A META ANALYSIS STUDY ON THE EFFECTIVENESS OF HIGHER ORDER THINKING SKILLS (HOTS) BASED LEARNING IN SCIENCE AND MATHEMATICS SUBJECTS

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Abstrak

Thinking ability is one of the essential components need to be mastered by the students to help them solve problems and face the challenges in various fields of education today. This meta-analysis study will examine the effectiveness of learning based on Higher Order Thinking Skills (HOTS) in Science and Mathematics. HOTS-based learning environment involves establishing ways of thinking and the acquisition of students' knowledge through independent learning, active learning and student-centered learning. Online data bases, such as EBSCOhost, ProQuest, SpringerLink, Eric and Google Scholar were used to find relevant studies on HOTS-based learning in Science and Mathematics from 2005 to 2015. A total of 15 samples were selected and the data gathered was analyzed using effect sizes and coding. Six elements of HOTS used to observe the effect of HOTS-based learning are the critical thinking, creative thinking, scientific thinking, problem solving, metacognitive skills and mathematical thinking. Results from the meta-analysis revealed that HOTS greatly influence students' academic achievement and the ability to solve problems. This is because the effect size obtained from the 15 selected studies show the majority of studies reveal a medium effect size. Eight studies showed medium effect size and seven studies showed large effect size. This study also identifies fourteen different types of instruments to track the effectiveness of HOTS elements. The results of this study can also be used for further research focusing on other micro elements of HOTS to identify the effectiveness and impact on any chosen subject.

Keywords : The Effects of HOTS- Based Learning, meta analysis, Science and mathematics subjects.

INTRODUCTION

The Malaysia Education Blue Print (PPPM) 2013-2025 has introduced Kurikulum Standard Sekolah Rendah (KSSR) in 2011 to emphasize on Higher Order Thinking Skills (HOTS) in teaching and learning. This move is made in order to shape highy competitive, creative and innovative students who are able to face challenges in the future. The next generations are the nation's future leaders and it is hoped that these future leaders are equipped with enough skills to face the various changes in various aspects of life such as economics, science and technology, social and humanity. The

future leaders need to have a creative and critical mind to generate new meaningful ideas to find smart solution in dealing with any challenges.

PPPM will continuously uphold the aspiration of the National Education philosophy to implement a balanced education to inspire the students. This plan is carefully established by referring to other high performance education system to specify each detail on specific skills and positive attributes to be inculcated in students in order to equip them with the skills to lead the economics and global world in the future. (Ekshibit 8, PPPM 2013-2025). Six main characteristics have been identified to help students to compete globally, accsess, quality, equity, unity and proficiency. To achieve all these aspirations, HOTS based learning is the answer, for it helps to produce highly competitive students who are creative and innovative. Exam oriented and drilling education system is no longer relevant nowadays. Thus, HOTS are the essential elements in teaching and learning of Science and Mathematics today to keep our education system relevant and competitive in the global arena.

Higher Order Thinking Skills (HOTS) involves various aspects of thinking such as critical thinking, creative thinking, logical thinking, reflective thinking, problem solving skills and metacognitive. Hots are triggered by problems not routines, unsolved problems or dilemmas. According to Boom Taxonomy revised by Anderson & Krathwohi (2001), HOTS involves four processes namely applying, analyzing, evaluating and creating.'

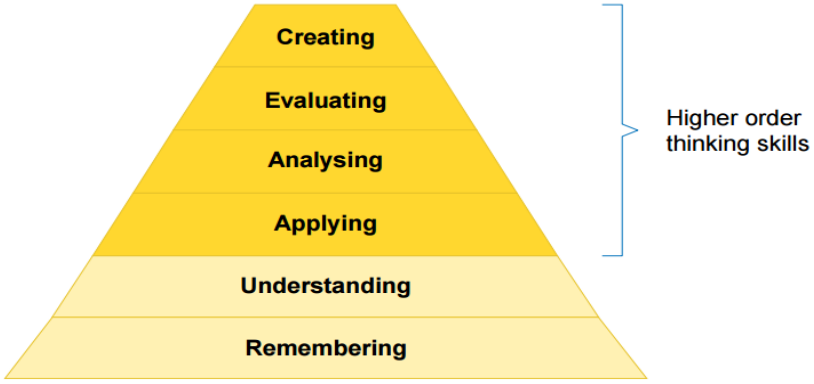


Figure 1 : Bloom's categorization of cognitive process

Onosko & Newman (1994) defined HOTS as the use of potential mind to face new challenges. HOTS require an individual to use new information or existing knowledge to manipulate information until the reasonable answer for the new situation is obtained (Lewis & Smith, 1993).

There are many essential HOTS elements in the teaching and learning of science and mathematics. The essential elements include "Critical thinking", "Creative Thinking", "Mathematical Thinking", "Scientific thinking", "Problem Solving Skills" and "Metacognitive". (Robert Swartz, 2011). Thinking skill is the basic skill that helps to shape the development of a creative education experience among students. The emphasize on thinking skills in all the subjects taught in school stimulates more thinking activity to take place and enables students to think and make a rational, considerate and objective decision. (Abdul Rahim, 1999; Maimunah, 2004).

According to Philips (1997), generally, the development of thinking skills is not really emphasized in schools. Some teachers have the perception that if students were given more freedom to think, they will question, criticize or raise inappropriate issues to discuss in class. Furthermore, some teachers assumed that students are not mature enough to involve themselves in the thinking process or involve in depth in a topic or a concept (Philips, 1997). Indirectly, these conventional assumptions have caused students to not be able to establish their knowledge. The process of the knowledge establishment should blend the existing knowledge and new knowledge received, in order to ensure the smooth running of teaching and learning in class. In establishing the knowledge, students will make inferences, connection, interpretation, evaluation and create new ideas.

PROBLEM STATEMENT

Teachers are too dependent on the conventional teacher - oriented teaching method (PPPM,2012). Therefore, Curriculum Development Centre (2011) has proposed HOTS based teaching as one of the main teaching pedagogy in transforming the education system in Malaysia. The introduction of HOTS based teaching aimed to prepare students with various 21st century skills to help them face challenges in the 21st century and beyond. Teachers are given professional, adequate hands on session to plan, try out, evaluate and learn from their teaching experience. The HOTS knowledge and skills possessed by the teachers are hoped to help produce a more versatile students who are able to apply any element of HOTS in any field they wish to explore in the future.

Generally, Malaysian students' achievement in Science and Mathematics subjects is not encouraging yet. Based on the students' performance in Program for International Student Assessment (PISA) 2009, Malaysia was in the 57th place from 74 countries evaluated, lower than the international average. In addition, the formal report in Trends in Mathematics and Science Study (TIMSS) in 2011 revealed that Malaysia's results are declining as in 16 (1999), 10(2003), 20 (2007) and 26 (2011) from 45 participating nations. These declining results showed that Malaysian students have not fully mastered creative and innovative thinking skills to survive future challenges. Therefore, to compete in global education stream, the teaching and learning of Mathematics needs to include HOTS elements mentioned earlier. The HOTS elements are incorporated in teaching and learning to not only improve Malaysia's performance in PISA and TIMMS to be at the same par with the international standard, but also, to provide a detailed and systematic long term plan to nurture high quality human capitals

to lead our nation. To achieve this aspiration, teachers and students need to work hand in hand and help each other to be a dynamic thinker in global context.

RESEARCH AIM AND OBJECTIVE

This study aimed to review past studies on the incorporation of HOTS elements in the teaching and learning of Science and Mathematics subjects. The main objective of this study is to investigate the effectiveness of HOTS based learning and teaching in Science and Mathematics subjects.

RESEARCH QUESTIONS

Based on literature review, generally, the teaching of learning based on HOTS is not foreign to other subjects such as technical subjects, engineering subjects, language and social sciences subjects. However, this study aims to look at the effectiveness of HOTS based learning to science and mathematics subjects based on the following questions:

1. What are the HOTS elements incorporated in the teaching of Science and Mathematics subjects?
2. What is the effect size of each approach?
3. Is the approach effective in the education context?

RESEACH METHODOLOGY RESEARCH DESIGN

Meta-Analysis is a synthesis study with a quantitative approach which involves measuring the effect size to determine the strength of the relationship between variables (treatment) and dependent variables (e.g effect on achievement) on selected studies. (Gliner et al. 2003).

SELECTION OF STUDIES

The studies involved in this meta-analysis study are studies related to learning based on HOTS which focused on improvement in students' performance and skills. A comprehensive search strategy is implemented to identify potential studies which fulfill research requirement stated above. The search is done through online data bases such as Scopus, EbscoHost, Springerlink, Routledge, Science Direct, ERIC and Google Scholar. The search for relevant studies is limited to the studies published between 2005 and 2015. A few keywords were used to find desired studies such as ("*higher order thinking skills*" OR "*mathematical thinking" OR "Metacognitve" OR "Problem Solving" OR "critical thinking" OR "creative thinking" OR "Scientific Thinking "*) AND("*achievement"* OR "*performance")* The search of the articles for this study is based on the selected six elements and the search alsofocused on the effects of these elements in students' ability, performance and achievement in Science and Mathematics subjects.

DATA EXTRACTION

After article selection is finalized, the selected studies are merged and coded independently. Generally, the characteristics of each study are coded based on these three categories : study design (sample size, HOTS mode, duration of intervention), the characteristics of respondents (age), and the characteristics of the intervention (number of interventions involved, the sample size, subjects specification, and any additional information that helps the calculation of effect size). The list is established upon the recommendation of the previous studies and research articles published studies. Articles are coded to provide a more descriptive information based on the dependent variable such as students' achievement and problem-solving abilities in science and mathematics.

HIGHER ORDER THINKING SKILLS (HOTS)

HOTS are the ability to reason beyond the information given, the establishment of critical awareness of the metacognitive and problem solving abilities. HOTS include critical thinking, logic, reflex, metacognitive and creative thinking skills. These skills are used when making decisions, solving the outstanding problems. HOTS activities are such as searching for scientific function of a system, formulate hypotheses for various purposes, using specific measurement, identifying hypothesis, accept new technology and operations, using their own skill level and determine the needs of each of the skills acquired. Higher order thinking skills is the ability to apply knowledge, skills and values to make reasoning and reflection to solve problems, make decisions, innovate and strive to create something new. (MOE, 2013)

ELEMENTS IN HOTS

Mathematical Thinking

It is vital to inculcate Mathematical thinking skills right from the beginning of the construction process, especially when the child is in elementary school. Math skills require students to think logically. Mathematical thinking skills need to be mastered by elementary school students to help digest the learning of science in higher education (Wimbarti, 2012). The mathematical thinking skills process involves inductive reasoning, deductive and inductive analogy. Inductive reasoning is observing data, correlate the data, observe patterns, summarize data, making generalization and provide evidence. The mathematical thought process is not only very important for proving a theorem and numerical solution, even expression of these elements are very important in solving problems that involve reasoning and Problem solving project based such as those found in Science Project, Experiment and Additional Mathematics Project Work. Generating ideas through logical and mathematical thinking are helpful to generate new ideas to form an argument or a new theorem.

Critical Thinking

Critical thinking is defined as the strategy and the meaningful cognitive skills, as well as having a reason and purpose. (Halpern 1999, p. 70). It requires students to engage actively in the process of finding a concept, analyze, synthesize, evaluate and disseminate information (Scriven and Paul 1996). However, there are a variety of perspectives on critical thinking with a variety of definitions, such as analytical reasoning, problem solving, decision making, and cognitive process. In the pedagogical context, Moon (2008) defines critical thinking as activities such as reflection submissions with regard to student development in learning in higher education. In line with this reasoning, King (1995) suggests that critical thinking skills are included in particular processes including analyzing the arguments presented, to make conclusions, and to make a critical and logical conclusion and evaluate all the relevant elements. Critical thinking can also assess the possible consequences of each decision.

Creative Thinking

Creative thinking is a conscious effort that involves inducing the idea of creativity as well as the creative act on a concept or approach or old features. In short, creativity is the ability to generate a new idea and be able to use these ideas to solve problems faced. Creativity is also defined by looking at the four main aspects of the natural creative talent, the creative product, the creative process and the emphasis on creativity or a condusive environment support the process. Creativity covers the entire brain. Creative thinking is the basis for bringing constant change. Torrance (1969) sees creativity as a process to identify problems, find solutions, make hypotheses, test and evaluate and make decisions. This process includes adding from the original idea to the creation of new ideas. Creativity is usually associated with and reflected in the development of ideas and original and unique products Gallagher (1994). The process of creative thinking requires a very high imagination to generate ideas to form a new idea. This process is very important in the reasoning processes, particularly for science and mathematics.

Scientific Thinking

Scientific Thinking Thought is a scientific effort to determine what is right and wrong in terms of the logic of human thought. Logic is divided into two logical creations of the human mind for example mathematics and secondly, is the logic based on the realities of the real world. Individuals who think using scientific thought is someone who likes to think before making an action. For instance, scientists and individuals who use scientific thinking skills will usually build up a hypothesis in order to embark on a study on any topic. They will collect data related to the topic as much as possible to compare and make an assessment of whether the study will be able to meet the hypothesis or assumptions made in the early stages of the. Scientific thinking skills are necessary especially in experiments, science projects and problem solving activities.

Problem Solving Skills

Problem-Based Learning, founded by John Dewey (1963), and it emphasizes on the importance of learning through experience and then it was popularized by Barrows and Tamblyn in 1980 (Abdull Sukor 2011). Problem Based Learning (PBL) is a learning method that uses real problems that are relevant and meaningful as the main focus in the learning process. These problem-solving skills will enable students to use mathematics step process effectively and could spark ideas on how to solve problems and introduced a new method to a problem or conflict in learning.

Metacognitive Skills

Metacognitive is one kind of awareness and regulation in a thinking process. Metacognitive is a plan for all actions, specific strategies, monitoring the process, evaluate the results, review the plans and strategies. (Robert Swartz, National Center For Teaching Thinking USA). Ranking of metacognitive is guided to perform this type of thinking, planning how to get the next thought process when necessary, reflective evaluation of the effectiveness of the strategies used, understand the strategies used to think and be aware of the thought process used.

RESEARCH FINDINGS

Criteria of the studies selected

A total of 15 studies analyzed met the criteria of HOTS-based learning and relevant with this study as listed in Table 1. The characteristics of the study were detailed out in Table 3. All of the studies selected were conducted between 2005 and 2015. The total of fivestudies were conducted on primary schools, two studies on secondary schools, seven studies conducted at the university level and one study in pre-school. All 15 studies obtained were those published in the academic journal.

Table 1 : General Criteria of HOTS-Based Learning Study

Criteria	Number of study based on subject		Total
	Mathematics	Sciences	
Year Conducted 2005-2015	6	9	15
Pre School	5	1	1
Primary School			5
Secondary School		2	2
Tertiery Education	1	6	7
Journal Articles	6	9	15

Effect size calculation Matrix

Matrix is used to estimate and explain the effect of HOTS on student achievement is the mean difference effect size (d - index). The matrix introduced is suitable for comparison mean for the two groups (Dochy et al. , 2005; Gijbels et al. 2005).

Table 2: Conversion statistical formula used to calculate effect sizes

Given statistic data	Formulas
Mean and standard deviation in one group	$\frac{\bar{X}_{post} - \bar{X}_{pre}}{SD_{pre}} \frac{\bar{X}_{post} - \bar{X}_{pre}}{SD_{pre}}$
Mean and standard deviation in two groups (post test)	$\frac{\bar{X}_E - \bar{X}_C}{SD_C} \frac{\bar{X}_E - \bar{X}_C}{SD_C}$

If the value of the effect size obtained is large and positive, then this indicates that the variable is a big influence in the group receiving treatment. Therefore, the effect size is reported separately to represent the effects of problem-based learning approach. According to Cohen (1988), the effect size is interpreted as in Table 3.

Table 3 : Effect Size Interpretation

Effect Size	Interpretation
0.2	Small
0.5	Medium
0.8	Large

THE CHOICE OF CALCULATION METHOD

Chambers (2004) describes various methods that can be used to calculate effect sizes of the studies that have been conducted. However, most researchers want to calculate directly as much as possible. The more steps you take, the more mistakes will be made in estimating the size of the effect. One example involving the calculation of the effect size difference is:

1. Min calculated in the design of the study subjects
2. The proportion of the experimental group and the control group.

RESULTS AND DISCUSSION

The Effects of HOTS

The studies presented in this meta-analysis study are limited in small numbers to give a comprehensive overview of research data collected. In addition, the focus of the study was only a meta-analysis to journal articles and not extended to other materials. The study also does not involve materials that are not published. These unpublished materials may have different impact from the published journal article. The main effectsof HOTS on students performance in this study is is summarized in the following table.

Table 4: The Comparison of size effect on the study in science and mathematics subjects.

No	Title	Author	Subject	Dependant Variables	Research Instrument	Effect Size	Code
1	A study on the Effect of Science Activities on Fostering Creativity in Preschool Children	Rasol Abdullah, Farideh Hamidi, Ashraf Anaraki 2009	Science	Creativity Fluency Meticulous	Torrance‟ s Test of Creative Thinking (TTCT)	1.29	a
2.	Effect of Problem Solving Method on Science Process Skills and Academic Achievement.	Elvan Ince Aka, Ezgi Guven, Mustafa Aydogdu 2010	Science	Academic Achievement	Science Process Skills Test Electric Unit Achievement Test	0.742	b
3.	The Effect of The Developed Differentiation Approach On Students‟ Creativity : Cognitive and Affective Factors	Esra Altintas, Ahmet S.Ozdemir 2014	Mathematics	Students Creativity	Mathematics Achievement Test Torrance Creative Test Divergent Feeling Test Multiple Intelligences Inventory	1.23	c
4.	The Effect of creative and critical thinking based laboratory applications on creative and logikal thinking abilities of	Ozlem Koray, Mustafa Koksal 2009	Science	The ability to think logically and creatively	Torrances‟ s Creative Thinking Test Logikal Thinking Test	0.59	d

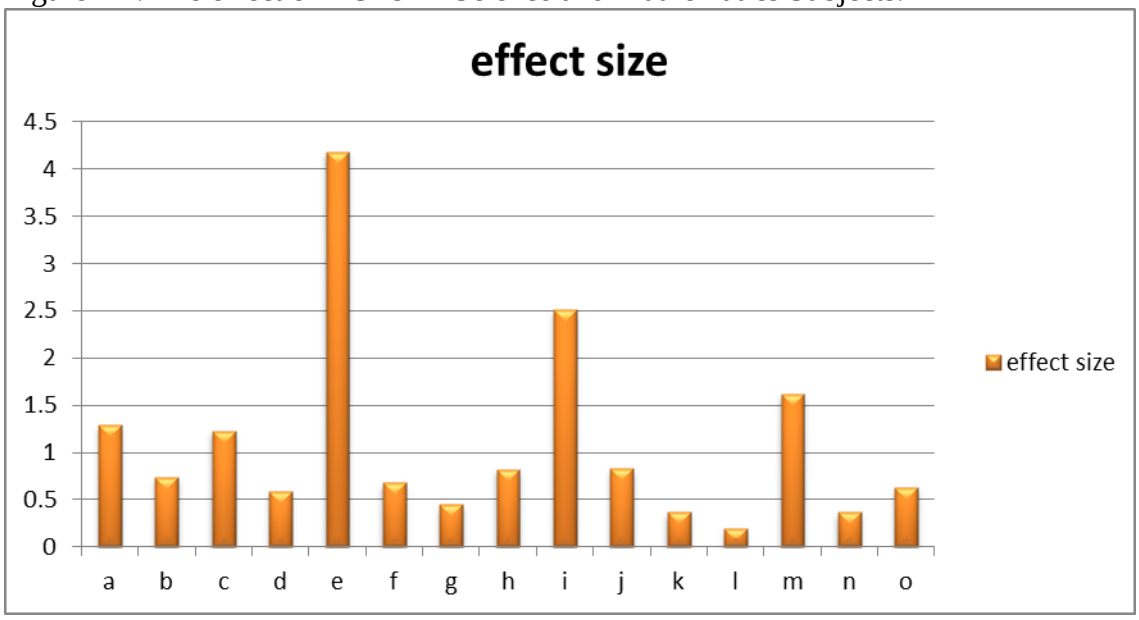
prospective teachers.

5.	Kesan penggunaan perancahan kognitif dalam pembelajaran berasakan masalah terhadap strategi metakognitif, pemikiran saintifik dan pencapaian pelajar dalam mata pelajaran Fizik	Mohd Ali Samsudin, Kamisah Osman&Lilia Halim 2007	Physics	Students achievement	Objective and structured test, Essay Writing	4.18	e
6.	The Impact of the Development of Prospective Teachers‟ Critical Thinking Skills On Scientific Argumentation Training And On Their Ability To Construct An Argument.	Asuman Seda Saracaloglu, Hilal Aktamis, Yesim Delioglu 2011	Science	Critical thinking skills Asking question skills	Concept Test On Unit of Force and Motion California Critical Thinking Dispositions Inventory (CCTDI)	0.682	f
7.	Effects of Active Learning on Enhancing Student Critical Thinking in an Undergraduate General Science Course	Kyoungna Kim, Priya Sharma, Susan M.Land, Kevin P.Furlong 2012	Science	The ability to think and critical report writing skill	Active Learning Module I & II	0.45	g

8.	The Effect of Metacognitive Strategy training on mathematical problem solving achievement	Gokhan Ozsoy, Aysegul Ataman 2009	Mathematics	Achievement in problem solving skills	Mathematical Problem Solving Achievement Test Turkish Version of Metakognitive Skills and Knowledge Assessment (MSA-TR)	0.822	h
9.	Metacognitive Strategies on Classroom Participation and Student Achievement in Senior Secondary School Science Classroom	Helen Ngozi ibe 2009	Science	Students achievement	Metacognitive questions Think-Pair-Share (TPS) strategy	2.51	i
10.	The Impact of Using the Integration Approach between Science and Math on Acquiring the Skills for Solving Scientific Problems for Fourth Grade Students	Sheikla Al Orime, Abdullah Ambusaidi 2011	Mathematics Science	The ability to solve problems in science and mathematics	Scientific Problem skills test	0.83	j
11	The Effect of Geogebra Mathematical and The Level of Van Hiele Geometrical Thinking	Omer Faruk Tutkun, Betul Ozturk 2013	Mathematics	Students Achievement	Geogebra Software Geometric thinking Van Hiele Model	0.369	k
12	Hubungan antara kemahiran berfikir kritis dengan pencapaian akademik dalam kalangan pelajar fakulti pendidikan universiti teknologi Malaysia	Marlina Ali, Shaharom Noordin 2012	Physics	Students scientific reasoning skill level.	Formal classroom Reasoning Test	0.2	l

13	The Effects of Metacognitive Reflective Assessment on Fifth and Sixth Graders‟ Mathematic Achievement	John B.Bond 2013	Mathematics	Performance in Mathematics	Pre test Post test	1.62	m
14	The Effects of Problem Based Learning and Traditional Teaching methods on Students‟ Achivements, Conceptual developments and scinentific process Skills according their graduated High School Types	AslahanKartalTasoglu & Mustafa Bakaqa. 2010	Physics	Achievement, Conceptual development and scientific process skill	Test	0.369	n
15	Mathematical Critical Thinking Ability Through Contextual Teaching and Learning Approach	Kurniati, Yaya S.Kusumah, Jozua Sabandar, Tatang Herman 2015	Mathematics	Students thinking ability and students initial ability.	Mathematical Prior Ability Test (MPA) Mathematical Critical Thinking Ability (MCTA)	0.632	o

Figure 2 : The effect of HOTs in Science and Mathematics Subjects.



The comparison of effect sizes study for Science and Mathematics subjects

Table 5:The effects of HOTs –based learning to students' academic achievement.

Academic Achievement	**Effect Size (ES)**				**Total Number of Studies**
	ES<0.2	**0.2<ES<0.5**	**0.5<ES<0.8**	**0.8<ES**	
Subject in Science and Mathematics	0	4	4	7	15
TOTAL	0	4	4	7	15

The Effects Of HOTS In The Science And Mathematics Subjects.

The largest effect size obtained in studies on science and mathematics subjects is 4.18, while the smallest effect size is 0.2. Studies that have the largest effect size is a study conducted by Mohd Ali Samsudin, Kasimah Osman and Lilia Halim (2007) entitled " Effects of cognitive scaffolding in problem-based learning (PBL) of metacognitive strategies, scientific thinking and students achievement in Physics ". According to the researchers cognitive activities played important roles to provide scaffolding to support students involvedment in problem solving activities. Metacognitive combines elements of memory, comprehension, application, analysis and synthesis can indeed be very important in the learning process in the classroom.

These techniques are integrated into the problem-based learning in the form of guidance and support to students thinking in carrying out an operation when undergoing major steps of learning with HOTS elements. In this study, three cognitive scaffolding technique proposed by Beyer (1977) are used to support the students to perform certain thinking operations such as procedural checklists, questions of process management of

structured and graphics. By applying cognitive scaffolding through problem-solving activities as featured in HOTS elements had a major impact on students performance in Physics.

A study conducted by Marlina Ali, Noordin (2012) showed the smallest size of 0.2. The study entitled " The relationship between critical thinking and academic achievement among students in the Faculty of Education, Universiti Teknologi Malaysia ". Research shows that there is a significant correlation between critical thinking skills, " Creative student performance " and academic achievement but the level of thinking skills based on students' academic year (year one and year four) is still low. The study also suggests that thinking skills should be practiced in learning in the classroom or lecture halls starting from the beginning of the semester.

The study also revealed that students in the first year and students in the fourth year have similar level of critical thinking skills. To sum up, out of the 15 studies on science and mathematics subjects scrutinized, seven studies showed a very large effect size of 0.8 and above. This indicates that HOTS can help in improving students achievement. However, attention should also be given to studies with the small effects size to identify improvements that can be designed and implemented to boost student achievement through incorporation of HOTS in science and mathematics subjects. The entire study shows HOTS elements have been used during the teaching and learning process. Although there are few studies that has shown medium effect size, but there are other factors that contribute to such results. These contributing factors include gender, environment, education level and social level. However, all the findings indicate a significant relationship between HOTS and achievement and students' ability to cope with science and mathematics subjects.

IMPLICATIONS

This meta-analysis study provides the answer to the research questions posed in this research. Firstly, the research question on what is the main effect of HOTS on students' achievement in science and mathematics subjects has been answered with a complete description of the effect size of the selected studies in the field of science and mathematics. The calculation of the effect size of this study implies that almost all studies that use HOTS element in teaching and learning helped to improve students achievement. The results of this meta-analysis study have a lot of similarities with a study conducted by by Mohd Ali Samsudin, Kasimah and Lilia Halim Othman (2007). In the study they discovered that the problem-solving skills, which is one element KBAT have a significant impact on the achievement of low- ability students in the physics exam topics.

The effects of HOTS are clearly stated in the study by Helen Ngozi Ibe stating that HOTS element such as metacognitive has great implications on students achievement in science. Metacognitive element is also described in a study conducted by John B.Bond. Both studies concluded that metacognitive skill is a strategic and vital skill that can motivate students to understand and identify the information received, and apply it in their daily life. Besides, metacognitive also affect students' achievement in

problem solving. Metacognitive is one of the HOTS element that helps control students thinking throughout the learning or thinking (Ozoy, 2008). Students exposed to this activity can correlate the findings and new knowledge to any situation (Ashman and Conway, 1977).

The chosen instruments in the study were Torrance' s Creative Thinking, Logical Thinking Test, Mathematical Problem Achievement Test, metacognitive Questions, Science Process Skills Test, Mathematical Achievement Test, Divergent Thinking and Creative Thinking Test and Critical Mathematical Ability. Each instrument used to measure the effectiveness of this HOTS-based learning in mathematics and science subjects like Physics, Chemistry, Science and Mathematics. In addition, a test instrument with a specific focus such as Geometry Test Test Topical is also used in the study.

CONCLUSION

This meta-analysis study was conducted to analyze and synthesize the findings obtained from studies on HOTS-Based learning and the effect on students' academic performance. This meta-analysis study can be used as a pilot study to analyze the impact of HOTS to students. However, this study focused on the perspective of students' academic achievement only. Hence, the results of this meta-analysis show that HOTS had a great impact on students' academic achievement. This is because the effect size obtained from the15 selected studies show the majority of studies show medium and largeeffect size.A total of seven studies showed the effect size greater than 0.8 with the largest effect size of 4.18. This finding proves that HOTS have a great influence in improving student achievement on science and mathematics subjects.Thus, it is proposed that more study meta-analysis to be carried in the future out to identify the effect of intergration of HOTS elements on other subjects.

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