jr., Money, A.H., Samouel, P., & Page, M. (2007). *Research methods for business*. United States of America: John Wiley & Sons.

Hamdan Ab. Kadir, Madon Mawel, Syed Hussin Jaafar. (2007). *Panduan Menjadi Fasilitator Efektif*. Bentong, Pahang: PTS.

Hashim, I. (2006). *An integrated concept of Islamic education: a study on Islamic education in Muslim Religious Secondary Schools in Selangor, Malaysia*. unpublished PhD thesis, Al-Maktoum Institute, Dundee.

Hein, G.E. (1998). *Learning in the Museum*. New York: Routledge.

Hergenhahn, B.R., & Olson, M.H. (2005). *An introduction to theories of learning*. (7th Ed.). New Jersey: Pearson Prentice Hall.

Hewson, M., & Hewson, P.W. (1983). Effect of instruction using students' prior knowledge and conceptual change strategies on science learning. *Journal of Research in Science Teaching*, *20*(8), 73 1-743.

Hofstein, A., & Rosenfeld, S. (1996). Bridging the Gap Between Formal and Informal Science Learning. *Studies in Science Education*, *28*(1), 87–112.

Hogan, C. (2002). *Understanding facilitation: Theory & principles.* Kogan Page Publishers.

Holmes, J.A. (2011). Informal learning: Student achievement and motivation in science through museum-based learning. *Journal Learning Environment Research*, *14*: 263-277.

Hooper-Greenhill, E. (1992). *Museums and the Shaping of Knowledge*. *American Anthropologist* (Vol. 95). London & New York: Routledge: Taylor & Francis Group.

Hooper-Greenhill, E. (2007). *Museums and Education: Purpose, pedagogy, performance*. Abingdon: Routledge.

Hooper-Greenhill, E., Dodd, J., Creaser, C., Sandell, R., Jones, C., & Woodham, A. (2007). *Inspiration , Identity , Learning : The Value of Museums Second Study: An Evaluation of the DCMS/DCSF National/ Regional Museum Partnership Programme in 2006-2007*.

Hunter, D., & Thorpe, S. (2005). Facilitator values and ethics. In. *The IAF Handbook of Group Facilitation*. Retrieved from http://elena.ait.ac.nz/homepages/phd-students/stetho09/docs/IAF_book_chapter.pdf [9 November 2014].

Jaffry Zakaria. (2011). Program Latihan Khidmat Negara (PLKN) sebagai Agen Pendidikan Luar di Malaysia. In *Pendidikan Luar: Definisi, Falsafah dan Aplikasi* (pp. 83–88).

Jasbir, S. S., & Mukherjee, H. (1993). Education and national integration in Malaysia: Stocktaking thirty years after independence. *Int. J. Educational Development*, *13*(2), 89–102.

Kahn, T.M., & Rockman, S. (2002). *Leveraging San Francisco Bay Area Science-Technology Museums and Other Informal Science Education Programs as a Key Educational Resource for Student Learning and Teacher Professional Development*. The William and Flora Hewlett Foundation Menlo Park, CA.

Kalaian, S. (2008). Research Design. In P. J. Lavarkas (Ed.), *Encyclopedia of Survey Research Methods* (pp. 724–731). Thousand Oaks, CA: Sage Publications.

Kamogawa, A. (2003). Higher Education Reform : Challenges towards a Knowledge Society in Malaysia. *African and Asian Studies*, *2*(4), 1–8.

Kamolpattana, S., Chen, G., Sonchaeng, P., Wilkinson, C., Willey, N., & Bultitude, K. (2015). Thai visitors' expectations and experiences of explainer interaction within a science museum context. *Public Understanding of Science*, *24*(1), 69–85.

Kisiel, J.F. (2003). *Revealing teacher agendas: An examination of teacher motivations and strategies for conducting museum trips*. Unpublished PhD Thesis. Faculty of Graduate School, University of Southern Calorina.

Kisiel, J. (2005). Understanding elementary teacher motivations for science fieldtrips. *Science Education*, *89*(6): 936 - 955.

Kisiel, J. (2012). Reframing collaborations with informal science institutions: the importance of communities of practice. In. Doris B.A., Jrène, R. & Leah M.M. (Eds.). *Putting theory into practice: tools for research in informal settings*. Rotterdam: Sense Publishers.

Kisiel, J. (2013). Introducing future teachers to science beyond the classroom. *Journal of Science Teacher Education*, *24*(1): 67-91

Knox, K.L., Moynihan, J.A., & Markowitz, D.G. (2003). Evaluation of short-term impact of a high school summer science program on students' perceived knowledge and skills. *Journal of Science Education and Technology*, *12*: 471-478.

Kolb, J.A., Jin, S., & Hoon Song, J. (2008). A model of small group facilitator competencies. *Performance Improvement Quarterly, 21*(2): 119-133.

Korff, R. (2001). Globalisation and communal identities in the plural society of Malaysia. *Singapore Journal of Tropical Geography*, *22*(3), 270–283.

Krepel, W.J., & Duvall, C.R. (1981). *Field trips: a guideline for planning and conducting educational experiences*. Washington, DC: National Science Teachers Association.

Kuenzi, J.J. (2008). *Science, Technology, Engineering, and Mathematics (STEM) Education : Background, Federal Policy, and Legislative Action*. Washington, DC: Congressional Research Service.

Lam-Kan, K.S. (1985). *Contributions of enrichment activities towards science interest and achievement*. EdD dissertation, National University of Singapore.

Lee, M.N.N. (1997). Education and the State: Malaysia after the NEP. *Asia Pacific Journal of Education*, *17*(1), 27–40.

Lee, M.N.N. (1999). Education in Malaysia: Towards Vision 2020. *School Effectiveness and School Improvement*, *10*(1), 86–98.

Lee, O., & Luykx, A. (2007). Science education and student diversity: Race/ethnicity, language, culture, and socioeconomic status. In. Abell S.K. & Lederman N.G. (Eds.). *Handbook of research in science education*. (2nd Ed.). p. 171-197. Mahwah, NJ: Lawrence Erlbaum Associates.

Lilia Halim. (2013). *Pendidikan Sains dan Pembangunan Masyarakat. Syarahan Perdana Jawatan Profesor*. Bangi: Penerbit UKM

Ling, J., Jiang, N., & Liu, S. (2011). Consumer Perceptions of E-Service Convenience : An Exploratory Study. *Procedia Environmental Sciences*, *11*, 406–410.

Loke, S.H., Idris, N., Zamri, S.N.A.S., Eng, L.S., Hun, W.H., Fatt, L. L., Sin, L. T. (2003). *National Science Centre: An evaluation of its role*. Kuala Lumpur: National Science Centre of Malaysia.

Lowe, J. (1975). *The education of adults: a world perspectives*. Toronto.

Maarschalk, J. (1986). Scientific literacy through informal science teaching. *Journal of Science Education*, *8*(4), 353-360.

Malaysia. (1995). *Education Bill 1995. D. R. 35/95*.

Mansor Mohd Noor. (1999). Crossing Ethnic Borders in Malaysia Measuring the Fluidity of Ethnic Identity and Group Formation. *Akademika*, *55*(Julai), 61–82.

Markowitz, D.G. (2004). Evaluation of the long-term impact of a university high school summer science program on students' interest and perceived abilities in science. *Journal of Science Education and Technology*, *13*(3): 395–407.

Martin, M.O., Mullis, I.V.S., Foy, P., & Stanco, G.M. (2011). *TIMSS 2011 International Results in Science*. Boston: TIMSS & PIRLS International Study Center, Lynch School of Education, Boston College.

Maxwell, J.A. (2013). *Qualitative research design: An interactive approach*. (3rd Edition). Los Angeles, CA: Sage.

Md Amin Md Taff. (2011). *Pendidikan Luar: Definisi, Falsafah & Aplikasi*. (Md Amin Md Taff, Ed.) (First Ed.). Tanjong Malim, Perak: Penerbit Universiti Pendidikan Sultan Idris.

Melber, L.M. (2007). Maternal scaffolding in two museum exhibition halls. *Curator*, *50*(3): 341-354.

Michie, M. (1998). Factors influencing secondary science teachers to organize and conduct field trips. *Australian Science Teacher Journal*, *44*: 43-50.

Ministry of Education. (2012). *Laporan Strategi Mencapai Dasar 60:40 Aliran Sains/Teknikal: Sastera*. Putrajaya: KPM.

Ministry of Education. (2013). *Malaysia Education Blueprint 2013 - 2025 (Pelan Pembangunan Pendidikan Malaysia 2013-2025)*. Putrajaya: KPM.

Ministry of Education Malaysia. (2003). *Syllabus for Integrated Curriculum for Primary Schools Science*. Putrajaya : KPM: Curriculum Development Centre.

Ministry of Higher Education. (2011). *Blueprint on Enculturation of Lifelong Learning for Malaysia 2011–2020*.

Mirrahimi, S. Z., Tawil, N. M., Abdullah, N. A. G., Surat, M., & Usman, I. M. S. (2011). Developing conducive sustainable outdoor learning: The impact of natural environment on learning, social and emotional intelligence. *Procedia Engineering*, *20*, 389–396.

Morentin, M., & Guisasola, J. (2013). Primary and secondary teachers' ideas on school visits to science centres in the Basque Country. *International Journal of Science and Mathematics Education*, (December 2013).

MOSTI. (2010). *Malaysian Science & Technology Indicators 2010*. Putrajaya.

Munn, P., & Driver, E. (2004). *Using questionnaires in small-scale research: A beginner's guide*. University of Glasgow: The SCRE Centre.

Nabors, M.L., Edwards, L.C., & Murray, R.K. (2009). Making the case for field trips: what research tells us and what site coordinators have to say. *Education, 129*(4): 661-667.

National Research Council. (1996). *National Science Education Standards*. Washington, D.C.: National Academy Press.

Neill, A. C. (2010). *Museum docents' understanding of interpretation*. Pennsylvania State University Department of Education.

Noorani, M. S. M., Ismail, E. S., Salleh, A. R., Rambely, A. S., Mamat, N. J. Z., Mudaf, N., Majid, N. (2010). Exposing the Fun Side of Mathematics via Mathematics Camp. *Procedia - Social and Behavioral Sciences, 8*, 338–343.

OECD. (2012). *PISA 2012 Results in Focus: What 15-year-olds know and what they can do with what they know*.

Ogbu, J.U. (1995). The Influence of Culture on Learning and Behavior. In Falk, J.H. and Dierking, L.D. (Eds.). *Public Institutions and Informal Learning: Establishing a Research Agenda*, Washington, DC: American Association of Museums, 79–96.

Olson, J.K., Cox-Petersen, A.M., & McComas, W.F. (2001). The inclusion of informal environments in science teacher preparation. *Journal of Science Teacher Education, 12*: 155–173.

Orion, N., & Hofstein, A. (1991). The measurement of students' attitudes towards scientific field trips. *Science Education, 75*: 513-523.

Osborne, J., Simon, S., & Collins, S. (2003). Attitudes towards science: A review of the literature and its implications. *International Journal of Science Education, 25*(9), 1049–1079.

Pallant, J. (2007). *SPSS Survival Manual: A step by step guide to data analysis using SPSS for Windows* (3rd Ed.). Open University Press.

Parker, V., & Gerber, B. (2000). Effects of a science intervention program on middle-grade student achievement and attitudes. *School Science and Mathematics, 100*(5): 236–242.

Paulsen, D. (2004). Leadership Essentials: Facilitation Skills for Improving Group Effectiveness. *SIGUCCS '04 Proceedings of the 32nd annual ACM SIGUCCS fall conference*, p. 153-160.

Pedretti, E. (2002). Meets T. Rex: critical conversations and new directions in science centers and science museums. *Studies in Science Education, 37*: 1-42.

Phipps, M. (2010). Research trends and findings from a decade (1997–2007) of research on informal science education and free-choice science learning. *Visitor Studies, 13*(1): 3–22.

Piaget, J., & Inhelder, B. (1967). *The Child's Conception of Space*. "Systems of Reference and Horizontal-Vertical Coordinates." p. 375-418. New York: Norton & Co.

Plummer, J. D., & Small, K. J. (2013). Informal science educators' pedagogical choices and goals for learners: The case of planetarium professionals. *Astronomy Education Review, 12*(1), 010105.

Pompea, S., & Hawkins, I. (2002). Increasing science literacy in optics and photonics through science centres, museums, and web-based exhibits. In T.-K. Lim & A.H. Guenther (Eds.), *Proceedings of SPIE: Vol. 4588. Seventh International Conference on Education and Training in Optics and Photonics,* (pp. 554–560). Singapore.

Pong, S. L. (1993). Preferential policies and secondary school attainment in Peninsular Malaysia. *Sociology of Education*, *66*(4), 245–261.

Pringle, R., Hakverdi, M., Cronin-Jones, L., & Johnson, C. (2003). *Zoo school for pre-schoolers: Laying the foundation for environmental education*. American Educational Research Association: Chicago, IL.

Pugh, K.J., & Bergin, D.A. (2005). The effect of schooling on students' out-of-school experience. *Educational Researcher, 34*(9): 15-23.

Quin, M. (1990) What is hands-on science and where can I find it? *Physics Education, 25*, 243–247.

Ramey-Gassert, L., Walbert, H.J., & Walberg, H.J. (1994). Reexamining Connections: Museums as Science Learning Environments. *Science Education*, *78*(4), 345–365.

Razali, M., Jantan, R., & Hashim, S. (2003). *Psikologi pendidikan*. PTS Professional.

Rebar, B.M. (2009). Evidence, explanations, and recommendations for teachers' field trip strategies. Unpublished PhD theis. Oregon State University: Corvallis.

Recht, D., & Leslie, L. (1988). Effect of prior knowledge on good and poor reader's memory on text. *Journal of Educational Psychology*, 16-20.

Reid, N., & Reid, N. (2006). Thoughts on attitude measurement. *Research in Science & Technological Education*, *24*(1), 3–27.

Renner, J. W., Abraham, M. R., & Birnie, H. H. (1985). The importance of the form of student acquisition of data in physics learning cycles. *Journal of Research in Science Teaching*, 22(4), 303-325.

Rennie, L. J. (1994). Measuring affective outcomes from a visit to a science education centre. *Research in Science Education*, *24,* 261–269.

Rennie, L. J. (2001). Communicating science through interactive science centres: A research perspective. In S. M. Stocklmayer, M. M. Gore, & C. Bryant (Eds.), *Science Communication in Theory and Practice (Vol. 14)* (pp. 107–121). Netherlands: Springer.

Rennie, L. J. (2014). Learning Science Outside of School. In N. G. Lederman & S. K. Abell (Eds.), *Handbook of Research on Science Education: Volume II* (pp. 120–144). New York: Routledge.

Resnick, L.B., Levine, J.M., & Teasley, S.D. (1991). *Perspectives on socially shared cognition*. Washington, DC: American Psychological Association.

Richards, L. (1999). *Using NVivo in Qualitative Research*. London: Sage Publications.

Rickinson, M., Dillon, J., Teamy, K., Morris, M., Young Choi, M., Sanders, D., & Benefield, P. (2004). *A review of research on outdoor learning*. London: National Foundation of Educational Research.

Rix, C., & McSorley, J. (1999). An investigation into the role that school-based interactive science centres may play in the education of primary-aged children. *International Journal of Science Education*, *21*(6), 577–593.

Roberson, S.V. (2010). *Science Skills on Wheels: The exploration of a mobile science lab's influence on teacher and student attitudes and beliefs about science*. Unpublished PhD Thesis. University of Pennsyvania.

Robinson, L.B. (2016). *Visitor Learning on Guided Tours : An Activity Theory Approach*. University of California, San Diego.

Romance, N.R., & Vitale, M.R. (2001). Implementing an in-depth expanded science model in elementary schools: multi-year findings, research issues, and policy implications. *International Journal of Science Education*, *23*(4): 373–404.

Roth, W.M., & Lee, S. (2003). Science Education as/for Participation in the Community. *Science Education, 88*: 263-291.

Rozita, I. (2007). Multiculturalism and Education in Malaysia. *Culture and Religion*, *8*(2), 155–167.

Ruto, S.J. (2004). *The Contribution of Non-Formal Schools in Enhancing the Provision of Basic Education in Kenya*. Ruprecht-Karls Universität Heidelberg.

Salmi, H. (1993). *Science Center Education: Motivation and Learning in Informal Education*. University of Helsinki, Finland. Retrieved from http://faculty.rmu.edu/~short/research/science-centers/references/Salmi-H-1993.pdf [22 January 2014].

Salmi, H. (2003). Science centres as learning laboratories: experiences of Heureka, the Finnish Science Centre. *International Journal of Technology Management*, *25*(5), 460–476.

Samkange, W. (2012). Analysing Research Methodologies : A case study of Masters of Education in Educational Management Dissertations at the Zimbabwe Open University. *International J. Soc. Sci. & Education*, *2*(4), 606–618.

Scarce, R. (1997). Field trips as short-term experiential education. *Teaching Sociology*, *25*(3): 219-226.

Schauble, L., & Bartlett, K. (1997). Constructing a science gallery for children and families: The role of research in an innovative design process. *Science Education*, *81*, 781–793.

Schneider, R. M., & Lumpe, A. T. (1996). The nature of student science fair projects in comparison to educational goals for science. *Ohio Journal of Science, 96* (415): 81-88.

Schneider, N. (2003). Making the informal formal: An examination of why and how teachers and students leverage experiences in informal learning environments. Unpublished PhD thesis. Stanford University.

Schugurensky, D. (2000). *The forms of informal learning: Towards a conceptualization of the field*.

Scott, M.M. (2006), From the editor, *Journal of Museum Education, 31*(3), 243-244.

Selvakumar, M., & Storksdieck, M. (2013). Portal to the public: Museum educators collaborating with scientists. *Curator the Museum Journal*, *5*(1): 69-78.

Senturk, E., & Ozdemir, O.F. (2014). The Effect of Science Centres on Students' Attitudes Towards Science. *International Journal of Science Education, Part B*, *4*(1), 1–24.

Sharifah Maimunah, S.Z., & Lewin, K.M. (1993). *Insights into Science Education: Planning and Policy Priorities in Malaysia*. Paris.

Smith-palmer, T., Schnepf, S., Sherman, A., Sullenger, K. S., & Macdonald, L. (2015). *An exploration of summer science camps as an informal learning environment*. In K.S. Sullenger & R.S. Turner (Eds.), New Ground: Pushing the Boundaries of Studying Informal Learning in Science, Mathematics, and Technology (pp. 67–91). Rotterdam: Sense Publishers.

Spencer, L., & Spencer, S. (1993). *Competencies at Work: Models for Superior Performance* New York: John Wiley and Sons.

Spencer, L.M., & Spencer, P.S.M. (2008). *Competence at Work models for superior performance*. John Wiley & Sons.

Stake, J.E., & Mares, K.R. (2001). Science enrichment programs for gifted high school girls and boys: predictors of program impact on science confidence and motivation. *Journal of Research in Science Teaching, 38*(10): 1065-1088.

Stewart, J.-A. (2006). High-Performing (and Threshold) Competencies for Group Facilitators. *Journal of Change Management*, *6*(4), 417–439.

Storksdieck, M. (2001). Differences in teachers' and students' museum field trip experiences. *Visitor Studies Today!*, *4*(1), 8–12.

Stroud, N.S. (2008). Teaching and learning science in a museum: examining the role of attitudes toward science, knowledge of sciences, and participatory learning in an astronomy internship for high school students. Unpublished PhD thesis. Columbia University.

Suzuki, M. (2005). Toward enhanced learning of science: an educational scheme for informal science institutions. Unpublished PhD thesis. North Carolina State University.

Taber, K.S., & Akpan, B. (2017). *Science Education: An international course Companion*. Netherlands: Sense Publishers.

Tal, R.T. (2001). Incorporating field trips as science learning environment enrichment- an interpretive study. *Learning Environments Research, 4*: 25-49.

Tal, R.T. (2004). *Guided school visits to natural history museums in Israel: different approaches and student learning*. Paper presented at the annual meeting of the National Association of Research in Science Teaching: Vancouver, Canada.

Tal, T. & Morag, O. (2007). School visits to natural history museums: teaching or enriching? *Journal of Research in Science Teaching, 44*(5): 747-769.

Tal, T. & Morag, O. (2009). Reflective practise as a means for preparing to teach outdoor in an Ecological Garden. *Journal Science Teacher Education*, *20*: 245-262.

Tan, L.W.-H. (2011). State of Science Communication and its Development in Singapore. *International Journal of Science Education, Part B, 1*(1), 15–16.

Tan, Y.S. (2012). Democratization of secondary education in Malaysia: Emerging problems and challenges of educational reform. *International Journal of Educational Development*, *32*(1), 53–64.

Teddlie, C., & Tashakkori, A. (2009). *Foundations of Mixed Methods research: Integrating Quantitative and Qualitative Approaches in the Social and Behavioral Sciences*. London: SAGE Publications.

The Macquarie Dictionary. (1997). A. Delbridge, J. Bernard, D.Blair, S. Butler, D. Peters, & C. Yallop (Eds.) (3rd Ed.). The Macquarie Library Pty Ltd.

Thomas, G.J. (2005). *Dimensions of facilitator education*. The IAF handbook of group facilitation: Best practices from the leading organisation in facilitation, p.525-541.

Thomas, G. (2008). Facilitate first thyself: The person-centered dimension of facilitator education. *Journal of Experiential Education*, *31*(2): 168-188.

Thurston, A., Topping, K. J., Tolmie, A., Christie, D., Karagiannidou, E., & Murray, P. (2010). Cooperative learning in science: Follow-up from primary to high school. *International Journal of Science Education*, *32*(4), 501–522.

Tran, L.U. (2002). *The roles and goals of educators teaching science in non-formal settings*. Unpublished Master Thesis. North Carolina State University, Raleigh.

Tran, L.U. (2004). *Teaching science in museums*. Unpublished PhD thesis. Raleigh, NC: North Carolina State University.

Tran, L.U. (2006). Teaching science in museums: The pedagogy and goals of museum educators. *Science Education*, *91*: 278-297.

Tran, L.U. (2008). The work of science museum educators. *Museum Management and Curatorship*, *23*(2), 135–153.

Tran, L.U., & King, H. (2007). The professionalization of museum educators: The case in science museums. *Museum Management and Curatorship 22*(2): 131-149.

Tran, L.U., & King, H. (2009). Professional Knowledge : Implications for Emerging Leaders. *Journal of Museum Education*, *34*(2), 149–162.

Tran, L.U, & Heather K. (2007). The professionalization of museum educators: The case in science museums. *Museum Management and Curatorship*, *22*(2): 131-149.

Tuan Soh, T. M., & Meerah, T. S. M. (2013). Outdoor Education: An Alternative Approach in Teaching and Learning Science. *Asian Social Science*, *9*(16), 1–8.

Tytler, R., Osborne, J., Williams, G., Tytler, K., & Clark, J. C. (2008). *Opening up pathways : Engagement in STEM across the Primary-Secondary school transition*. Canberra: Australia Department of Education, Employment and Workplace Relations.

UNESCO. (2002). *Innovations in Non-Formal Education: A Review of Selected Initiatives from the Asia-Pasific Region*. Bangkok.

Vygotsky, L.S. (1978). *Mind in society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press.

Walton, R. (2000). Heidegger in the hands-on science and technology center: Philosophical reflections on learning in informal settings. *Journal of Technology Education, 12*,49–60.

Wan Norjihan Wan Abdullah. (2003). *Panduan Menjadi Fasilitator*. Kuala Lumpur: PTS

Weinburgh, M.H., & Steele, D. (2000). The modified attitudes toward science inventory: developing an instrument to be used with fifth grade urban students. *Journal of Women and Minorities in Science and Engineering*, *6*: 87-98.

Wellington, J. (1990). Formal and informal learning in science: The role of the interactive science centres. *Physics Education*, *25*(5), 247–252.

Wellington, J. (2004). *Educational Research Contemporary Issues and Practical Approaches*. London: Continuum.

World Development Indicators. (2012). *Malaysia Statistics*. Retrieved from http://data.worldbank.org/country/malaysia%0A [25 April 2014]

Wright, E. L. (1980). Analysis of the effect of a museum experience on the biology achievement of sixth-graders. *Journal of Research in Science Teaching*, 17(2), 99-104.

WWF-Malaysia. (2009). *Environmental citizenship : A report on emerging perspectives in Malaysia*. Malaysia.

Yavuz M., & Kiyici, F.B. (2013). Teachers' opinions regarding the effects of the usage of out-of-school learning environment and anxiety towards science. 4th International Conference on New Horizons in Education. *Procedia-Social and Behavioral Sciences*, *106*: 2532-2540.

Yerrick, R., & Beatty-Adler, D. (2011). Addressing Equity and Diversity with Teachers Though Informal Science Institutions and Teacher Professional Development. *Journal of Science Teacher Education*, *22*(3): 229-253.

Yin, R. K. (2003). *Case study research: Design and method* (4th.). USA: SAGE.

Yin, R.K. (2009). *Case study research: Design and method* (4th ed.). USA: Sage. Zafar

Zandstra, A.M. (2012). The Impact of an Informal Science Program on Students' Science Knowledge and Interest. Unpublished PhD thesis. Texas: Baylor University.

Zhai, J., & Dillon, J. (2014). Communicating science to students: Investigating professional botanic garden educators' talk during guided school visits. *Journal of Research in Science Teaching*, *51*(4), 407–429.