YEAR FIVE PUPILS' MENTAL MODEL OF ENVIRONMENT

KAVITHA MASLAMANY

FACULTY OF EDUCATION

UNIVERSITY OF MALAYA

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KAVITHA MASLAMANY

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Matric No: **PGJ 140007**

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ABSTRACT

In the current society, pupils are given less opportunity to discover the natural world around them. This has resulted in 'nature deficit disorder' among the pupils especially among those who are living in urban areas which are surrounded by the built environments. This becomes worse when pupils get less exposure to environmental education in schools where they learn environmental concepts as disconnected pieces of information. Pupils who are unable to comprehend the environment as a complex and interconnected system will have less awareness of environmental problems. Studying pupils' mental models of the environment enable teachers to understand pupils' conceptualization of how the environment works as a system. Therefore, this study has been carried out to investigate the Year Five pupils' mental models of the environment and their relationships with their perceived pro-environmental behaviours. The present study has also investigated the factors that have influenced pupils' mental models of environment. A descriptive survey research design was employed in this study. The sample comprised 104 Year Five pupils from one of the schools in an urban area at Petaling Jaya. Pupils' mental models or images of the environment were elicited using Draw-an-Environment Test (DAET) and were analysed using a 4-factor analytic rubric (DAET-R). Mental Model Factors and Environmental Behaviour Questionnaire (MMFEB) which consisted of two-parts were used to identify the factors that had influenced the Year Five pupils' mental models and their perceived pro-environmental behaviours. Descriptive statistics, Pearson correlation, content analysis and regression were used to analyse the data obtained through MMFEB. The findings revealed that 65% of the pupils in this study did not include human elements in their drawings. Overall, pupils held a moderate level of

environmental mental models which is an incomplete mental model. Four types of mental models namely, Model 1 (a Perfect Environment), Model 2 (Interaction Between Human and Environment), Model 3 (Environmental Problems) and Model 4 (Solving Environmental Problems) were present among the pupils. The finding from the correlations further revealed that pupils with a higher level of mental model tended to demonstrate more positive pro-environmental behaviour. The finding further reveals that that school, experience, environmental problems and socio-culture factors have influenced the level and the types of pupils' mental models of environment. The present study also confirms that drawings can serve as an appropriate tool to gain insights into pupils' mental model of the environment and the relationshipwith human. Such insights are important for an impactful teaching and learning of environmental education. Teachers may also use pupils' drawings to develop more complete mental models. A holistic view of developing curriculum and instruction is recommended to provide learning opportunities for pupils to understand the definition of environment.

Key words; Year Five pupils', mental model of environment, pro-environmental behaviour

MODEL MENTAL ALAM SEKITAR DALAM KALANGAN MURID TAHUN LIMA

ABSTRAK

Kanak-kanak zaman kini kurang diberi peluang untuk meneroka dunia sekeliling mereka. Ini menyebabkan kanak-kanak menghadapi '*nature deficit disorder*' khususnya kanak-kanak yang tinggal di kawasan bandar yang dikellilingi alam buatan manusia. Perkara ini menjadi lebih serius apabila murid-murid kurang diberi pendedahan tentang pendidikan alam sekitar di sekolah kerana mereka mempelajari konsep alam sekitar sebagai komponen berasingan yang tidak berhubung kait. Murid-murid yang tidak dapat memahami konsep alam sekitar sebagai satu sistem yang kompleks dan saling berhubung kait, akan mempunyai kurang kesedaran terhadap masalah alam sekitar. Kajian model mental membolehkan kita memahami konsepsi murid tentang bagaimana alam sekitar berfungsi sebagai satu sistem. Oleh itu, kajian ini bertujuan untuk memahami model mental alam sekitar murid-murid Tahun Lima dan hubungannya dengan tingkah laku mesra alam sekitar. Pengkaji juga telah meneroka faktor-faktor yang membentuk model mental murid tentang alam sekitar.

Reka bentuk kajian tinjauan deskriptif digunakan dalam kajian ini. Sampel terdiri daripada 104 murid Tahun Lima di sebuah sekolah kawasan bandar di Petaling Jaya. Model mental atau gambaran persekitaran murid dianalisis menggunakan data yang dikumpul melalui instrumen *Draw-an-Environment Test* (DAET). Data yang dikumpul dianalisis dengan menggunakan rubrik analisis 4-faktor (DAET-R). Instrumen *Mental Model Factor and Environmental Behavior* (MMFEB) yang terdiri daripada dua bahagian digunakan untuk mengenal pasti faktor-faktor yang mempengaruhi model mental murid Tahun Lima dan tingkah laku mesra alam sekitar.

Statistik deskriptif, korelasi Pearson, analisis kandungan dan ujian regresi digunakan untuk menganalisis data yang diperoleh melalui MMFEB.

Hasil kajian menunjukkan bahawa 65% daripada murid dalam kajian ini tidak memasukkan unsur manusia dalam lukisan mereka. Secara keseluruhan, murid tergolong dalam tahap model mental yang sederhana, iaitu model mental yang tidak lengkap. Empat jenis model mental iaitu, Model 1 (Alam Semula Jadi Sempurna), Model 2 (Interaksi Manusia dengan Alam Sekitar), Model 3 (Masalah Alam Sekitar) dan Model 4 (Penyelesaian Masalah Alam Sekitar) telah dikenalpasti dalam kalangan murid. Dapatan daripada korelasi Pearson membuktikan bahawa murid yang mempunyai tahap model mental tinggi, adalah lebih cenderung ke arah tingkah laku mesra alam sekitar. Hasil kajian juga menunjukkan bahawa model mental murid dipengaruhi oleh sekolah, pengalaman, masalah alam sekitar dan faktor sosio budaya. Kajian ini mengukuhkan lagi lukisan sebagai alat yang sesuai untuk mendapatkan pandangan tentang konsepsi murid mengenai alam sekitar dan hubungan dengan manusia. Pandangan seperti ini memberi impak tinggi dalam pengajaran dan pembelajaran pendidikan alam sekitar. Guru juga boleh menggunakan lukisan murid untuk mengembangkan model mental yang lebih lengkap. Pembangunan kurikulum yang holistik adalah dicadangkan bagi memberi peluang pembelajaran kepada murid untuk memahami definisi alam sekitar.

Kata kunci; Murid Tahun Lima, model mental alam sekitar, tingkah laku

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CHAPTER 1

INTRODUCTION

1.1 Introduction

There have been many important changes over the last two decades in research about mental models (Gentner & Stevens, 2014). Researchers began to focus on mental model frameworks that explained the thought processes and the frame of ideas in the minds of individual (Kussmaul, 2017). Cognitive psychologists and educators consider an individual's mental representation of their basic knowledge as a "mental model" (Johnson-Laird, 1983; Greca & Moreira, 2000). It is mainly used to describe and explain the various aspects of a person's intuitive perception towards a phenomenon that is taking place in the surrounding world. In that regard, Johnson-Laird (1983), suggests that mental models offer insights into how people adopt and abandon knowledge to shape a worldview and how they behave in different circumstances. Generally, most mental models commonly comprise of "categories, concepts, identities, prototypes, stereotypes, causal narratives, and worldviews" (UNESCO, "World Bank ", 2015, pp. 24-55). In short, the main function of a mental model is to describe, infer and forecast a phenomenon (Franco & Colinvaux, 2000; Greca & Moreira, 2000).

Pupils experience the world by interpreting their environment and understanding them through their mental models. In that regard, an investigation into their mental models is necessary to understand their learning development, particularly in the field of science (Frederiksen & White, 1992; Frederiksen, White & Gutwill, 1999). Mental models provide essential data pertaining to the starting point of pupils' information structures (Vosniadou & Brewer, 1992). Teachers and instructors have the responsibility to understand pupils' initial information or mental models and to help

them comprehend complex topics and concepts. According to Chiou and Anderson (2010), educators should, in the first place, be able to understand pupils' mental models to help them grasp scientific knowledge.

Each pupil has his or her own method of responding to nature through drawings known and the drawing could be viewed as their mental models. It can be contended that depicts a person's mental model and that one model isn't preferred over another. However, mental models can be portrayed as drawings and made clearer through supporting clarification at that point they become a significant method for understanding pupils' thinking and their advancement of thoughts. As pupils think that it's interesting to draw pictures that speak of their encounters (Van Sommers, 1984), that give a basic method of a social occasion conceptualising a condition (Barraza, 1999). These drawings would then be windows into the imagination of students, as they mirror pictures of their minds and views (Thomas & Silk, 1990).

Pupils' initial information, which can be obtained from their mental models, are influenced by previously acquired knowledge or prior knowledge. This relates to Vosniadou and Brewer's (1992) assertion that mental models and beliefs are constructed from prior knowledge structures that are put into effect to create new knowledge. Additionally, Ifenthaler (2008) explains mental models as basic cognitive conceptions that reveal the fundamental conceptual awareness among pupils in general. In other words, the mental models of pupils in their incipient state of development are largely superficial and consequently shape their attitudes in how they react to changes in the environment around them. Pupils' mental models of the environment should be guided based on the way of understanding on the environmental behaviour (Shepdarson, 2005). Environmental behaviour refers to an individual's behaviour that contributes to environmental sustainability. The

constructive environmental practices that individual connect, for example, energy saving, staying away from waste and reusing are examples of their own lifestyles. People who have more environmental knowledge are more prone to behave in a pro-environmental way (Oguz, 2010). Inadequate knowledge or having contradictory information might limit pro-environmental behaviour. Environmental knowledge can be acquired through many sources such as media, school, family, experience, and religion.

In order to comprehend environmental issues, pupils should have an idea what the environment is, the phenomena and processes that interact to shape and characterize the environment. In addition, pupils must be able comprehend the environment as an entirety of communication systems amongst human, living things other than human (biotic), the physical environment (abiotic), and the constructed or designed environment. If the pupils fail to comprehend the environment as complex and interconnected systems, they would underestimate the extent and impact of environmental degradation (Kollmuss and Agyeman, 2002) which would in turn seriously compromise one's emotion and pro-environmental behaviour. Studying students' mental models of the environment helps us understand their conceptualization of how the environment works as a system: the nature and interactions among objects, components, or factors, the critical issues, and the causal links. These models provide insights into the explanations and predications and a needed perspective for creating interventions that will help students revise and eventually improve their existing mental models toward a deeper, more coherent understanding of the environment (Payne, 1998).

Unlike stable values or beliefs that are established in the early stage of human life, mental models are circumstantial and, as a result, may theoretically be modified when exposed to new knowledge or experience; accordingly, mental models can more accurately predict actions than values or beliefs (Jones, Ross, Lynam, Perez & Leitch 2011). Evidently, in the opinion of Arslan and Durikan (2016), mental models allude to the structures of day-to-day experiences and the learning processes, which can be changed unintentionally or when required. Pupils' mental models are, therefore, subjective and contextual, highly dependent on their personal experiences and knowledge, social relationships and exchange of ideas, as well as previous classroom instructions. It can, thus, be understood that no two pupils can share the same mental model of a phenomenon (Schollum & Osborne, 1985; Driver, 1989; Duit, 1991; Glynn & Duit, 1995). Cognitive structures are consistently altered as pupils acquire new information. Adaptability, in other words, is a vital aspect of mental models.

Pupils' environmental conceptualisations are not independent of human activities but are coded and reinforced by their sociocultural experiences. Reality is far from static, and students learning is influenced by implicit cultural assumptions, perspectives, and biases (Ogbu, 1992). Although science is invariably a theory-laden subject, it is also a vibrant manifestation of unique sociocultural factors that aid our understandings and explanations of phenomena.

Drawing is one of the common activities that everyone could be involved in (Soundy, 2012). It is also considered that the drawing activity indulged in their cultures. The children can produce the same artwork as any other adult as noted by Kellogg (1970). The knowledge would be the same, but expressions could be dissimilar (Alland, 1983). For instance, the children would prefer to draw the family photos which displays the characteristics of the culture (Cox, 2005) and Alland (1993)

amplifies that the impact of the culture insists them. It is also renowned that the children's drawing can be distinguished based on their cultures and socials which reflects in their drawings.

Pupils' educational development is inextricably linked to how they assess and interpret new information through the lens of their mental models. This makes it imperative that the mental models transition from a personalized structure towards a more scientific model (Glynn & Duit, 1995). Mental models cast shed considerable light on how pupils shape their behaviour towards the environment. In order to obtain deeper insights into this matter, it is important to investigate the Year Five pupils' mental models of environment.

1.2 Background of the Study

Environment is entirely depending on the living creatures and the nature which offers for circumstances for improvement and progress just as risk and harm. (Wynne et al., 2018). (Omosulu & Inja, 2019).

There is a need to inculcate in children the natural instinct to take care of the environment. Therefore, environmental education should be introduced as process that permits these children to investigate natural issues, take part in critical thinking, and make a move to improve the earth (Gould, Coleman & Gluck, 2018). It would lead to these young children having comprehensive ideas and informative information on the environmental issues to make wise decisions. In general, Environmental education edifies the individuals to think critically, find an amicable solution and make a tactful decision.

The idea of environmental education first began during The Intergovernmental Conference on Environmental Education at Union of Soviet Socialist Republic (USSR) in 1977. Environmental education has been acknowledged as the most suitable

medium in the desire to manage the earth, maintain turn of events, natural training and instruction for sustainability, as these are all methods of managing natural issues (Huckle, 1983 & Fien, 1993). This implies the school has been entrusted to disseminate helpful knowledge that can improve humanity. In addition, schools in the best situation to address natural issues. Next, schools can create a progressively ideal human life by bringing environmental issues to light (Moroye, 2005). For the past decade, the extent of environmental education has customarily been a constrain that has diminished ecological contamination (Taylor, Nathan & Coll, 2003). Environmental education has been discussed universally since the Stockholm Human and Environmental Conferences held in 1972. Figure 1.1 shows a series of international environmental issues that were discussed, and solutions were sought to address the increasingly tenuous environmental situation.

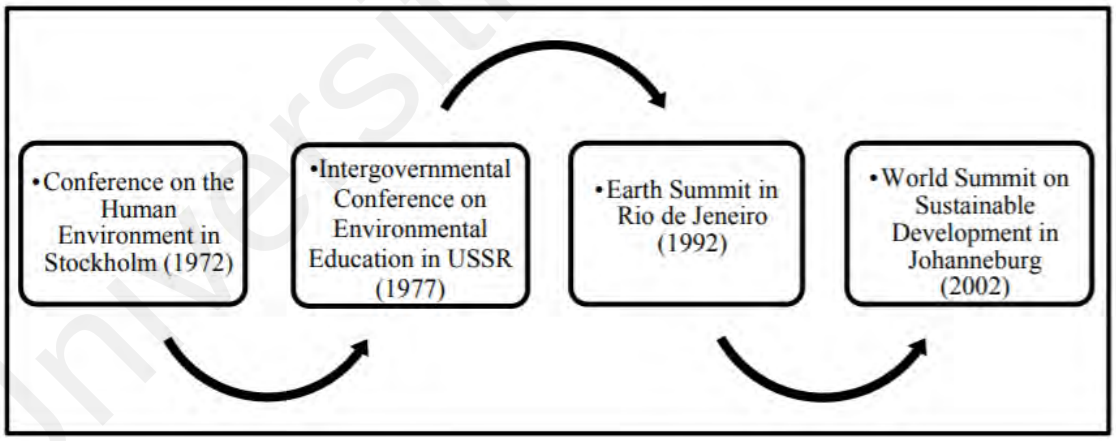


Figure 1.1 International environmental issues discussions

The Ministry of Education plays an essential role in conveying environmental information and to create awareness of nature through the instruction process. The information delivered through the instruction procedure can educate human capital and there is a possibility to propel the country from different perspectives. Learning

process is a ceaseless procedure that will normally cause an adjustment in human conduct in a positive way. At the end of the day, instructions have a compelling force in forming human personality on how to deal with nature in the future. In the meantime, Educational Environment (EE) is likewise a significant component in improving the nature of the earth by sustaining and imparting awareness about the significance of environmental protection and preservation.

The Curriculum Development Centre, Ministry of Education has developed a guidebook for educators entitled "KBSR Teacher's Handbook: Environmental Education over the Curriculum" in 1998. Environmental instruction is incorporated in all subjects in schools, for example, Science, Mathematics, Music, English and Islamic Education. Among all these subjects, Science is one of the most pertinent areas where knowledge relating to the environment can be incorporated, since the relationship between the subject itself and the environment is mutually compatible and relevant.

The present Year Five pupils have been learning about the concept of environment since they were in Year One through various topics in Science. The revised Science curriculum (2011) for primary level is divided into six learning spheres: Introduction to Science, Life Science, Physical Science, Material Science, Earth and Space Science, and Technology and Sustainable Living. Throughout the syllabus, the relationships between the environmental factors are incorporated into the other subjects. The topics pertaining to the environment in the Science subject from Year One to Year Six are outlined in the following Table 1.1.

Table 1.1

Environment-Related Topics in the Science Subject

Year One	• Importance of food, water, air and shelter to human and animals. • The use of soil contents.
Year Two	• Importance of plants to humans and animals. • The need of water, air and suitable temperature for germination of seeds. • The role of human in maintaining clean source of water and water flow. • The effects of air movement in everyday life.
Year Three	• The use of technology in plant reproduction. • Importance of pulleys in daily life.
Year Four	• Importance of photosynthesis. • Advantages and disadvantages of technology.
Year Five	• Importance of the survival of the animal species to other living things. • The food relationships between living things and the process of photosynthesis in terms of energy transfer. • Sources of energy and the forms of energy produced, the transformation of energy. • Importance of natural water cycle to maintain water resources • The factors that causes contamination of water resources and ways to maintain its cleanliness. • The factors that disrupt the natural water cycle and its impact on living things.
Year Six	• Interactions between animals, interactions between plants. • Interactions between plants and other living things in a habitat. • Human's role on the preservation and conservation of animals and plants. • Proper ways of waste management and proper usage of non-biodegradable waste. • The effects of improper waste disposal and human role in managing waste disposal for a sustainable life. • The importance of inventing sustainable machine.

The relevance of the topics is to create a deeper understanding of the environment clearly show that science education aims to help pupils to systematically develop their knowledge on the basic aspects of the environment (Lieflander &

Bogner, 2018). Therefore, science education has been gaining significance for providing environmental awareness by bringing to the fore important environmental concepts and principles and to encourage the growth of environmental-friendly behaviour among the pupils.

Other than formal EE, casual natural training in Malaysia is attempted by government and non-legislative associations (NGOs) (Chelliah, 1982). Activities conducted by the administration are generally under the Department of Environment (DOE), for example, advancing natural awareness through open air exercises, ecological topic rivalries, Sustainable School or Sekolah Lestari Competition, Environmental Hero (Wira Alam), and Environmental Awareness Camp (KeKAS). It likewise incorporates instructive materials, for example, the Green Era book (Buku Era Hijau), pamphlets, articles, and rules on executing natural assurance and guidelines.

In 2004, the 3K programme emerged collaborating three concepts together namely Security (Keselamatan), Health (Kesihatan) and Cheerfulness (Keceriaan). This concept encapsulated programmes such as *Program Sekolah Selamat*, *Program Kesihatan dan Kebersihan* and *Program Keceriaan dan Keindahan Sekolah*. This project was helmed to introduce green technology into the education system in order for students to see and generate interest and commitment to green technology and the environment.

The environment related NGOs too organised many environmental programs and activities in schools to educate the younger generations about environment. Among the activities carried out in school are exhibition, 4R (Recycle, Reuse, Reduce and Replace) programs, tree planting, colouring and drawing contest (Trees, 2016).

Thus, pupils are receiving environmental knowledge formally and informally from various entities.

1.3 Statement of Problem

At the early stage of The Integrated Curriculum for Primary Schools (ICPS-Kurikulum Bersepadu Sekolah Rendah -KBSR) implementation, environmental-related education was integrated into the curricula across 302 primary schools in 1982. Subsequently, in 1983, all primary schools were brought under this initiative. Thus far, specific environmental-related subjects have still not been included into the curriculum of the national education system (Haliza Abdul Rahman, 2018).

However, quality education was highlighted in the Malaysia Education Blueprint 2013- 2035 as an effort to strengthen quality education in Malaysian schools, these initiatives are somewhat not substantive and some of them are perhaps questionable, both in theory and in practice (Abdul Rahman Md Aroff, 2014). Therefore, pupils are found to have failed to develop sufficient environmental values (Haliza, 2018). This can be seen through environmental problems that resulted from the lack of environmental awareness among school pupils which can be supported by the statement below:

> *"Recycling started with much fanfare, but its charm diminished over time in schools. The number of plastic water bottles strewn around school compounds is evidence of our failure to create awareness in students."*
>
> *There is "disengagement", that is, students forget once outside school."* (Suganthi, News Straits Times, 2019).

Based on the above statement, even though recycling was given priority in schools, but its implementation was not as successful as it was expected. This statement can be further supported by a study conducted by Musfirah (2011) which shows that even though recycling bins are provided in schools, 59.3 percent of the students do not use them. This situation explains that being aware about the existence of recycling bins in the school area does not influence the students to use them. This evidently shows that the practice of recycling among students is still inadequate. Those findings agree with the findings by Hanifah, et al. (2015), which reveal that sustainability behaviour through recycling practice among pre-school students are at a medium level. In another study conducted among 2 primary school students in Hulu Langat, Selangor, Malaysia, Sobri etal (2016) found the practice of recycling activities is only at moderate level. This can be seen by the amount of plastic water bottles and litters scattered around the school compound which reflected the unfavourable environment behaviour among pupils. This type of behaviour has been caused by the lack of environmental knowledge among pupils. This statement is supported by Otto and Pensini (2017) who have revealed that environmental knowledge is important in producing ecological behaviours.

Louv (2005) has described human beings, specifically a child, that spends less time outdoors and results in a wide range of behaviour problems. He argued that most people, particularly children who prefer to occupy themselves inside the house feel isolated from the nature. *Nature-deficit disorder* has been used to describe the lack of connectedness that pupils feel about the natural world; this concept is used to induce the lack of a bond with other living beings (Howard, 2013). Studies have shown that pupils who perceive themselves as more connected to nature are likely to perform more sustainable behaviours (Barrera-Hernandez, Sotelo-Castillo, Echeverria-Castro, &

Tapia-Fonllem, 2020). An individual's behaviour can be reflected through their mental model (Jones, 2011). Mental models are unique and constructed by individuals based on their personal life experiences, perceptions, and understandings of the world. With regards to this, eliciting students' mental models are crucial as it gives teachers an indication of their current knowledge and beliefs about environment. It would be beneficial to teachers to have this knowledge when they want to introduce instructive materials.

Regardless the fact that environmental education has been assimilated into several subjects and activities in the primary and secondary level in Malaysia, the objectives have yet to be fully achieved (Rohana, Rosta, Azizi, & Ismi 2013). In Malaysian primary education, EE was mainly incorporated in the Science subject as compared to other subjects. However, pupils have been learning environmental concepts in a fragmentary fashion. For example, pupils learn about human beings, animals, plants, air, soil, water, technology and waste management across different topics in Science from Year One to Year Six. As a result, pupils are gaining new knowledge as bits and pieces, which do not tightly link together. This may result in a shallow understanding of the environment. They will also not be able to make sense of the interrelationships between the four elemental factors, namely human beings, other living organisms (biotic), the physical environment (abiotic) and the artificially constructed environment. As inexperienced learners, are pupils able to establish links between information provided in their primary school education? According to Ambrose et al. (2010, p.44), novice learners frequently struggle to organize new knowledge cognitively, thereby failing to comprehend the information, which in turn affects their learning. It is, therefore, necessary to figure out pupils' conception about the natural environment; in other words, what are their mental models.

Studies focusing on mental models have been established so that most pupils and teachers have an imperfect understanding of the environment (Wuellner et al., 2017; Moseley et al., 2010). While there have been studies exploring pupils' mental models of environment, there is also a need to look at their current mental models. This is mainly because the mental models of pupils are complex, developing continuously as they absorb new knowledge and expand their worldview based on experiences (Riley & Pidgeon, 2019). Pupils may construct environmental concepts that may differ from the actual or accurate conceptual models. Despite what they have learned in school, they are likely to adhere to their own interpretations about the world. Mental models need to be studied to improve pupils' learning development process by focussing on how one perceives and understands the concept of environment (Prager & Curfs, 2016). By studying pupils' prior knowledge, educators can help improve their learning. Thus, it is important to study pupils' mental model of environment and the factors that influence the construction of their mental models.

When they encounter experiences that question their assumptions, it is unlikely that they will change their models of how things function or consider alternative explanations as relevant (Suping, 2003). Thus, knowing what students' mental models about environment are is pivotal so teachers are aware of the existence of various mental models and how teachers may induce the appropriate changes in their students' mental models. Similarly, students can be aware of their mental models as they seem how their drawings. Therefore, it is crucial to understand pupils' existing mental models pertaining to the environment, and what experiences that have led them to build such mental models (Vaiopoulou & Papageorgiou, 2018). Well-developed and structured mental models enable pupils to absorb newly acquired knowledge into existing models. By comparison, underdeveloped mental models can be easily altered

when presented with new experiences (Libarkin, Beilfuss & Kurdziel, 2003). Thus, assessment of the origins of prior knowledge that influence the development of pupils' mental models is important.

Most countries have required environmental education as being a significant component in formal and informal educational programs (Von Roten, 2012). Choi, Lee, Shin, Kim & Krajcik (2011) have pointed out that science education should help individuals develop an ecological worldview, with which they can appreciate and make decisions based on the interdependence of humans and the natural world. Sociologists and environmentalists for decades have called for a shift of the dominant environmental worldview from the mechanistic anthropocentric model to a holistic ecological one. Science curricula, however, seem to continuously separate nature from human society, while emphasizing students' scientific knowledge and process skills (Korfiatis, Stamou & Paraskevopoulos 2004; Sharma 2012). Education is one of the most important variables in explaining high levels of environmental concern and behaviour (Zsoka et al., 2012). Studies reported that highly educated individuals are more concerned about environmental quality and are more motivated to engage in environmentally responsible behaviour since they are better aware of the potential damage (Wong et al, 2018). Environmental education is a vital requirement to promote sustainable consumption and pro-environmental behaviour (Michelson etal., 2018). General knowledge and even specific skills related to environmental issues are often acquired through the education system (Garcia-Valinas et al., 2010). Therefore, understanding how education impacts on environmental knowledge and thus on the development of pro-environmental behaviour is an important issue for policy makers, marketers, green businesses, educators and other parties interested in the acceptance and enhancement of pro-environmental behaviour.

Most commonly, pupils construct their mental models through daily experiences. They may, therefore, have various mental models based on specific experiences and knowledge (Greca & Moreira, 2000). Positive prior learning experiences and knowledge are crucial if pupils are to grasp certain concepts in a comprehensive manner.

1.4 Objectives of the Study

The aim of this study is to examine Year Five pupils' environmental mental models and their perceived environmental behaviour. The objectives of the study are as follow:

1. To investigate the Year Five pupils' mental models of environment using the Draw an-Environment Test (DAET).
2. To investigate the relationship between the Year Five pupils' mental models of environment and their perceived pro-environmental behaviour.
3. To identify the factors that influence the Year Five pupils' mental models of environment.

1.5 Research Questions

Thus, the research questions for this study are as follows:

1. What are the Year Five pupils' mental models of environment?
2. What is the relationship between the Year Five pupils' environmental mental models and their perceived pro-environmental behaviour?
3. What are the factors that influence the Year Five pupils' mental models of environment?

1.6 Research Hypotheses and Null Hypotheses

Based on research question two, the research hypotheses and null hypotheses for this study were formulated as below:

Research Question 2:

H_0: There is no significant relationship between the Year Five pupils' mental models of environment and perceived environmental behaviour.

H_1: There is a significant relationship between the Year Five pupils' mental models of environment and perceived environmental behaviour.

Based on research question three, the research hypotheses and null hypotheses for this study were formulated as below:

Research Question 3:

$H_{0:}$ The sources (school, media, and family) has no impact on the Year Five pupil's mental models of environment.

$H_{1:}$ The sources (school, media, and family) has impact on the Year Five pupil's mental models of environment

1.7 Significance of the Study

In this study, determining pupils' present mental models will give teachers useful information in preparing a basis for them to structure knowledge as desired by knowing whether their present knowledge is correct or not. A deeper understanding of pupils' mental models will allow educators to identify potential impediments to learning and provides insight toward planning curriculum and designing instruction that builds on pupils' existing mental models. Effective learning experiences require a curriculum that combines pupils' conceptions with current scientific understanding in a meaningful fashion, thereby allowing curriculum and instruction to be sequenced in a way that encourages curricular continuity and moves pupils toward higher levels of scientific literacy. Knowledge about mental models will be instructive for teachers in understanding and accommodating difficulties among their pupils in conceptualizing certain phenomena or system.

Nowadays, meaningful learning takes a central role in science education and is based in mental models that allow the representation of the real world by individuals. Thus, it is essential to analyse the pupil's mental models by promoting an easier reconstruction of scientific knowledge, by allowing them to become consistent with the curricular models presented in the classroom.

Studies conducted by Liu and Lin (2015) and Iliopoulou (2016) on the understanding of educational environment. It was found that the mental models give a deep understanding to pupils to figure out how the environment involves in the system which relates to the nature and interaction, objects and other mechanisms. As such, the understanding of environment may cultivate pupils to see the mental model in a different perspective. Understanding pupils' mental models of the environmental phenomena is crucial to understand their environmental decision making. The accuracy of individuals' models of the causal mechanisms that drive environmental phenomena is a good predictor of their level of concern about environmental issues and willingness to take pro-environmental actions. Although developing a more accurate mental model may not always be sufficient to increase pro-environmental behaviours, it appears to be a decisive step.

1.8 Operational Definition

Various terminologies frequently used in this study are defined.

Mental Model is an individual's internal representation of their working knowledge (Johnson-Laird, 1983; Greca & Moreira, 2000).

In this study, mental models of pupils represent their understanding of the environment in the system which relates to the nature and interaction, objects and other mechanisms or factors, the critical issues, and the causal links. The pupils' mental models are expressed through their drawings.

Perceived Pro-Environmental Behaviour refers to "individual behaviours contributing to environmental sustainability (such as limiting energy consumption, avoiding waste, recycling, and environmental activism)" (Mesmer-Magnus et al., 2012: p. 160). The term 'perceived' is used to indicate the environmental behaviours which are reported by the pupils themselves rather than being observed.

Sources of environmental knowledge refers to sources where peoples claimed that they gain information about the environment. Those include television, family, social media, school etc. In this study, pupils choose how frequent they gain information about environment from the sources given.

1.9 Limitations of the Study

Limitations are the potential weaknesses of the research that are beyond the control of the researcher (Price & Murnan, 2004). This study, has several limitations. Firstly, the sample of this study was restricted to only one school and non-randomized sample for this study. The population sample of Year Five pupils from a school in Petaling Jaya is purposely chosen as the sample for this study. A small sample was used in this study. The sample chosen was restricted to Year Five pupils; a larger sample would provide a stronger conclusion and eventually interpret a detailed analysis. Thus, this represents only a very small percentage of the total population of the primary school pupils in Malaysia.

Several limitations of mental model research have been noted by researchers across various disciplines. Most fundamentally, it is impossible to directly observe people's mental models (Doyle & Ford, 1998) and people may not be sufficiently self-aware to be able to verbalize their mental models (Westbrook, 2006). The latter is especially true for children, who may also have insufficient manual dexterity skills and/or mental agility to prepare an accurate representation of their mental models

(Marhan, Micle, Popa & Preda, 2012). Goodman (1976) further pointed out that some children's drawings are merely symbolic, failing to resemble the drawn item and to convey any detailed information about it.

Since the data reflected behaviours that were self-reported by pupils and not actually observed, the quality of pupils' responses may have been compromised and thus considered a limitation. Pupils might not answer the questionnaire honestly.

1.10 Summary

This chapter presented a brief introduction and background of the research area, the objectives, research questions, problems statement, significance as well as the limitations of this study and the definition of terms were used in this research. In the next chapter, the reviews of the studies related to new and current literature applicable to this research, the theoretical and conceptual framework are presented.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter includes and offers critical evaluation of the sources relevant to the topic of the of mental models regarding the concept of environment. The first part deals with environmental knowledge, environmental education and behaviour and mental models and factors affecting mental models. The following section deliberates the mental model framework and the eliciting process used in the study. Mental model, which underlies the theoretical framework of the thesis, is explained first, followed by the conceptual framework. Previous studies on mental models are discussed in the final section, which concludes with a summary of the literature review.

2.2 Environmental Knowledge

The term 'environment' has a broad array of meanings, interpretations and etymological origins. For most people, it literally denotes the natural landscape or, in other words, the natural environment, along with all its non-human attributes, features and functions. ‘Environment’ is simply understood in this sense as the 'surroundings' or 'environs' of a person, object and other entities (Allan, 2019). These elements seldom function separately, but instead interact in close contact with their surrounding entities to varying degrees. Indeed, in many instances, the 'environment' can be seen as an open field of a dynamic network of interactions, interrelationships, and reactions between entities. Hence any conceptualization of the 'environment' should include aspects of its fundamental interconnected relationships. This conceptualization is especially common to ecological scientists, since they are concerned with the relationships between biotic (living) and abiotic (non-living) and the environmental

systems in which they live. Therefore, environmental knowledge is important to allow people, particularly school pupils, to conceptualize the world as a network of interacting organisms with their physical environment, and to equip them with a mentality to view it in ways that can lead to positive change.

Kollmuss & Agyeman (2002), define environmental awareness as, "knowing of the impact of human behaviour on the environment". Environmental knowledge contains sixty-eight important factors that influence the behaviour of individuals towards the environment. Kennedy et al., (2009), conducted a study in Canada, where it was found that more than sixty per cent of respondents felt that their lack of environmental knowledge often constrained their pro-environmental behaviour. If an individual does not possess proper environmental knowledge than he or she is most likely to make decisions which may adversely impact the environment. Proper environmental knowledge help make people environmentally appropriate decisions (Heberlein, 2012). Therefore, it is essential that people should be well informed about the contemporary environmental threats. Furthermore, knowledge is an influential forecaster of pro-environmental behaviour, hence has a strong influence on it. Kollmuss and Agyeman (2002), revealed that a more in-depth knowledge of environmental issues and how to solve them increases the likelihood of individuals taking action to protect the environment. Hence, we must not be only creating awareness about the environmental issues but also on activities that they can carry out for the environment protection. Environmental knowledge is considered a valid and reliable predictor of pro-environmental behaviour. This implies that informing people about the different kinds of environmental threats would significantly determine their change in behaviour (Courtney-Hall & Rogers, 2002). Only educating is not enough but the emphasis should be on evolving strategies to mitigate the problem.

Environmental knowledge is essentially the amount of information and understanding that individuals possess about environmental issues, and their tendency to recognize and measure their implications on society and the environment. Lee (2011) provides a straight-forward description of that as the interpretation of environmental issues by an individual. Araghi, Kroesen, Molin and Wee (2014) looks from a more nuanced interdisciplinary perspective on environmental knowledge, gleaning aspects from the natural and social sciences as well as anthropology. It has also been related to ethics, including values and behaviours. The scope of what may be regarded as knowledge of the environment is necessarily broad and varied, since the essential needs of humans and survival in general are directly related to their relationship to the natural environment. For this reason, any information related to the environment which is consequential to people's life and the environment itself will count as environmental knowledge (Mantzicopoulos & Patrick, 2011).

Therefore, environmental knowledge is important not only to promote positive environmental behaviours but also to allow a person to make informed decisions in environmental management. This is an important intellectual and moral precondition needed to practice positive environmental behaviour (Frick, Kaiser, & Wilson, 2004, Gardner & Stern, 2002; Otto & Kaiser, 2014). Environmental information is gained from multiple sources in the case of school pupils, but there is a strong possibility that their perception of it is highly skewed and largely misinformed. This relates to the assertion made by Palmer (1995) that it is necessary to identify what information learners have about the environment, so that educators are conscious of their inadequate awareness, biased or stereotypical thinking that may impede understanding of environmental issues. In this respect, environmental literacy as part of science

education plays a significant role in defining the scope and implications of prior experience and understanding of the natural environment among school pupils.

2.3 Environmental Education

The environment is not just an abstract idea rather is a whole set of diverse physical, biological, economic, social and cultural factors concerning human beings. Environmental awareness means that people possess due knowledge about and are conscious of the factors that contribute towards environmental degradation. Not only that they themselves avoid but also persuade others to avoid actions detrimental to the environment (Rafe et al., 2015). This environmental awareness must be inculcated right from the childhood. One way to achieve this goal is to converge environmental education with Science education (Dillon, 2016). It is observed in the schools that a single teacher handles students in the primary section. Therefore, it is for the teacher to create environmental awareness among these children by blending education with other subjects. Since environmental conservation is a scientific activity, hence, there should be a mechanism placed in the schools that teachers with non-Science background must be given necessary training to teach environmental studies at regular intervals. However, Dillon (2016) further observes that environmental education is best dispensed through constructivism pedagogy where the learning process is continuous and is built on prior knowledge on sustainability practices; where one formulates their individual subjective representations of reality.

Environmental education for the most part alludes to the learning procedure about environmental issues. Environmental education is vital for developing concerns and awareness about clean environment among school students. Environmental education starts with environmental knowledge. The school curriculum must be designed in such a way that it contains the compulsory paper of Environmental

Education. A quality education about environments equips students to effectively deal with environmental issues (Kusturica et al., 2016; Wiseman et al., 2014). Environmental knowledge prepares students, very early in their lives, to obtain a fundamental knowledge as well as understanding of environment and environmental issues. Also environmentally aware students are more likely to explore and engage their communities and their neighbourhood to protect environment and to adopt environment friendly practices. This way school students learn to associate their personal life problems with environmental issues. This correlation helps them acquire social values especially about keeping the environment clean. It encourages them to participate in environmental protection and improvement programs. Environmental education encourages students to link their personal lives and actions with problems of the environment (O' Donoghue et al., 2016). Therefore, students acquire some social values regarding the importance of a clean environment. It drives pupils to participate in the protection and improvement of the environment. Another benefit of environmental awareness from such a young age, according to Stanisic & Maksic (2014) is that pupils gain meaningful insights into the human behaviour and how it impacts the environment.

EE is therefore crucial for the development of a holistic outlook and environmental awareness among school pupils, so that they would be better positioned to handle the environment responsibly in the future. There is no doubt that this is one of the systematic ways to promote environmental awareness, especially among younger generations in schools, which play an important role in providing environmental knowledge to pupils through both formal and informal education. Formal environmental education is generally integrated through the curriculum across a range of subjects. The informal kind, on the other hand, is essentially outdoor

education activities involving nature-based experiences. Otto and Pensini (2017) consider that this process, which encourages the improvement of the relationship of pupils to the natural environment and the acquisition of environmental awareness, is an effective approach to improving environmental behaviour. In other words, increased involvement in nature-based activities develops good environmental behaviour. Thus, both formal and informal approaches to environmental education are equally important for raising environmental awareness among pupils to shape environmental behaviour.

2.4 Pro-Environmental Behaviour

Pro-environmental behaviour is simply mean 'behaviour that consciously seeks to minimize the negative impact of one's actions on the natural and built world (Runhaar et al., 2019). Moreover, such good habits as voluntarily dropping glass bottles and aluminium cans into recycling bins or donating some cash for the cause of environmental protection also do qualify as pro-environment behaviour (Blok et al., 2015 & Wong et al., 2018). However, according to Karimi (2019), this thought is not absolute rather relative in nature and hence reflect value judgement.

As the result of humans' greed, the natural resources are being drained out and depleting at much fast pace and not being adequately replenished (Aman et al., 2012). This indiscriminate exploitation has given rise to some serious environmental problems prominent among them being climate change and global warming, Ozone layer depletion and deforestation (Chen and Chen, 2009). This precarious situation warrants our immediate attention to immediately arrest this dangerous trend. One of the most effective way to instil the value of environmental protection among the pupils is by educating them from the young. The environmental knowledge thus acquired from the beginning would lead them make critical judgement about our environment

(Courtney-Hall & Rogers, 2002). To awaken the critical judgement in ourselves, a fairly in-depth comprehension as well as analysis of a variety of factors shape our attitudes towards is required. A lot of theories and models are afloat to decipher this complex relationship, for example, Steg & Vlek (2009) point out that there are two major categories of the factors that influence an individual's behaviour towards his or her environment namely external and internal factors. By external factors they mean the aspect of the environment or society where individual lives whereas internal factors imply aspects within an individual personality that influence his or her behaviour towards the environment.

Since environmental issues are primarily triggered by human behaviour, improvements in human behaviour are the only means of seeking a solution. This point of view is gaining broader interest in an area typically dominated by physical scientists, such as chemists, biologists and ecologists, who claim that the solution to the problem of environmental degradation lies in the invention and widespread use of greener technology. It is important to note here that the explanation of pro-environmental behaviour by Kollmuss and Agyeman (2002) is intended to indicate a total change of attitude to mitigate negative environmental effects. While in the field of psychology individual behaviours can be clinically evaluated, the notion of behaviour is, nevertheless, a generic term. Its connotation contains all the intricacies and nuances that together form a person's behaviours (Lee, 2011). As far as environmental behaviour is concerned, a complex collection of innate mental processes forms the behaviour or actions of an individual in relation to the natural world.

Alatawi, Dwivedi, Williams and Rana (2012) specifically describe an environmental behaviour as the type of action that a person or group demonstrates in

attempting to address a particular environmental issue. That means, in other words, the course taken to avoid or rectify environmental problems (Chen, Peterson, Hull, Lu, Lee, Hong & Liu, 2011). If a person has enough environmental awareness, positive environmental mind-set, and environmental skills, he or she will be prepared to act and contribute in solving different types of environmental issues. Participation in this context may be named differently, such as environmental action, citizen participation, or responsible environmental behaviours. What is commonly stressed, however, is effective participation and individual responsibility to address or avoid environmental problems (Hadzigeorgiou, Prevezanou, Kabouropoulou & Konsolas, 2011).

2.5 Factors Influencing Mental Model of Environment

2.5.1 Experiences

Most work indicates that pupils learn about the natural environment through personal experience, such as sensory learning or first-hand interactions (Hyun, 2005; Kellert, 2002). However, in modern circumstances, pupils can very well know as much from the media, parents, and peers (Louv, 2005; Littledyke, 2008). It must be noted that the media can often appear to contradict what they have experienced and learned from their own everyday observations of the environment (Payne, 1998).

As most pupils tend to perceive nature from personal life experiences, and not as the scientific knowledge they have learned in school, pupils' perceptions from either direct or indirect experience primarily affect their understanding of the environment. However, sources from first-hand exposure to nature or second-hand information from media are difficult to distinguish. Otherwise, if asked what they understand about the environment, the students would very likely regurgitate the definitions in the textbook. The best way to understand how students perceive their natural environments is to explain their mental models in terms of the meanings that they attach to the

environment. This approach may unravel the way in which the environment means to the pupils used in this study, especially in the urban context, at a personal level and represent their perceptions of their surrounding environment.

2.5.2 Environmental factors

2.5.2.1 School

How children are exposed to environmental issues is critical for understanding their mental conceptualization of the environment (Loughland, Reid, & Petocz, 2003). It is crucial to know where children receive their information and to assess the accuracy of the information. Schools with environmental policies or with a serious interest in the environment are the main source of information of their environmental knowledge (Ruiz, Barraza, Bodenhorn, Adame, & Reyes, 2010).

Undoubtedly, children learn a lot more about nature and the environment at school through curricula, projects and practical conservation activities, in particular recycling (Bonnett & Williams, 1998; Littledyke, 2008). It is here that they begin to learn through cognitive models that allow them to gain scientific understanding of the environment (Hyun, 2005; Wilson, 2006). Nevertheless, since environmental education is often not compulsory in school curricula, students rely largely on their different life experiences in understanding the environment (Littledyke, 2008).

2.5.2.2 Media

As said by Shaban and Al-Awidi (2013), pupils' drawings depict objects that they observe and encounter every day which is inspired by their previous knowledge and interest. The media, particularly television, which children spend many hours watching, plays a huge part in learning environmental knowledge. In fact, television is the second most popular source of environmental information. Children from schools without environment policies cite television as their major source of

getting to know about the environment. Children, however, are more interested in watching environmental programs on television than to read about these topics in print media. Study by Matsaridou (2015) revealed that one third of the children learns about the environment in fantasy stories that are creative, mysterious, and adventurous. This helps explain why books and newspapers are the least appealing and thus inefficient source of environmental interest for children. On the other hand, Shay-Margalit (2017) found that students who spent their leisure time watching TV or engaging with other electronic media expressed less concern about the environment.

2.5.2.3 Socio-Culture

Furthermore, pupils with different culture held different mental models (Glynn & Duit, 1995). In America, it was found that children drew people who with smiling faces whereas in Japan the children drew people in a complete figure (Voy, Pederson, Reitz, Brauch, Luxenberg, & Nofisnger, 2001). In line with that, children in Cameroon and German drew themselves in a bigger size. In the same vein, a study was conducted in the United Arab Emirates on the drawing by the children. The finding indicates the children's patriotic by drawing the nation's emblem, non-permanent tattoos by using dye and TV animated characters. Most of their drawings were reflected their expensive cars, houses which is next to camel sand tent. Female's favourite drawing was houses, scenes and nature whereas male's favourite drawing was animals, cars and astronauts. In general, the drawings show that the children could understand that they are belong to the earth (Shaban, & Al-Awidi, 2013). This represents, even though students are taught environmental science content in a similar manner, their understanding of the material will differ based on socio-cultural dimensions that are unique to each individual based on their culture and social phenomena which reflects through their drawings.

2.6 Mental Model

Models in general are the fundamental elements for the representation of scientific ideas. They can be described as “a surrogate object, a conceptual representation of a real thing” (Hestenes, 1987, p.441), suggesting that they are mental representations of physical structures and mechanisms (Wells, Hestenes, & Swackhamer, 1995). Conceptual models are scientifically established models and primary tools for scientists, science teachers and science students. (Coll, France, & Taylor, 2005). Individuals, however, have personal models in their minds, called mental models (Glynn & Duit, 1996), which they use to communicate ideas and explain events.

A mental model operates in a person's mind as a representation of how the world functions. This model was developed by Kenneth Craik in 1943, explaining that it is an act of mind creating small versions of reality used to predict events. It is based on the experience, knowledge, values, beliefs and expectations of an individual, describing how he or she thinks, makes choices, acts, and systematically interprets and analyses information (Easterby-Smith, 1980). Mental model is often based on understanding, perception or discourse interpretation (Johnson-Laird, 1983). Johnson-Laird (1983) suggests, among others, that the mental model is the basic framework of cognition for the representation of objects, state of affairs, series of events, social experiences and the psychology of everyday situations.

A series of diagrams can be used to explain combinations and assumptions (Johnson-Laird, 1983) as a way of understanding mental models by problem-solving logical deduction. It is part of an attempt to learn, see outcomes and improve behaviours in a variety of situations. This model is very beneficial as it is generally accepted that it is reliable, precise and efficient in achieving the objectives set out in a given scenario (Dove, Davidson, & Weltz, 1999). Although mental models are

functional, they are imperfect projections of reality that depend on context and change over the course of learning (Jones et al., 2011; Pearson & Moon, 2014). In a strict sense, mental models are unique to individuals, since no two minds are the same (Jones, Ross, Lynam, & Perez, 2014).

Mental models are different and unique and therefore have different characteristics. Norman (1983) found that mental models are incomplete and unreliable, as people tend to forget the specifics of the system they use in the long run. According to Gentner (2002), people can have two or more conflicting mental models in the same context. This is mainly since mental models do not have strict and clear boundaries, which are likely to cause similar processes to be confused with each other. Mental models appear 'unscientific' when people follow 'superstitious' practices, even though they recognize that they are irrational because they cost little in mental energy and effort. People often perform additional physical activities that require a basic rule to be applied in the process, rather than complicated mental preparation, to alleviate cognitive burden and decrease the possibility of confusion. In addition, Redish (1994) lists a set of characteristics for mental models as consisting of "propositions, images, rules of procedure, and statements as to when and how they are to be used". Johnson-Laird (1983) distinguishes mental models as "physical analogues of the world," (p. 165), relating to, and compatible with, the phenomena described in terms of the individual dynamics that represent the phenomena and the relationships that exist between them. Mental models, however, are not accurate representations of the phenomena (Halford, 1993; Norman, 1983).

This study focuses on the mental models of pupils as their internal representations or perceptions of how they interpret their daily experiences with the natural environment (Driver, Guesne, & Tiberghien, 1985; Osborne & Freyberg,

1985). Understanding mental models gives pupils the opportunity to identify the different factors that cause a phenomenon and how best to control it (Greca & Moreira, 2001). Mental model is also essential for pupils to make assessments and describe phenomena and occurrences (Greca & Moreira, 2000). Mental modelling process allows them to modify poor models with insights from newly gained knowledge and experience. This includes the reconstruction and rearrangement of existing cognitive constructs (Mintzes, Wandersee & Novak, 1998). Thus, a mental model has to be functional and effective in order for students to be able to use it to interpret and explain the natural environment and its entities in a more empirical manner, i.e. by making inferences and observations on a specific phenomenon (Franco & Colinvaux, 2000; Greca & Moreira, 2000).

2.6.1 Mental Model of Environment

In environmental education, students gather knowledge on the causes and consequences of environmental problems from environmental science through the construction of a mental model. Within environmental science research, which concentrates primarily on diversity and complex developmental problems, the construction of mental models of environment is quite lacking (Herbert, 2003). This may be the case because many pupils have difficulty grasping complex environmental problems (Ekborg, 2003). However, environmental education, on the other hand, includes several studies on mental models that have a broad impact on students' perceptions of the environment, including its problems. Elements of mental models of environmental problems include designing approaches to environmental concerns that include knowledge of legal implications, moral and ethical principles, as well as awareness of the ecosystem (Zandbergen & Petersen, 1995). When the models are elicited, it can be seen how individuals organize ideas cognitively relating to the

existence and interlinked elements of the social-ecological structures (Jones, Ross, Lynam, Perez, & Leitch, 2011).

In addition, Strommen (1995) suggests that children's understanding of prototypic wild animals, such as bears and wolves, and their perceptions of a specific animal reflect the nature of animal life; animal feeding, for example, implies prey-predator relationships. However, their understanding of the ecological functions of various plants and animals in the forest ecosystem is mostly 'incomplete,' poorly organized, and involves contradictions or misunderstandings.

A research by Littledyke (2008) finds that elementary school pupils in the United Kingdom appear to link animals with the environment in which the species live. Alerby (2000) shows that Swedish elementary and high school students consider the environment to be a good place without human interference, and that humans have used it to their advantage. Whereas, Loughland, Reid and Petocz (2002) show that primary and secondary schools in Australia are looking at the environment in six separate ways. The environment is seen either as a natural habitat, as natural habitat for living organisms, as a place with objects and human beings, as an environment for all, as humans are part of and responsible for the environment or humans and the environment are all in connection with one another.

Similarly, Payne (1998) also observes that Australian students at primary schools recognize the idea of environment as an ecosystem that has been made up of living and non-living components. As the environment around children has been increasingly altered because of human activity, students have started to consider the effect of human influence on the ecosystem, as they conceptualize the environment (Walker, Brady & Yong, 1999). Students' viewpoints on the consequences of air

pollution seem to be more focused on humans, such as the health of the respiratory system, compared to animals and plants (Myers, Boyes & Stanistreet, 2000).

Chase (1997) studies environmental education as a decision-making model to solve problems in everyday life. Some levels and points for the resolution of environmental issues are identified, including the explanation of the problems of the natural environment, the development of knowledge by experts in the field prior to the negotiations, the identification of the initial position of study participants, the innovation of a strategy for the exploration of potential solutions, and finally the development of a solution.

Shepardson, Wee, Priddy, and Harbor (2005) undertook the study with pupils (Grade 4 through Grade 12) from 25 different teachers to develop their environmental mental models. Pupil feedback was initially evaluated inductively, and the second stage of research included the above-mentioned assessment of the mental model statistics established. The study has developed four mental models of environmental models among the students. The first Model depict environment as a natural habitat for animals and plants. The second model refers environment as a place that protects the existence of plants, animals and humans. The third model depict environment as a place that has a special impact on the development of human activities and finally the forth model depict environment as the real ecosystem of animals, plants and human beings.

In addition, the said research also shows that there is a need to understand the relationship between the mental model construction of the pupils and their environment. In that regard, Grob (2004) has examined the model of environmental attitude and behavioural structure. Subsequently, the nature of the relationship between environmental attitudes and pro-environmental behaviour is established.

Systematic model research questions relating to environmental awareness, feelings, personal values, influences and actions have been proposed and evaluated. The findings confirm the significance of one's personal views and attitudes in influencing environmental behaviour. The investigators have also found a set of mental models that allow students to perceive the natural environment based on current knowledge, facts and personal observations.

Most of the current works on environmental mental models focus primarily on assessing the mental models of college students (Wuellner 2017; Liu & Lin 2014), pre-service teachers (Taskin et al. 2015) and pre-school pupils (Ahi, 2016). Broadly speaking, these studies have suggested that the conception of the environment and, within which, the role of individuals are linked to the level of education and geography (i.e. urban versus rural settings). In their research, Liu and Lin (2015) have recently discovered that the environmental mental models of pupils are strongly linked to environmental impacts and behaviour patterns. They have continued to insist that pupils who maintain a comprehensive and therefore more refined mental model are more likely to feel integrated with the environment, and perhaps even responsible for it. However, fewer studies have explored the effect of elementary pupils' mental models in influencing their potential behaviour towards the environment.

A well-constructed mental model of what organizes and defines the environment requires understanding relationships and interactions within and between natural and human systems. Consistent with the Guidelines for the Initial Preparation and Professional Development of Environmental Educators of the North American Association for Environmental Education (NAAEE, 2010), “environmental literacy hinges on understanding the processes and systems that comprise the environment, including human systems and their influence” (p. 8). The Australian policy statement

Environmental Education Policy for Schools defines environment as the aggregate of all the conditions that support living things (New South Wales Department of Education and Training, 2001). In turn, living things, including humans, are all interactive parts of the environment. The environment consists of both natural and human-made systems. In this study, the environment is defined as a totality of interacting systems between four factors: humans, other living organisms (biotic factor), the physical environment (abiotic), and the built and designed environment (Moseley, Desjean-Perrotta, and Utley, 2010). These factors along with the above definition of environment served as the conceptual framework for this study and for the scoring rubric to interpret mental models of the environment.

2.6.1.1 Human factor

Man is thus an inseparable part of the environment. Man and Environment have very close relationship with each other. The social life of man is affected by environment. This is the reason for various types of social and cultural activities around the world. The hilly people have different life styles than people in the plain area. Similarly, people around the world differ in their food, cloth, festivals etc. All these are influenced by the factors around him.

Environmental literacy hinges on understanding the processes and systems that comprise the environment, including human systems and their influences. Humans are interacting with the environment to obtain food, water, fuel, medicines, building materials and many other things. Advances in science and technology have helped human to exploit the environment for own benefit. Unfortunately, human have introduced pollution and caused environmental destructions. The impact of environmental problems on humans is significant, affecting all human activities, including health and socio-economic development.

2.6.1.2 The biotic factor

The biological constituent or the biotic component of environment consists of all the living things including man, animal, plants, micro and unicellular organisms. There is a constant interaction between the biotic and abiotic components of the environment in various ecosystems of varying sizes such as pond, marine, desert. Our earth boasts of a self-sufficient ecosystem that contains three types of animals namely producers, consumers and decomposers.

Producers are generally green plants and other photosynthetic bacteria which produces various organic substances such as carbohydrates, proteins etc. with the help of water, soil and light energy. Consumers depend for their nutrition on the organic food produced by the green plants. Decomposers bring about the decomposition of dead plants and animals and return various important minerals for the running of the biogeochemical cycles.

2.6.1.3 The abiotic factor

The Physical Constituent of environment includes soil, water, air, climate, temperature, light etc. These are also called abiotic constituents of the environment. This part of the environment mainly determines the type of the habitat or living conditions of the human population. This physical constituent of the environment is again divided into three parts namely Atmosphere (gas), Hydrosphere (liquid) and Lithosphere (solid).

These three parts represent the three important states of matter constituting the environment. This physical component of environment only consists of non-living things like air, water and soil. All these non-living things influence much to all living organisms including man. Water and temperature are the most important abiotic

components affecting living beings. Larger proportion of body's weight is due to water.

All living organisms require water for their survival. Besides water is the main vital fluid to keep optimum temperature of the body. All life activates work in a range of temperature. When temperature will be more than necessity, living beings will die.

Air is main physical component which provides oxygen for respiration. All living beings including plants & animals require oxygen for their existence. Oxygen is taken into the body by respiration process and comes out in from of carbon dioxide. Plants, on the other hand takes in carbon dioxide for food preparation during photosynthesis and gives out oxygen to the surrounding.

Soil is the most important for all living beings to create their habitat. It is the soil in which plant grows and man constructs houses to live in. It is the ground water present in the soil which provides for drinking and other farming activities.

The term-built environment refers to the human-made surroundings that provide the setting for human activity, ranging in scale from buildings and parks or green space to neighbourhoods and cities that can often include their supporting infrastructure, such as water supply or energy networks. The built environment is a material, spatial, and cultural product of human labour that combines physical elements and energy in forms for living, working, and playing. It has been defined as "the human-made space in which people live, work, and recreate on a day-to-day basis"

2.6.2 Eliciting Mental Model

Eliciting individual mental models can be particularly useful in making explicit the implicit assumptions individuals make or hold, and how it affects their understanding of a system (Moon, Blackman, Adams, & Kool, 2017). Revealing

connections between assumptions, preferences, and knowledge makes it possible to understand why individuals have points of view, how they make decisions, and how conflict might arise. In these applications, mental models can enable sharing of knowledge, correct misconceptions, permit solutions to be negotiated, and aid in conflict resolution by providing people with an opportunity to share their point of view on the basis of their own knowledge and experiences (e.g., Halbrendt et al., 2014).

There are different methods to elicit mental models. The drawing method has been commonly used not only as a data collection technique for research purposes, but also as an educational tool by educators who seek to learn about their pupils' comprehension of a scientific concept and how it evolves over time. At the same time, the method of drawing itself facilitates the construction of mental models (Glynn, 1997). A pupil's mental model can expose his or her evolving understanding of an issue, including any misconceptions that the person may have. This data can, in effect, allow the teacher to adapt a different strategy to the planning of lessons better suited to the specific student(s) at a specific time point (Brandt, 2001; Denham, 1993; Glynn, 1997; Papastergiou, 2005). While mental models open a window of opportunities in studying how people perceive a process or system, several researchers have questioned if the view we obtain in this way is, in fact, reliable.

Several studies have used open-ended drawing technique as a method of producing people's mental models, compared to closed-ended methods, which require participants to choose from a set of existing images or symbols (see, for example, Palmquist, 2001). The studies discussed here concentrate mainly on all those focused on the generation of human mental models of data analysis and action. Similar methods have been used to generate different types of mental models among pupils in different circumstances: violin-pupils' perceptions (aged 8=18) about the collaboration with the

teachers, their violin lessons, and the experiences they had encountered (Creech & Hallam 2006); pupil's (aged 8-12) experience of victimization in school as a result of bullying and mistreatment ((Bosacki, Marini, & Dane, 2006); university junior's understanding of the greenhouse effect (Libarkin, Thomas & Ording, 2015). Westbrook (2006) attempted to elicit graduate students' (aged 23-29) mental models, in particular about information retrieval, by asking them to draw up a process diagram and to write an elaborate explanation of their drawings.

Rieh, Yang, Yakel & Markey (2010) instructed a number of undergraduate students (aged 18–25) in order to generate their mental models of preference for using Google or the university's institutional repository (IR) by arranging them in pairs to perform two search tasks using both digital platforms, and to draw up representations and explain in words what they thought. Similarly, Holman (2011) used first-year university students (aged 16-19 of age) to create their mental models of browsers and article repositories by asking them to define how they felt these tools operated on the basis of the terms they entered and to relate them to the results. Thatcher and Greyling (1998) asked university respondents, mainly undergraduate students, and to some lesser extent postgraduate students, as well as academic and administrative staff, to illustrate conceptual models of the Internet by sketching a diagram of how they understood its structure and functions.

When the related work in the literature is reviewed, it seems to be that data collection methods are generally used in the form of surveys, group interviews, individual interviews, and video recordings (Einarsdottir, Dockett, & Perry, 2009). However, the draw-and-explain method is basically more effective, as it may be difficult for students to express their feelings through words, particularly technology concepts. Research has shown that not only do students feel most at ease when

drawing, they also develop a closer bond with the investigator, and so they are more prepared to participate in the study process without exerting any pressure on themselves (Barraza, 1999; Dove, Everett, & Preece, 1999). In addition, through drawing, students can describe their thoughts and emotions in a visual sense that allows a deeper understanding of their feelings, wants and needs (Einnarsdottir et al., 2009; Leonard, 2006; Moseley, Perrotra, & Utley, 2010; Piperno, Di Biasi, & Levi, 2007). The method is not only used to depict memory and situation, but to also narrate a story (Minkoff & Riley, 2011).

Punch (2002) describes the benefits of making a pupil draw as the stimulation of a pupil's imagination, the effective use of cognitive faculties, and the provision of ample time for the pupil to reflect. If the pupil is helped to overcome his or her creative insecurities, the process can be very enjoyable. Vygotsky (1971) and Pillar (1998) claim that, during the drawing process, students could make good use of their creativity to clearly express their views and beliefs, suggesting there is a strong relationship between drawing and thought processes.

Drawing is of major significance for both the cognitive and emotional progress of the pupil (Coates & Coates, 2006). Since each drawing is a unique creation of the child, it generally represents his or her viewpoints (Yavuzer, 2010). Pahl (1999) sees this as a true representation of the child and as the first phase of his or her creativity (as cited in Coates, 2002). In addition, a single drawing contains small amounts of cultural background, many of which are connected to various areas (Cox, 2005). The method also has educational dimensions, since students can develop new knowledge by drawing and then examining their own drawings, just as they engage in verbal and physical communication with external objects and individuals (Anning, 2002).

Since drawings provide a great deal of information of children's imaginative realities (Pillar, 1998), the study and analysis of such drawings can demonstrate far more than what their written or verbal products could provide. Thus, drawing is becoming an increasingly prevalent method among researchers (Punch, 2002). In carrying out a study to understand how students perceive environmental knowledge from their creative faculty, Alerby (2000) has divided their drawings into four types: (1) clean environment, (2) polluted environment, (3) clean and polluted environment, and (4) environmental conservation activities. A similar study by Shepardson (2005) aimed at assessing students' awareness of the environment finds that students are capable of identifying what the environment is, but in a very restricted way. In another study, Shepardson, Wee, Priddy, and Harbor (2011) used drawings to visualize and characterize children's perceptions of the environment and scientific concepts. Kalvaitis and Monhardt (2012) used drawings and written narratives to characterize elementary students' understanding of their relationship to nature, finding that 'children had a positive deep-seated appreciation' for nature. Judson (2011) used drawings by fourth and seventh grade students as representations of mental models of the desert environment.

In Turkish literature, there is a body of research primarily aimed at assessing the pupil's perception of the environment. For example, Taskın and Sahin (2008) have investigated how a group of six-year-old pre-schoolers perceived the environment, the impact of their habitual place of residence and the social and economic status of their families on their perception, and what kind of community they would want to live in. Yardimci and Kilic (2010) carried out a study to show the significance and value that 8th grade pupils attach to environmental and ecological topics. Chang (2012) recommended that since drawings are mechanisms of expression for children that it

'would be logical and reasonable to incorporate pupils' drawings into building science concepts.

The research by Ozsoy (2014) who examined the environmental perceptions of the pupil through their drawings is of great significance. Using the same approach, Barraza (1999) attempted to assess how a specific group of pupil respondents viewed the present and possible future state of the environment, discovering that, even as 43% of them had positive perceptions of the current situation, 54% of them had pessimistic views of the future state of the environment. A comparable research was conducted by Fleer (2002) among pupils aged 5 and 12, in which one of the significant results was that, as the age of the pupils increased, negative environmental opinions became considerably more likely. When the relevant literature in Turkish is investigated, there are previous studies that use different drawings of pupils for specific purposes. These include: the depiction of a scholar (Buldu, 2006; Turkmen, 2008), impressions of the shape of the earth (Ozsoy, 2014), conceptions of the Internet (Ersoy & Turkkan, 2009), understandings of the European Union (Belet & Turkkan, 2007) and perceptions of the human physical anatomy (Daglioglu, Calisandemir, Alemdar, & Bencik-Kangal, 2010).

2.7 Theoretical Framework

In demonstrating the mental models of Year Five pupils in relation to the environment, Piaget's Cognitive Constructivism, Vygotsky's Social Constructivism and Mental Model Theory were used.

2.7.1 Piaget's Cognitive Constructivist Theory

In this study, the researcher wishes to explore the thought process of the Year Five pupils about the concept of the environment. For this purpose, the most useful theoretical framework appears to come from constructivism. Constructivism is based

on the premise that learners consciously derive their own understanding and interpretation from their experiences by perceiving different events and things in a specific learning context. Learning is flexible and adaptable, as it blends new insights with existing knowledge and promotes the development of new ideas. Constructivism, in short, generally includes innovation and invention.

Piaget's cognitive development theory suggests that individuals could never have the information that they instantly grasp and then use. Instead, people must construct their own knowledge through experience that enables them to create patterns or mental models. In this study, pupils are believed to develop their mental models of the environment based on their knowledge and experience gained from both formal and informal environmental education in science classrooms and their personal lives.

In a constructive context, children are effective builders who build knowledge internally through a cognitive process from personal encounters with the environment to learn how it functions (Campbell & Jobling 2012). Thus, knowledge is built on well-established understanding, which means that children develop new knowledge by focusing on their physical and mental behaviour. Ideas and thoughts are then formed or rendered significant as children incorporate them into their existing knowledge structures.

2.7.2 Vygotsky's Social Cognitive Constructivist Theory

The second theory of learning that forms the basis of this thesis is the Vygotsky-inspired Social Constructivism Theory of Scaffolding. According to Vygotsky (1986), individuals gain knowledge through socialization, and this theory applies to the way a pupil perceives the environment as being influenced by the people around them. The point is that the surrounding environment plays a key role in the development of knowledge by individuals.

In formal environmental education, teachers, peers and NGOs work together to form the pupil's environment. Similarly, parents, friends, teachers and their local communities also act as the environment in an informal setting. Both situations are very helpful in improving student achievement. It is in accordance with Vygotsky's theory of the proximal development zone that adults and the brightest people are supposed to help pupils develop the skills and abilities they choose to acquire. In a broader sense, the context in which a person masters skills and abilities with the support of others, which include peers and adults, is referred to as the Scaffolding Zone. Proximal development, which emphasizes external scaffolding, has been administered in formal education, such as schools, where teachers, classmates and NGOs can significantly improve the environmental knowledge of pupils, while parents, media, peers and the public are responsible for delivering informal support. To acquire environmental awareness and promote effective cognitive progress, individuals are encouraged to communicate actively in a formal and informal environment. Pupils are also encouraged to explore complex topics with other individuals in both settings. Overall, both approaches would enhance their zone of proximal growth.

2.7.3 John Laird's Mental Model Theory

Over the past few years, much of the research in cognitive psychology and science has centred on studying how individuals engage cognitively to construct concepts in their minds (Greca & Moreira, 2000). Johnson-Laird (1983) essentially suggests that people build cognitive structures or mental models of their physical reality. These, in turn, play a significant role in the mental processing of concepts, the communication of issues, the arrangement of events, the understanding of the environment, and the interpretation of psychological and emotional situations in

ordinary life. Mental models thus offer the opportunity to assess how individuals carry out the process of interpreting a phenomenon, assessing mental processes, and evaluating the degree to which scientific knowledge is acquired (Gilbert, Boulter, & Elmer, 2000).

Various descriptions of mental models have been provided in the literature. For example, Glas (2002) and Hubber (2006) described mental models as the connection between reality and the mind. Ingham and Gilbert (1991) and Nersessian (1995) stressed the simplification of the role of mental models, describing them as a reflection of the physical process or system in which the entity takes the form of a mental model. In addition, Franco and Colinvaux (2000) defined mental models as new knowledge, which depicts a restricted version of the individual's view of life, even if it is implicit to the person.

Fundamentally, mental models are adaptive, evolving cognitive constructs determined by day-to-day experiences and newly acquired knowledge (Jones et al, 2011). Although there is some consensus on the concept and mechanism of mental models, views as to where models are processed in the mind differ. While Johnson-Laird (1983) and Vosniadou and Brewer (1992) claim that mental models are processed mostly in short-term memory, Nersessian (1995) contends that they are always stored in long-term memory, but they are also triggered by short-term memory and undergo fundamental changes. The prevalent observation in writings has been that mental models are specific cognitive information constructs that interpret ideas and events based on individual mental and cultural experiences. Vosniadou and Brewer (1994) have remarked that, to build a mental model, each aspect of the idea is perceived personally, without the use of a systematic approach, prior to the acquisition of a specific bit of knowledge. Boulter and Buckley (2000) have found that mental models

can be expressed externally in multiple ways, although it is difficult to measure them on an individual basis.

While researchers have suggested that mental models are useful in identifying complex and organized concepts, Kollmuss and Agyeman (2002) have argued that the idea of the environment is, in fact, a topic relevant to many fields and is structured by itself, rendering it almost impossible to establish. However, it is generally accepted that mental models can reveal the knowledge that an individual has on the environment in a comprehensive manner (Payne, 1998). In cognitive science and psychology literature, for instance, it is generally agreed that people build and use internal representations or mental models based on their own personal experiences of physical reality to interpret the environment (Craik, 1943; Johnson-Laird, 1983). As Jones et al. saw in 2011, mental model has a significant influence on how we understand and react to problems, particularly in relation to the natural environment. This research will therefore investigate the perceived environmental behaviour of children pertaining to the mental models of the environment.

In addition, Judson (2010) proposed that mental models could be described through drawings in conjunction with writing to better understand the dimensions of the constituent elements as important components of mental models. If mental models are seen as reflective of an individual's understanding of reality, a drawing that a person produces of a subject, idea or phenomenon can be used to assess the functioning of mental models (Moseley, Desjean-Perrotta & Utley, 2010). By stimulating the process of creativity and imagination, drawing offers a valuable way to explore a person's mental constructs. When a drawing is carefully studied, the underlying concept, despite the possible ambiguity and complexity, can reveal much on the patterns that form in the mind of the drawer and their relation to other structures, as

well as the cognitive construct of the drawer (Schafer, 2012). Figure 2.1 shows how the research is derived from existing environmental mental model and behavioural studies.

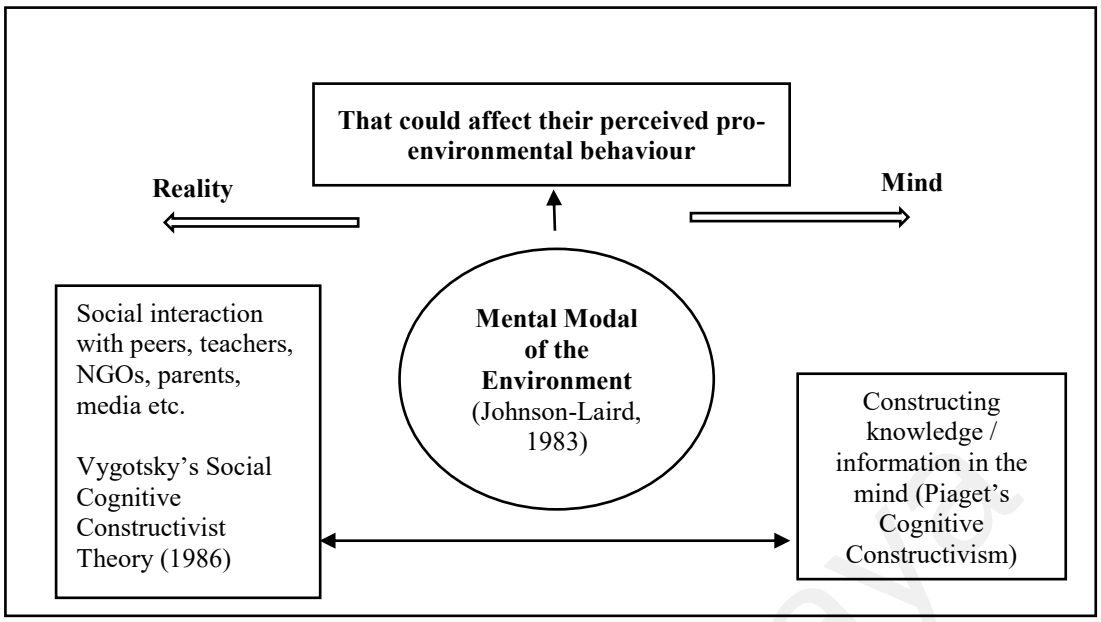


Figure 2.1 Theoretical Framework of Year Five Pupils' Mental Model of Environmental

As people interact with others (such as peers, teachers, Non-government Organisations, media, parents), they come to see environment of how others react towards the environment. For instance, if a pupil always exposed to their parents throwing rubbish everywhere, the child might construct knowledge that is alright to throw rubbish everywhere. This information is constructed in the mind of the pupils and this is how pupils connect this new information from reality into their mind. This mental model become a significant influence on how pupils understand and behave to any problems in relation to the natural environment.

2.8 Conceptual Framework

Figure 2.2 shows the conceptual framework of mental models or pictures in place of determining how the Year Five pupils interprets the environment and the factors that influence their conceptualisation of environment as an interaction between the four factors, namely, human, biotic, abiotic and the built environment.

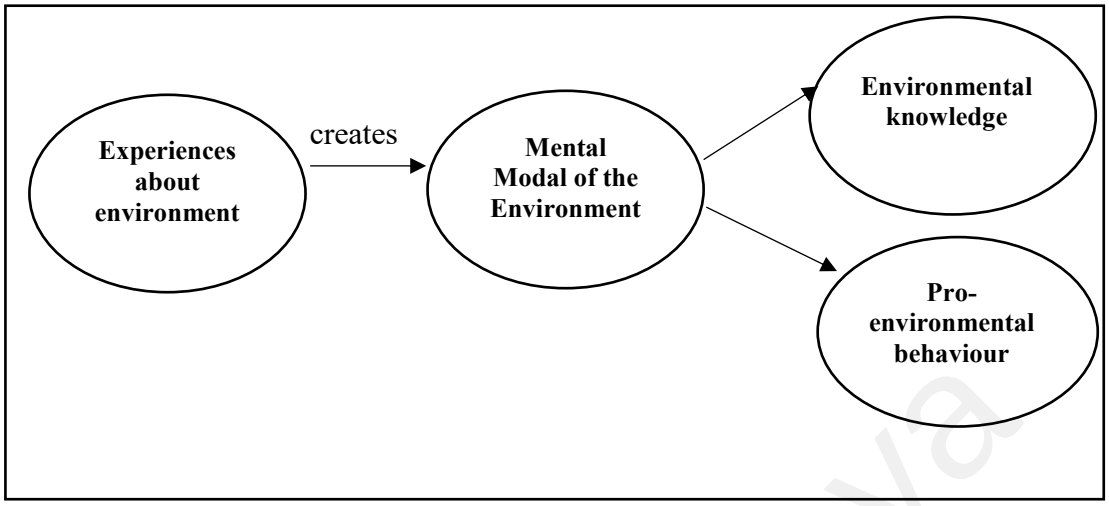


Figure 2.2 The conceptual framework of Year Five Pupils' Mental Models of Environment

Pupils' knowledge and experience (independent variables) are believed to influence their mental models of environment (dependent variable). The flow clearly shows that Johnson-Laird's (1983) assertion on the development of environmental mental models is based on formal education in schools and from family and media, and on informal environmental education from vacations and recreational activities, as suggested by Piaget (1973) and Vygotsky (1972). The resulting perceived environmental behaviour, a major concern of Jones et al (2011), essentially lays the foundation of this research.

Environmental mental models of pupils show their perception of the environment as an interconnected network of four factors: human, biotic, abiotic and built environments. In a relatable manner, Moseley, Desjean-Perrotta and Utley's (2010) interpretation of the environment as a dynamic system of interaction involves four factors, namely humans, other living organisms, the physical environment and the constructed and designed ecosystem. This interpretation provided the conceptual framework for this research and the benchmark for understanding the mental models

of the environment. Pupils who frequently portrayed interactions between humans, organisms (biotic), physical environments (abiotic) and designed environments in their drawings were given higher scores, indicating wide-ranging understandings of the environment as an interconnected network of the four factors. The complexity scales of mental models are classified into low, moderate and high scores. The researcher assumed that students with established experience and knowledge had an influence on their mental models of the environment. Further emphasis was given to comprehend the part of mental models in environmental education (EE) and the degree to which they contribute to environmental behaviour. The researcher believes that a higher degree of complexity of the mental model correlates with better pro-environmental behaviour.

2.9 Previous Studies on Mental Models of Environment

In general, the literature on mental models in the education field focuses on issues relating to astronomy (Kurnaz, Kıldan & Ahi, 2012; Nobes et al., 2003; Panagiotaki, Nobes & Potton, 2009; Samarapungavan, Vosniadou & Brewer, 1996; Straatemeier, van der Maas & Jansen, 2008; Saçkes & Korkmaz, 2015; Vosniadou & Brewer, 1992; 1994). Mental model research specifically concerned with environmental education tends to concentrate on the concept of "green" issues (Ahi, 2015; Liu & Lin, 2015; Moseley, Desjean-Perrotta & Utley, 2010; Shepardson, Wee, Priddy & Harbor, 2007). Palmer's (1994) research is generally regarded to be a seminal study of children's perception of environmental concepts, whereas later studies appear to concentrate on how various ecological and biological concepts are understood (Braund, 1998; Prokop, Kubiatko & Fanccoviccova, 2007).

Nearly all of the environmental problems being examined in Malaysia typically relate to environmental awareness, understanding, behaviours, attitudes and knowledge of the environment. Nurul Hidayah Liew Abdullah, Haryati Shafii and Seow (2013) found that the approach used by the science teacher could improve students' environmental knowledge and behaviour. They have found that, while students' awareness of the environment has been improved by their science teacher and the content of science textbooks, a great deal remains to be done to inspire them to respond positively to the environment. This thesis further illustrates the relationship between the students' perceptions and attitudes towards the environment. Additionally, the teaching aid used by teachers also influences the ability of students to make sense of the environment, as shown by Pudin (2006), who found that attractive teaching aids, such as posters and toy books, helped to improve their attitudes towards the environment.

The research conducted by Baniah Mustam (2017) used a mental model approach to examine the behavioural experience of secondary school pupils in a polluted region of Malaysia. The mental models of the participants are classified as follows: ‘A Perfect Environment’, ‘Environmental Problems’, ‘Interaction between the Environment and Humans’ and ‘Solving Environmental Problems. It is therefore relevant to further study the environmental perceptions of pupils using a mental model approach in Malaysia.

From a methodological point of view, fewer studies have explored mental models using drawing and clarifying methods determine in what way pupils interpret the environment (Moseley et al., 2010; Shepardson et al., 2007) and the human-environmental connection (Kalvaitis & Monhardt, 2011). In one case, Barraza's (1999) investigation shows that pupils often illustrate strong environmental concerns in their

sketches. Many of them have described environmental concerns such as environmental degradation, radioactive waste and global climate change. The predominant concepts in their artworks were garbage and contaminated or befoul cities which shows in what way the environmental problem had influenced their lives. Kalvaitis and Mondardt (2011) have studies young pupils' mental models to comprehend in what way they interpret and explain the connection with the environment. The finding shows that pupils typically had better connections with the environment and they were not kept apart from it, since the pupils relished with the nature and they were connected to the environment in a manner like their closed.

Using the draw and clarifying methods, Shepardson et al. (2007) have discovered four types of environmental mental models of middle and high school students such as (i) a natural habitat in which animals / plants survive; (ii) a place that sustains life; (iii) a place affected or transformed by humans; and (iv) a place in which animals, plants, and humans coexist. Shepardson et al. (2007) noticed that the primary mental model was prevalent at all grade levels examined, and that students typically took the view that distinguished humans from the environment despite improved exposure to EE lessons and programs at school. Payne (1998) has observed that Australian urban sixth grade students usually have a simplistic view of nature that living and non-living objects simply exist in the so-called natural world, which does not include human and man-made objects. They mainly look at the world through its physical characteristics, while not considering dynamics and changes. The perceptions of the school pupils in the above-mentioned studies, carried out using various approaches, indicate that these children have had a lack of knowledge of the environment, and the researchers clearly relate how they view the world from what

has been taught in classrooms (Loughland, Reid, & Petocz 2002; Shepard son, Wee, Priddy, & Harbour (2007).

In their phenomenography research of school-aged pupils (aged 3, 6, 8 and 11), Loughland et al. (2002) have encountered six different environmental perspectives; the main qualitative distinction between these perceptions is of the environment as an entity or as a relationship between humans and the environment. It has been proposed that students expressing a relationship-view prefer to adapt their behaviour towards the environment. On the other hand, those reported an object-view might not want to accept responsibility for the environment.

Moseley, Desean-Perrotta, and Utley (2010) conducted another study researching mental models of the environment. Using the Draw-an-Environment Test (DAET), the authors attempted to distinguish the mental models of pre-service environmental teachers. It was reported that 79.7% of them considered the environment as a one-dimensional structure, 17.8% identified two related variables, and only 2.5% perceived the environment as a system of living and non-living things. In a study with elementary school pupils, Ahi (2014) concludes that people have a pessimistic view of the future of the environment. Liu and Lin (2015) have attempted to identify the environmental mental models of undergraduate pupils by factoring their environmental behaviour. They figured that 75.8% of them perceived the environment in simplistic ways; 22.2% were able to relate two interconnected factors; and only 2.0% described the world as a complete structure. The general finding from these experiments is that, regardless of age, individuals do not seem to see the environment as a dynamic, multidimensional structure.

Several studies were conducted on the students' understandings of different environmental problems or concepts, such as rainforest and species biodiversity by Sneddon, Turner and Foster (2008), greenhouse impacts by Shepardson, Choi, Nihongi, and Charismata (2011), radioactivity by Neumann and Hop (2012) and sustainable development by Walshe (2008).

Limited studies have focused on how students interpret the environment in a comprehensive way (Kalvaitis & Monhardt, 2011; Shepardson, Tiny, Priddy, & Harbor, 2007). In adding, the studies have employed a qualitative method to distinguish their mental models by concepts that are inappropriate to studying the influence of pupils' mental models on pro-environmental behaviour. Therefore, in this thesis, the quantitative approach, using the draw-and-explain task of Moseley et al. (2010) and rubric scoring, which generated ordinal data suitable for quantitative analysis, was used to further assess the relationship between the two variables. The influencing factors of the mental model that have been little discussed are another void in this field of research. In this regard, the study also examined certain factors which influenced the mental models of the environment of the Year Five pupils. By filling these gaps, the researcher expects this thesis to contribute to new developments in environmental mental models.

2.10 Summary

The background of environmental education has been illustrated in the earlier sections of the literature review. Surveys on definitions and advancements in environmental education are made with the view that they will provide a clearer view and comprehension of environmental education. Several experiments on environmental education have also been noted as being conducted in Malaysia. The findings of previous environmental concept studies by local investigators have similar

implications that could be used to recognize resemblances or distinctions with future research. The distinctive aspect of this thesis, which has not been identified in previous studies, is that the mental model for exploring the conceptualization of the environment among the Year Five students is approached in a systematic manner, considering their prior knowledge and experience. The following chapter explains the methods used to carry out this research.

CHAPTER 3

METHODOLOGY

3.1 Introduction

This study aims to examine the Year Five pupils' mental models of environment and the relationship with their perceived pro-environmental behaviour. This chapter begins by explaining the research design and followed by the setting and sample of this study. After clearly explaining who and where this study was conducted, research instruments, data collection procedures, ethical consideration are described briefly.

3.2 Research Design

Research design is important in guiding the research to answer the research questions. In addition, research design provides a logical sequence that connects between questions and conclusion through data collection, analyses and interpretation (Yin, 2003). Creswell (2014) documented that research designs are measures to collect, analyse, interpret and report data in research studies. In this study, a descriptive survey research design was being used to investigate the Year Five pupils' mental models of environment.

When the proposed research seeks to identify characteristics, frequencies, trends, correlations, and categories than descriptive method is best suited. It can be both qualitative and quantitative. Also, the survey research allows researcher to gather large volumes of data that can be analysed for frequencies, averages and patterns. Therefore, descriptive survey research design is the most appropriate research design to achieve the objectives of this study. Table 3.1 shows the research objectives, research questions, and what data are collected and how it was analysed.

Table 3.1

Research Objectives, Research Questions, Data Collected and Data Analysis

Research objectives	Research questions	Data collection method	Data Analysis
To investigate the Year Five pupils' mental models of environment using the Draw an-Environment Test (DAET).	What are the Year Five pupils' mental models of the environment?	Drawings (DAET)	Draw An Environment Test-Rubric (DAET-R) Content Analysis SPSS Descriptive Pearson Correlation
To investigate the relationship between the Year Five pupils' mental models of environment and their perceived environmental behaviour.	What is the relationship between the Year Five pupils' level of environmental mental models and their perceived environmental behaviour?	Drawings (DAET) and Questionnaire (MMFEB)	SPSS Descriptive Pearson Correlation
To identify the factors that influence the Year Five pupils' mental models of environment.	What are the factors that influence the Year Five pupils' mental models of environment?	Questionnaire (MMFEB) Open ended questions	SPSS Descriptive Regression Content Analysis

3.3 Sample

This study was conducted at one national primary school located in a high-density urban area in Petaling Jaya Selatan (PJS). These pupils live in low cost interlink houses and flats. This sample was selected as improper waste management such as dumping of rubbish was observed around the residential area nearby school. The total number of pupils in this school was 975 and 110 in Year Five (11 years old). All the three Year Five classes in this school took part in the study. The sampling was convenience sample of 104 (male: 48; female: 56) Year Five pupils who volunteered with the consent of their parents. Two pupils didn't take part in this study as the researcher did not receive their parents' consent. Based on the final year results, these pupils academic background is average and below average [based on *Sistem Analisis Peperiksaan Sekolah* (SAPS) data 2018].

The reason for selecting the Year Five pupils is, they have studied environmental related topics for more than four years (since Year One), especially in Science subject. In addition, environmental education also has been exposed to them across the curriculum through other subjects, such as Bahasa Malaysia, English, Religious Study and Arts since they were in year one (Azlinawati Abdullah, Sharifah Zarina Syed Zakaria & Muhammad Rizal Razman, 2018). Additionally, approval was granted by the Ministry of Education to involve Year Five pupils in research because they are not sitting for any national examination.

3.4 Research Instruments

Two instruments were used to collect data in this study. They were Draw-an-Environment Test (DAET), questionnaire. The DAET and questionnaire (MMFEB) which consisted of two parts (Table 3.2). DAET (see Appendix A) was used to answer

the first and second research questions whereby MMFEB (Appendix B) for the third research questions.

Table 3.2

Instruments

Instruments	Parts	
DAET	i.	Draw what you think the environment is.
	ii.	'My description of the environment is….'
Questionnaire (MMFEB)	i.	What prompts you to draw such an environment?
	ii.	Sources of Prior Knowledge (5-point Likert Scale)
	iii.	Pro-environmental behaviour (5-point Likert Scale)

3.4.1 Draw-an-Environment Test (DAET)

DAET was used to access pupil's mental models of the environment. DAET was adopted Moseley et al (2010). Several studies in science and environmental education have used similar drawing activities to investigate peoples' conceptions of specific topics. DAET entails of one page with two prompts. The survey form has the prompt 'My drawing of the environment is…' with space on the page for a drawing and a prompt to conclude the sentence 'My description of the environment is….'. The instrument was translated into National Language, (Bahasa Malaysia as the pupils are more fluent in it compared to English language. The translated instrument was validated by two Science teachers. There was no change made as the teachers confirmed the content and language were clear. These items were pilot tested with a similar group of Year Five pupils from another school to obtain the internal consistencies (Cronbach's α =.753) which was acceptable.

3.4.2 Questionnaire (MMFEB)

The questionnaire used in this study consist of two parts; Factors Influencing Mental Models of Environment (adapted from Wuellner, 2017) and Pro-

Environmental Behaviour (adapted from Wong, Afandi, Ramachandran, Kunasekaran, & Chan, 2018). These two parts were integrated as Mental Model Factors and Environmental Behavior (MMFEB).

3.4.2.1 Factors Influencing Mental Models of Environment (Part I)

Part I of MMFEB consists of a set of two-tier questions, including an (I) open-ended question and follow-up (ii) Likert-type questions, to identify the factors that influence the Year Five pupils' mental models of environment. The sources of environmental knowledge are among the factors that influence the Year Five pupils' mental models of environment.

Open-ended question

Pupils are required to answer an open-ended question "What encouraged you to draw such an environment?" (In Malay: *Apakah perkara-perkara yang mendorong anda untuk menggambarkan alam sekitar seperti dalam lukisan tadi*?).

In this study, the open-ended question allows to collect qualitative answers from the pupils that are, for the most part, full of information. Therefore, this open-ended question aims to find the factors that have influenced the environmental mental modelsother than the sources of environmental knowledge of the pupils in this study. The pupils are required to state from where they got the idea to draw the picture of the environment. The respondents were required to answer this question based on their drawings of environment in DAET

Likert Type Question (Sources of Prior Knowledge)

A 11-item 5 Likert type questionnaire was used to identify the Year Five pupils' source of environmental knowledge that had influenced their mental models of environment. This questionnaire was adapted from the Environment Tasks Tool proposed by Wuellner, Vincent and Felts (2017) which was used to compare college

students' mental models of environment before and after completing a 16-weeks 'Environmental Conservation' course. There were 3 parts in the Environment Tasks Tool. In Part I, students were required to draw what they thought the environment was and label the parts of their drawings followed by a written description of the drawing. Part II of the instrument requires the respondent to choose one or more pictures which depicts environment from a series of seven pictures and justify their response. In part III, ten sources of previous knowledge were given with prompt 'Where did you learn about the environment?'. The respondents were required to choose one or more options. They could also provide responses other than the options given (item 10 – 'others'). The researchers' aim was to find out where did the respondents receive their prior knowledge about what defines the environment that they've drawn. The sources of environmental knowledge in the initial questionnaire were (1) family, (2) clubs, (3) high school class, (4) television news or programs, (5) college class, (6) popular magazines, (7) online news or website information, (8) popular books, (9) newspaper and (10) others.

Only Part III of the Environment Tasks Tool was used in this study with some modifications in the instrument to suit this study. The items were grouped into 3 sections; Section 1 (School): (1) School text books, (2) Science teachers, (3) Other subject teachers, and (4) Clubs/ Society/Uniform units. Section 2 (Media): (5) Social media, (6) Television, (7) Internet (You Tube, Google etc), and (8) Newspaper & Magazines. Section 3 (Family): (9) Family members, (10) Holidays, and (11) Indoor/outdoor gardening. These changes were made because the sample in the previous study were college students while this study involves primary school pupils. The modified instrument was validated by two experts, an environmental education Scholar and a Science teacher. Some modifications were made in the Sources of

Environmental Questionnaire. Both experts suggested some changes to be made in Items 4 and 10. Item 4 was changed from *kelab/persatuan/badan beruniform* (club/society/uniform units) to *aktiviti ko-kurikulum* (co-curriculum activities) so that it covers all the activities through informal education in the school. Item 10 was changed to *aktiviti rekreasi* (recreational activity as the word *percutian* (holiday) was very general. Table 3.3 shows the validated MMFEB.

Table 3.3

Modified and Changes Made After Validation in MMFEB Part 1

Sections	Modified Items	Changes Made After Validation
School		
1	School Textbooks	School Textbooks
2	Science teachers	Science teachers
3	Other subject teachers	Other subject teachers
4	Club/society/uniform units	Co-curriculum activities*
Media		
5	Social Media	Social Media
6	Television	Television
7	Internet	Internet
8	Newspapers & Magazines	Newspapers & Magazines
Family		
9	Family members	Family members
10	Holiday	Recreational activities*
11	Indoor/outdoor gardening	Indoor/outdoor gardening

* Changes made after validation.

In the original questionnaire respondents were required to choose one or more from the ten options given. This format was changed into 5-point Likert scale format measuring the sources of prior knowledge about the concept of environment ranges from 'never' (entitled for 1 point) to 'very often' (entitled for 5 points). The sources of environmental knowledge scale were scored by creating a sum of the 11 items, with the possible total scores ranging from 11 to 55. The higher scores indicated the most influenced source of environmental knowledge that defined the environment that respondents had drawn as compared to the lower scores. These items were pilot tested

with a similar group of Year Five pupils from another school and obtained internal consistencies (Cronbach's α =.871) which showed good overall. Therefore, these items were suitable for the Year Five pupils in this study.

3.4.2.2 Pro-Environmental Behaviour (Part II)

The questionnaire consists of 10-item Likert-type was used to survey pupils perceived environmental behaviour. This questionnaire was adapted from the Primary School Environmental Literacy Instrument (PSELI) which was used to examine the environment literacy among the Year Five pupils in Sabah, Malaysia who had actively participated in environmental education programs such as SERASI and *Sekolah Lestari* Competition (Wong et al., 2018).

PSELI was developed based on the four-environmental literacy (EL) components: ecological knowledge (knowledge - 16 items), disposition (affect -25 items), issue identification and action strategy (cognitive skills – 3 items) and pro-environmental behaviour (behaviour – 12 items). The level of each component was set based on former studies on environment literacy carried out by McBeth et al (2009) and Erdogan (2010). The level of pro-environmental behaviour was considered high at 73-100%, moderate at 46-72% or low at 20-45%. PSELI's Cronbach alpha value for various items ranged between 0.75 – 0.90 (Wong et al, 2018). Pupils with higher level of pro-environmental, tend to behave positively towards achieving environmental sustainability.

This study adapted the items from behaviour domain to examine the Year Five pupils' perceived environmental behaviour. The environmental behaviour domain contained 12 questions initially. Item 1 and 12 (Table 3.3) were removed after it was validated by an environmental education scholar, from University Putra Malaysia (UPM) and a science teacher. The expert from UPM had been involved in

environmental subjects for more than 20 years and having related PhD degree on that matter. The Science teacher has been teaching Science for upper primary pupils for more than ten years and has a doctorate degree in Science Education. The experts found that Item 1 and 12 did not suit the sample of this study as most of the pupils were staying in flats where they had less chances to prepare food for birds. They also suggested that writing letter to someone regarding environmental pollution was not practical for primary school pupils. Therefore, only 10 items were used to examine the Year Five pupils' environmental behaviour. The 10 items included in the Pro-Environmental Behaviour Questionnaire scale was presented in a 5-point Likert response format measuring the occurrence of the behaviour ranges from 'never' (entitled for 1 point) to 'very often' (entitled for 5 points). These items were pilot tested with a similar group of Year Five pupils from another school and obtained internal consistencies (Cronbach's ɑ = .821) which show good overall.

Table 3.4

Removed items from MMFEB Part II

Number	Items
1	I have never written a letter to anyone regarding environmental pollution. *Saya belum pernah menulis surat kepada seseorang tentang sesuatu masalah pencemaran.*
1 2	*I prepare food for birds outside my house.* *Saya menyediakan takung makanan burung di luar rumah saya.*

3.5 Validity and Reliability of the Instruments

Two instruments (DAET and MMFEB) were used in this study. Both instruments had undergone evaluation before it could be administered. This was done through content validation and pilot study. It is very important to check the validity and reliability of the instrument to draw valid conclusions about the environmental behaviour and factors influencing mental models of the sample in this study. An instrument is valid when it is accurately measuring what is supposed to measure (Campbell & Stanley, 1963).

Content validity refers to whether the content of the items, from the instrument show that the test's content relates to what the test is intended to measure (Creswell, 2014). The researcher had made an extensive search of the literature from theories, previous instruments, frameworks and past research findings for the mental models, environmental behaviour and sources of prior knowledge instruments. To accomplish content validity of the instruments, two experts validated the questionnaires. One of them is an environmental education scholar, from University Putra Malaysia (UPM) who has involved in environmental subjects for more than 20 years and a PhD degree on that matter. Another expert is a Science teacher with doctorate in Science education who is teaching Science in primary school for more than 15 years. The purpose of the study was explained to the experts and they were requested to evaluate the newly added items, the clarity of the items as well as whether the language and terms were suitable for the Year Five pupils. For the first instrument, DAET, both experts found the translation of instructions from English to National Language is good overall. There was no comment or change made to this instrument. Changes were made in MMFEB based on the experts' comments. Two items (Item 1 and 11) from the Pro-Environmental Behaviour (Part I of MMFEB) were removed as the experts found that

the questions were unsuitable for the pupils' in this study. Secondly, some modifications were made in the Sources of Environmental Knowledge (Part II of MMFEB). Both experts suggested that Item 3, holiday be *(percutian)* changed to recreational activity (*aktiviti rekreasi*) and Item 6, club/society/uniform units (*kelab/persatuan/unit beruniform*) be changed to co-curriculum activities (*aktiviti ko-kurikulum*).

On the other hand, reliability is defined as 'the extent to which test scores are stable and consistent' (Creswell, 2014). Internal consistent reliability is looking at the connection between all items that make up the constructs to ensure that the items are measuring the same concept. The pilot study was intended to investigate any weakness in the research design. It was conducted under the same conditions using similar respondents and the same instrument planned for the study. The pilot study was also intended to test how well the design can be applied in the field, to find errors in the data collection instrument and to locate errors in the interpretation of the data collected. The pilot test was done by using the instruments, DAET and MMFEB with a different group of Year Five pupils (n= 30) from a different school for validity and reliability which had similar characteristics from location, teacher qualifications and curriculum. The internal consistencies of each instrument are shown in Table 3.5. All the instruments showed acceptable and good overall internal consistency.

Table 3.5

Reliability Test Results of the Instruments

Instrument	**Internal Consistency**
DAET	.753
MMFEB	
Pro Environmental Behaviour	.821
Sources of Environmental Knowledge	.871

3.5.1 Inter-rater Reliability of DAET Scoring

Inter-rater reliability (IRR) is the level of agreement between raters. Inter-rater reliability helps to identify whether the rubric of the instrument considered relatively subjective and precise scoring (Creswell, 2014). If everyone agrees, IRR is 1 (or 100%) and if everyone disagrees, IRR is 0 (0%). Percent agreement between raters is one of the basic measures for inter-rater reliability. In general, above 75% is considered acceptable for most fields (Crewson, 2005). The researcher and a Science teacher with doctorate degree in Science education who are teaching Science in the university and primary school for more than 15 years analysed had scored all the 104 drawings.

Firstly, 10 randomly selected samples were scored independently by the two inter-raters utilising DAET-4 factors of analytical rubric which resulted in 40 individual scores. Then, researcher and the Science teacher deliberated the differences in order to elucidate the scoring criteria. The scorers recurrent this procedure choosing another random subset of ten of the remaining samples. During the second standardization session, a slighter amount of inconsistencies was found and deliberated.

The scorers deliberated on how a drawing of car (without human in the car) should be scored. The scorers agreed that, to be identified as an interaction, the interacting objects must be drawn or indicated in the text. After discussion, both agreed to give a score of one for the built environment factor (car) as there was no visible interaction between human and car in the drawing. Another discrepancy occurred in scoring the drawings of bird nest on the tree. The scorers agreed on the maximum score of 2 for interaction between two biotic factors (bird and tree). After completing the second standardization session, agreement was attained on the standards and steps; the two scorers then scored the remaining drawings (n=84) independently. Finally, the

scorers compared their results of 336 individual scores (4-factors of 84 remaining drawings). The percent-agreement score reached 95.0%. The disagreements (for the balance 5.0%) were conversed and agreed in the final meeting. The disagreements were deliberated and determined in the final discussion.

The accord information for the respective drawing consisted of four individual scores (0−2) and an all-out score that was accomplished by summary of the four scores (0−8). The absolute score is demonstrative of the level of culmination for a mental model of the earth. The higher the score, the comprehensive and advanced the mental model. Three drawings were deliberately chosen to represent scoring measures and give instances of various degrees of mental model scores in the data analysis as in Figures 3.1-3.3.

3.5.2 Inter-rater Reliability of Open-Ended Question

The open-ended question was analysed using coding manually as the responses were less than 100 (n=75). A researcher and a science teacher independently identified the key words from the responses. These were subsequently sorted into similar categories and sub-categories. This approach was considered the most suitable as the responses were in single words and short sentence responses. The main categories and sub-categories that arose were then identified to enable further interpretation. The researchers then compared identified categories for validation purposes. The percent-agreement score reached 82.5 %. The disagreements were discussed and resolved.

3.6 Data Collection Procedure

Data collection is the process conducted by researcher to find the answers of formulated research questions. In general, all processes can be divided into three general steps namely obtaining permission, administrating the instrument to pupils and scoring pupils drawings.

Initially, the researcher identifies the schools to conduct the research. Then, the researcher applied for permission to the Educational Planning and Research Division (EPRD) via online to conduct this research. Then using the permission letter from EPRD (see Appendix D), the researcher obtained permission from the Selangor State Education Department. The permission from the Selangor State Education Department was submitted to the school headmistress to conduct the research.

Upon obtaining permission from the school headmistress, all the Year Five pupils were gathered in the school hall to brief about this study. All the Year Five pupils present were explained about the purpose of this study. Parents' consent forms (see Appendix E) were given to all of them and requested to return them to the researcher within three days after obtaining permission to take part in this research from their parents. 108 pupils returned the parents' consent forms whereby 2 pupils didn't return the forms to researcher. The total population of the Year Five pupils took part in this study shown in Table 3.6.

Table 3.6

Population of the Sample

Class	**Number of Pupils**
X	38
Y	35
Z	35

Data collection was done in one day in three sessions. The pupils from Class X were gathered at the school library during the first lesson of the day. Beforehand, permission was obtained from the headmistress as well as the subject teacher of the lesson to excuse the pupils for one hour for this study. The school library was chosen as it is comfortable and spacious enough to keep the pupils in distance to avoid from copying. The researcher was accompanied by one Science teacher to control the discipline of the pupils. Initially, the Science teacher was briefed about the instrument and the purpose of this study. The pupils were briefed on the general instructions in the instrument. The objectives of the study were explained to the pupils and they were told to give their best cooperation. They were reminded that this is not a drawing competition and just draw what they think of environment from their own point of view. They were given 20 minutes to complete the Draw An-Environment Test (DAET) and 15 minutes for answering the questionnaire (MMFEB). Ten minutes break was given to the respondents after completing DAET to ensure the pupils were comfortable during answering the questionnaires. The same procedure was repeated with the respondents from Classes Y and Z on the same day. The summary of the data collection procedure is presented in Figure 3.1.

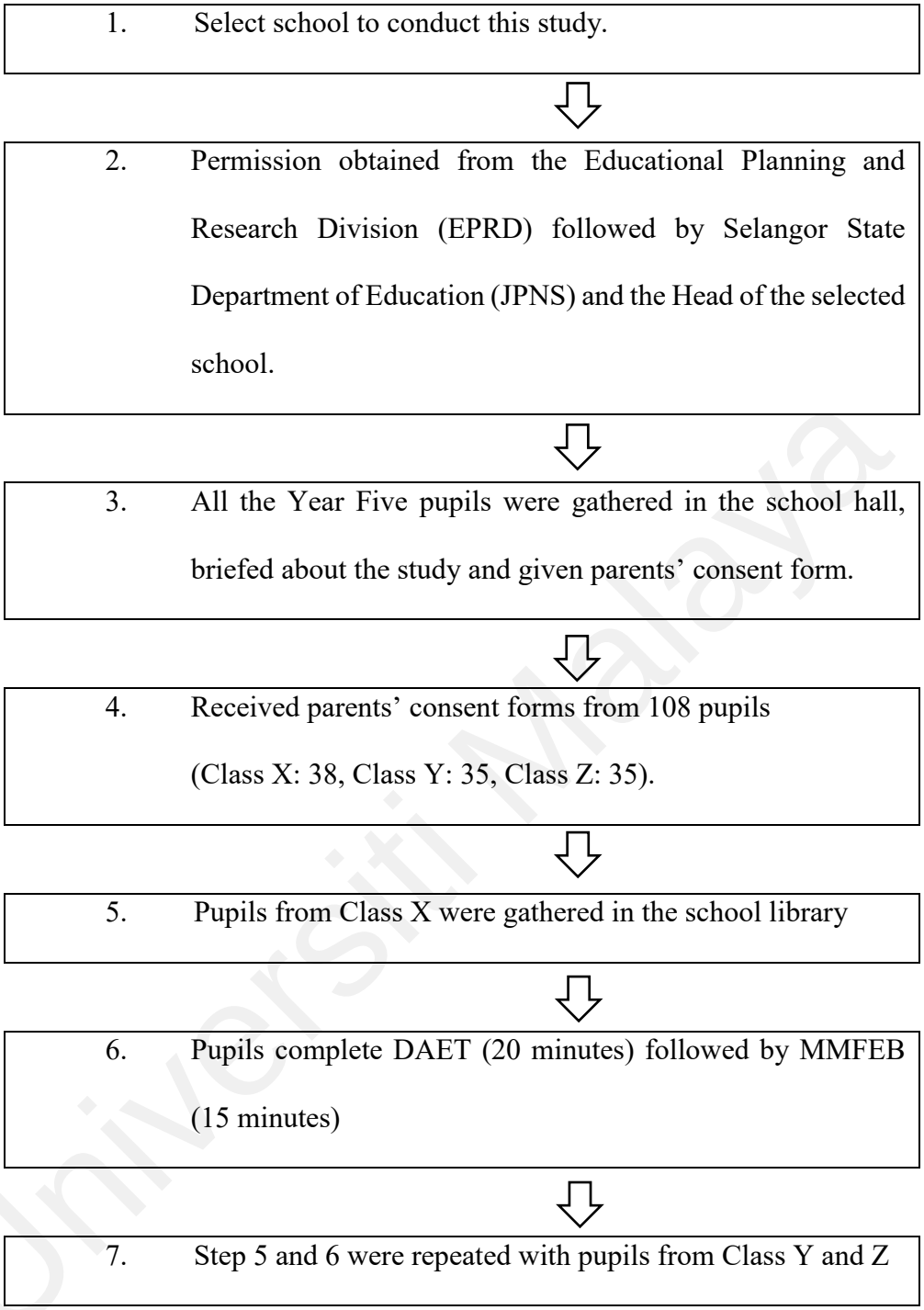


Figure 3.1 Data Collection Procedure

3.7 Data analysis

Pupils' drawings were analysed by using Draw-an-Environment Rubric (DAET-R), descriptive statistics and Pearson Correlation. The open-ended questions in the questionnaire were analysed by using content analysis. Finally, the 5-point Likert Scale data in Questionnaire were analysed using descriptive statistics, Pearson Correlation and Regression.

3.7.1 Mental Model of the Environment

The drawings which represents pupils' mental models of environment were further analysed in two ways; (i) level of mental models and (ii) types of mental models. The level of mental model is identified to find how complete is the pupil's mental model regarding the concept of environment. Whereby, the types of mental models will provide insights on how pupils view the environment.

3.7.1.1 The Level of Mental Models

The levels of mental models were determined by a scoring method using The Draw-an-Environment Rubric (DAET-R). DAET-R was framed by Moseley et al (2010) to quantify image elements and develop ordinal scores suitable for statistical analysis. DAET-R was adapted to score the drawings produced by the respondents in this study. The DAET-R (see Appendix C) uses four factors as rubric categories including: (1) humans, (2) other organisms (biotic), (3) the physical environment (abiotic) e.g. water and rocks, and (4) the built or designed environment - e.g. ships and garbage.

The DAET-R rubric has been alienated into three segments that focus on the degree of evidence in the drawings of interactions of the four environmental factors with each other: factor not present, factor present and factor interacting with other factors. A score of zero was given if there was no evidence of a factor in the drawing.

The range of possible total scores on an individual rubric was 0 - 8. In the DAET-R. The higher the score, the more evidence there is of the respondent's understanding of the environment's interactions between the four factors, as defined by the North American Association for Environmental Education (NAAEE) Guidelines (2004). The higher score is indicative of a more complete understanding of the environment as interacting with the four factors. Initially, in the DAET-R developed by Moseley et al (2010), drawings of environment were scored using a score of 0-3. The maximum score of 3 was given if respondent indicated an interaction among factors with an emphasis on a systems approach to the definition of environment. This scoring was used to determine the level of mental models of pre-service teachers. Considering the age of respondents in this study, the interaction among factors with an emphasis on a systems approach was omitted from this rubric. Therefore, in this study, the modified DAET-R used by Liu and Lin (2019) to examine ninth grade (14-15 years old) pupils' mental models of marine environment was adopted to score the drawings of environment. In this study, drawings of environment were scored using a score of 0-2 [(factor not present = 0), (factor present = 1), (factor interacting with another factor =2)]. The maximum score of 2 was given if respondent indicated an interaction among factors. Hence, the total score can range between 0−8 (Table 3.7). Based on the total scores obtained, the pupils' level of mental model will be determined as shown in Table 3.9. A higher score is an indicative of a more complete understanding of the environment.

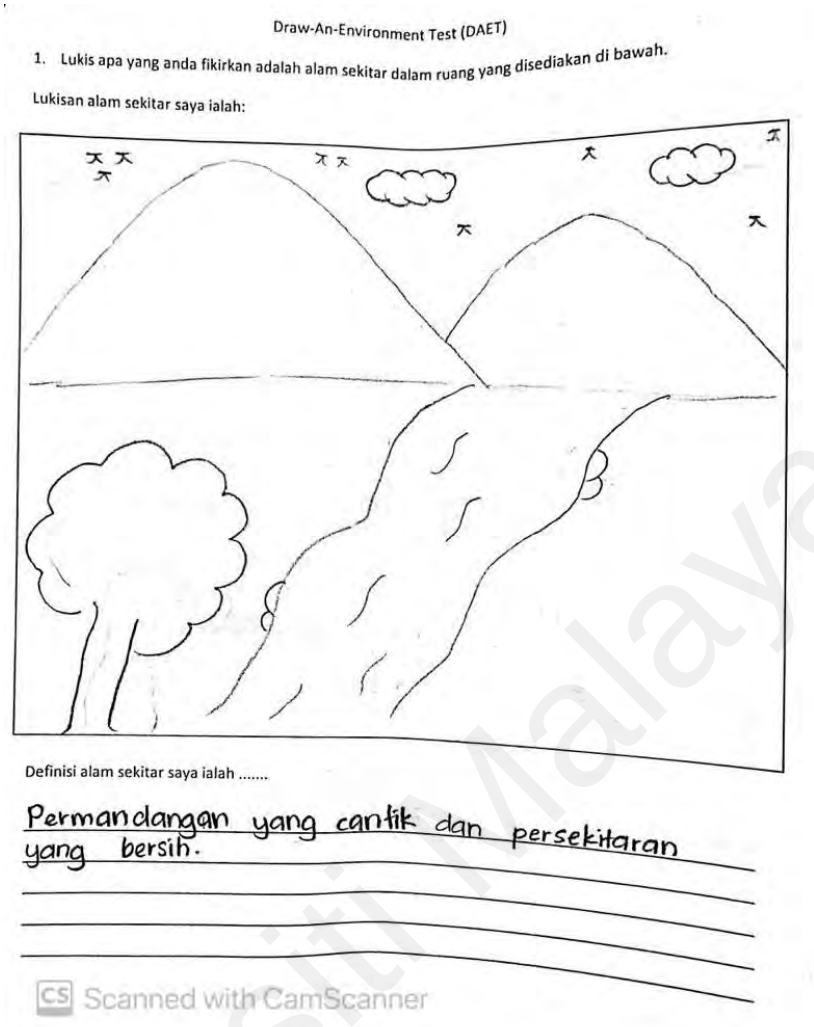
Table 3.7

The Level of Mental Model of Environment

Total score	Level of mental Model
0-2	Low
3-5	Moderate
6-8	High

(Adapted from Liu & Lin, 2019)

Three drawings from pilot test were purposely selected to show scoring criteria and provide examples of three different levels of mental model scores. Figure 3.1 shows a pupil's drawing containing only biotic (F2) and abiotic (F3) factors without any visible interactions. Human (F1) and built environment (F4) factors were not present, which resulted in total score of two (F1 = 0; F2 = 1; F3 = 1; F4 = 0; total score = 2). The birds and a tree in the drawings represent the biotic factors which were drawn in isolation, meanwhile clouds, river and mountains represent the abiotic factors without any visible interactions. The total score for this model is 2. Therefore, this drawing is categorised as low level of mental model of environment.


Draw-An-Environment Test (DAET)

1. Lukis apa yang anda fikirkan adalah alam sekitar dalam ruang yang disediakan di bawah.

Lukisan alam sekitar saya ialah:

Definisi alam sekitar saya ialah .....

Permandangan yang cantik dan persekitaran yang bersih.

Figure 3.2 An example drawing illustrated low level of mental model of environment

Figure 3.2 shows a pupil's drawing containing biotic (F2) and abiotic (F3) factors with some visible interactions. The is a visible interaction present between the animals (F2) interacting with water (F3) from river. Therefore, score 2 was given for F3. Another visible interaction was present between the giraffe and tree receiving a score of 2 for F2. The human and built environment factors were not drawn, thus this drawing is categorised as moderate level of mental model with a total score of 4 (F1=0, F2=2, F3=2, F4=0; total score=4).

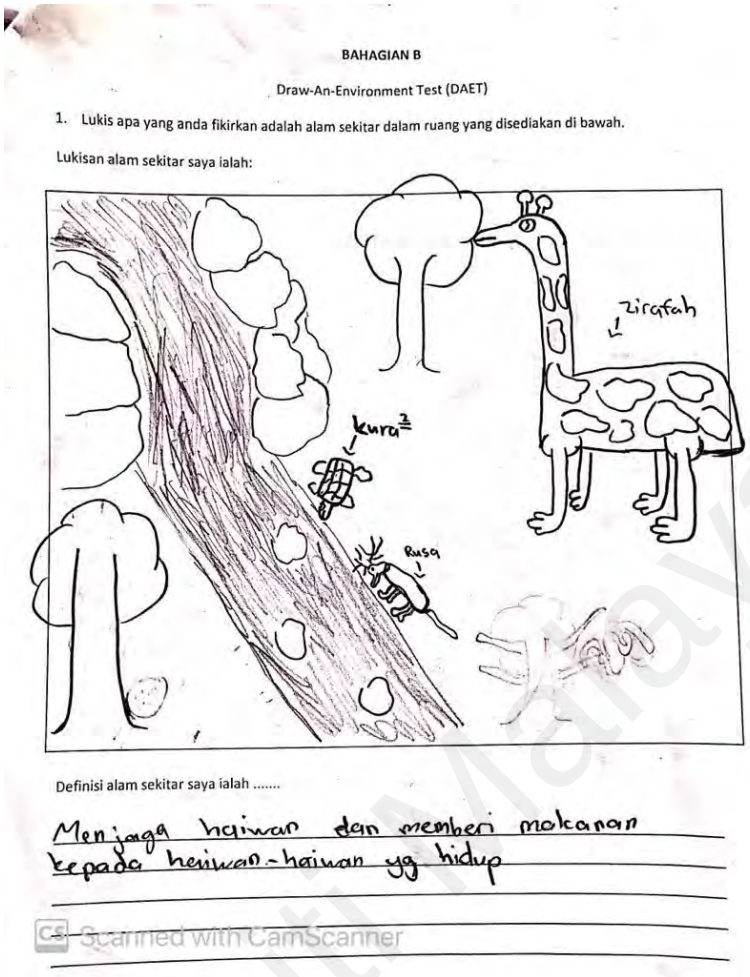


Figure 3.3 An example drawing illustrated moderate level of mental model of environment

Figure 3.3 shows a drawing of environment which was categorised as high level of mental model. This drawing received the maximum score of 8 by indicating all the factors with some visible interactions. The human factor (F1) was drawn interacting (fishing) with biotic factor (F2) which was given a score of 2 for F1. Another visible interaction was observed between the biotic factors (tree as resource for animals; monkey and bees) received a score of 2 for F2. The formation of rainbow and rain indicated interaction between the abiotic factors which scored 2 for F3. The use of fishing rod and container (built/designed environment) by human for fishing indicated a visible interaction between these two factors, received a score of 2 for F4.

Therefore, this drawing of environment depicted all the factors with visible interactions scored the maximum score of 8 (F1=2, F2=2, f3=2 and F4=2; total score = 8).

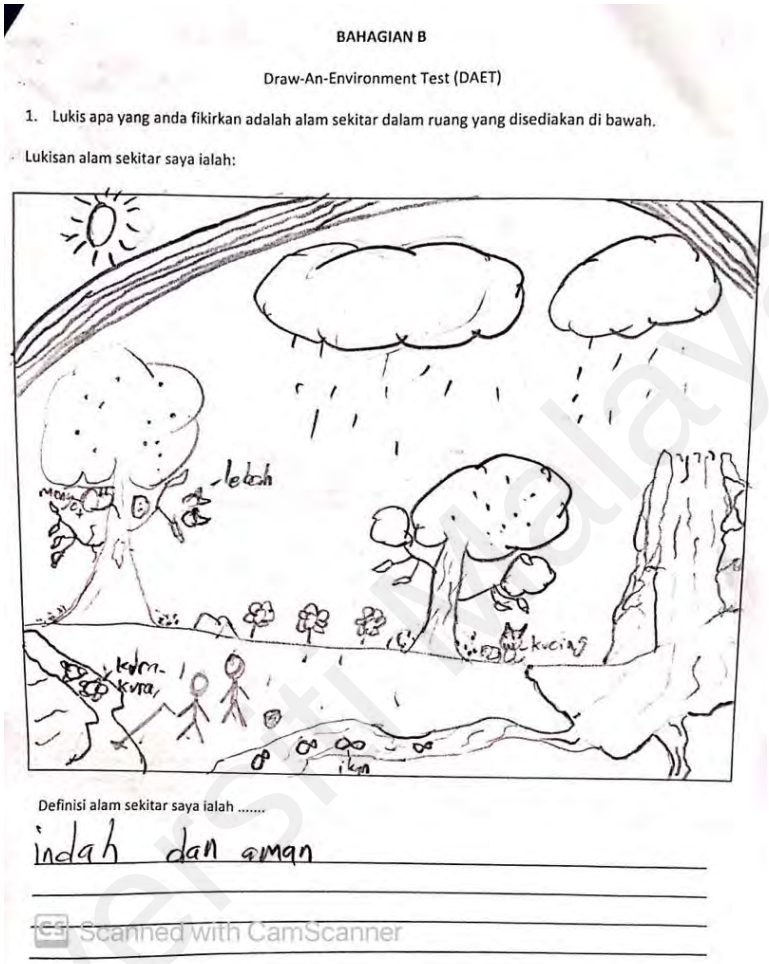


Figure 3.4 An example drawing illustrated high level of mental model of environment

3.7.1.2 The Types of Environmental Mental Models

The Year Five pupils' drawings of environment were further analysed to identify the types of mental models based on thematic approach which was used by Mustam (2017). This approach was used because the sample of this study lives in a similar setting as the sample in Mustam (2017). Their mental models of environment were categorised into four models as shown in Table 3.7 Next, the

frequencies of types of mental models among pupils with low, moderate and high level of mental models are identified.

Table 3.8

Description of Type of Models

Types of Model	Description
Model 1: A Perfect Environment	Mental model of good, beautiful, natural and non-polluted or protected environment consist of different components of living and non-livings things except human.
Model 2: Interaction Between the Environment and Humans	Mental model which consists of various social, cultural and political elements that influences the behaviour or the outcome of human interaction with environment.
Model 3: Environmental Problem	Mental model that shows environmental problems such as pollutions, deforestation etc.
Model 4: Solving Environmental Problems	Mental model that always consider the reformation of ethical and moral values aspects. They include related aspects with the preservation, conservation or solution of environmental problems.

3.7.2 Perceived Pro-Environmental Behaviour

Analysis was done in order to find the relationship between pupils' mental model of environment and their pro-environmental. Firstly, the environmental behaviour data was analysed descriptively, to find the mean, standard deviation and frequencies of each item. Next, the pro-environmental behaviour scores were categorised into three levels as shown in Table 3.8.

Table 3.9

Level of Perceived Pro-Environmental Behaviour

Scores	Level of Pro-Environmental Behaviour
10-22	Low
23-37	Moderate
38-50	High

(Adapted from Mohd Majid, 2005)

3.7.3 Factors that Influenced the Mental Model of Environment

In order to find the factors that influenced the Year Five pupils' mental model of environment, the data from the 11 items were assessed using a 5-point Likert scale. Quantitative content analysis was used to analyse the responses to the open-ended question. The researcher coded the open responses on the basis of a predefined categorisation scheme. The procedure can be outlined only in brief here. However, a detailed description can be found in Fruh (2011).

The data obtained from 5-point Likert Scale was analysed quantitatively using SPSS version 26. Frequency (Mean=M) test was carried out to determine the most dominant source of prior knowledge. Regression test was used to determine the predicting factor. From the pilot test, media was the most significant domain which influenced mental models. Regression Coefficient was done to determine the predicting factor of pupil's mental models of environment.

The open-ended question is 'What prompts you to draw such an environment?

Examples of pupils' answers (from the pilot test):

*I have **been to that place [1] with my family [2]**.... (S003)*

*'I always go and **play in the park [1]** near my house... (S015)*

Based on respondent S003, two codes were discovered, experience and family. ***'been to that place'*** shows the respondent's experience that has influenced his/her mental model of environment. Meanwhile, respondent S015 also indicated '***play in the park'*** which is categorised as experience. Based on the pilot study, experience was identified as one of the factors that influenced pupils' mental model of environment.

3.8 Summary

This study explored environmental mental model among the Year Five pupils and the relationship with their perceived pro-environmental behaviour. The factors that influenced their mental models of the environment was also examined. This chapter discussed the methodology that was used in the present study. It explained the design of the study which involved data collection and analysing techniques. Detailed explanation of location and sampling techniques of present study were given. Instruments used in the present study were described and validity and reliability issues were discussed. Pilot studies were conducted before the actual study. Issues faced during pilot study were discussed to improve the actual study. Following that, an explanation on how the data of this study was analysed and reported. In summary, this section summarises the issues discussed in chapter three. The next chapter, that is chapter four will present and discuss the results of data analysis based on the actual study.

CHAPTER 4

FINDINGS

4.1 Introduction

The main objective of the present study was to examine the Year Five pupils' environmental mental models. There are three sections in this chapter. The first section presents the findings related to mental models of the Year Five pupils on the concept of environment in order to answer the first research question. In this section, the frequencies of individual factor score for the four sub-dimensions of the environmental mental models, frequencies of total scores for the environment mental models (the levels) and the correlation between environment mental model sub-dimensions (four factors) are presented. The second section presents the findings of level of environmental behaviour and the relationship with mental model of environment to answer the second research question. The factors that influence the environmental mental models of the Year Five pupils were discussed in the third section in order to answer the third research question. All the statistical analyses were carried out using the Statistical Package for the Social Sciences (SPSS) version 26.0. Subsequent sections discussed the data screening, the descriptive statistics for all variables, the instruments construct validity, and results of each research question.

4.2 Data Screening

In any research data screening is essential and it is the first stage in making sure the data is steadfast. According to O'brien (2007) data screening is the process of ensuring your data is clean and ready for statistical analyses. Subsequently, the idea of the researcher on the data screening is to make sure the collected data is useable, reliable, and valid in achieving the objective of the research. The process involved the entry of data collected in statistical software. As discussed in preceding sections, the DAET

was used to measure the Year Five pupils' mental model whereby MMFEB was used to measure perceived environmental behaviour and factor influencing mental model of environment. The two instruments were administered to 108 Year Five pupils in the selected school. Each set of instruments was given a three-digit sequel numbers (i.e., R001).

At the first stage, the researcher created a template in the SPSS platform and systematically code the template in order the predefined items' code can be used to key the data correctly. The researcher employed SPSS version 26, the current version available in the market. For each respondents' views the numbering is used as the numbering of data was important to trace errors.

However, prior the data entry the researcher came to know that only 104 out of 108 data sets are useable and were taken for data analysis purpose. Hence, the researcher decided to discard the four-survey data, which is not contributing to the research and the same time the effect to the research quality is zero. According to Toepoel and Schonlau (2017), the purpose of nonresponse adjustment is needed in research as to reduce nonresponse biases while preserving the precision of the data which will be used for the analysis.

The next process is, as mentioned in the beginning is to screen our data for any irregularity. According to Stephen (2016), the customary practice is, check for (a) if data have been entered correctly, such as out-of-range values. It may be caused by human error in data entry (eg: entering "22" when it is supposed to be "2" for likert scale item), (b) for other kind of outliers. Outliers are suspiciously larger or smaller observation (data) than most of the observations, (c) for missing values. Is it because researcher miss out entering some data or the participant did not provide a response for some questions and then (d) for checking assumptions before conducting tests. The

assumptions that employed in this research is a normality check via skewness and kurtosis reading.

For a start in the data screening process, to identify for existence of human error in data entry, the researcher checked the data manually as the sample size is not that big. Followed by the check on the frequency output. By these procedures human error is avoided.

The next step is identifying the outliers. Outliers are observations that differ greatly from the majority of a set of data. Outliers can affect the normality of your data, although some researchers are against the idea of removing outliers simply because it does not fit the normality assumption (Connolly, 2017; Stephen 2016). However, as the research uses correlation and ANOVA statistical analysis, outliers could threaten data analysis output by creating unwanted effect on the correlation coefficient. Thus, it is important to detect outliers in the early stage of data analysis. Hence, outliers were examined in SPSS version 26 using minimum and maximum function. The particular set of papers was then traced using the sequel number given earlier and rectified (George & Mallery, 2020). The box plots show there is no outliers (Figure 4.1).

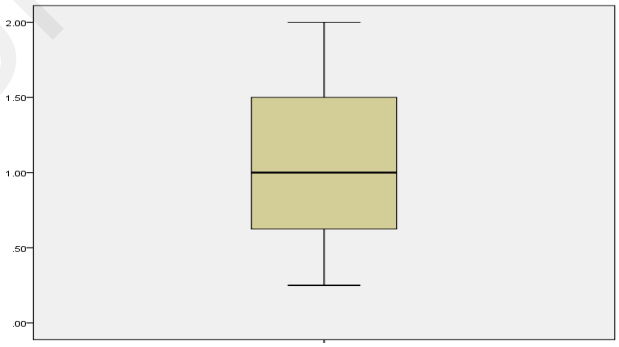


Figure 4.1 Assumption of no outliers for Mental Models

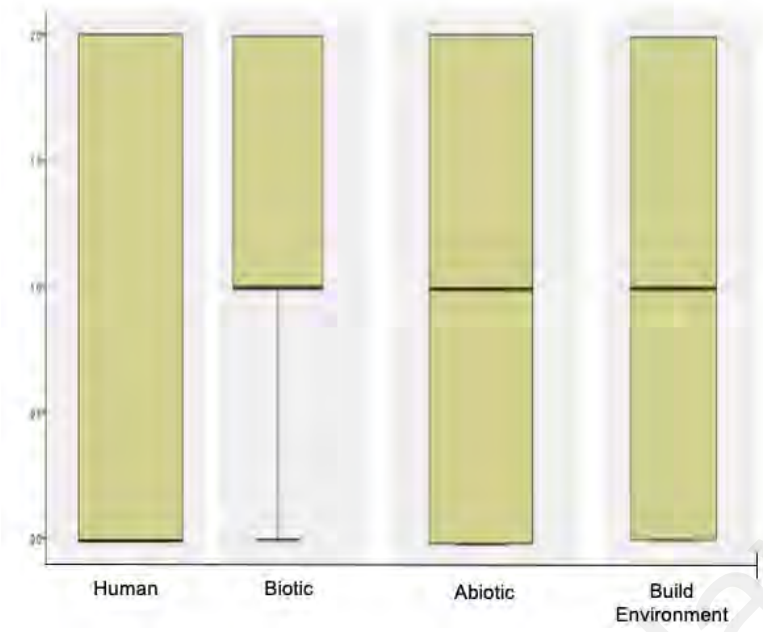


Figure 4.2 Assumption of no outliers for Sub-Dimension Mental Models

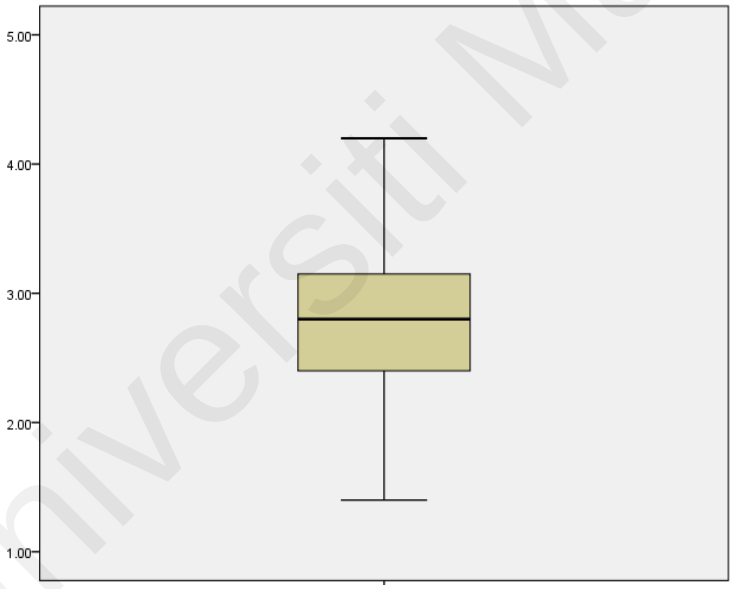


Figure 4.3 Assumption of no outliers for Behaviour

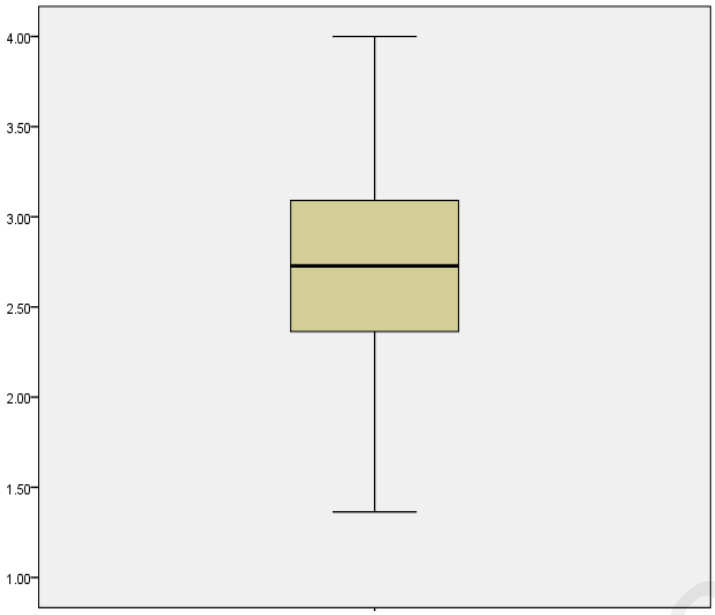


Figure 4.4 Assumption of no outliers for Sources

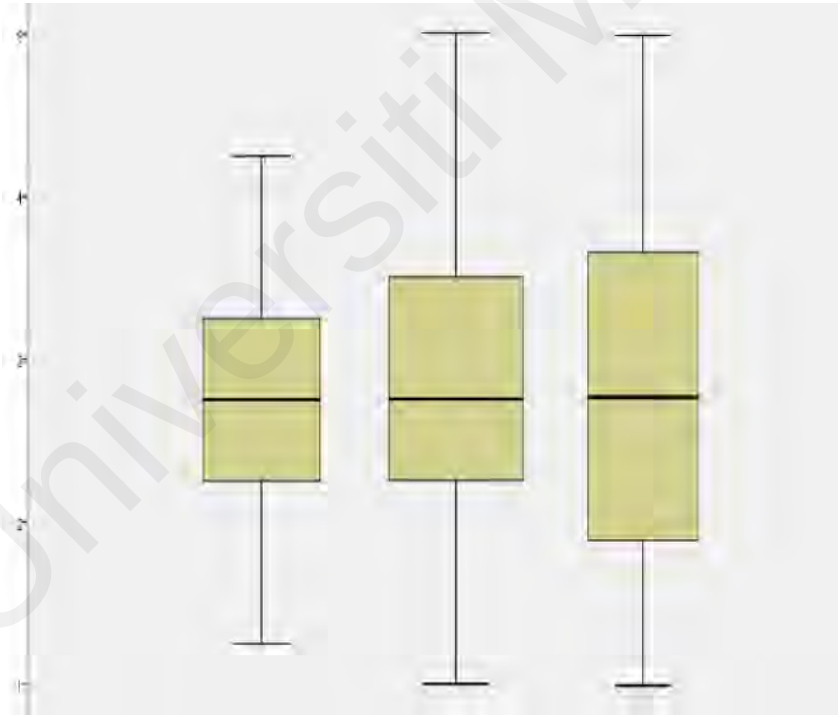


Figure 4.5 Assumption of no outliers for School, Media and Family

The following step is identifying the missing values. Missing values refers to the participants (purposely/accidentally) did not answer some questions (Stephen, 2016). In the research the researcher did not encounter this issue as the procedure of data collection is taken place in upright manner as indicated by Creswell (2014).

The subsequently step is checking assumptions before conducting tests. The assumptions that employed in this research is a normality check via skewness and kurtosis reading. According to Geasly (2008) and Stephen (2016, Skewness and kurtosis is enough to see whether the data fit the assumption of normality. Skewness is a measure of symmetry. This is to know whether the data is skewed to the left or to the right of the center point. Kurtosis is a measure of whether the data are peaked or flat relative to a normal distribution (the height). The general rule of thumb is that, the values must be in between -2 to +2 (George & Mallery, 2020; Trochim & Donnely, 2006; Field, 2009; Gravetter & Wallnow, 2014). As indicated in the Table 4.1, the values of the skewness and kurtosis for all the variables of this study; mental model, human, biotic, abiotic, built environment, perceived environmental behaviour and source of environmental knowledge are in the acceptable range as suggested.

Table 4.1

Skewness and Kurtosis of Research Variables

Items	Skewness	Kurtosis
Mental Model	**0.32**	**0.14**
Human	0.82	-0.22
Biotic	0.55	-0.27
Abiotic	0.83	0.05
Built environment	0.48	-0.59
Perceived environmental behaviour	**-1.87**	**0.21**
Source of environmental knowledge	**-0.65**	**0.91**
School	-0.13	-0.43
Media	0.02	-0.38
Family	0.03	-0.88

4.3 Findings of First Research Question

Research Question 1: What are the Year Five pupils' mental models of environment?

The Year Five pupils' drawings concerning the environment were scored with the DAET-R and then evaluated. Each drawing obtained four individual factor scores (F1=human, F2=biotic, F3=abiotic and F=built environment) and one total score. Next, the correlations between the individual factor scores were determined. Further, the Year Five pupils' mental models of environment were categorised into three levels of mental models (low, moderate and high). In addition, pupils' drawings were categorised according to four themes of mental models identified by Mustam (2017).

4.3.1 Individual Factor Scores for the Dimensions of the Environmental Mental Models

In agreement of the sampling, 104 samples were analysed to control the frequencies of four individual factors included in individual drawings and interactions of those factors. Table 4.2 shows the frequencies of the four individual factor scores for the dimensions of the Year Five pupils' environmental mental models.

Table 4.2

Frequencies of Individual Factor Scores for the Dimensions of the Environmental Mental Models

Score	F1(Human)		F2 (Biotic)		F3(Abiotic)		F4 (Built environment)	
	f	%	F	%	f	%	f	%
0	65	62.5	7	6.7	8	7.7	36	34.6
1	5	4.8	64	61.5	82	78.8	23	22.1
2	34	32.7	33	31.7	14	13.5	45	43.3
Total	104	100	104	100	104	100	104	100

Note: Criteria for scoring: 0 = factors not present, 1 = factor present, 2 = factor interacting with other factors.

Findings show that among all the factors, human (n=65, 62.5%) factor is the most frequently missing in pupils' drawings of environment followed by the built environment (n=36, 34.6%). However, the number of participants drawing a built environment and human in connection with other factors was relatively high. Out of all the participants, (n=45, 43.3%) have drawn built environment and (n=34, 32.7%) have drawn human figure interacting with other factors. The most frequently drawn factors are biotic and abiotic. Out of 104 participants in this study, (n=97, 93.2 %) have drawn biotic factors and (n=96, 92.3%) have drawn abiotic factors either in isolation or interacting with other factors. However, the abiotic factor was illustrated mainly as isolated objects; only (n=14, 13.5%) of the pupils showed the abiotic factor interacting with other factors.

4.3.2 Correlation Coefficients Between the Individual Factor Scores

Pearson correlation was used to measure the relationship among the four individual factor scores. The result of the analysis is shown in Table 4.3.

Table 4.3

Correlation Coefficients between the Individual Factor Scores

	Human	Biotic	Abiotic	Built Environment
Human	-	0.340**	0.318**	0.550**
Biotic	-	-	0.862**	0.263**
Abiotic	-	-	-	0.328**
Built Environment	-	-	-	-

**p < 0.01, *p < 0.05, N=104

Findings show that there are significant correlations among the four individual factors. The correlation between biotic and abiotic factors is very strong and very significant ($r=0.862$, $p<0.01$). Similarly, the correlation between human factor and built environment are very strong and very significant ($r=0.550$, $p<0.01$). Whereas, there was a weak but very significant correlation between human and biotic factor

(r=0.340, p<0.01), human and abiotic (r=0.318, p<0.01), biotic and built environment (r=0.263, p<0.01) and abiotic and built environment (r=0.328, p<0.01). According to Greasly (2008), a value ranging from 0.1 to 0.4 would be classed as a weak correlation, and anything above 0.5 would be regarded as a strong correlation. A value approaching zero indicates the absence of any relationship between two variables, in other words no correlation.

4.3.3 The Level of Pupils Mental Model of Environment

Based on the total scores of the four individual factors, pupils' drawings were categorised into three levels of mental models.

Table 4.4

Frequencies of Total Scores for the Level of Mental Models of Environment

Total Score	Frequency (n)		Percent (%)		Level of Mental Model
0	-		-		
1	5		4.81		Low
2	21	26	20.19	25.0	
3	24		23.08		
4	15		14.42		Moderate
5	7	46	6.72	44.2	
6	14		13.46		
7	16		15.39		High
8	2	32	1.93	30.8	
Total	104		100.00		

Table 4.4 shows the frequencies of the total scores of the Year Five pupils' level of environmental mental models. The range of the total scores is 0-8. The higher score agrees to a more complete, systemic mental model of the environment, integrating more factors and displaying more interactions among them. In this study, drawings which obtained score 1 and 2 were categorised as low level of mental model,

score 3 to 5 as moderate and 6 to 8 as high. The majority of the pupils held moderate level (n=46, 44.2%) of mental model of environment by incorporating more factors or visible interactions. However, most of them (n=24, 23.08%) only obtained the lowest score of 3 in moderate level of mental model. Only (n=7, 6.72%) achieved the highest score of 5 in this level. Pupils (n=32, 30.8%) obtain the uppermost level of extensiveness with the total scores of 6-8, showing more factors and visible interactions in their drawings of environment. However, only (n=2, 1.93%) obtained the highest score of 8 for their drawings of environment. Only (n=26, 25%) pupils held low level of mental models in this study. These drawings were typically dominated by missing or isolated factors.

4.3.4 The Types of Mental Model of Environment

The Year Five pupils' drawings of environment were further analysed to identify the types of mental models. Their mental models of environment were categorised into four types of model based on Mustam (2017). The description of each type of models was shown in Table 3.7 (Chapter 3). Further, pupils' type of models was categorised as low, moderate and high. Table 4.5 shows the level of mental model (low, moderate and high) and the types of mental models (Model 1, Model 2, Model 3, and Model 4) of Year Five pupils.

Table 4.5

The Level of Mental Model and the Types of Mental Model of Environment

Level of Mental Model	Model 1		Model 2		Model 3		Model 4		Total	
	n	%	n	%	n	%	n	%	n	%
Low	26	100.0	-	-	-	-	-	-	26	100
Moderate	18	39.13	9	19.57	5	10.87	14	30.43	46	100
High	-	-	16	50.00	10	31.25	6	18.75	32	100

All pupils with the low level of mental model depicted Model 1 (n=26, 100.0%) in their drawings. Pupils with moderate level of mental model depicted Model 1 (n=18, 39.13%) the most, followed by Model 4 (n=14, 30.43%), Model 2 (n=9, 19.57 %) and Model 3 (n=5, 10.87%). Finally, pupils with high level of mental models depicted Model 2 (n=16, 50%) the most followed by Model 3 (n=10, 31.25%) and Model 4 (n=6, 18.75%).

Overall, the findings indicated that most of the pupils in this study depicted Model 1 (n=44, 42.31%) followed by Model 2 (n=25, 24.04%), Model 4 (n=20, 19.23%) and Model 3 (n=15, 14.42%) in their drawings of environment. Table 4.6 shows the frequencies of types of mental models.

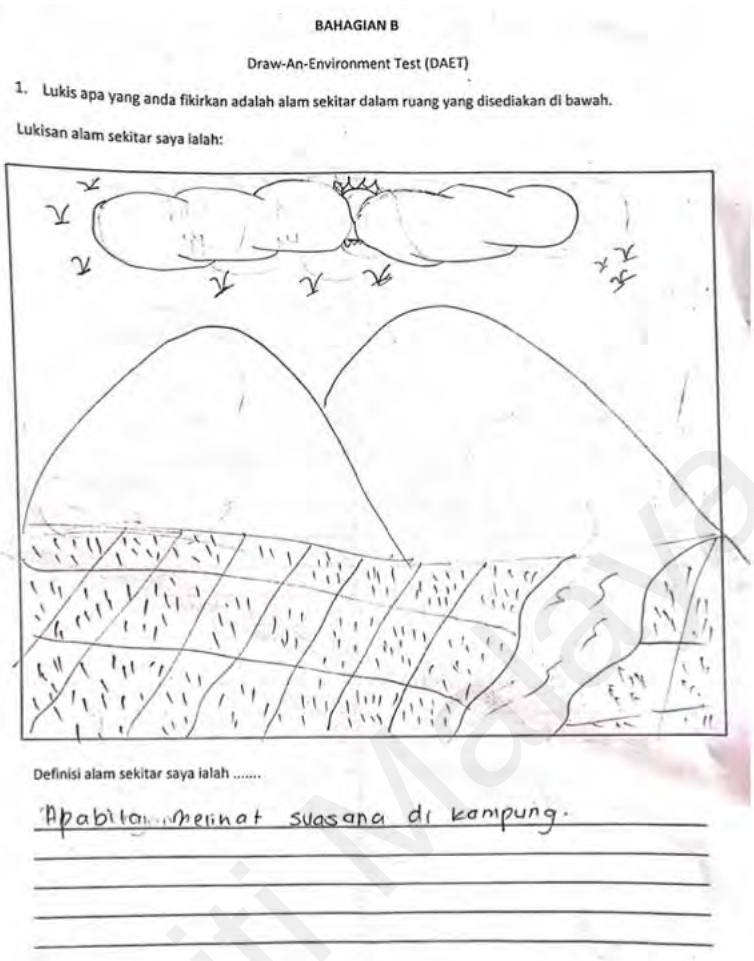
Table 4. 6

The Types of Mental Model of Environment

Type of Mental Model							
Model 1		Model 2		Model 3		Model 4	
n	%	n	%	n	%	n	%
44	42.31	25	24.04	15	14.42	20	19.23
Total (n=104)							

4.3.4.1 The Low Level of Mental Model and the Types of Mental Model of Environment

There are 26 pupils with low level of environmental mental model. All (n=26, 100%) of them depicted environment as Model 1 (Natural Environment). Figure 4.6 shows one of the drawings which illustrated Model 1.


BAHAGIAN B

Draw-An-Environment Test (DAET)

1. Lukis apa yang anda fikirkan adalah alam sekitar dalam ruang yang disediakan di bawah.

Lukisan alam sekitar saya ialah:

Definisi alam sekitar saya ialah .....

Apabila melihat suasana di kampung.

Figure 4.6 Drawing of Low Level Environmental Mental Modal (Model 1)

Figure 4.6 shows drawing of respondent (R007). The pupil has drawn picture of natural environment without human and built environment. This drawing portrays clean, beautiful, natural and non-polluted or protected environment consist of different components of living things (other than human) and/or physical environment (abiotic). All the elements are present in isolation; there is no obvious interaction among or between the elements.

Human: Not present

Abiotic elements: Mountains. The Sun, clouds, river

Biotic elements: Paddy field, bird

Built environment: Not present

4.3.4.2 The Moderate Level of Mental Model and the Types of Mental Model of Environment

There are 46 pupils with a moderate level of mental model. Out of them (n=16, 34.78%), depicted environment as Model 1, Model 2 (n=9, 19.57%), Model 3 (n=5, 10.87%) and Model 4 (n=16, 34.78%). Figure 4.7 - Figure 4.10 shows drawings which illustrated Model 1, Model 2, Model 3 and Model 4.

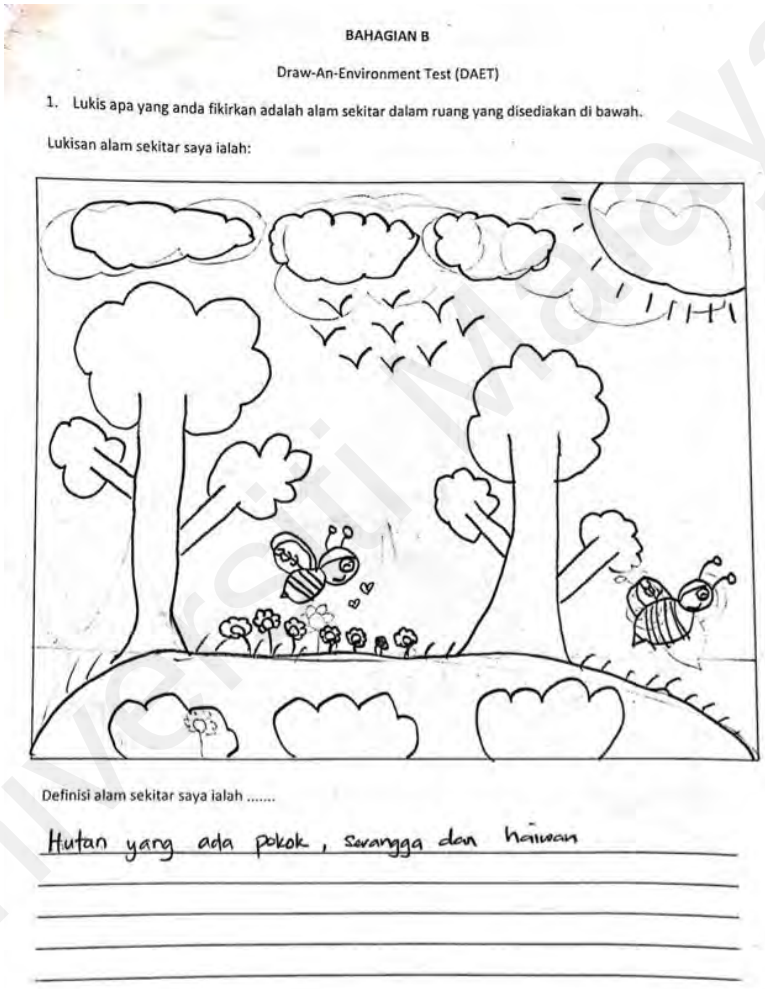


Figure 4.7 Drawing of Moderate Level Environmental Mental Modal (Model 1)

Figure 4.7 shows drawing of respondent (R094). This drawing depicts natural environment without human and built environment. It consists of different components of living things (other than human) and/or physical environment (abiotic). An interaction between the bees and flowers is shown in the picture.

Human: Not present

Abiotic factors: The Sun, clouds, soil/land.

Biotic factors: Birds, bees, flowers, trees.

Built environment: Not present

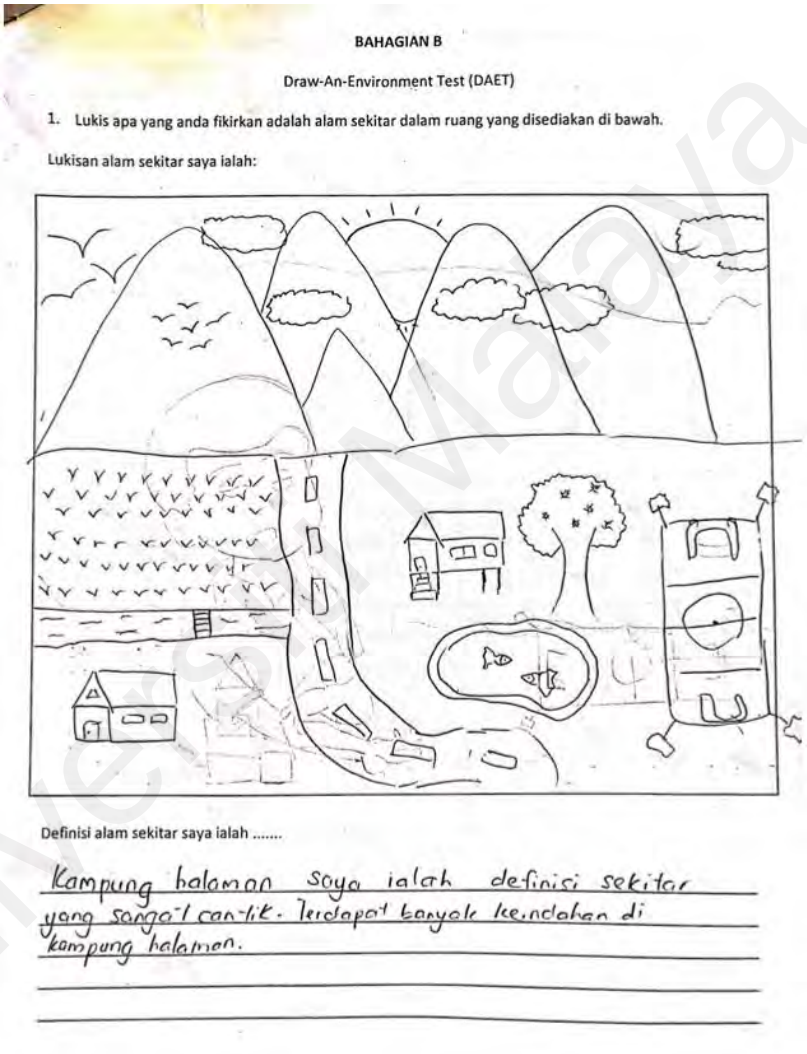


Figure 4.8 Drawing of Moderate Level Environmental Mental Modal (Model 2)

Figure 4.8 shows drawing of respondent (R023). This drawing of an environment consists of biotic factors, abiotic factors and built environment. Two interactions between the factors are depicted in the picture, i) interaction between the paddy field and canal, ii) interaction between fish, water and pond.

Human: Not present

Abiotic factors: Mountains, Sun, Clouds

Biotic factors: Trees, paddy field, birds, fish

Built environment: Canal, fish pond, houses, football field, road

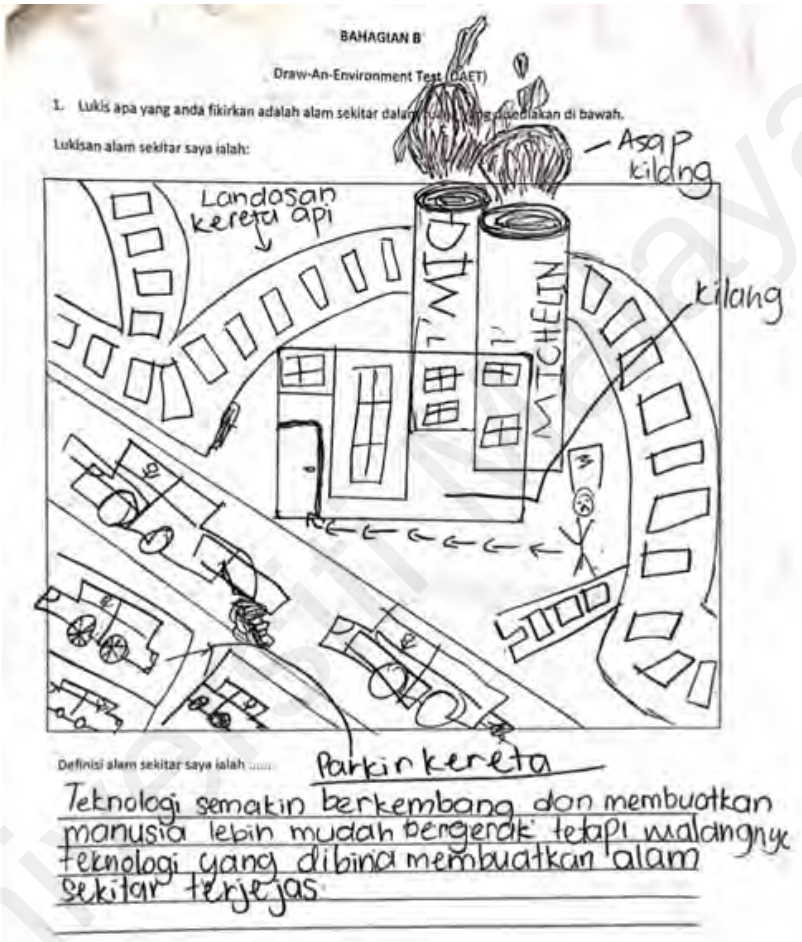


Figure 4.9 Drawing of Moderate Level Environmental Mental Modal (Model 3)

Figure 4.9 shows drawing of respondent (R092). This drawing depicts the negative effects of the development of technology. The environmental problem shown in this drawing is air pollution caused by the smoke from factories and vehicles. There are only human and built environment in this drawing. Among the interactions shown

in the picture are; i) Smokestack emitting smoke into the air, ii) cars emitting smoke into the air and iii) Human driving a car

Human: Present

Abiotic factor: Not present

Biotic factors: Not present

Built environment: Railway track, road, car park, cars, factories, house, smoke

Figure 4.10 Drawing of Moderate Level Environmental Mental Modal (Model 4)

Figure 4.10 shows drawing of respondent (R065). This drawing depicts solution for environmental problem. All the factors except human were drawn in this picture. Recycle bins emphasise the need to recycle.

Human: Not present

Abiotic factor: The Sun, Cloud

Biotic factors: Trees, grass

Built environment: Recycle bins

4.3.4.3 The High Level of Mental Model and the Types of Mental Model of Environment

There are 32 pupils with a high level of mental model. Out of them (n=16, 50.0%) depicted environment as Model 2, (n=10, 31.25%) Model 3 and Model 4 (n=6, 18.75%). Figure 4.7 - Figure 4.10 shows drawings which illustrated Model 2, Model 3 and Model 4.

Figure 4.11 Drawing of High Level Environmental Mental Modal (Model 2)

Figure 4.11 shows drawing of respondent (R008). This drawing depicts several interactions between human and the other factors in the environment. All the factors are present in this drawing, mostly with some interactions.

i. Human sitting in the swing tied to the tree

ii. A bird made a nest in the tree

iii. The ants-built hive

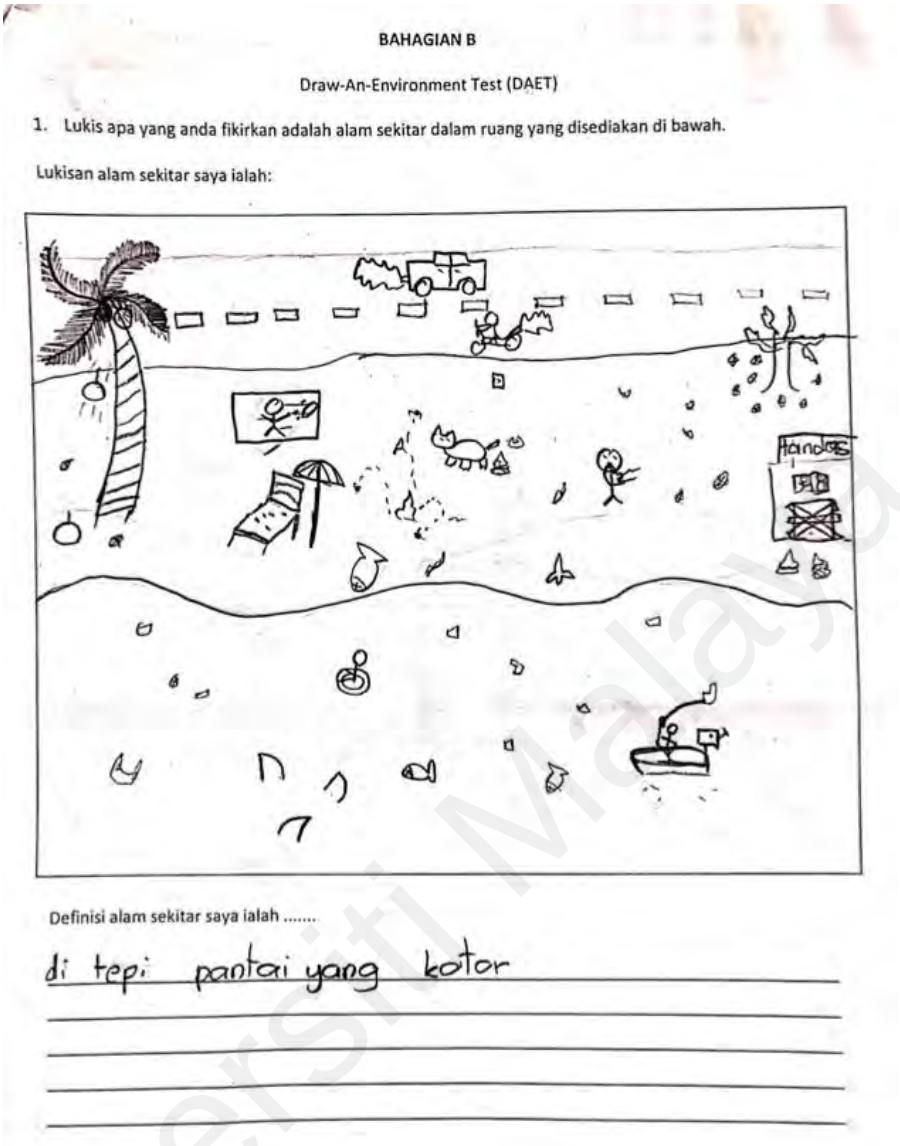
iv. Fish live in the water in a pond

Human: Present

Abiotic factors: Mountains, Sun, cloud,

Biotic factors: Bird, Cows, fish, ants, tree, flower.

Built environment: House, swing, road, fish pond


BAHAGIAN B

Draw-An-Environment Test (DAET)

1. Lukis apa yang anda fikirkan adalah alam sekitar dalam ruang yang disediakan di bawah.

Lukisan alam sekitar saya ialah:

Definisi alam sekitar saya ialah .....

di tepi pantai yang kotor

Figure 4.12 Drawing of High Level Environmental Mental Modal (Model 3)

Figure 4.12 shows drawing of respondent (R030). This pupil sees the environment as a polluted place. The drawing shows a polluted beach and sea. Water, air and land pollution are addressed in this picture of environment. All the factors are present in the picture. A few interactions among the factors were identified:

People swimming in the sea

People fishing in the sea

Cars emitting smokes

People responding to the polluted air

Human: Present

Abiotic factor: Sea, beach

Biotic factors: Trees, fish, cat, flies

Built environment: Toilet, car, boat, buoy, road, rubbish, umbrella and beach chair, smoke

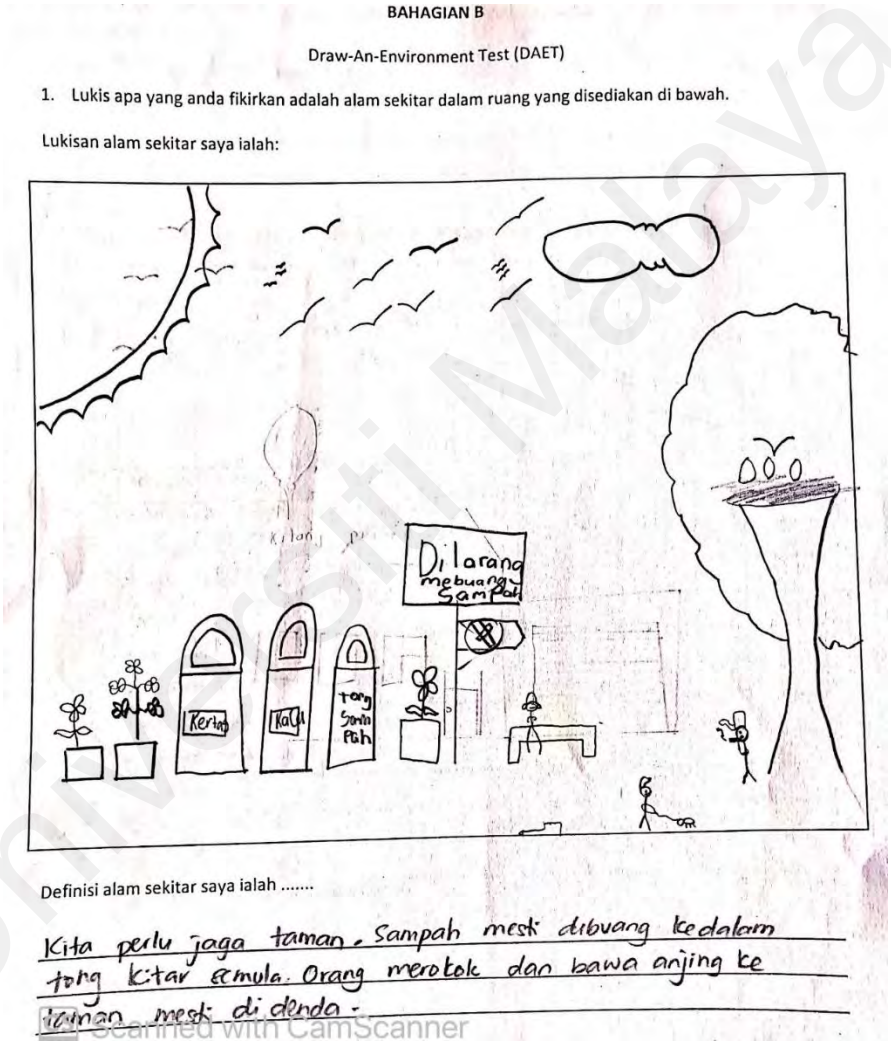


Figure 4.13 Drawing of High Level Environmental Mental Modal (Model 4)

Figure 4.13 shows drawing of respondent (R067). This drawing and text are conveying some solutions for environmental problem. All the factors present in this drawing with some obvious interactions among them. Among the interactions are:

Bird built a nest on the tree.

A sign board indicating ‘Do not litter’ and ‘No smoking’.

Presence of recycle bins

A man is smoking (polluting the air)

Human: Present

Abiotic factors: Sun, Cloud

Biotic factors: Tree, flowers, birds, dog

Built environment: Bench, recycle bins, sign boards, flower pots

4.4 Findings of Second Research Question

RQ 2: What is the relationship between the Year Five pupils’ mental models of environment and their perceived pro-environmental behaviour?

The descriptive statistics of pupils’ perceived pro-environmental behaviour (10 items) is provided in Table 4.8. The highest mean (M=3.94) was in item 3 (*I turn off the light at home when not needed to save energy*) and the lowest mean (M=1.89) was in item 1 (*I have discussed with my parents about ways to help in solving environmental issues)*. Items 2, 8 and 9 also show higher score means. These items indicated energy savings behaviour. However, lower score means were observed in environmental behaviour related to recycling activity. The score likely 10−50 for perceived environmental behaviour (M =29.08, SD=2.712).

Table 4.7

Descriptive Statistics of Perceived Environmental Behaviour

Item	Description of behaviour	Mean	Std. Deviation
1.	I have discussed with my parents about ways to help in solving environmental issues.	1.89	1.079
2.	I turn off the tap when brushing my teeth to save water.	3.90	.990
3.	I turn off the light at home when not needed to save energy.	3.94	1.087
4.	I have requested to my parents not to buy products made from animals' skin or products that can be harmful to the environment.	2.29	1.275
5.	I have requested to my family members to recycle certain things that we use.	2.10	1.219
6.	I have recycled items such as papers, glass, plastics and metals.	2.80	1.295
7.	I always read stories related to environment.	2.43	1.147
8.	I make sure all the lights, fans and electrical apparatus are switched off before I leave the room.	3.90	1.093
9.	I keep the refrigerator door closed while deciding on what to take.	3.25	1.349
10.	I remind my mother to bring a recycle bag when going shopping.	2.58	1.370

The corresponding hypothesis were formulated to answer the second research question of this study.

Ho: There is no significant relationship between the Year Five pupils' mental models of environment and perceived environmental behaviour.

H: There is a significant relationship between the Year Five pupils' mental models of environment and perceived environmental behaviour.

Pearson correlation coefficients were done to measure the relationship between the Year Five pupils' mental models and their perceived environmental behaviour. The result shows that there is a low, positive correlation between the two variables, which was statistically significant ($r = .282$, $n = 104$, $p = .004$). Therefore, the null hypothesis is rejected. Table 4.9 shows correlation coefficients between the mental model and perceived environmental behaviour.

Table 4.8

Correlation Coefficients Between the Mental Model and Perceived Environmental Behaviour

	Mental Model	Perceived environmental behaviour
Mental Model	-	0.238*
	-	0.015
Perceived environmental behaviour	0.238*	-
	0.015	-

**p < 0.01, *p < 0.05, N=104

4.5 Findings of Third Research Question

Research Question 3: What are the factors that influence the Year Five pupil's mental models of environment?

Questionnaire was used to collect the data on factors that influence the Year Five pupil's mental models of environment. Part II of MMFEB consist of an open-ended question and 11 items 5 Likert scale. The data from the 11 items Likert Scale was analysed by using descriptive statistics and regression analysis. Whereby, the data from the open-ended question was analysed to determine the factors that influence the Year Five pupil's mental models of environment.

4.5.1 Findings from Likert Scale Questionnaire

The five Likert scale questionnaire used to get data to answer the third research question consists of 11 sources of information pupils have gained their knowledge of the environment. There sources of environmental information were categorised into three groups, namely, school (School textbooks, Science teachers, other subject teachers and co-curriculum activities), media (social media, television, internet and newspaper/magazines) and family (family members, recreational activities and gardening with family). Pupil answered the questionnaire to select the most and the least dominant sources of information where they have gained their knowledge about the environment. Table 4.9 shows the descriptive analysis of source of environmental knowledge.

Table 4.9

The Mean of Source of Environmental Knowledge

Category	Items	M	SD
School		2.79	0.66
	School Textbooks	3.24	1.23
	Science teachers	3.01	1.03
	Other subject teachers	2.64	0.98
	Co curricula activities	2.27	0.97
Media		2.89	0.84
	Social Media	2.80	1.35
	Television	3.37	1.21
	Internet	3.08	1.40
	Newspapers & Magazines	2.33	1.30
Family		2.43	0.75
	Family members	2.29	1.20
	Recreational activities	2.75	1.30
	Gardening	2.24	1.19

The main information source that pupils acquire their environmental knowledge is media (M=2.89, SD=0.66). Among all the media factors, television (M=3.37, SD=1.21) is the main source of environmental knowledge followed by

internet (M=3.08, SD=1.40), social media (M=2.80, SD=1.35) and newspapers/magazines (M=2.33, SD=1.30).

The second dominant source of environmental knowledge is school (M=2.79, SD=0.66). School textbooks of various subjects is the second largest source where pupils acquire knowledge about environment (M=3.24, SD=1.23). Next the most important source related to school is the Science teachers (M=3.01, SD=1.03) followed by other subject teachers (M=2.64, SD=0.98) and co-curriculum activities (M= 2.27, SD=0.97).

Findings from this study indicates that family (M=2.43, SD=0.75) is the least dominant source of environmental knowledge. In this category, recreational activities with family members (M=2.75, SD=1.30) is the leading source of environmental knowledge followed by family members (M=2.29, SD=1.20) and finally gardening with family (M=2.24, SD=1.19).

To analyse further, the corresponding hypothesis were formulated:

$H_{0:}$ The sources (school, media, and family) has no impact on the Year Five pupil's mental models of environment.

$H_{1:}$ The sources (school, media, and family) has impact on the Year Five pupil's mental models of environment.

The SPSS statistical test chosen to perform in order to tackle these hypotheses is multiple regression analysis. Since, linearity and homoscedasticity play an important role in multivariate analysis assumptions (Hair et al., 2014), these two assumptions will be tested prior to the multiple regression analysis.

Linearity. Linearity refers to all variables in the study that are significantly associated linearly to each other. This assumption is to avoid underestimating the actual relationship's strength (Hair, Black, Babin, & Anderson, 2009). To verify this

assumption, linearity of the present study data was analysed using Pearson product-moment correlation coefficients. Table 4.11 shows correlation matrix of all variables. Based on the table, all variables are correlated significantly at a 0.01 significance level and the relationship among the variables is moderate. Hence, the data have fulfilled the linearity requirement as it can be seen positive relations between the variables.

Table 4.10

Correlations matrix of all variables

Variable	School	Media	Family	Mental Model
School		0.15**	0.46**	0.24**
Media			0.28**	0.13**
Family				0.20**
Mental Model				

**p < 0.01, N=104

Homoscedasticity. Homoscedasticity refers to the relationship between the variables. This requirement refers to an assumption that dependent variables establish equal levels of variance across the range of independent variables (Hair, Black, Babin, & Anderson, 2009). If the data is not homoscedasticity, analysis will not be invalidated but it will result in weakened analysis (Hair et al., 2009).

Therefore, the homoscedasticity test was carried out graphically. The residuals scatterplot was used to examine if there is any violation of homoscedasticity using SPSS version 26. It provides the information homoscedasticity with the associated variables. Figure 4.14, 4.15 and 4.16 show the residual scatterplots between the sources with the mental model of the environment. It concluded that the data fulfilled the homoscedasticity condition as there was no noticeable pattern in the scatterplots.

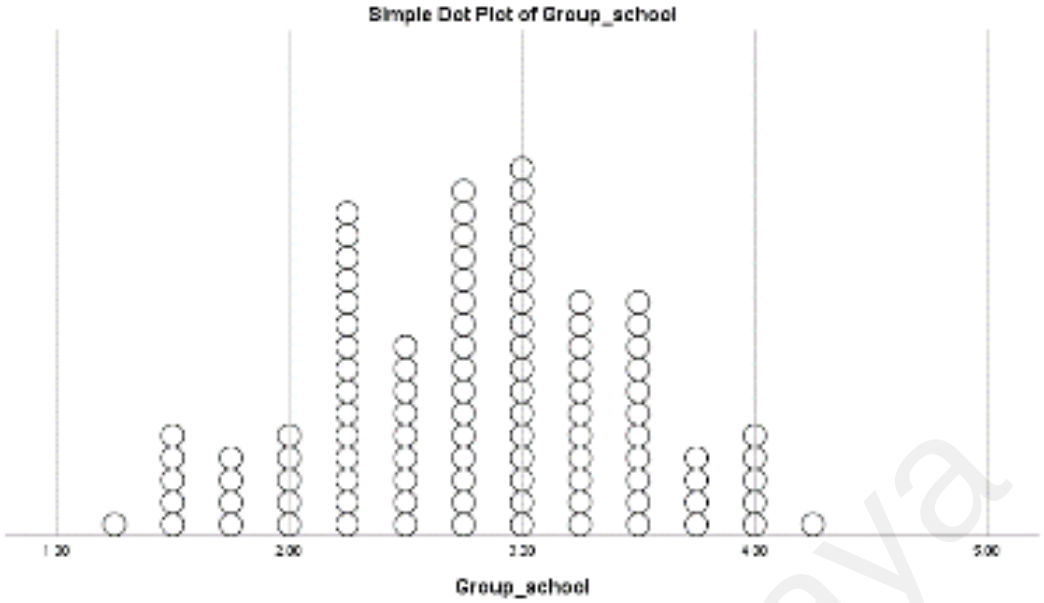


Figure 4.14 Residual scatterplots between the school and the mental model of the environment

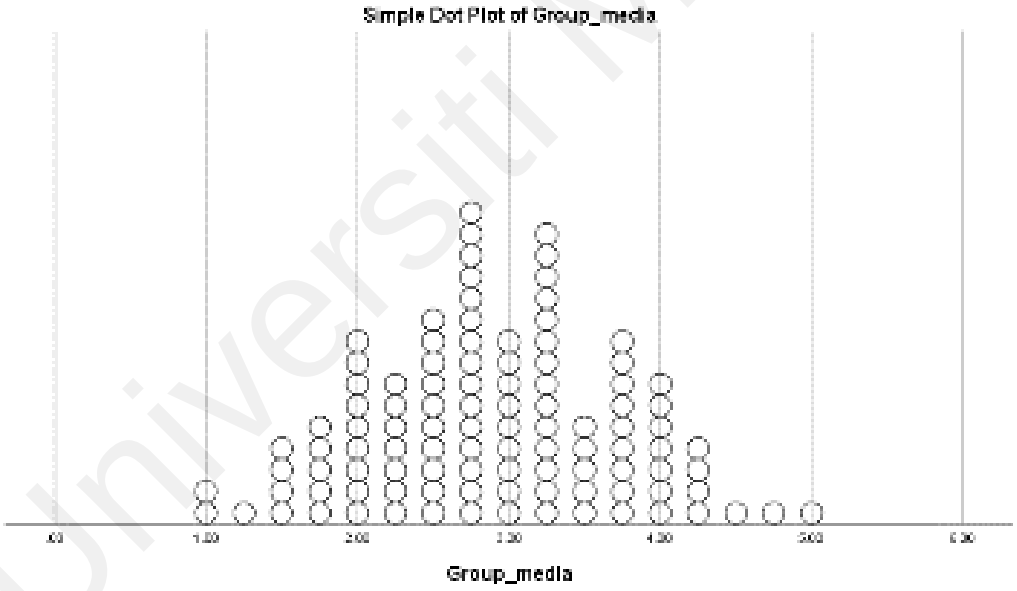


Figure 4.15 Residual scatterplots between the media and the mental model of the environment

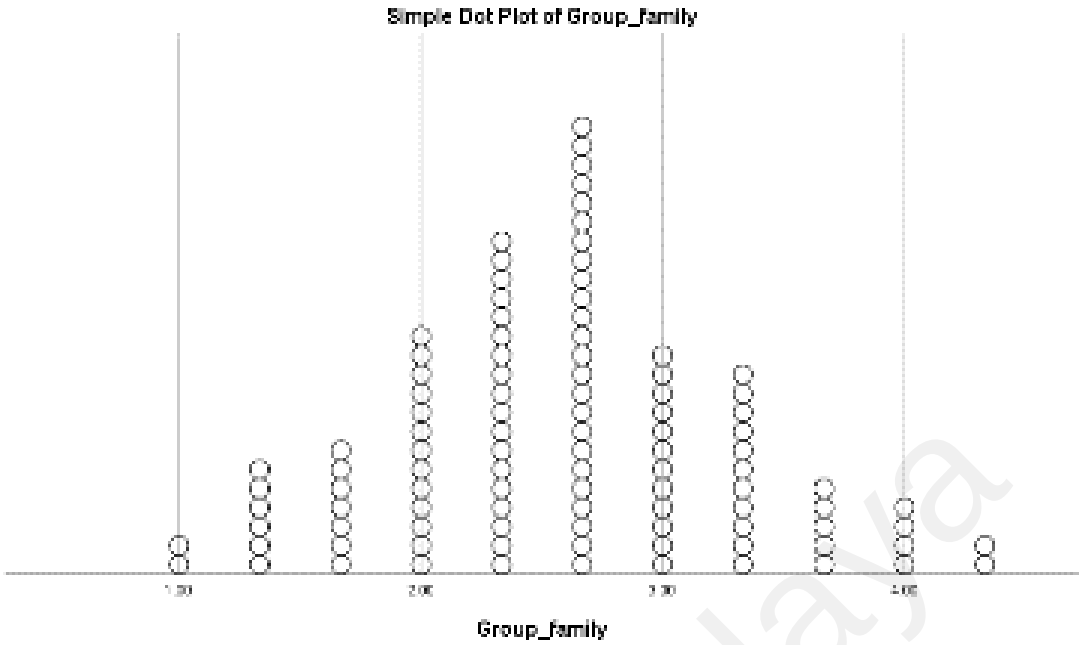


Figure 4.16 Residual scatterplots between the family and the mental model of the environment

As both assumptions are fulfilled the multiple regression is performed and the output were portrayed below.

Table 4.11

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.623[a]	0.557	0.464	0.47568

a. Predictors: (Constant), School

Table 4.12

ANOVA [a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1.361	1	1.361	60.128	.006[b]
	Residual	23.079	102	0.226		
	Total	24.440	103			

a. Dependent Variable: Mental Model
b. Predictors: (Constant), School

Table 4.13

Coefficients [a]

Model				Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
				Beta			Lower Bound	Upper Bound
1	(Constant)	1.539	0.203		7.566	0.000	1.135	1.942
	School	0.174	0.071	0.236	2.452	0.006	0.033	0.314

α= Dependent Variable: Mental Model

Table 4.14

Excluded Variable [b]

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics
						Tolerance
1	Media	.097[b]	0.999	0.320	0.099	0.977
	Family	.121[b]	1.115	0.267	0.110	0.785

α= Dependent Variable: Mental Model
β= Predictors in the Model: (Constant), School

A multiple regression was run to predict the mental model of the environment of Year Five pupil from their sources; school, media and family. The school; a variable of the source statistically significantly predicted the mental model, $F(1,102) = 60.13$, $p < 0.01$, $R^2 = 0.557$. From the output, only school is statistically significantly to the prediction, $p < 0.05$. Furthermore, school contributes 55.7% as source of the Year Five pupils' environmental knowledge. Hence, the hypothesis is partially accepted.

4.5.2 Findings from Open Ended Question.

Open-ended questions allow to collect qualitative answers from the participants that are, for the most part, full of information. Therefore, this open-ended question aims to find the factors that have contributed to the construction of the mental models of environment of participants in this study.

The findings show that there are three main factors that influenced pupils' mental models of environment, namely, experiences, environmental problems and socio-culture. Pupils responses show that their various experiences that have influenced their mental models of environment. Their types of experiences are shown in Table 4.15.

Table 4.15

Experiences

	Experiences
R019	I have been to this beautiful beach
R031	I have been to river
R037	I was prompted to draw the environment of the place I went for picnic
R043	I have been to that island
R050	View of waterfall that I have been
R076	Gone for camping in that hills
R059	I have been to my grandfather's farm My grandfather has planted some beautiful flowers and the place is very beautiful. My sister and I take care of the plants while my grandfather was away for some time.
R018	I swam in the river in my *kampung*.

The responses show that pupils mental models of environment, elicited by their drawings, were influenced by their experience. They have gained experiences through recreational activities, picnicking, camping, swimming in the river and involving in gardening activities.

Pupils responses shows that environmental pollution that they have viewed, heard or studied have influenced their mental models of environment which were depicted through their drawings. Pollution, impact of technology and recycling are part of the Science syllabus. Table 4.16 shows responses related to environmental issues that they have acquired through formal and informal environmental education as well as the environmental problems around them.

Table 4.16

Environmental Problems

R011	Don't throw rubbish into the sea because that can kill the aquatic animals.
R044	I have picked up litter in the river.
R056	Many trees have been cut down and illegal hunting taking place.
R065	Don't litter everywhere
R079	We should throw rubbish into the bins to reduce pollution.
R082	I don't like to throw rubbish on the grass. The park is dirty.
R090	Rubbish was thrown/dumped everywhere.
R071	The Environment is polluted
R075	We should take care of the polluted Environment
R093	We should care for the environment to reduce pollution.
R099	We should care for the environment, otherwise everything will be polluted.
R092	The development of technology caused environmental destructions.

Respondents R011 and R044 indicated polluted sea and river prompt them to draw polluted environment. Respondent 56 has responded that illegal hunting and deforestation encouraged him/her to draw the picture of an environment. According to responses from, R065, R079, R082 and R090, their drawings of environment were prompt by dirty environment with litter/rubbish everywhere. Environmental pollution has influenced R071, R075, R093, R099 and R092 to draw picture of an environment.

Pupils responses also prompt by the influence of socio-culture factor. The socio-culture factor which have influenced the Year Five pupils' mental models of environment were discovered as unique findings. Their responses are shown in table 4.17.

Table 4.17

Socio-culture

R039	I have seen this environment in my *kampung*
R059	I have been to my grandfather's farm. My grandfather has planted some beautiful flowers and the place is very beautiful. My sister and I take care of the plants while my grandfather was away for some time.
R018	I swam in the river in my *kampung*.
R044	The waterfall in my village made me draw such an environment.
R102	From the park that I built with my friends in the village
R026	A beautiful paddy field
R078	I like to *balik kampung* because I love to see the beautiful view of paddy field.

Several pupils have mentioned that their drawings of environment visualized their *kampung* which resembles their socio culture influence into their mental models. Pictures of paddy field and wooden *kampung* houses were often found in pupils' drawings. Some of the responses also reflects pupils' experiences (R059, R018, R102) in their *kampung*. Waterfall and rivers in their *kampung* had inspired them to draw the picture of environment even though these pupils are residing in urban area.

4.6 Summary

The Year Five pupils' mental models were examined in this study in terms of levels and types of mental model to answer the first research question. Majority of the pupils held moderate level of environmental mental models followed by high and low mental models. Four types of Mental Models were identified based on the themes emerged from pupils' drawings of environment. All the pupils with low level of mental model portrayed environment as a 'Natural Place'. Pupils with moderate level of mental models depicted either Model 1 (A Perfect Natural Environment), Model 2 (Interaction between Human and Environment), Model 3 (Environmental Education) or Model 4 (Solving Environmental Problems). Whereby, pupils with high level of mental model depicted either Model 2, Model 3 or Model 4. Overall, most number of the pupils

depicted Model 1 followed by Model 2. The finding for the second research question shows that pupils in this study have a moderate level of environmental behaviour. A significant relationship between their mental models of environment and perceived environmental behaviour was identified. In order to answer the third research question, media was identified as the main source of environmental knowledge. However, school was identified as the predicting factor of pupils' mental models of environment. In addition, environmental problems, experience and socio-culture were identified as the factors that have influenced their mental models of environment.

CHAPTER 5

DISCUSSIONS AND CONCLUSION

5.1 Introduction

This chapter is divided into three parts. The first part has discussed the Year Five pupils' mental models of environment which answered the first research question of this study. The correlation between the identified mental models of the Year Five pupils and their perceived pro-environmental behaviour was discussed in detail in the second part of this chapter to answer the second research question. In order to answer the third research question, the factors that influenced the Year Five pupils' mental models of environment was discussed. Overall, this chapter presents the summary of findings, discussions, implications and recommendations for further studies.

5.2 Summary of the Study

The first research question was analysed using DAET-R, descriptive statistics, Pearson Correlation Coefficient and content analysis. The findings showed that human factor was the most excluded element in pupils' drawing of environment followed by the built environment. However, pupils' have drawn built environment and human in connection with other factors. The biotic and abiotic factors were the most frequently depicted factors in pupils' drawings of environment. Yet, the abiotic factor was mostly presented in isolation by the least number of pupils who drew this factor interacting with other factors.

Analysis of Pearson Correlation Coefficient showed that very strong and very significant correlation was present between biotic and abiotic factors and between human factor and built environment. Whereas, there was a weak but very significant correlation present between other factors. Descriptive analysis of pupil's mental

models scores showed that the majority of the pupils held a moderate level of mental model regarding the concept of environment. Four types of mental models (Model 1 – A Natural Environment, Model 2 – Interaction Between Human and Environment, Model 3- Environmental Problems, and Model 4 – Solving Environmental Problems) emerged from the analysis of pupils' drawings. Pupils with low level of mental models held Model 1 only. Pupils with moderate level of mental models were found to depict either Model 1, Model 2, Model 3 or Model 4. Pupils with high level of mental models exhibited Model 2, Model 3 or Model 4.

Overall, the Year Five pupils in this study had a moderate level of perceived pro-environmental behaviour. More positive behaviour was identified in behaviours related to energy savings such as switching off lights after use and turning off water taps while brushing teeth. Pearson correlation coefficients were computed to test the null hypothesis (H=There was a significant relationship between the Year Five pupils' mental model of environment and their perceived environmental behaviour). The data revealed that there was a low, positive correlation between the Year Five pupils' mental models and their perceived pro-environmental behaviour.

Findings from the descriptive analysis of sources of environmental knowledge indicated that media was the main source of environmental knowledge followed by school and family. Among all the 11 sources of environmental knowledge, television was the most dominant source where pupils acquired knowledge about environment followed by school textbooks, internet and Science teachers. A multiple regression was run to predict the mental model of the environment of Year Five pupils from these sources; school, media and family. The school; a variable of the source was statistically significantly and predicted the mental model. Furthermore, school contributed 55.7% as source of the Year Five pupils' environmental knowledge.

Other than sources of environmental knowledge, experiences, environmental problems and socio-cultural factors were identified as the influencing factors of the Year Five pupils' environmental mental models. Knowledge acquired through formal and informal environmental education had influenced the pupils to illustrate some of the environmental problems and solutions. Pupils' life experiences such as camping, fishing, swimming in the river/waterfall had influenced their conceptualisation of the environment. Finally, *kampung* as part of their culture had influenced their mental model of environment in the socio-cultural perspective. The influences of the socio-culture factor can be seen through the presence of paddy fields, river, waterfalls and *rumah kampung (*village house).

5.3 Discussions

5.3.1 First Research Question

Generally, the analysis of the Year Five pupils' mental models was presented with superficial and scientifically incomplete descriptions of the environment in their drawings. This finding corresponds with those of many other studies (Moseley et al., 2010; Liu & Lin, 2015; Loughland et al., 2003; Shepardson et al., 2007). Liu and Lin (2014) stated that this result was due to individuals attempting to explain the environment from a reductionist approach and placing it in a scientific framework. From this viewpoint, it can be difficult to see the environment as a unity of dynamic systems.

The environment is the atmosphere that people, and other living things continue to interact through their entire life. Generations that are raised with an environmental awareness will help arrange the existing environment and will make an effort to leave a cleaner and habitable environment for the following generations. Pupils with a more complete mental models of environment tend to exhibit more

positive behaviour towards their environment. In spite of expanded introduction to environmental education and projects in schools, and different sources of natural information, understudies persistently hold a view that isolates people from the environment. In light of the discoveries, the Year Five pupils' mental models of the environment are dissimilar from the description of nature as the entire people, other living beings (biotics), and the physical conditions (abiotic factors). A total mental model of what establishes and defines the environment requires the emotions inside human beings. The absence of human elements in more than half of the pupils' drawings of environment seemed to indicate a distinct separation between humans and the environment. The nature deficit disorder which is observed among the children today stops them from realising themselves as the part of the environment.

This finding is conforming with the study conducted by Shepardson et al. (2007) who found that the majority of the students (grade 4) hold a view that isolates people from nature. Another significant finding showed that youngsters will generally see the environment as a characteristic substance without any human interference (Leal, 1997 Payne, 1998). This finding does not agree with the finding of Kalvaitis and Mondardt (2011) who mentioned that kids commonly showed a positive relationship with the environment and didn't consider themselves to be separated from nature. In another study, Gunindi (2012) reported that most of the children included human in their drawings of environment. Therefore, we can assume that the children regard people as a part of the environment.

However, in this study, the number of pupils drawing a human figure in connection with other factors was quite high compared to biotic and abiotic factors. Several pupils have drawn human interacting with other factors particularly with built environment. This finding is parallel with the study conducted by Loughland et al.

(2002) who found that children viewed the environment as nature which was separate from human beings, but they were aware of the relationship between human beings and the environment. In addition, the findings of this study are also parallel with similar research conducted with undergraduates (Wuellner 2017, Liu & Lin 2015) and pre-service teachers (Ahi, 2017) who depicted human interacting with other factors.

In the current study, almost all the pupils have drawn biotic and abiotic elements, which indicated that the Year Five pupils placed greater emphasis on these elements in the environmental system. The reason for their attention to biotic elements may be that they view the environment as a natural resource that is essential for human needs and survival (Liu & Lin, 2014). In the majority of the drawings, biotic elements were represented as trees, flowers, and animals. A similar study by Ozsoy (2012) has shown that children commonly associate the term "environment" with green spaces and often include trees and grass. However, a number of pupils have drawn paddy field which are not found in other similar research. Paddy fields were found in pupils' drawings which depicted their *kampung* (hometown) as an environment. The abiotic elements were mostly represented by the sun, mountains, clouds, river, waterfall and sea but most of the time, in isolation. In this study, the built environment was mainly represented by houses, cars, dustbins, recycle bins and roads. Even though the number of pupils who didn't include built environment were quite high, built environment was the most frequently drawn factor that interacted with other factors. The most common interactions found were; human throwing waste into dustbin, recreational park for human use and vehicles and factories emitting smoke.

When environmental education is based on textbooks which only focus on ecosystem concepts or environmental problems, pupils have trouble developing a holistic view and an accurate conception of the environment (Shepdarson etal, 2007).

The pupils in this study often failed to incorporate more visible interactions between the factors in their drawings. Therefore, the overall results indicated that the Year Five pupils were thoughtful of the environment superficially in spite of dissemination of environmental education. This finding is similar to other studies by Judson (2011), Liu and Lin (2015) and Ahi et al., (2017) which show more pupils with less sophisticated mental models of environment.

The findings showed the Year Five pupils in this study conceptualise environment as a perfect environment where they viewed environment as a good, beautiful, clean and natural place without human beings. This finding is supported by a study conducted with Swedish elementary school pupils who consider the environment to be a good place without human interference (Alerby, 2000). In another study, Shepdarson etal. (2005) found that the pupils (grade 4-12) continuously hold a view of environment as a 'pristine' or pure place without human beings. However, this finding contradicts the study conducted in Malaysia by Mustam (2017). She found that most of the secondary school students (16 years old) depicted environmental problems and solution to the problems. It is believed that their polluted surrounding had influenced them towards thinking of environmental problems and solving the environmental problems.

Pupils viewed the environment as a place for them to relax or to be calm and to have fun. This can be evidenced in more than half of the drawings which depicted Model 2. The pupils drew pictures illustrating recreational activities at beaches, waterfalls, camping and parks which they had observed, experienced or adored. This is supported by a study by Sali, Akyol and Baran (2014) which revealed that children generally illustrate what they enjoy. In another study, Merriman and Guerin (2012) found that children may describe things they have experienced or something that they

desire to happen in their drawings. Only two pupils illustrated environment as a place that provided resources to support human life. However, in a study conducted by Shepdarson et al., (2005), 20% of the pupils conceptualized the environment as providing the resources like plants, animals that human beings needed to live.

Despite living in low cost flats located in high density urban area with improper waste management and litter, only 15% of the pupils in this study depicted environmental problems (Model 3) in their drawings. This is because they strongly believe that environment is a clean and beautiful place without pollution. Among the environmental problems that were depicted in their drawings were polluted beach, sea, river, litter and air pollution caused by vehicles and attitude of peoples (such as smoking in the park). Negative impacts on beach/sea, and river were portrayed in several drawings which were similar to a study conducted among young children which reported the impact of marine pollution due to the urban litter dumping in their drawings (Ozsoy, 2012). Generally, the pupils in this study seldom see other environmental problems such as endangering of species, global warming, deforestation, open burning etc. except one drawing which depicted deforestation. It is surprising that current affairs such as the ozone layer depletion, greenhouse effect and global warming have not been depicted or mentioned in the pictures or written texts of the pupils in this study. The same scenario was evident in a study conducted in Turkey (Murat, 2016). This shows that, pupils reflect the environmental issues which they have observed directly or experienced in their everyday lives (Demirbas & Pektas, 2009). However, none of the drawings depicted environmental problems such as littering in their school or housing area. This shows that pupils in this study did not accept their place of living or school as an environment.

Compared to Model 3, more pupils depicted Model 4, portraying solutions for environmental problems. Majority of the drawings in this model illustrated either human beings throwing rubbish into dustbin or recycle bins, signboards indicating 'Do not litter' and 'No smoking'. None of the drawings illustrated the need for protecting endangered species as reflected in drawings of environment in other studies (Murat, 2016). This finding shows that the pupils in this study have a limited knowledge of environmental problems and ways of solving them compared to the pupils in other studies.

5.3.2 Second Research Question

Overall, the Year Five pupils in this study have a moderate level of perceived pro-environmental behaviour. This finding is different compared the Year Five pupils in Sabah who = hold a high level of pro-environmental behaviour (Wong et al., 2017). Despite having a moderate level of environmental behaviour, in out of 10 behavioural commitments, the pupils in this study showed higher mean scores in a few behavioural commitments. The finding indicates that the participants are prone to adopt pro-environmental behaviour related to energy saving such as turning off the taps when brushing teeth to save water, turning off the lights at home when not needed to save energy, making sure all the lights, fans and electrical apparatus are switched off before leaving the room and keeping the refrigerator door closed after opening. This shows that the participants only favoured conservation actions, such as switching off fans, which required minimum skill and effort. These are the common behaviours that pupils undertake to save energy. The Year Five pupils have learnt about the ways of saving energy in their Year Five Science syllabus (DSKP Year Five Science) which have contributed to their positive behaviour in this element. Similar findings were reported by Cornelius et al. (2014) and De Waters and Powers (2011) who have investigated

American high school students and found that 68.6% of the respondents have reported that they would turn off the lights when leaving a room and 34.9% of the students reported that they would switch off appliances when not using them.

Low score mean was reported for item 4 (I have requested to my parents not to buy products made from animals' skins or products that can be harmful to the environment) in this study. This report is obviously different from a study conducted among primary school pupils in Turkey where more than half of the pupils (61%) do not agree with parents buying products made from animal fur (Evan et al, 2008). Besides, the smallest mean score in Item 1 indicated that pupils seldom discuss ways to help in solving environmental issues with their parents. The low mean scores in these items indicate that family doesn't play an important role in infusing and educating the pupils regarding environment. Even though, the concept of recycling always has been highlighted in all the subjects particularly Science, recycling habits seems lacking among the pupils in this study.

According to Jones, et al (2011), the mental model has a significant influence on how people understand and react to problems, particularly in relation to the natural environment. The findings from this study support this fact as there is a significant relationship between the Year Five pupils' mental model of environment and their perceived environmental behaviour. Pupils' with higher level of mental models have reported more positive environmental behaviour. This finding is similar to another study conducted among Taiwanese undergraduates which found students with higher sophistication level of mental models exhibit stronger intention to act environmentally (Liu & Lin, 2015). To the researcher's knowledge, there is hardly any other study that has reported correlation between pupils' mental models and pro-environmental behaviour.

5.3.3 Third Research Question

Research Question 3: What are the factors that influence the Year Five pupil's mental models of environment?

Mental Model Theory reveals, first and foremost, that the environmental mental model among the Year Five pupils is to be shaped by their prior experience and knowledge attained through formal and informal environmental education. Based on the literature, several sources of environmental knowledge were identified to determine the most dominant source and the predicting factor of the Year Five pupils' mental models of environment.

From the point of view of Vygotsky's (1986) Social Constructivism Theory, the pupils of this study could be said to have gained environmental knowledge as a result of their frequent contact with their school, family and media. Among these three types, the media, and television are the main source of environmental knowledge, that provide pupils access to information about environment through nature programs, documentaries and movies. This finding is supported by the study of Said, Yahaya, and Ahmadun (2007) that the most predominant source of information has been collected in Malaysia from the broadcast programmes, internet, and official reading materials. In Greece too, television was one of the sources to gain information about environmental matters (Liarakou, Athanasiadis, & Gavrilakis 2011). In this digital era, it is not surprising that internet was reported as one of the main sources of environmental knowledge for not only the pupils in this study but around the world (Bozoglu etal, 2016; Zsoka etal, 2013). However, in this category, social media and newspapers/magazines were less accessed sources similar to other findings. In the related literature on environmental issues, television is found as more preferred and more effective source of information compared to printed resources (Spellman et al.,

2010). Family was found to be the least dominant source of environmental knowledge among the pupils in this study. This finding is similar to Olufemi et al., (2016) who reported that family was perceived as a less contributing source of information regarding environment.

Even though media was identified as the most dominant source of environmental knowledge, the multiple regression analysis reported school as the predicting factor of pupils' environmental mental knowledge. Furthermore, in this study, the school contributes 55.7% as a source of the Year Five pupils' environmental knowledge. When explaining pupils' mental models of environment, school was found to be a powerful factor. The present findings provide further support to the related literature that an individual's mental models of environment depend more on their school as the source of environmental knowledge. The role of a school as an important source of environmental knowledge was revealed in a study conducted among college students who reported receiving their prior knowledge about what defines an environment from their school (Wuellner, 2017). The empirical results presented in this study suggest that school should be considered as an important factor in developing pupils' mental models of environment.

The analysis of open-ended question revealed that experience, environmental problems and socio-culture are among the factors that have influenced pupils' mental models of environment.

School serve as one of the main sources of pupils' environmental information (Rickinson, 2001). Therefore, information delivered by teachers and other resources such as school books influence pupils' conceptions of environment. According to Shepdarson etal, (2005), many textbooks used in schools tend to take an ecosystem perspective or a pollution-oriented view of the environment instead of developing a

conceptual model of the environment. The pupils in this study have mentioned about the polluted environment, the development of technology that have caused environmental destructions and the need to care for environment as the base of their drawings of environment. Therefore, the influence of environmental problems can be observed in their elicited mental models.

Besides environmental problems, pupils' life experiences have impacted their conceptualisation of environment. In this study, pupils have reported that camping, swimming in the river, farming in the village, picnicking etc. have stimulated them to draw such environment. This shows that some pupils tend to conceptualise environment from personal life experiences. Pupils who have more experiences in nature-based activities tend to have better environmental knowledge (Clayton etal, 2019) which can contribute to more sophisticated mental models of environment. This finding is supported by a study by Farokhi and Hashemi (2011) who revealed that pupils' experience often demonstrated in their drawings.

Some of the students in this study have drawn paddy fields which are hardly found in other studies of mental models of environment. Although all the participants in this study are residing in a high-density urban area surrounded by concrete buildings, a number of participants drew their home town *(kampung),* as an environment. None of the students drew concrete buildings such as flats which they observed daily as an environment. All the pupils in this study are Malays and most of them have the culture of *balik kampung* (going back to their home town) during holidays and for attending family functions. Thus, the influence of culture of '*kampung'* was reflected in a few drawings which illustrated views of *kampung* with coconut trees, wooden *kampung* houses, paddy fields and fruit trees. The finding from this study is supported by another study conducted by Glynn & Duit (1995) who found

that children with different cultural background held different types of mental models. Jamal Fathi Ahmad (2018) also revealed that the drawings of pupils in Jordan also influenced by their culture.

As a conclusion, environmental problems, experiences and socio-cultural factors have been identified as the factors that influence the Year Five pupils' environmental mental models. The findings of this study support the fact that mental models are rooted in culture, education, and personal experience as mentioned by Jones et al., (2011). Among all the sources of environmental knowledge, school serves as the predicting factor of pupils' mental models of environment. Therefore, schools have an imperative role in developing pupils' mental models with a comprehensive mental model of environment that tend to exhibit a more positive environmental behaviour.

5.4 Contribution of the Study

This study contributed to the literature on the mental models of primary school pupils regarding the term environment. In the literature, there was limited research focusing on relationship between primary school pupils' mental models of the environment and their perceived environmental behaviour. This study discovered that there was an important relationship amongst the pupils into mental models of environment and their pro-environmental behaviour. This is an important finding as developing pupils' mental models into a more complete model would improve their environmental behaviour. Most of the previous study used either quantitative or qualitative method to identify environmental mental models. However, this study attempted to identify the types of mental models among the pupils with different sophistication level of mental models using both quantitative and qualitative methods. In addition, there is

also contribution to the literature of mental model of this the present study by exploring the factors that influence pupils' mental model of the environment.

5.5 Implication of Research Findings

The findings in this investigation are significant for the education of nature since scientists and educators are commonly centred around encouraging and observing pupils' comprehension of ecological issues and related ideas instead of the environment itself. Pupils are infrequently allowed the chance to investigate and examine the implications of the environment in spite of the fact that this thought is integral to related exercises and materials. As a component of instructing and learning exercises, instructors can create arrangement of learning exercises that concentrate on making mental models of natural condition and looking at those models to empower them to distinguish how complete are their pupils' mental models.

This will help them to plan suitable activities to develop the pupils' conceptions on the environment. The findings of this study can also provide insight to the curriculum developer to plan and design instructions that would develop pupils' existing mental model of environment as effective learning experiences. This requires a curriculum that associates pupils' conceptions with current scientific understanding in a meaningful way.

Finally, this study confirms that drawings can serve as a powerful tool to gain insights into pupils' conceptions of the natural environment and their relationships with human beings. The open-ended nature of drawings highlights ideas and aspects that are imperative or interesting to the pupils regarding the topics studied. This provides a particular insight to their conceptual understanding. Such insights are valuable orientations for teaching and learning environmental science. Teachers can also use pupils' drawings created over time to document and promote changes in

pupils' conceptions or mental models. Besides, teachers can provide pupils with opportunities to explore their own mental models by using self-generated drawings, and to share and discuss with others, thereby developing more complete and connected mental models (Shepardson et al., 2007). Teachers can also integrate drawings as an effective formative assessment.

5.6 Delimitation

This study only involves Year Five pupils from a high-density urban area. The findings of this study may not be suitable to generalise to other geographic locations as pupils may be from entirely different cognitive background. Hence, generalisation of findings is limited to similar groups who are from the same general geographic area with similar demographics. The findings might also be different if compared with pupils from vernacular schools.

There are many other factors in the literature that were not considered in this present analysis, such as gender, age, race, type of schools, parents' socio economy background, parents' education level etc.

5.7 Recommendations for Further Research

Findings on the factors that influenced the Year Five pupils' mental models of environment have contributed a few insights on how and where the children obtain the information that can advantageous to both the educational planners and instructors. Thus, there is an essential for further research to investigate the role of pupils' experience and education in forming the expansion of their mental models.

Although this study separated students' mental models by grade level and community setting, there is a need to investigate students' mental models by gender, age, culture, and socio-economic conditions. Longitudinal studies of students' developing mental models are also useful in determining the impact of experience and

schooling on students' conceptualisation of the environment. Furthermore, there is a need to understand the relationship between students' mental models and their decision-making.

Considering the above findings and the restricted size of the investigation, more research endeavours are expected to (an) increase a profound comprehension as such and in what way mental models, or originations, of nature are built by understudies and (b) make mediations that might encourage variations from a constrained and shorten perspective toward a fundamental and all-encompassing one.

5.8 Conclusion

Although environmental education has been incorporated in many ways particularly through formal education in school, specifically through Science subject, many pupils in this study held incomplete and unconnected mental models of the environment. Only two pupils have the most complete mental model of environment. More than 60% of the pupils didn't include human as a part of environment. The findings showed that pupils generally perceived the environment as a natural place which consists of plants, animals and natural physical environment. Human beings and their intervention are seldom accepted as a part of the environment. The findings also reveal that pupils with more sophisticated mental model show more positive environmental behaviour. Among the four types of mental models, Model 2 (Interaction Between Human and Environment), Model 3 (Environmental Problems) and Model 4 (Solving Environmental Problems) were present among the pupils with moderate level of mental model of environment. School, experiences, environmental problems and socio-culture factors have influenced the level and the types of mental models identified among the pupils in this study. If the children have enough knowledge and environmental understanding, some effective programmes can be established. In sum,

pupils should conceptualise environment holistically to understand environmental issues and to be more environmentally friendly.

REFERENCES

Abdullah, N. H. L., Shafii, H., & Seow, T. W. (2013). Pengetahuan dan tingkah laku murid terhadap alam sekitar: satu kajian awal.

Ainsworth, S., Prain, V., & Tytler, R. (2011). Drawing to learn in science. Science, 333(6046), 1096–1097.

Ahi, B., Balcı, S. & Özcan, H. (2015). Children and the environment: Young children's understanding of forest and deforestration. Paper presented in 2015 International Business & Education Conferences (2-6 Ağustos 2015, New York, USA).

Ahmad, M. Z., & Razak, N. A. (2007). Pendidikan alam sekitar di sekolah: Komitmen guru. *Pendidikan Lestari*, *7*(2), 74-81.

Alatawi, F. M. H., Dwivedi, Y. K., Williams, M. D., Rana, N. P. (2012): Conceptual Model For Examinig Knowledge Management System (KMS) Adoption in Public Sector Organizations In Saudi Arabia. – tGOV Workshop, 2012, Brunel University, London, UK.

Alerby, E. (2000). A way of visualising children's and young people's thoughts about the environment: A study of drawings. *Environmental Education Research*, *6*(3), 205-222.

Amalia, R., Sari, I. M., & Sinaga, P. (2017, February). Students' mental model on heat convection concept and its relation with students conception on heat and temperature. In *Journal of Physics: Conference Series* (Vol. 812, No. 1, p. 012092). IOP Publishing.

Ambrose, S. A., Bridges, M. W., DiPietro, M., Lovett, M. C., & Norman, M. K. (2010). *How learning works: Seven research-based principles for smart teaching*. John Wiley & Sons.

Ahi, B. (2016). A Study to Determine the Mental Models in Preschool Children's Conceptualization of a Desert Environment. *International Electronic Journal of Elementary Education*, *8*(3), 333-350.

Anning, A. (2002). Conversations around young children's drawing: the impact of the beliefs of significant others at home and school. NSEAD, 21(3), 197-208.

Araghi, Y., Kroesen, M., Molin, E., Wee, B. V. (2014): Do social norms regarding carbon offsetting affect individual preferences towards this policy? Results from a stated choice experiment. – Transportation Research Part D 26: 42-46.

Arslan, A. S., & Durikan, U. (2016). Pre-Service Teachers' Mental Models of Basic Astronomy Concepts. *Science Education International*, *27*(1), 88-116.

Bandura, A. (1977). Self-efficacy: toward a unifying theory of behavioral change. *Psychological review*, *84*(2), 191.

Barrera-Hernandez, L. F., Sotelo-Castillo, M. A., Echeverria-Castro, S. B., & Tapia-Fonllem, C. O. (2020). Connectedness to Nature: Its Impact on Sustainable Behaviors and Happiness in Children. *Frontiers in Psychology*, *11*, 276.

Bonnett, M., & Williams, J. (1998). Environmental education and primary children's

attitudes towards nature and the environment. Cambridge Journal of Education, 28(2), 159–174

Bosacki, S. L., Marini, Z. A., & Dane, A. V. (2006). Voices from the classroom: Pictorial and narrative representations of children's bullying experiences. *Journal of Moral Education*, *35*(2), 231-245.

Boulter, J. C., & Buckley, B. C. (2000). Constructing a typology of models for science

education. In J. K. Gilbert & C. J. Boulter (Eds.), in Developing models in science education (pp. 41–58). Dordrecht, Netherlands: Kluwer Academic Publishers.

Brandt, D. S. (2001). Information technology literacy: task knowledge and mental models.

Brennan, S. R., & Withgott, J. (2005). *Environment: The science behind the stories*. Benjamin-Cummings Pub Co.

Buldu, M. (2006). Young children's perceptions of scientist: A preliminary study. Educational Research, 48(1), 121-132

Cerovsky, J. (1971). Environmental education in the school curriculum.

Campbell, Coral and Jobling, Wendy 2012, Effective science learning environments, *in Science inearly childhood*, Cambridge University Press, Cambridge, England, pp.80-93

Campbell, D. T., Stanley, J. C., & Gage, N. L. (1963). Experimental and quasi-experimental designs for research. 1963.

Chan, K. M., Guerry, A. D., Balvanera, P., Klain, S., Satterfield, T., Basurto, X., ... & Hannahs, N. (2012). Where are cultural and social in ecosystem services? A framework for constructive engagement. *BioScience*, *62*(8), 744-756.

Chase, R. L. (1997). The knowledge-based organization: an international survey. *Journal of Knowledge Management*, *1*(1), 38-49.

Chen, X., Peterson, M. N., Hull, V., Lu, C., Lee, G. D., Hong, D., & Liu, J. (2011). Effects of attitudinal and sociodemographic factors on pro-environmental behaviour in urban China. *Environmental Conservation*, *38*(1), 45-52.

Chiou, G. L., & Anderson, O. R. (2010). A study of undergraduate physics students' understanding of heat conduction based on mental model theory and an ontology–process analysis. *Science Education*, *94*(5), 825-854.

Coll, R. K., France, B., & Taylor, I. (2005). The role of models/and analogies in science education: implications from research. *International Journal of Science Education*, *27*(2), 183-198.

Coates, E. (2002). 'I Forgot the Sky!'Children's Stories Contained Within Their Drawings' J'AI OUBLIÉ LE CIEL!'Histoires contenues dans les dessins d'enfants'¡ ME OLVIDÉ DEL CIELO!'Los cuentos infantiles encerrados en sus dibujos. *International Journal of Early Years Education*, *10*(1), 21-35.

Coates, E., & Coates, A. (2006). Young children talking and drawing. International Journal of Early Years Education, 14(3), 221-241.

Cox, S. (2005). Intention and meaning in young children's drawing. NSEAD, 24(2), 115-125.

Craik, K. J. (1943). W. The Nature of Explanation.

Creech, A., & Hallam, S. (2006). Every picture tells a story: Pupil representations of learning the violin. *Educate~*, *6*(1), 35-56.

Crewson, P. E. (2005). Reader agreement studies. *American Journal of Roentgenology*, *184*(5), 1391-1397.

Creswell, J. W. (2002). Educational research: Planning, conducting and evaluating quantitative and qualitative research (4th ed.). Boston, MA: Pearson.

Creswell, J. W. (2014). *A concise introduction to mixed methods research*. SAGE publications.

Daglıoglu, H. E., Çalışandemir, F., Alemdar, M., & BencikKangal, S. (2010). Examination of humans figure drawings by gifted and normally developed children at preschool period. Elementary Education Online, 9(1), 31-43.

Demirbaş, M., & Pektaş, H. M. (2009). Elementary students' levels of realization of basic concepts related with environment problem. *Necatibey Faculty of Education Electronic Journal of Science and Mathematics Education*, *3*(2), 195-211.

Dove, J., Everett, L. A., & Preece, P. F. W. (1999). Exploring a hydrological concept through children's drawings. *International Journal of Science Education*, *21*(5), 485-497.

Doyle, J. K., & Ford, D. N. (1998). Mental models concepts for system dynamics research. *System dynamics review: the journal of the System Dynamics Society*, *14*(1), 3-29.

Driver, R., & Easley, J. (1978). Pupils and paradigms: A review of literature related to concept development in adolescent science students.

Driver, R., Guesne, E., & Tiberghien, A. (1985). Children's ideas and the learning of science. *Children's ideas in science*, 1-9.

Driver, R., & Oldham, V. (1986). A constructivist approach to curriculum development in science.Taylors & Francis, 105-122.

Duit, R. (1991). Students' conceptual frameworks: Consequences for learning science. *The psychology of learning science*, *75*(6), 649-72.

Duit, R., & Treagust, D. F. (1995). Students' conceptions and constructivist teaching approaches. *Improving science education*, 46-69.

Duit, R., & Glynn, S. (1996). Mental modelling. *Research in science education in Europe*, 166-176.

Einarsdottir, J., Dockett, S., & Perry, B. (2009). Making meaning: Children's perspectives expressed through drawings. *Early child development and care*, *179*(2), 217-232.

Ekborg, M. (2003). How student teachers use scientific conceptions to discuss a complex environmental issue. *Journal of Biological Education*, *37*(3), 126-132.

Ersoy, A., & Türkkan, B. (2009). Perceptions about Internet in elementary school children's drawings. Elementary Education Online, 8(1), 57-73.

Fien, J. (1993). *Education for the environment: Critical curriculum theorising and environmental education*. Deakin University.

Fleer, M. (2002). Curriculum compartmentalisation? A futures perspective on environmental education. Environmental Education Research, 8(2), 137-154.

Franco, C., & Colinvaux, D. (2000). Grasping mental models. In *Developing models in science education* (pp. 93-118). Springer, Dordrecht.

Frick, J., Kaiser, F. G., & Wilson, M. (2004). Environmental knowledge and conservation behavior: Exploring prevalence and structure in a representative sample. *Personality and Individual differences*, *37*(8), 1597-1613.

Früh, W. (2011). Inhaltsanalyse - Theorie und Praxis (Vol. 7., revised ed.). Konstanz: UVK Medien

Gardner, G.T. and Stern, P.C. (2002) Environmental Problems and Human Behavior. 2nd Edition, Pearson Custom Publishing, Boston.

Gentner, D. (2002). Psychology of mental models. *International encyclopedia of the social and behavioral sciences*, *8*, 9683-9687.

Gilbert, J. K., Boulter, C. J., & Elmer, R. (2000). Positioning models in science education and in design and technology education. In *Developing models in science education* (pp. 3-17). Springer, Dordrecht.

Glas, E. (2002). Klein's model of mathematical creativity. Science and Education, 11, 95–104.

Goodman, N. (1976). *Languages of art: An approach to a theory of symbols*. Hackett publishing.

Gould, R. K., Coleman, K., & Gluck, S. B. (2018). Exploring dynamism of cultural ecosystems services through a review of environmental education research. *Ambio*, *47*(8), 869-883.

Glynn, S. M., & Duit, R. (Eds.). (1995). *Learning science in the schools: Research reforming practice*. Routledge.

Glynn, S. (1997). Drawing mental models. *The Science Teacher*, *64*(1), 30.

Greasly, P. (2008). Quantitative Data Analysis Using SPSS: An Introduction for Health & Social Science. New York: McGraw-Hill Education.

Grob, A. (1995). A structural model of environmental attitudes and behaviour. *Journal of environmental psychology*, *15*(3), 209-220.

Gungordu, N., Yalcin-Celik, A., & Kilic, Z. (2017). Students' Misconceptions about the Ozone Layer and the Effect of Internet-Based Media on It. *International Electronic Journal of Environmental Education*, *7*(1), 1-16.

Gralton, A., Sinclair, M., & Purnell, K. (2004). Changes in attitudes, beliefs and behaviour: A critical review of research into the impacts of environmental education initiatives. *Australian Journal of Environmental Education*, *20*(2), 41-52.

Greca, I. M., & Moreira, M. A. (2000). Mental models, conceptual models, and modelling. International Journal of Science Education, 22(1), 1–11.

Günindi, Y. (2012). Environment in my point of view: Analysis of the perceptions of environment of the children attending to kindergarten through the pictures they draw. *Procedia-Social and Behavioral Sciences*, *55*, 594-603.

Hadzigeorgiou, Y., Prevezanou, B., Kabouropoulou, M., & Konsolas, M. (2011). Teaching about the importance of trees: A study with young children. *Environmental Education Research*, *17*(4), 519-536.

Halford, G. S. (2014). *Children's understanding: The development of mental models*. Psychology Press.

Harrison, A. G., & Treagust, D. F. (1996). Secondary students' mental models of atoms and molecules: Implications for teaching chemistry. *Science education*, *80*(5), 509-534.

Herbert, B. E. (2003, November). The role of scaffolding student metacognition in developing mental models of complex, Earth and environmental systems. In *DFG-NSF international workshops on research and development in mathematics and science education* (pp. 19-21).

Hestenes, D. (1987). Toward a modeling theory of physics instruction. American Journal of Physics, 55, 440 – 454

Hillman, M., Stanisstreet, M., & Boyes, E. (1996). Enhancing understanding in student teachers: The case of auto-pollution. *Journal of Education for Teaching*, *22*(3), 311-326.

Holman, L. (2011). Millennial students' mental models of search: Implications for academic librarians and database developers. *The Journal of Academic Librarianship*, *37*(1), 19-27.

Hubber, P. (2006). Year 12 students' mental models of the nature of light. Research in Science Education, 36(4), 419–439.

Huckle, J. (1983). Environmental education. *Geographical education: Reflection and action*, 99-111.

Hungerford, H., Peyton, R. B., & Wilke, R. J. (1980). Goals for curriculum development in environmental education. *The Journal of Environmental Education*, *11*(3), 42-47.

Hyun, E. (2005). How is young children's intellectual culture of perceiving nature different from adults'? Environmental Education Research, 11(2), 199–214.

Ifenthaler, D. (2008). Practical solutions for the diagnosis of progressing mental models. In *Understanding models for learning and instruction* (pp. 43-61). Springer, Boston, MA.

Ingham, A. M., & Gilbert, J. K. (1991). The use of analogue models by students of chemistry at higher education level. International Journal of Science Education, 13, 193–202.

Iliopoulou, I. (2018). Can young students think systemically about the environment? The case of pollution. *Education 3-13*, *46*(3), 362-377.

Joel Novek and Karen Kampen, "Sustainable or Unsustainable Development? An Analysis of an Environment Controversy", *The Canadian Journal of Sociology / Cahiers canadiens de sociologie*, Vol. 17, No. 3, 1992, pp. 249-273.

Johnson-Laird, P. N. (1983). Mental models. Cambridge: Harvard University. Judson, E. (2011).

Johnson-Laird, P. N. (1983). *Mental models: Towards a cognitive science of language, inference, and consciousness*(No. 6). Harvard University Press.

Jones, N. A., Ross, H., Lynam, T., Perez, P., & Leitch, A. (2011). Mental models: an interdisciplinary synthesis of theory and methods. *Ecology and Society*, *16*(1).

Jones, N. A., Ross, H., Lynam, T., & Perez, P. (2014). Eliciting mental models: a comparison of interview procedures in the context of natural resource management. *Ecology and Society*, *19*(1).

Judson, E. (2010). The impact of field trips and family involvement on mental models of the desert environment. International Journal of Science Education, 33, 1455–1472.

Kalvaitis, D. & Monhardt, R.M. (2011). The architectures of children's relationships with nature: A phenomenographic investigation seen through drawings and written narratives of elementary students. Environmental Education Research, 18, 209-227.

Keles, O. (2012). Elementary teachers' views on mind mapping. *International Journal of Education*, *4*(1), 93.

Kellert, S. R. (2002). Experiencing nature: Affective, cognitive, and evaluative development in Children. In P. H. Kahn & S. R. Kellert (Eds.), The human relationship with nature: Development and culture. Cambridge, MA: The MIT Press.

Kollmuss, A., & Agyeman, J. (2002). Mind the gap: Why do people act environmentally and what are the barriers to pro-environmental behavior? Environmental Education Research, 8, 239–260.

Kildan, A. O., Kurnaz, M. A., & Ahi, B. (2013). Mental models of school for preschool children. *European Journal of Educational Research*, *2*(2), 97-105.

Kussmaul, P. (2017). A cognitive framework for looking at creative mental processes. *Intercultural Faultlines: Research Models in Translation Studies: v. 1: Textual and Cognitive Aspects*, 57.

Lampert, A. (2019). Over-exploitation of natural resources is followed by inevitable declines in economic growth and discount rate. *Nature communications*, *10*(1), 1-10.

Leal Filho, W. (1997). Integrating environmental education and environmental management. *Environmental management and health*.

Lee, K. (2011): The Green Purchase Behavior of Hong Kong Young Consumers: The Role of Peer Influence, Local Environmental Involvement, and Concrete Environmental Knowledge. – Journal of International Consumer Marketing 23: 21-44.

Leonard, M. (2006). Children's drawings as a methodological tool: Reflections on the develop plus system in northern Ireland. Irish Journal of Sociology, 15(2), 52-66.

Libarkin, J. C., Beilfuss, M., & Kurdziel, J. P. (2003). Research methodologies in science education: Mental models and cognition in education. *Journal of Geoscience Education*, *51*(1), 121-126.

Libarkin, J. C., Thomas, S. R., & Ording, G. (2015). Factor analysis of drawings: Application to college student models of the greenhouse effect. *International Journal of Science Education*, *37*(13), 2214-2236.

Littledyke, M. (2008). Science education for environmental awareness: approaches to integrating cognitive and affective domains. *Environmental Education Research*, *14*(1), 1-17.

Liu, S. C. & Lin, H. (2014). Undergraduate students' ideas about nature and human-nature relatiopships: An empirical analysis of environmental worldviews. Environmental Education Research, 20(3), 412-429.

Liu, S. C., & Lin, H. (2015). Exploring undergraduate students' mental models of the environment: Are they related to environmental affect and behavior? The Journal of Environmental Education, 46(1), 23-40.

Loughland, T., Reid, A., & Petocz, P. (2002). Young people's conceptions of environment: A phenomenographic analysis. Environmental Education Research, 8(2), 187-197.

Louv, R. (2008). *Last child in the woods: Saving our children from nature-deficit disorder*. Algonquin books.

Louv, R. (2012). *The nature principle: Reconnecting with life in a virtual age*. Algonquin Books.

Lynam, T., & Brown, K. (2012). Mental models in human–environment interactions: theory, policy implications, and methodological explorations. *Ecology and Society*, *17*(3).

Mantzicopoulos, P., Patrick, H. (2011): Reading picture books and learning science: engage young children with informational text. – Theory into Practice 50: 269-276.

Marhan, A. M., Micle, M. I., Popa, C., & Preda, G. (2012). A review of mental models research in child-computer interaction. *Procedia-social and behavioural sciences*, *33*, 368-372.

Matsaridou, I. 2015. Children's Drawings: Mirrors of Children's Individual Thoughts – A Case Study in a Maltese Preschool Setting. http://www.hioa.no/content/download/107829/2515891/file/IoannaMatsaridou.pdf.

McMillan, E. E., Wright, T., & Beazley, K. (2004). Impact of a university-level environmental studies class on students' values. *The Journal of Environmental Education*, *35*(3), 19-27.

McBeth, W., & Volk, T. L. (2009). The national environmental literacy project: A baseline study of middle grade students in the United States. *The Journal of Environmental Education*, *41*(1), 55-67.

Mesmer-Magnus, J. R., Viswesvaran, C., & Wiernik, B. M. (2013). Book Highlight—The Role of Commitment in Bridging the Gap Between Organizational and Environmental Sustainability. *Global Business and Organizational Excellence*, *32*(5), 86-104.

Michelsen, G.; Fischer, D. Sustainability and education. In Sustainable Development Policy: A European Perspective; Hauff, M.V., Kuhnke, C., Eds.; Routledge: London, UK, 2017.

Minkoff, Y., & Riley, J. (2011). Perspectives of time-use: Exploring the use of drawings, interviews and ratingscales with children aged 6-7 years. Journal of Occupational Science, 18(4), 306-321.

Mintzes, J. J., Wandersee, J. H., & Novak, J. D. (1998). Teaching science for understanding; a human constructivist view academic press. *San Diego, California*.

Moroye, C.M. (2005). Common ground: An ecological perspective on teaching and learning. Curriculum and Teaching Dialogue, 7(1/2): 123-139. http://www.highbeam.com/doc/1P3- 1040187551.html

Moseley, C, Desjean-Perrotta, B. & Utley, J. (2010). The draw an environment test rubric (DAET-R): Exploring pre-service teachers' mental models of the environment. Environmental Education Research, 16(2), 189-208

Mohammad Zohir Ahmad & Nordin Abdul Razak. (2007). Pendidikan AlamSekitar di Sekolah: Komitmen Guru. Kuala Lumpur: Dewan Bahasa dan Pustaka

Mohd Majid, K. (2005) *Kaedah Penyelidikan Pendidikan*. Kuala Lumpur: Dewan Bahasa dan Pustaka.

Murat, G. E. N. Ç., Genç, T., Ergenç, M., & ERKUZ, N. (2016). Environmental Problem Perception of 6th Grade Students. *World Journal of Environmental Research*, *6*(1), 25-35.

Mustam, B. (2017). Model Mental Murid Tentang Alam Sekitar Di Satu Kawasan Yang Tercemar. *JuKu: Jurnal Kurikulum & Pengajaran Asia Pasifik*, *3*(4), 36-45.

Myers, G., Boyes, E., & Stanistreet, M. (2000). Urban and rural air pollution: A cross-age study of school students' ideas. Environmental Education and Information, 19, 263–274.

Nersessian, N. (1995). Should physicists preach what they practice? Science and Education, 4, 203–226.

Norman, D. A. (1983). Some observations on mental models. In D. Gentner & A. Stevens (Eds.), Mental models (pp. 7–14). Hillsdale, NJ: Lawrence Erlbaum.

Otto, S., & Kaiser, F. G. (2014). Ecological behavior across the lifespan: Why environmentalism increases as people grow older. *Journal of Environmental Psychology*, *40*, 331-338.

Ozsoy, S. & Ahi, B. (2014). Elementary school students' perceptions of the future environment through artwork. Educational Sciences: Theory & Practice, 14(4), 1-26. Özsoy, S., Ozsoy, G. & Kuruyer, G. (2011).

Price, J. H., & Murnan, J. (2004). Research limitations and the necessity of reporting them. *American Journal of Health Education*, *35*(2), 66.

Nadeson, T., & Rasid, N. S. A. (2006). The implementation of environmental education in Malaysian schools: an NGO's overview. In *Conference on Best of Both Worlds: Environmental Education for Sustainable Development,, Kuala Lumpur (Malaysia), 6-8 Sep 2005*. Gemilang Press Sdn Bhd.

Neumann, S., & Hopf, M. (2012). Students' conceptions about "radiation": Results from an explorative interview study of 9th grade students. Journal of Science Education and Technology, 2012(21), 826–834.

Nor Azlin, Y. N., Chong, M. I., Azyyati, A. K., Roslina, M., & Azahari, M. Y. To Assess Needs, Benefits and Effectiveness of Environmental Education for Plant Conservation.

North American Association for Environmental Education (NAAEE). (2010). Guidelines of initial preparation and professional development of environmental educators. Washington, DC: Author.

Nurul Hidayah Abdullah, H. L., Hamid, H., Shafii, H., Wee, S. T., & Ahmad, J. (2018, July). Pupils perception towards the implementation of environmental education across curriculum in Malaysia primary school. In *Journal of Physics: Conference Series* (Vol. 1049, No. 1, p. 012098). IOP Publishing.

Ogbu, J. U. (1992). Understanding cultural diversity and learning. *Educational researcher*, *21*(8), 5-14.

Oguz, V. (2010). The factors influencing childrens' drawings. *Procedia-Social and Behavioral Sciences*, *2*(2), 3003-3007.

Omosulu, R., & Inja, T. (2019). HUMANISM AND ENVIRONMENTALISM: A DIALOGUE. *NNAMDI AZIKIWE JOURNAL OF PHILOSOPHY*, *11*(2), 87-100.

Osborne, R., & Freyberg, P. (1985). *Learning in Science. The Implications of Children's Science*. Heinemann Educational Books, Inc., 70 Court Street, Portsmouth, NH 03801.

Otto, S., & Pensini, P. (2017). Nature-based environmental education of children: Environmental knowledge and connectedness to nature, together, are related to ecological behaviour. *Global Environmental Change*, *47*, 88-94.

Palmer, J., & Neal, P. (1994). The Durham study, phase 1. *The handbook of environmental education*, 3-10.

Palmer, G. W. (1995). *Environment: The International Challenge: Essays*. Victoria University Press.

Palmer, J. A. (1998). Environmental Education in the 21st Century: Theory, Practice, Progress and Promise. London and New York: Routledge.

Palmquist, R. A. (2001). Cognitive style and users' metaphors for the web: An exploratory study. *The Journal of Academic Librarianship*, *27*(1), 24-32.

Papastergiou, M. (2005). Students' mental models of the Internet and their didactical exploitation in informatics education. *Education and Information Technologies*, *10*(4), 341-360.

Payne, P. (1998). Childrens' conceptions of nature. Australian Journal of Environmental Education, 14, 19–26.

Piaget, J. (1970). Genetic epistemology. New York: Norton & Company.

Panagiotaki, G., Nobes, G., & Potton, A. (2009). Mental models and other misconceptions in children's understanding of the earth. *Journal of Experimental Child Psychology*, *104*(1), 52-67.

Pekel, F. O., & Ozay, E. (2005). Turkish high school students' perceptions of ozone layer depletion. *Applied Environmental Education and Communication*, *4*(2), 115-123.

Pillar, A. D. (1998). What do children think about the drawing process? NSEAD, 17(1), 81-86.

Piperno, F., Di Biassi, S., & Levi, G. (2007). Evaluation of family drawings of physically and sexually abused children. European Child & Adolescent Psychiatry, 16(6), 389-397.

Prager, K., & Curfs, M. (2016). Using mental models to understand soil management. *Soil Use and Management*, *32*(1), 36-44.

Prokop, P., Kubiatko, M., & Fančovičová, J. (2007). Why do cocks crow? Children's concepts about birds. *Research in Science Education*, *37*(4), 393-405.

Punch, S. (2002). Research with children: The same or different from research with adults? Childhood, 9(3), 321-341.

Pudin, S. (2006). Overview of environmental education and awareness programmes in Sabah. In *Fourth Sabah-Sarawak Environmental Convention* (pp. 1-14).

Redish, E. F. (1994). Implications of cognitive studies for teaching physics. *American Journal of Physics*, *62*(9), 796-803.

Richardson, G. P., Anderson, D. F., Maxwell, T. A. and Stewart, T. R. 1994. Foundations of mental model research. Proceedings of the 12th International System Dynamics Conference, Stirling, Scotland, 11±15 July

Rieh, S. Y., Yang, J. Y., Yakel, E., & Markey, K. (2010, August). Conceptualizing institutional repositories: Using co-discovery to uncover mental models. In *Proceedings of the third symposium on Information interaction in context* (pp. 165-174).

Rook, L. (2013). Mental models: A robust definition. *The Learning Organization*, *20*(1), 38-47.

Ruiz-Mallen, I., Barraza, L., Bodenhorn, B., Ceja-Adame, M. D. L. P., & Reyes-García, V. (2010). Contextualising learning through the participatory construction of an environmental education programme. *International journal of science education*, *32*(13), 1755-1770.

Saçkes, M., & Korkmaz, H. İ. (2015). Anaokulu Çocuklarının Dünyanın Şekline İlişkin Zihinsel Modelleri. *Ilkogretim Online*, *14*(2).

Samarapungavan, A., Vosniadou, S., & Brewer, W. F. (1996). Mental models of the earth, sun, and moon: Indian children's cosmologies. *Cognitive development*, *11*(4), 491-521.

Schafer, N. (2012). Finding ways to do research on, with and for children and young people. Geography, 97(3), 147-154.

Schollum, B., & Osborne, R. (1985). Relating the new to the familiar. *Learning in science: The implications of children's science*, 51-65.

Snaddon, J. L., Turner, E. C., & Foster, W. A. (2008). Children's perceptions of rainforest biodiversity: Which animals have the lion's share of environmental awareness? PlosONE, 3(7), 1-5.

Solarin, S. A., & Bello, M. O. (2018). Persistence of policy shocks to an environmental degradation index: the case of ecological footprint in 128 developed and developing countries. *Ecological Indicators*, *89*, 35-44.

Stapp, W. B. (1970). The Concept of Environmental Education. *Amer Biol Teacher*.

Straatemeier, M., van der Maas, H. L., & Jansen, B. R. (2008). Children's knowledge of the earth: A new methodological and statistical approach. *Journal of Experimental Child Psychology*, *100*(4), 276-296.

Strommen, E. (1995). Lions and tigers and bears, oh my! Children's conceptions of forests and their inhabitants. *Journal of Research in Science Teaching*, *32*(7), 683-698.

Suping, S. M. (2003). *Conceptual change among students in science*. ERIC Clearinghouse.

Swoboda, D. (2014). Applying Evidence-Based Principles of Learning to Teaching Practice: The Bridging the Gap Seminar. *Acknowledgments and Dedication*, 206.

Taylor, N., Nathan, S., & Coll, R. K. (2003). Education for sustainability in regional New South Wales, Australia: An exploratory study of some teachers' perceptions. *International Research in Geographical and Environmental Education*, *12*(4), 291-311.

Turkish pre-service primary school teachers' environmental attitudes: Effects of gender and grade level. Asia-Pacific Forum on Science Learning and Teaching, 12(2), 1-21.

Shepardson, D. P. (2005). Student's ideas: What is an environment? Journal of Environmental Education, 36(4), 49-58.

Shepardson, D. P., Wee, B., Priddy, M. & Harbor, J. (2007). Students' mental models of the environment. Journal of Research in Science Teaching, 44(2), 327-348.

Shepardson, D. P., Niyogi, D., Choi, S., & Charusombat, U. (2009). Seventh grade students' conception of global warming and climate change. Environmental Education Research, 15(5), 549-570.

Shepardson, D. P., Niyogi, D., Choi, S., & Charusombat, U. (2011). Students' conceptions about the greenhouse effect, global warming, and climate change. *Climatic Change*, *104*(3-4), 481-507.

Shay-Margalit, B., & Rubin, O. D. (2017). Effect of the Israeli "green schools" reform on pupils' environmental attitudes and behavior. *Society & Natural Resources*, *30*(1), 112-128.

Sobri, N. A., & Rahman, H. A. (2016). Knowledge, Attitude and Practices on Recycling Activity Among Primary School Students in Hulu Langat, Selangor, Malaysia. *Indian J. Environment. Prot.*, *36*(10), 792-800.

Tarciso Borges, A., & Gilbert, J. K. (1999). Mental models of electricity. *International Journal of Science Education*, *21*(1), 95-117.

Taşkın, Ö. ve Şahin, B. (2008). "Çevre" kavramı ve altı yaş okul öncesi çocuklar. Pamukkale Üniversitesi Eğitim Fakültesi Dergisi, 23(1), 1-12.

Taskin-Ekici, F., Ekici, E., & Cokadar, H. (2015). Exploring Pre-Service Elementary Teachers' Mental Models of the Environment. *International Electronic Journal of Environmental Education*, *5*(1), 21-39.

Thatcher, A., & Greyling, M. (1998). Mental models of the Internet *International journal of industrial ergonomics*, *22*(4-5), 299-305.

Tilbury, D. (1995). Environmental education for sustainability: Defining the new focus of environmental education in the 1990s. *Environmental education research*, *1*(2), 195-212.

Timoshenko, A., & Berman, M. (2017). The United Nations Environment Programme and the United Nations Development Programme. In *Greening international institutions* (pp. 38-54). Routledge.

Timur, S., Timur, B., & Yilmaz, S. (2013). Determining primary school candidate teachers' levels of environmental literacy. *The Anthropologist*, *16*(1-2), 57-67.

Toepoel, V. and Schonlau, M (2017), Dealing with nonresponse: Strategies to increase participation and methods for post-survey adjustments, An Internati Journal of Mathematical Demography, 24(2), 79-83

Trees. (December, 2016). Sustainable solution. http://trees.org.my/programmes/communities-for-conservation/living-sustainably/tips-to-go-green/composting

Vaiopoulou, J., & Papageorgiou, G. (2018). Primary students' conceptions of the Earth: Re-examining a fundamental research hypothesis on mental models. *Preschool and Primary Education*, *6*(1), 23-34.

Volk, T. L., & Cheak, M. J. (2003). The effects of an environmental education program on students, parents, and community. *The Journal of Environmental Education*, *34*(4), 12-25.

Vosniadou, S. & Brewer, W. F. (1992). Mental models of the earth: A study of conceptual change in childhood. Cognitive Psychology, 24, 535-585.

Vosniadou, S. & Brewer, W. F. (1994). Mental models of the day/night cycle. Cognitive Science, 18, 123-183.

Vygotsky, L. S. (1971). The psychology of art. Cambridge: The MIT.

Vygotsky, L. S. (1986). Thought and language (A. Kozulin, ed.).

Walker, K., Brady, L., & Young, G. (1999). The social cultural influences on environmental understandings of NSW school students. Paper presented at American Educational Research Association Annual Conference, Montreal, April.

Walshe, N. (2008). Understanding students' conceptions of sustainability. *Environmental Education Research*, *14*(5), 537-558.

Wells, M., Hestenes, D., & Swackhamer, G. (1995). A modeling method for high school physics instruction. *American journal of physics*, *63*(7), 606-619.

Westbrook, L. (2006). Mental models: a theoretical overview and preliminary study. *Journal of Information Science*, *32*(6), 563-579.

Wilson, R. A. (2006). The wonders of nature: Honoring children's ways of knowing. Early Childhood News, 18(1), 14–19.

Winn, W. (1990). Some implications of cognitive theory for instructional design. *Instructional Science*, *19*(1), 53-69.

Wong, C. A., Afandi, S. H. M., Ramachandran, S., Kunasekaran, P., & Chan, J. K. L. (2018). Conceptualizing environmental literacy and factors affecting pro-environmental behaviour. *International Journal of Business and Society*, *19*(S1), 128-139.

Wuellner, M. R., Vincent, L., & Felts, B. (2017). Environmental mental models of college students. *International journal of environmental & science education*, *12*(2), 105.

Yardimci, E., & Kiliç, G. B. (2010). Children's views of environment and environmental problems. İlköğretim Online, 9(3), 1122-1136.

Yin, R. K. (2003). Case study research: Design and methods. Case study research design and methods.

Zakri, A.H. (2006). Education for sustainable development (ESD) and United Nations UniversityInstitute of Advanced Studies (UN-IAS). In Omar Osman, Salfarina Abdul Gapor, & Zainal Abidin Sanusi (Eds.), Education for sustainable development. The roles of universities as Regional Centres of Experties (Healthy Campus Series, No. 11). Pulau Pinang, Malaysia: Penerbit Universiti Sains.

Zandbergen, P., & Petersen, F. (1995, May). The role of scientific information in policy and decision-making. In *The Lower Fraser Basin in transition: A symposium and workshop*. Kwantlen College Surrey, BC, Canada.