Faculty of Cognitive Science and Human Development

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TEACHERS' UNDERSTANDING ON BRAIN-BASED TEACHING AND LEARNING APPROACH IN MATHEMATICS CLASSROOM

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Statement of Originality

The work described in this Final Year Project, entitled "TEACHERS’ UNDERSTANDING ON BRAIN-BASED TEACHING AND LEARNING APPROACH IN MATHEMATICS CLASSROOM" is to the best of the author’s knowledge that of the author except where due reference is made.

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ABSTRACT

TEACHERS’ UNDERSTANDING ON BRAIN-BASED TEACHING AND LEARNING APPROACH IN MATHEMATICS CLASSROOM

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The emergence of TIMMS and PISA that measure the student cognitive performance against the international standards has become very important and the latest TIMMS and PISA result showed that critically 18% and 60% of the students did not meet minimum proficiency level in Mathematics. These students were identified as possessing only limited mastery of basic mathematical and scientific concepts. The new education policy has been designed to meet the standard and the teachers and pupils have to equip with new approach of teaching and learning method. Nevertheless, to ensure the students in primary school are equipped with the skills above, there must be a suitable instructional or suitable teaching and learning method to accommodate the demand. Brain-based learning is the one that can be proposed to be implemented by the teacher in the classroom. Brain based learning involves taking what we know about the brain, its development, its learning and combining the factors in the intelligent way to connect and excites the students’ learning. The implementation will be based on the twelve brain based learning principle promoted by Caine (2005) in order to facilitate learning and prepare the children towards 21st century. Hence, this study used qualitative approach through open-ended survey questionnaire by means of Facebook, electronic mail (e-mail), and educational portal and also interview to explore teachers understanding of the brain-based learning in the learning of the Mathematics and identify the potential of implementing the brain-based learning in the classroom. The samples consists of 30 mathematics primary school teachers purposively selected where 20 samples were from online open-ended survey questionnaire by using Google form and remaining 10 of the samples were collected from the one primary school in Padawan Division through the semi-structured interview and open-ended survey questionnaire form. The findings for this study discovered mathematics teachers’ lack of understanding on Brain-based learning. However, their educational practices and beliefs showed that there were potentials in implementing the brain-based learning in mathematics classroom.
ABSTRAK

KEFAHAMAN GURU MENGENAI PENDEKATAN PENGAJARAN DAN PEMBELAJARAN BERASASaskan OTAK DI DALAM KELAS MATEMATIK

SAIFULBAHRI BIN HJ. ABDUL RAHMAN

CHAPTER 1

INTRODUCTION

1.0 Background of the study

This study will explore the potentials of brain-based learning as a new medium of instructions for the teaching and learning of mathematics in primary school based on neuroscience findings and related theories derived from past researches. Diverse classrooms in the twenty-first century need responsive pedagogy to remedy varying abilities and learning styles (Marshall, 1998; Sousa, 1998b; Tomlinson & Kalbfleisch, 1998). The roots of brain-based research began in neuroscience and have crossed over to many fields of cognitive education or psychology (Marshall, 1998; Slavkin, 2002; Sousa, 1998; Wolfe & Brandt, 1998). Along with this development, educators should be aware of how the brain works and how research can improve student learning in the classroom (Biller, 2002; Morris, 2004).
In the process of learning and understanding, young children continuously try to organize new concepts and information about the world (de Lange, 1987; Gopnik, 2004; van den Heuvel-Panhuizen, 2001). In addition, Freudenthal (1978) contends that structuring is a fundamental method for children to organize the world. For this reason, method of organization contributes to gaining insight into important mathematical concepts such as patterning, algebra, and the recognition of basic shapes and figures (Mulligan, Mitchelmore, & Prescott, 2006; Waters, 2004).

Previous studies emphasized the significance of collaboration between the disciplines of mathematics education, cognitive psychology and neuropsychology that can contribute to research (Berninger & Corina, 1998; Byrnes & Fox, 1998; Davis, 2004; Griffin & Case, 1997; Joles et al., 2006; Lester, 2007; Siegler, 2003; Spelke, 2002). Moreover, it is important to incorporate findings from latest research to teach mathematics in the classroom for effective learning of all students regardless of their cultural or socioeconomic backgrounds. Educators in the twenty first century should apply brain-based learning and implement the theory in their classroom practices that will develop and construct better curriculum to meet pupils’ needs based on their abilities and backgrounds.

The introduction of the Trends in International Mathematics and Science Study (TIMSS) and the Programme for International Student Assessment (PISA) are managed by the International Association for the Evaluation of Educational Achievement and the Organisation for Economic Co-operation and Development (OECD) to measure the standard and competencies of the students in mathematics and science subjects at international level has proven the importance of mathematics education in children’s learning. Butterworth (2011) highlighted that low numeracy
is a substantial cost to nation, and improving the quality could dramatically improve economic performance. Recent analysis by the OECD demonstrated that an improvement of “one-half standard deviation in mathematics and science performance at the individual level implies, by historical experience, an increase in annual growth rates of GDP per capita of 0.87%.

For this reason, brain-based research in learning mathematics is crucial to prepare children to achieve the standard and competencies in mathematics education. The goal of this study is to explore the understanding and potential of brain-based teaching and learning in mathematics education in primary school in preparation towards 21st century learning.

1.1 Problem Statement

In order for students to succeed in life, a fundamental objective of any education system must be equipped with the knowledge and skills required and meet the requirement of the global demand that could impact the economic performance for the country. Thus, historically, like other countries around the world, the Malaysian education system has emphasized on the development of strong content knowledge in subjects such as science, mathematics, and languages. The emergence of TIMMS and PISA that measure students’ cognitive performance against the international standards there is, however, increases global recognition that it is no longer enough for a student to leave school with the 3Rs (Reading, Writing & Arithmetic). As a result, the emphasis is also on developing higher-order thinking skills and no longer just on the importance of knowledge.
Over several decades, although Malaysian students’ performance has improved, the increasing demands of international standards will affect those remarkable gains and may put it at risk in both relative and absolute terms. Due to the circumstances, firstly, those other systems are improving student performance more rapidly, and have found ways to sustain that momentum. The existence of the gap between Malaysia’s system and other systems is therefore growing. Secondly, international assessments standard suggests that Malaysian students’ performance is declining in absolute terms. This is based on the measurements of over the past two decades. International student assessments, such as the Programme for International Student Assessment (PISA) and the Trends in International Mathematics and Science Study (TIMSS), have emerged as means of directly comparing the quality of educational outcomes across different systems to set up a standard. The assessments are designed to assess a variety of cognitive skills such as application and reasoning.

In 1999 when Malaysia first participated in TIMSS, its average student score was higher than the international average in both Mathematics and Science subject. However, in 2007, the last published cycle of results, the system’s performance had slipped to below the international average in both Mathematics and Science with a commensurate drop in ranking. Results show that 18% and 20% of Malaysia’s students failed to meet the minimum proficiency levels in Mathematics and Science in 2007, a two to fourfold increase from 7% and 5% respectively in 2003. These students were identified as possessing only limited mastery of basic mathematical and scientific concepts. The results from PISA 2009+ (the first time Malaysia participated in this assessment) were also discouraging, with Malaysia ranking in the bottom third of 74 participating countries, below the international and OECD average (Exhibit 3). Almost 60% of the 15-year-old Malaysian students who participated in PISA failed to meet the minimum
proficiency level in Mathematics, while 44% and 43% did not meet the minimum proficiency levels in Reading and Science respectively. A difference of 38 points on the PISA scale is equivalent to one year of schooling. A comparison of scores shows that 15-year-olds in Singapore, South Korea, Hong Kong, and Shanghai performed as though they have had 3 or more years of schooling compared to 15-year-olds in Malaysia. (Malaysia Ministry of Education, 2012)

Apart from that, Malaysia’s Ministry of Education has introduced new education policies related to the new curriculums which are Standard Curriculum for Primary School and School Based Assessment which complies with the international standard of assessment. The new education policy has been designed to meet the standard and teachers and pupils have to equip themselves with new approaches and methods of teaching and learning. Nevertheless, to ensure students in primary school are equipped with the skills above, there must be a suitable instructional or suitable teaching and learning method to accommodate the demand.

Therefore, it can be proposed that teachers in the classroom implement brain-based learning. However, the teacher must be equipped and possess understanding about the approach of brain-based learning before they can be implemented in the classroom. Hence, this study will explore teachers’ understanding of brain-based learning approach in the learning of the Mathematics and identify if they implement brain-based learning in the classroom. This research also aims to find out potential problems that might occur and solutions to them.
1.2 Objectives

The objectives of this study are;

1.2.1 To find out teachers’ understanding on brain-based teaching and learning approach in the learning of Mathematics in primary school.

1.2.2 To explore the potentials of brain-based teaching and learning approach in the learning of Mathematics in primary school.

1.2.3 To find out the problems faced in the implementation of brain-based teaching and learning approach in the learning of Mathematics in primary school.

1.2.4 To find out the solutions on implementation of brain-based teaching and learning in the learning of Mathematics in primary school.

1.3 Research Questions

This study highlights and aims to discover four research questions which are:

1.3.1 What is the extent of teachers’ understanding on brain-based teaching and learning in the learning of Mathematics in primary school?

1.3.2 Are there any potential brain-based teaching and learning approach implemented in the learning of Mathematics in primary school?
1.3.3 Are there any problems in the implementation of brain-based teaching and learning in the learning of Mathematics in primary school?

1.3.4 What are the solutions for the problems in brain-based learning in the learning of Mathematics in primary school?

1.4 Definition of Terms

In this study, there are four essential terms used. These are the following definitions for those terms;

1.4.1 Brain-based learning can be defined as an interdisciplinary answer to the question of “what is the most effective way of the brain’s learning mechanism” (Jensen, 1998). Caine and Caine (2002) define brain-based learning as “recognition of the brain’s codes for a meaningful learning and adjusting the teaching process in relation to these codes.”

1.4.2 In this study, a teacher is identified as a person working under the Ministry of Education, Malaysia (MOE) and teaches the subject Mathematics using the Malaysian syllabus based on the National Curriculum Policy.

1.4.3 Mathematics is a subject based on the curriculum designed by the Ministry of Education, Malaysia (MOE) for Malaysian pupils. For Year 1 to 4, the curriculum used is Standard Curriculum for Primary School. For Year 5 and Year 6, the curriculum used is Integrated Curriculum for Primary School. Starting from 2016, all six levels will use the same curriculum.
1.4.5 Classrooms in this study refer to primary classes in Malaysia from three types of namely Sekolah Kebangsaan (SK), Sekolah Kebangsaan Jenis Cina (SJKC) and Sekolah Kebangsaan Jenis India (SJKI).

1.5 Significance of the Study

Based on the latest assessment by international standard agencies, Malaysia seems to be stuck in the bottom third of the countries surveyed in international assessments and not making any upward move towards the upper tier of the top third of the countries. (Malaysian ranking in PISA for 2011 and 2012 is 52 and 53 for Mathematics and Science respectively).

Hence, the Ministry of Education aims to enhance the standard of Mathematics, Science and languages in schools measured through international assessments such as Trends in International Mathematics and Science Study (TIMSS) and Programme for International Student Assessment (PISA). A special task force comprising various divisions in the ministry, agencies, and experts was created to look into methods in improving the mastery of the subjects.

Referring to the statement by Dr Masnah Ali Muda, the ministry’s Curriculum Development Division director in News Straits Times published on 12 December 2013, a task force had been formed and their task is to be responsible for strategic and thorough planning, sharing of ideas and views through analysis towards results of previous TIMMS and PISA tests to implement the most effective measures in order to improve student knowledge and skills in this domains. The task force, established in February last year, also collaborates with other professional bodies such as the Malaysian Industry-Government Group for High Technology (MIGHT), Southeast Asian
Ministers of Education-Regional Centre for Education in Science and Mathematics (SEAMEO RECSAM), Academy of Sciences Malaysia (ASM), Malaysian Institute of Chemistry and Petrosains. (Hana Naz Harun, 2013)

On the other hand, Dr Masnah also stated that the recent TIMMS and PISA results indicate that most students who took part in the assessment needed the skill to apply knowledge and think critically outside familiar academic contexts. She also stressed that it is important to improve the standards and achievements in Mathematics and Science subject. Therefore, a special plan and intervention was designed through the Malaysian Education Blueprint to ensure that the mastery of these subjects complies with the above needed skills. TIMSS is held every four years, and involves 13 to 14-year olds while PISA is held every three years and involves students between the ages of 15 and 16.

Hence, more research needs to be done to find out the best method to improve student performance. Brain-based teaching and learning is one of the latest strategies proposed based on research in neuroscience. There is a lack of research in this area, and the gap explored and discovered can be very important to related parties in order to improve the achievement of mathematics in the international stage. This study will focus on the teachers’ understanding about brain-based learning theory, the approach of brain-based learning, the problems and recommended solutions in the implementation of brain-based teaching and learning in the mathematics classroom especially in primary school. Furthermore, this study also will discover the potentials, readiness of the teachers, problems and solutions in implementing brain-based teaching and learning in learning mathematics for primary school. This is very important because
the teacher have to understand the theory first before they it can be implemented in the classroom. This is to ensure that they can successfully implement the theory in their classroom.

1.6 Limitations of the Study

The population of this research is confined to only teachers from primary schools who teach Mathematics subject only. This is a survey research and experimental studies need to be done to find out the efficacy of brain-based teaching and learning in mathematics classroom. This study is only to find out teachers’ understanding on brain-based teaching and learning in a Mathematics classroom within the Malaysian context.

The limitation of the study also includes the definition of brain-based learning, scope of the instrument and respondent honesty in filling the questionnaire which were distributed online. For online questionnaires uploaded via social media (Face book, educational portal and e-mail), it is assumed that all respondents have their password or permission before they logged in. For the issue of whether the purposive sample is the correct sample for the study, the researcher has uploaded the questionnaire to the target group. It is believed that the questionnaire was uploaded to the correct target group because to join the group, an individual has to obtain permission from an administrator of the Face book group. Therefore, if an individual does not meet certain criteria (in this case, a Mathematics teacher), that individual may not gain permission to join this group. The same goes to the distribution of questionnaire on educational portal and to email recipients.
CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

This chapter will discuss the development of brain-based learning. The second section of this chapter will be on neurosciences findings on the learning of arithmetic. This chapter will also discuss brain-compatible-implication for the classroom and an ideal brain-based development of Mathematics abilities in a classroom. This chapter will then look at brain-compatible education, the strategies related to brain-based learning in Mathematics education, and the implications of brain-based learning on Mathematics education. Lastly, it will discuss related theories and the studies on brain-compatible educational.
2.1 The Development of the Brain-based Learning Theory

Since 2,000 years ago, there have been primitive models on how the brain works. Up until the mid-1900’s, the brain is compared to a city’s switchboard. Brain theory in the 1970’s spoke of the right and left-brain. Later on, the concept of the triune brain (a term coined by Paul McClean that refers to the evolution of the human three-part brain) was introduced. In this theory, McClean hypothesized that survival learning is in the lower brain, emotions were in the mid-brain, and higher order thinking took place in the upper brain.

Beginning in late 1980s and the early 1990s, thousands of American teachers became intensely interested in learning about the brain-based multiple intelligences and finding multiple ways to reach their increasing numbers of diverse learners triggered by Howard Gardner’s seminal book Frames of Mind: The Theory of Multiple Intelligence. In this book, educators around the globe were taught to understand the actual connection that it has with learning. Educators and psychologist such as Amstrong (2009), Caine, Caine, and Crowel (1999) and Caine et al. (2009); Golemen (1994); Jensen (1995/2000, 2005); and Sousa (2006) have been forerunners in the BBL movement since the 1990s. All these researchers have helped with disseminating neurological research into research-based academic practices. Geoffrey and Renate Caine’s (1994; Caine, Caine, and Crowell 1999; Caine et al.,2009) twelve principles of brain-based learning was the most popular theory.

Currently, we embrace a whole system of complex brain model. During the last two decades, neuroscientists have been conducting researches that have implications for improved teaching practices. Neuroscience is based on information obtained through autopsies, experiments, and