Effects of Neuroscience-Based Thinking (NBT) and Thinking Skills (TS) Strategies on Thinking and Emotion among Primary Schools Pupils

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بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

In the Name of Allah. Most Gracious, Most Merciful

إِنَّ الْحَمْدَ لِلَّهِ، نَحْمَدُهُ، وَنَسْتَعِينُهُ، وَنَسْتَغْفِرُهُ وَنَعُوذُ بِاللَّهِ مِنْ شُرُورِ أَنْفُسِنَا، وَسَيِّئَاتِ أَعْمَالِنَا مَنْ يَهْدِهِ اللَّهُ فَلاَ مُضِلَّ لَهُ، وَمَنْ يُضْلِلْ فَلاَ هَادِيَ لَهُ، وَأَشْهَدُ أَنْ لاَ إِلَهَ إِلاَّ اللَّهُ وَحْدَهُ لاَ شَرِيْكَ لَهُ، وَأَشْهَدُ أَنَّ مُحَمَّدًا عَبْدُهُ وَرَسُولُهُ.

Verily all praise is for Allah, we praise Him and seek His aid and ask for His forgiveness, and we seek refuge with Allah from the evils of ourselves and our evil actions. Whomever Allah guides there is none who can misguide him, and whomever Allah misguides there is none who can guide him, and I bear witness that none has the right to be worshipped except Allah Alone, having no partner, and I bear witness that Muhammad is His slave and His Messenger.

DEDICATION

In the name of Allah, this completed work is dedicated to my beatitude, parents, whom donated to me their greatest love. This thesis is also dedicated to my life companions, my two wives. Delight of my eyes, my daughter Maymoona. I didn’t forget all my whole brothers and sisters, whom I learned from them the meaning of the cooperation.

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May Allah guide us all to the right path and approach.

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GLOSSARY OF ABBREVIATIONS

NBT: Neuroscience-Based Thinking Strategy

TS: Thinking Skills Strategy

P: Prevalent Strategy

TCT: Test of Creative Thinking

STT: Science Task of Thinking

STE: Science Task of Emotion

Kesan Strategi Pemikiran Berdasarkan Neurosains (NBT) dan Kemahiran Berfikir (TS) terhadap Pemikiran dan Emosi dalam Kalangan Pelajar Sekolah Rendah

ABSTRAK

Matlamat kajian ini adalah untuk mengkaji kesan strategi Pemikiran Berasaskan Neurosains (*Neuroscience-Based Thinking, NBT*) dan Strategi Kemahiran Berfikir (*Thinking Skills, TS*) terhadap pemikiran kreatif dan prestasi tugasan sains (pemikiran dan emosi) dalam kalangan pelajar sekolah rendah di Malaysia. Kajian ini menggunakan reka bentuk kajian kuasi-eksperimen dengan satu kumpulan kawalan dan dua kumpulan eksperimen. Sampel terdiri daripada 98 orang murid pelajar darjah lima bagi tahun pengambilan 2010. Kedua-dua kumpulan eksperimen dikenali sebagai NBT dan TS, manakala strategi pervalens (P) sebagai kumpulan kawalan. Pengajaran dikendalikan oleh tiga orang guru sains yang berbeza. Ketiga-tiga kumpulan menjalani dua penilaian (praujian dan pascaujian) bagi tiga instrumen berikut: Ujian Pemikiran Kreatif (*Test of Creative Thinking, TCT*), Tugasan Pemikiran Sains (*Science Task of Thinking, STT*) dan Tugasan Pemikiran Emosi *(Science Task of Emotion, STE*). Kebolehpercayaan instrumen adalah baik sebagaimana yang ditunjukkan oleh Cronbach Alpha dan korelasi Pearson. Statistik inferensi ANCOVA dua hala dan ujian MANCOVA, serta kaedah LSD post hoc digunakan pada tahap $p<.05$ untuk menentukan secara statistik perbezaan yang signifikan di antara kumpulan kajian. Dapatan kajian menunjukkan bahawa terdapat perbezaan yang signifikan di antara kumpulan. Dapatan ujian pemikiran kreatif dalam sains dan subkemahirannya (kefasihan, kefleksibelan dan keaslian) menunjukkan bahawa murid-murid dalam kumpulan NBT mendapat skor yang lebih tinggi berbanding dengan kumpulan TS dan P dalam semua aspek kecuali dalam subkemahiran (kefasihan) yang mana kumpulan TS memperoleh skor yang lebih baik. Selanjutnya, keputusan menunjukkan bahawa tiada perbezaan yang signifikan dalam pascaujian di antara gender dalam semua kumpulan. Begitu juga, tiada kesan interaksi yang signifikan dalam pascaujian di antara semua kumpulan dan kedua-dua gender terhadap semua pemboleh ubah. Justeru, kajian ini mencadangkan agar pendidik berusaha meningkatkan pembelajaran dan kreativiti dalam kalangan pelajar dengan menerapkan prinsip neurosains dalam proses pembelajaran dan pengajaran, Hal ini boleh dilakukan dengan menyepadukannya ke dalam kurikulum.

Effects of Neuroscience-Based Thinking (NBT) and Thinking Skills (TS) Strategies on Thinking and Emotion among Primary Schools pupils

ABSTRACT

The aim of this study is to investigate the effects of Neuroscience-Based Thinking (NBT) strategy and Thinking Skills (TS) strategy on creative thinking and the performance of science tasks (thinking and emotion) among Malaysian pupils in primary schools. This study used quasi-experimental research design with one control group and two experimental groups. Ninety eight pupils enrolled in standard five during the 2010 educational year formed the sample. The two experimental groups were named NBT and TS while prevalent strategy (P) as the control group. The instruction was carried out by three different science teachers. These three groups were measured twice (pretest and posttest) of three different instruments: the Test of Creative Thinking (TCT), Science Task of Thinking (STT) and of Emotion (STE). The instruments' reliabilities are good as showed by Cronbach alpha and Pearson correlation. Inferential statistics, namely two ways ANCOVA and MANCOVA tests, and LSD post hoc method were used at α .05 level to determine statistically significant differences between study groups. The results showed that there were significant differences between groups. The result of the test of creative thinking in science and its sub-skills (fluency, flexibility and originality) indicated that the pupils in NBT group scored higher as compared to TS and P groups in all but one sub-skill (fluency) where TS group has better score. Likewise, the TS pupils are higher than P pupils except in originality where both were similar. Similarly, the results of thinking and emotion of science tasks revealed that the pupils of NBT scored higher than TS and P groups in their thinking and emotion. Furthermore, the results revealed that there were no significant differences in posttest between gender in all groups. Similarly, there were no significant in interaction effects in post-test between all groups and both gender on all variables yet the female pupils of TS group have high scores in fluency. Therefore, the study recommends that educators should work to enhance learning and creativity among pupils by employing neuroscience principles in teaching and learning process by integrating them into curriculum.

CHAPTER ONE

1.1 Introduction

Thinking skill is one of the most important skills required in this era of knowledge and information. Therefore, with the stream of knowledge in our contemporary world, it is important for educators to keep up with this condition by giving learners chances to use their minds to apply the knowledge through various ways of thinking, such as creative thinking and problem solving (Alghafri, 2008; Gough, 1991). Thinking ability is related to learning, which is developed by the mind. Thereby, it is important to enhance the ability to think in order to reach its maximum potential that because the thinking is a natural part of human being and must be strengthened. Moreover, thinking skill is the basic for all cognitive and affective skills, and the mind will provide the help that individuals needs to interact with the society, life and world (Shaw, 1986).

Understanding on how thinking process occurs in the brain would support the improvement of students' learning and achievement (Jensen, 2005), and to make teaching becomes beneficial and easy (Daniel, 2009). According to Blakemore and Frith (2005), determining how the brain dealing with information and skills during learning is helpful to improve learning and to enhance better learning. Therefore, knowing the mechanisms of learning in the brain that focus in some processes like thought and emotion are important to apply them in educational strategies and to design programs that consider learning for learners of all ages and needs. The discipline that studies the brain process, thinking and learning is called neuroscience.

1.1.1 Field of Neuroscience

Neuroscience is a specific field which seeks to investigate the brain processes of learning and thinking (Blakemore & Frith, 2005) by studying the organization of nervous systems structures and the process of producing specific function of these structures to generate behavior (Purves, Augustine, Fitzpatrick, Hall, LaMantia, McNamara & Williams, 2004). It attempts to know more about the brain's structures and their functions and to interpret how the brain learns and how thought happen (Blakemore & Frith, 2005).

Recently, there are many methods and techniques on how to do neuroimaging, an activity to scan the human brain, which allows researchers to identify which regions of the brain are responsible for learning and thinking (Wolfe, 2001). In the light of that, multidisciplinary data (neuroimaging and physical data that are used by social and behavioral studies) revealed that the development of cognitive learning occurs in different regions of the brain (Jensen, 2005).

Because all findings concerning the functions of the brain structures are appealing to the psychologists and educators, they suggested some learning principles that can be used to develop thought and learning of human being (Goswami, 2008a; Jensen, 2005). The learning principles, which focused on educational theories that relates to the functions of the brain structures which have not yet been investigated by neuroscience researches (Jong et al., 2009). Thereby, the implications of the brain research results have taken place in the field of education (Blakemore & Frith, 2005).

In the light of that, neuroscientists and psychologists considered the implementation as the results of cognitive neuroscience in psychology and

education. They suggested several principles of learning and behaviors in terms of neuroscience' principles and they are related to the functions of the brain structures. These principles of neuroscience could play significant roles in improving learning and thinking. In addition, these principles could be implicated in education field in order to investigate the human brain (de Jong, et al., 2009).

The first neuroscience principle is related to complex process of the brain and multi sensory. For instance, according to Koester and Siegelbaum (2000), different regions of the brain cell perform specific signaling tasks. Some of them have simple process like axon, while other regions of a neuron have more complex information processes took place before passing it along. Kirchhoff and Buckner's (2006) study revealed that verbal elaboration and visual inspection strategies which implemented the multi sensory aspect engage distinct brain regions.

The other principle of neuroscience involved brain mechanisms and its memory through a special system. Hebbian's theory stated that activity in one neuron could affect presynaptic neurons in special synapse process that assists to trigger learning and thinking (Hebb, 2002). The third neuroscience principle supports the possibility of anyone has ability to learn. This principle considers that each brain is unique for each individual. According to Kandel, Schwartz and Jessell (2000), the nerve cells of brain transmit unique information by forming particular networks in brain surface.

Furthermore, one more principle which related to emotional information and thoughts of the brain is important in a patterning process of a positively intended of the brain map to produce learning. Norris, Chen, Zhu, Small, and Cacioppo (2004) uncovered the social and emotional processes impact on brain activation after they

investigated that interconnection of social and emotional information processes are related to the neural mechanisms. Moreover, results of McGeehan's (2001) study revealed that to provide the students learning by emotions, a community atmosphere in the classroom is required. In addition, the new experiences caused physical change in the brain, triggered by first-hand experiences that are rich in sensory input. Another finding advocated that in order to remember something, a student should have a personal connection to any knowledge that connected to related functional cells of the brain by sparking dendritic growth and increasing synaptic connections.

The last principle related to thought, as Dietrich (2004) and Srinivasan (2007) stated, is that many of previous studies showed that the higher order thinking, especially creative thinking, is a response to the prefrontal cortex activities in the human brain. This result helped us to understand more about how the brain works in order to engage with creative thoughts. Investigating the brain learning can be done through conducting specific tasks and activities that engage learners in various mental activities (Blakemore & Frith, 2005; Wolfe, 2001).

As a summary, previously stated principles emphasize that neuroscience studies took parts in psychology and education field which related to students activation in learning and thinking, as well as to employ their brain abilities in several situations. Furthermore, despite of some studies exploration of the implementation of neuroscience in psychology and education field, there are still little efforts that have been done to investigate how information is processed in the brain and how human brain learns and thinks (Wolfe, 2001).

1.1.2 Thinking skills

Holyoak and Morrison (2005) stated that thinking is "the systematic transformation of mental representations of knowledge to characterize actual or possible states of the world, often in serves of a goal" (p. 2). This definition considers the mental dealing of information during thinking process for producing ideas. Thereby, different types of thinking would produce different ideas (Guilford, 1957).

There are two common categories of thinking skills that produce ideas, namely Lower Order Thinking Skills (LOTS) and Higher Order Thinking Skills (HOTS). The LOTS occurs when learners received information and ideas or apply rules as a routine, while HOTS required students to handle information and ideas by perceptive way in order to use several thinking processes. Critical and creative thinking are examples of HOTS (Chen, Gualberto, Tameta, & Salle, 2009). Through thinking process, brain can use different thinking skills (Heilman, 2005).

Additionally, thought is inherited and implied several brain abilities. The brain processes thinking such as creativity that developed the thinking skills in the brain and mind of a person and change the behavior (Andreasen, 2005; Heilman, 2005). Therefore, can thinking be learned and be taught? The following brief summary of thinking skills attempts to answer.

According to Facione and Facione (1996), because of the growth in the international and local social, economic, educational, environmental, science, and health challenges of the 21st century, we are now focused on the thinking component of knowledge development and professional judgment across disciplines. Thus,

recent work has increasingly centered on defining the criteria to measure thinking and designing effective strategies to learn thinking skills and to teach them.

Bleedorn (1993) pointed that the most common types of higher order thinking are the creative and critical thinking. These thinking types could remove the borderline of the mind to a bold new initiative in the conversion of a global society. Moreover, Guilford (1967) described higher order thinking as a divergent thinking process of the mind that relates to creative and critical thinking. The generative power (creativity) of the minds and its judiciousness (criticality) cannot be separated distinctively (Paul & Elder, 2006).

Psychologists and researchers are attempting to take interdisciplinary and multifaceted approaches between creative and critical thinking that are the elements of the thinking way. Furthermore, Bailin (1993), Elder and Paul (2007), and Paul and Elder (2006) emphasized that creative thinking works consecutively with critical thinking. Bailin (1993) also stated that the product of criticism or the evaluation contained generative and creative component.

Research on learning, nature, processing, teaching and evaluation of thinking skills such as creative and critical thinking are ongoing and developing. Norris (1985), who had focused his research on requirements of students' abilities, believed that in order to be able to evaluate their own thinking and to change their thinking behavior, students should know how to apply their prior knowledge and understanding. Previous statement indicated that thinking skills are being considered by the researchers in education and psychology.

According to Bleedorn (1993), "developing good thinking based on context has been more categorized approach than focus on process, which invites and engages more integrative, interdisciplinary, systemic uses of the mind" (p.18). Consequently, both creative and critical thinking should be involved in the learning and curriculums through the context, activities and questions in schools subjects, especially mathematics and science (Dejnozka & Kapel, 1982). Pertaining to this argument, Cassel (1999) reasoned that the subjects like mathematics, science, and reading are considered critical for school curriculum, and as well as important elements of individuals' full development.

Moreover, in order to support students' psychological development, students should be put through programs where principles of motivation and their application would be introduced besides thinking, cognition, emotion and behavior (Amit & Mohd Jaladin, 2007). That is the reason why Weinstein (1988) underlined that learners must be motivated to use the higher order thinking such as skills of creative and critical thinking. According to Mant, Wilson and Coates's (2007) recommendation, all pupils in primary schools need to have curiosity and scientific understanding from the earliest age, and this can be learnt during science lessons that encourage thinking through discussion and practical investigations.

According to Nemirovsky, Rosebery, Solomon, and Warren (2005), by using events, tools, symbols, ideas, and objects in science subject; and by developing scientific knowledge; the science learning becomes meaningful and would encourage students to think. Sears and Sorenson (2005) pointed that by employing scientific knowledge and thinking skills, the children would be aware of the daily life, environment, world, and planet. Additionally, they can use the technological

advantages to make life easier and become more responsible for environment and the future.

In conclusion, the HOTS are important to enhance understanding, achievement, thinking skills, and to face new situations in life through the curriculum like science subject. Therefore, both creative and critical thinking skills are important for students' learning, such as to perform convergent and divergent thoughts. In addition, the higher order thinking occurs through the inquiry learning and embedded thinking via curriculums. According to this curriculum, the students will learn how to think and this can be done by taking into account of the important things that engage students' learning and thinking such as selecting the principles of learning about thinking, choosing conducive environment, and developing students' positive emotions. Thus, this current study aims to implement these two types of thinking (creative and critical) through a strategy that will be developed which will help to increase their level of thinking skills.

1.1.3 Neuroscience Based Thinking (NBT)

This study attempts to connect neuroscience principles and thinking skills. This kind of combination is implicated in a strategy called Neuroscience Based Thinking (NBT). NBT is a newly expanded application for developing innate creative and critical thinking skills by learning through neuroscience principles. This NBT strategy emphasizes on integrating creative and critical thinking instead of dealing with them as two separate thinking skills, thus making them more teachable and learnable. This is done by deducting suitable principles of cognitive neuroscience and neuro linguistic as well as combining skills of creative and critical thinking. Then both the principles and skills are integrated in one thinking strategy

based on neuroscience. On the other hand, the Thinking Skills (TS) strategy merges creative and critical thinking skills without integrating them with the principles of neuroscience.

1.2 Background of the Education System in Malaysia

Malaysia is part of Southeast Asia and a member of Association of South East Asian Nations (ASEAN). Malaysia is situated on the north east of Indonesia, north of Singapore and south of Thailand. Education in Malaysia is under the control of the federal government and all educational matters are under the authority of the Ministry of Education (MOE). It is a centralized system with common curricula and examination systems overall the country (Mokshein, 2004).

Prior to the independence period, the first generation of Malaysian modern schools was founded by the British colonial government. The earliest schools were started in Penang and Malacca, For example, school such as Penang Free School was founded in 1816 and Malacca High School being founded in the same year (Cheeseman, 1946; Education in Malaysia, 2009). Most schools in Malaysia are public schools and providing free education for all is the responsibility of the Malaysian federal government (Ministry of Education, Malaysia, 2001; Education in Malaysia, 2009).

The nation's education system consists of two stages (levels). The first stage is the primary education, which consists of 6 years of education, referred to as Year 1 through 6. Next is the second stage or secondary school level, which consists of 5 years of schooling and this is referred to as Form 1 to Form 5 before it is further divided into lower secondary (1-3) and upper secondary (4-5) schools. Pupils enter primary schools at the age of seven and complete primary education at the age of 12.

Primary schools in Malaysia are divided into two levels: one from Year 1- 3 years based on acquiring reading and writing skills, and the second level from Year 4- 6 with a basis in essential science and grounding on a strong foundation in content for the next level. Pupils are automatically promoted to the next stage regardless of their academic performance. It is noted that there is an evaluation system in Malaysian schools to assess the pupils' performance after they studied the content of primary curriculum. Thus, there is a continuous school-based assessment carried out at all levels, and the centralized examination carried out at the last level in primary schools (Ministry of Education, Malaysia, 2001).

One of the subjects in the curriculum of the primary level is the science subject. Science in Malaysia has been (re)introduced to fourth graders since 1993. While science was taught as a subject in primary schools in the past decades before, as part of a new curriculum for primary schools (KBSR) developed in 1983, science was combined with several other subjects such as health, history, geography to make up a subject called man and environment (Abdullah, & Yahaya, 2006; Mokshein, 2002).

Then in July 2002, the Malaysian government had approved the proposal that science and mathematics should be taught in English language (SME) whereas earlier they were taught in the Malay language which is national language in most schools. Based on the Professional Circular, Malaysia Ministry of Education No. 11/2002 / Pekeliling Ikhtisas, Kementerian Pelajaran Malaysia No. 11/2002 (dated 27 November 2002), the plan to teach science in English language was scheduled for year 2003 at all national and national-type schools. By virtue of the Circular that states that the period from 2003 until 2007 will constitute the transition period of

SME. Today, the plan of SME has reached grade six in the schools in Malaysia (Abdullah, & Yahaya, 2006). Recently, however, when the researcher of this study were in the process of met different educators from Malaysia Ministry of Education, Department of Education and the schools, the Ministry has declared that both science and math will be returned back to be taught in Malay language.

1.3 Problem Statement

1. 3.1 The Status of Integration of Neuroscience Principles in the current Curriculum

In 1999, Bruer had discussed the consequence of change in the traditional education, which is based on the cognitive and constructivist model of learning and that has become stable and rooted in more than thirty years of psychological research. McGeehan (2001), cited Leslie Hart (1983), stated:

> "Education is discovering the brain, and that's about the best news there could be. Anyone who does not have a thorough, holistic grasp of the brain's architecture, purposes, and main ways of operating is as far behind the times as an automobile designer without a full understanding of engines." (p. 12)

Although many people believe that the brain is somehow emerged in learning, yet various learning theories has not specifically investigated the role of the body's physical organ used in learning (Driscoll, 1994). In addition, Howard-Jones (2005) commented on Blakemore and Frith (2005) with regard to the lesson that considered on integrating neuroscience and education; one of them is that there are so few studies attempting to bridge the gap between them in the outcome of the suggestive scientific findings and classroom applications.

Goswami (2008a) pointed out that "the brain is the main organ of learning, and so a deeper understanding of the brain would appear highly relevant to

education" (p. 381). For instance, one result from brain studies has shown that the abilities and the thinking skills can be learned at different age stages and be applied for developing abilities and skills at any learners' age (Goswami, 2008a).

Today, developing curriculum and teaching method (particularly in science subject) without understanding on how the brain works would not be adequate to trigger the teaching and learning processes (Ward, 2007). According to Hale and Fiorello (2004), consideration of neuroscience research supports the curriculum's understandability and helps to meets the biological needs of students. In addition, for younger children, strategies related to neuroscience principles that depending on the nature and biological aspect could be important. That could be because, the teacher, the curriculum, and the classroom structure affected children's learning, thinking and behavior. In contrast, without adequate understanding in neuropsychology, educators and school curriculum designer might negatively affect students' learning and thinking due to their ignorance on biological aspects. For instance, some students might fail in some academic subject because the curriculum and the instruction do not consider the right and left hemisphere properties.

In this regard, the researcher has surveyed different sources of Malaysian-related knowledge and information providers such as the newspapers, websites, conferences and journals of education and medical disciplines. Yet, any argument concerning the implementation of neuroscience in the school curriculum was not acquired. In addition, when the researcher studied Year 5 science curriculum – syllabus guide and textbook prepared by the Education Ministry of Malaysia (2006; 2008), the application of the principles of neuroscience in the curriculum was not found. Moreover, the pilot study for this research showed that the science teachers in

the primary schools are lack of knowledge regarding neuroscience and its learning principles, in spite of the fact that they are interested to apply this perspective in their classes.

Thus, this study attempts to imply deducted principles of both cognitive neuroscience and neuro linguistic in one suggested thinking strategy, which is called the **N**euroscience-**B**ased **T**hinking (**NBT**) strategy for Malaysian pupils in primary schools and to investigate the effectiveness of the implication of the NBT strategy on thinking and emotion.

1. 3.2 Lack of Thinking Skills in pupils

One of the main purposes of education is to impart knowledge and skills and to develop stable emotions for learners to make them ready for their environment and society (Hassan, 2009). There should be a continuous development of the students' skills by they learning important knowledge, thinking skills and creative skills according to their tendencies and interests (Alghafri, 2004; Daniel, 2009; Geist & Hohn, 2009). However, there are very little importunities in schools for the students to learn and apply the thinking skills. For instance, Cassel (1999) stated that the basis for all schools' problems is twofold and related to two basic causes. First one is the problems related to learning strategies and techniques for engaging students thinking, and the second is the individuals' abilities of pupils are not involved. Even though many students complete their basic courses and acquire some basics knowledge, very few of them are taught to learn the necessary thinking skills needed (Geist & Hohn, 2009; Sutton & de Oliveira, 1995).

Along with that, when a subject matter is made to be memorized by the students, their capacity and understanding are often limited and eventually the

information will be easily forgotten. Thus, the students' role is not to memorize the information; rather, the students should know how to learn and how to use their thinking skills on learning (Alghafri, 2008). So, students must understand the knowledge and use their thinking skills and abilities when they study. For that reason, Brophy (1990) said: "it is not enough that the content is being taught and that much of what is taught does not need to be taught" (p. 367). Relevant to that, Perkins and Simmons (1988) stated that, “students do not approach subjects new to them with empty minds. They bring preconceptions that are often rival and override those of the topic itself” (p. 308). Especially, each age has specific thinking skills and operation for understanding the conceptions. For, instance, according to Piaget (1977), he pointed that children started in their thinking at early age with concrete operation and slowly grow to formal operation.

Therefore, if the curriculum does not implicated and involved thinking skills in each stage, such as science subject of grade five, and they do not taken care by education experts, the pupils will find difficulties to use their higher thinking in understanding knowledge of specific area, In addition, the science subject has another global issue as Rowlands (2008) pointed that people have a common conception about the science subject. People believe that science discipline by nature is tough and is difficult to study because it needs higher order thinking. Thereby, this view will have an effect on students learning, the way they think and performance. This is particularly true if most teachers do not focus on their students' thinking during their instructions (Merrill & Twitchell, 1994).

The Malaysian Ministry of Education continues to support schools with good learning programs, strategies and activities that engage pupils' thinking. Also, the

country has invested a lot of time and money to supply the pupils with good quality of learning in order to improve their skills and be able to integrate thinking skills in various disciplines of life. However, even with the resources and these supports, many pupils still striving and struggling to insert thinking strategies into their daily learning (Ministry of Education, Malaysia, 2001).

According to the 2001 UPSR reports of pupils' performance (L*aporan Prestasi UPSR*), the majority of the pupils failed to use and understand many scientific terminologies and most of the pupils learn through rote memorization without using their higher order thinking skills (Talib et al., 2009). The Malaysian Syndicate of Examination (2003) reported that the pupils are unable to answer science subject questions by using the scientific thinking and higher order thinking, and the pupils find it difficult to understand specific scientific terminologies of science subject (Nabilah, 2009). Consequently, the results of TIMSS 2007 reveal that Malaysia's pupils science subject score is only 471 points as compared to other 60 nations in the international assessment of the mathematics and science achievements of Year 8 pupils (Thomson, Wernert, Underwood & Nicholas, 2009). Moreover, similar trend found in the report of the National Center for Education Statistics (NCES) which shows that the score of science subject in the ranking of TIMSS 2007 (grade 8) showed that Malaysia is at No. 21, which is behind many countries. This result (471 points) is below TIMSS scale average of 500, a drop of 39 points as compared to 510 points in year 2003 (Gonzales et al.). Thus, the National Union of Malaysian Muslim Students (PKPIM, 2009) believes that the nation's education system needs more supports in order to improve the pupils' performance in science and mathematics. Accordingly, Mokshein's study (2002) mentioned that

Malaysian primary science subject needs specific programs to promote pupils' interests and understanding.

The learning process in the Malaysian's classrooms needs some changes by shifting to learner-centered classrooms that stimulates thinking, creativity and caring, caters to individual differences and applying several learning features (Mae, 2002). The needs arose due to the fact that high schools' learners are generally lacking in higher order thinking skills such as critical thinking (Yaacob & Seman, 1993). Fah's (2009) study focuses to measure the logical thinking abilities based on gender and science achievement among Form 4 students of rural secondary schools at the Interior Division of Sabah, Malaysia. The results of this study revealed that the overall mean of students' logical thinking abilities (except for conservational reasoning's assessment scores) was low, whereas the mean scores of their abilities were lower than the overall mean. The study also revealed that there was no significant difference between the means of logical thinking abilities (except for conservational reasoning) among male and female students. However, a significant difference based on their science achievement at lower secondary level was found.

Moreover, there are other related Malaysian studies that found that the pupils are lacking in achievement of science learning, especially, the questions which they need high ability thinking (Lee, 2001) and they need to learn how to use their abilities in science subject by employing the skills during the learning of scientific knowledge (Talib et al., 2009). Furthermore, many teachers do not provide their students the suitable educational environment and good opportunities to deal with their mind through thinking process to practice the higher order thinking skills (Merrill & Twitchell, 1994). Particularly, previous study found that there are

teachers in Malaysian primary schools who are less sensitive about the function of thinking in understanding process (Norain, 2005). Thus, examination of pupils shows that the pupils have low level of scientific reasoning and creative thinking due to the routine teaching style (Sharifah & Lewin, 1991). Globally, also in science subject field, a study indicated that male pupils are a little higher than females in science achievement and verbal ability. However, for pupils of ages between 11-14 years, there is large gender difference (Hyde & McKinley, 1997).

It is acknowledged that good thinking ability and successful science learning outcome does not only related to the process of teaching and learning but also on other factors such as students' emotion and gender (Feist, 2006). According to Zembylas (2004), both positive and negative emotions in science are important in science subject teaching and learning. Moreover, emotions play role in curricula, pedagogic content knowledge of teacher and relationships with the pupils. For example, Brígido, Bermejo, Conde and Mellado (2010) found that the males have more tendencies for science content than female whereas Murphy and Beggs (2003) study uncovered that the primary school's female pupils enjoy more than male. Thus, Malaysian should recognize the importance of emotions in teaching and learning science.

Similarly, the findings from this particular research's pilot study showed that science teachers in primary schools are lacking of knowledge and skills of creative thinking. They hardly used and encouraged the creative thinking in their teaching. Consequently, their pupils also are lack of knowledge and skills of creative thinking. This result is consistent with Ling (2000) whom mentioned that the questions which are asked during science subject classroom did not help activating the used of high

order thinking skills. Furthermore, the results of paper and pencil's of thinking tasks showed that the number of pupils who answered the questions that focused on familiar critical thinking pictures were more than those who chose the creative thinking pictures. Likewise, their answers on performance of emotion in science task were largely within the pleasant to regular critical thinking pictures while that of creative thinking picture were within unpleasant. This pilot study result was supported by Rosnani (2002) study where she pointed that there is a lack of model in creative and critical thinking over Malaysian students and teachers in the schools.

Consequently the ability of Malaysian students to be creative has not increase because there isn't any concerted effort done to teach the students' creative thinking skills. Thus, the researcher believes that there is a dire need for investigation of the status of creative thinking in science subject among Malaysian pupils in primary schools. Therefore, present study aims to investigate the effect of Neuroscience-Based Thinking (**NBT**) and Thinking Skills (**TS**) strategies on thinking and emotion among Malaysian pupils in primary schools through science subject.

1.4 Objective of the Study

This study was conducted to address the impact of integrating the principles of cognitive neuroscience and neuro linguistic as well as creative and critical thinking skills in instructional strategy. This study has the following objectives:

1- To examine the effects of implementing Neuroscience-Based Thinking (NBT) strategy and Thinking Skills (TS) strategy in science subject on creative thinking in science activities among Malaysian pupils in three primary schools at Penang Island.

2- To investigate the effects of implementing Neuroscience-Based Thinking (NBT) strategy and Thinking Skills (TS) strategy in science subject on thinking and emotion of science tasks among Malaysian pupils in three primary schools at Penang Island.

3- To examine the differences between male and female on thinking and emotion the study's among Malaysian pupils in three primary schools at Penang Island.

1.5 Research Questions

The study has several research questions:

Q1- Does the implementation of the Neuroscience-Based Thinking (NBT) strategy and Thinking Skills (TS) strategy in science subject have any effects on creative thinking among Malaysian primary schools' pupils?

Q2- Does the implementation of the Neuroscience-Based Thinking (NBT) strategy and Thinking Skills (TS) strategy in science subject have any effects on sub-skills of creative thinking (fluency, flexibility and originality) among Malaysian primary schools' pupils?

Q3- Does the implementation of the Neuroscience-Based Thinking (NBT) strategy and Thinking Skills (TS) strategy in science subject have any effects on thinking (performance on science tasks) among Malaysian primary schools' pupils?

Q4- Does the implementation of the Neuroscience-Based Thinking (NBT) strategy and Thinking Skills (TS) strategy in science subject have any effects on emotion (performance on science task) among Malaysian primary schools' pupils?

Q5- Is there any difference between male and female pupils of each group (NBT, TS & P) on the creative thinking scores?

Q6- Is there any difference between male and female pupils of each group (NBT, TS & P) on the sub-skills of creative thinking scores (fluency, flexibility and originality)?

Q7- Is there any difference between male and female pupils of each group (NBT, TS & P) on the thinking scores (performance on science task)?

Q8- Is there any difference between male and female pupils of each group (NBT, TS & P) on the emotion scores (performance on science task)?

Q9- Is there any interaction effect between the types of strategy (NBT, TS & P) and gender (Male & Female) on the thinking and emotion scores among Malaysian primary schools pupils?

Q9a- Is there any interaction effect between the types of strategy (NBT, TS & P) and gender on the creative thinking scores?

Q9b- Is there any interaction effect between type of strategy (NBT, TS & P) and gender on the sub-skills of creative thinking scores (fluency, flexibility and originality)?

Q9c- Is there any interaction effect between type of strategy (NBT, TS & P) and gender on the thinking scores (performance on science task)?

Q9d- Is there any interaction effect between type of strategy (NBT, TS & P) and gender on the emotion scores (performance on science task)?

1.6 Research Hypotheses

Thus, this study tried to test the following hypotheses for statistical purpose (based on the significant difference $\alpha \leq 0.05$):

Ho1- There is no significant difference in the mean scores of creative thinking between Neuroscience-Based Thinking (NBT) strategy, Thinking Skills (TS) strategy and prevalent strategy among Malaysian primary schools pupils.

Ho2- There is no significant difference in the mean scores of sub-skills of creative thinking (fluency, flexibility and originality) between Neuroscience-Based Thinking (NBT) strategy, Thinking Skills (TS) strategy and prevalent strategy among Malaysian primary schools pupils.

Ho3- There is no significant difference in the mean scores of thinking (performance on science task) between Neuroscience-Based Thinking (NBT) strategy, Thinking Skills (TS) strategy and prevalent strategy among Malaysian primary schools pupils.

Ho4- There is no significant difference in the mean scores of emotion (performance on science task) between Neuroscience-Based Thinking (NBT) strategy, Thinking Skills (TS) strategy and prevalent strategy among Malaysian primary schools pupils.

Ho5- There is no significant difference in the mean scores of creative thinking between male and female pupils of each group (NBT, TS & P).

Ho6- There is no significant difference in the mean scores of sub-skills of creative thinking (fluency, flexibility and originality) between male and female pupils of each group (NBT, TS & P).

Ho7- There is no significant difference in the mean scores of thinking (performance on science task) between male and female pupils of each group (NBT, TS & P).

Ho8- There is no significant difference in the mean scores of emotion (performance on science task) between male and female pupils of each group (NBT, TS & P).

Ho9- There is no significant difference in interaction effect between the types of strategy (NBT, TS & P) and gender on thinking and emotion among Malaysian primary schools pupils.

Ho9(a)- There is no significant difference in interaction effect between the types of strategy (NBT, TS & P) and gender on creative thinking.

Ho9(b)- There is no significant difference in interaction effect between the type of strategy (NBT, TS & P) and gender on sub-skills of creative thinking (fluency, flexibility and originality).

Ho9(c)- There is no significant difference in interaction effect between the type of strategy (NBT, TS & P) and gender on thinking (performance on science task).

Ho9(d)- There is no significant difference in interaction effect between the type of strategy (NBT, TS & P) and gender on emotion (performance on science task).

1.7 Significance of the Study

The future of neuroscience in the education domain is still in the argumentation and query stage (Davis, 2004; Jong et al., 2009). Particularly, the social perspective is dominant in the field of education where some believe that nothing can be predicated by science, which is just beginning to meditate the complexities of social interaction (Davis, 2004). Others have already accepted the new concept of education in terms of brain development alone (Koizumi, 2004). That was because a gap between neuroscience and education is still open for fulfillment (Zull, 2002), and "also need to bridge the methodological approaches used in both fields" (Jong et al., 2009; Zull, 2002), Therefore, the educators and

learners may see themselves as the biological creatures, when they started to study the learning concept based on the biological aspect (Zull, 2002). Current study attempts to fill the gap between neuroscience and education in primary school by implicated the neuroscience principles in thinking strategy because the principles of learning are based on cognitive neuroscience (Goswami, 2008a) and processes thinking of mind (Kaufman, 2009). Accordingly, this current study tries to support thinking and learning of pupils by implicating the principles of neuroscience in a strategy for primary schools pupils.

On the other hand, Amit and Mohd Jaladin (2007) mentioned that what importance for the pupils is their psychological development in preparation for vision 2020 of Malaysia, which is related to the development of personal/individual quality and personality growth of Malaysian pupils. This involves their development of personality, thinking, behavior and emotion. Thus, the main objective of primary school's science in Malaysia is providing pupils with enough scientific knowledge to interpret and make sense of everyday experiences, positive attitudes towards science, scientific literacy and scientific skills. The other objective is developing the pupils' interest and creativity as well as gaining the scientific and thinking skills in positive emotion (Ministry of Education, 2002). Thus, to these objectives, the current study focuses on importing the thinking and emotion through a neuroscience-based.

Moreover, according to recommendations of Faux's study (1992) results, there was a need to build and design the curriculum for all levels of students' achievements in several type thinking skills, because hardly everyone are able to make all students become creative thinkers. Likewise, Paul and Elder (2006) stated that all truly excellent thinking combines both creative and critical thinking.

Therefore, many studies asserted to investigate the relationship between creative and critical thinking. Hence, present NBT study was designed to be suitable for all levels of pupils and it includes both the creative and critical thinking skills via neuroscience principles.

To the researcher knowledge, no study done on the relationship between effects of thinking strategy, that is based on neuroscience principles, and test of creative thinking and science tasks of thinking and emotion, that are developed in science subject activities, at least among Malaysian primary school pupils. However, there are numerous studies done on the influence of adult training on thinking during thinking task without interesting on relationship between its effect and thinking and emotion (e.g. Benedek, Fink, & Neubauer, 2006; Dolcos & Cabeza, 2002; Fink, Grabner, Benedek & Neubauer, 2006; Robinson, 2009).

The results of current study are expected to deliver support in the following matters:

i. Identifying the accurate information of pupils' thinking and emotion using several learning strategies.
ii. Providing the specialists in the Malaysian Ministry of Education and in the fields of neuropsychology and neuroeducation with information regarding the advantage of the Neuroscience-Based Thinking (NBT) based on the neuroscience domain.
iii. Designing the Neuroscience-Based Thinking (NBT) strategy which integrates the principles of neuroscience and thinking skills to be implemented in schools.

iv. Designing the syllabus of neuroscience-based thinking (NBT) strategy (which considers both the neuroscience principles and thinking skills) for year 5 science subject curriculum to be used in the schools.

v. Designing the syllabus of Thinking Skills (TS) strategy (which considers the thinking skills) for year 5 science subject curriculum to be used in the schools.

vi. Informing the Ministry of Education about the levels of thinking among year five pupils.

vii. Recognizing the relationship between the neuroscience (Neuroscience-Based Thinking NBT) or Thinking Skills (TS) strategy and creative thinking.

1.8 Rationale of the Study

There are many benefits of conducting research related to science subject in the schools, specifically the learning of science using thinking skill strategies. The National Science Education Standards (NRC, 1996) stated that science is for all students and that curriculum content should be designed to develop the students' brain, thinking, interests, emotion, abilities, understandings, experiences, and knowledge. Furthermore, there is a general agreement on the urgency to improve the quality of learning at school because there is too much focus on teaching, and not enough focus on learning (Alghafri, 2008; Daniel, 2009). There are too much emphasis on rote and memorization (Daniel, 2009) but lack of focus on higher order thinking process (Alghafri, 2008).

This challenge has fostered many researchers to investigate and explore the reasons which lay behind the problems of only a few students who use strategies of