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Enhancing Primary School Students' Higher Order Thinking Skills in Data Handling through Active Learning with Smart Board

Hon-Mun SOH[a], Abdul Halim Abdullah [b] & Mahani Mokhtar [c]
[a]*School of Education, Universiti Teknologi Malaysia, Malaysia*
[b] *School of Education, Universiti Teknologi Malaysia, Malaysia*
[c] *School of Education, Universiti Teknologi Malaysia, Malaysia*
*munmun1103@live.com.my

Abstract: Data Handling is a very important subtopic in statistics that brings learners out into the real world of seeing data; however, the level of Higher Order Thinking Skills (HOTS) in Data Handling among Malaysian students is declining. Thus, this study was conducted to evaluate the effectiveness of active learning using smart board programme in enhancing HOTS in Data Handling among students in Malaysian primary schools. The quasi-experimental design, non-equivalent control group design with pretest and post-test was used. Ninety year five students were split into three groups equally; two experimental groups (Active learning using smart board programme and active learning instruction) and one control group (conventional learning method). This study was conducted for eight weeks where quantitative data were collected and analysed. Pretest posttest, and a set of rubric for cognitive domain in HOTS were used. ANOVA test results indicated that there were significance differences between the mean scores of post-test. Comparison of the mean score of each cognitive domain for pretest and posttest showed that active learning using smart board programme contributed the largest improvement to students in HOTS regarding Data Handling (applying = 70.9%, analysing = 110.8%, evaluating = 200.4%, and creating = 460.8%). Consequently, active learning using smart board programme can be assumed suitable to be applied in schools with smart board as it could help students enhancing their HOTS effectively.

Keywords: Data Handling, active learning, smart board, higher order thinking skills, primary school

1. Introduction

Since the 1980s and 1990s, the need for higher order thinking skills (HOTS) among students has been documented since complicated real life problems often require complicated solutions, which are gained through higher level thinking processes (McDavitt, 1993; Son and VanSickle, 1993). Through the years, variations in meaning of HOTS have been accrued. King, Goodson, and Rohani (1998) define HOTS as including logical, critical, metacognitive, reflective and creative thinking. HOTS expand the use of mind to cater new challenges (Rajendran, 2008).

In Malaysia, the four levels of cognitive thinking in HOTS are applying, analysing, evaluating and creating (Lembaga Peperiksaan Malaysia, 2013). On the level of applying, students need to use learned material in new and concrete situations. It involves applying rules, methods, concepts, principles, laws and theories (Truschel and Deming, 2007). Next, analysing emphases on the process of investigating and breaking information into various parts through identifying the purposes or reasons to build an organisational structure that can be easily understood (Krathwohl, 2002; Noble, 2004). On the level of evaluating, students need to be able to defend and present ideas by making judgements about information, quality of work based on a set of criteria, or the validity of ideas (Krathwohl, 2002; Noble, 2004). Lastly, in the cognitive domain, creating compiles information from different elements by offering alternative solutions or joining the elements in a new meaning. The major emphasis is given on the formulation of structures or new patterns, creating stresses on a person's creative behaviours and actions (Krathwohl, 2002; Noble, 2004).

Lately, HOTS has been given a major concern in Malaysia mathematics education field, where the Ministry of Education announced the policy that by the year 2000, a minimum of 60% of the public examination questions in Malaysian schools will test the analytical and creative thinking skills of the students. At least 40% of the questions for the Ujian Pencapaian Sekolah Rendah (UPSR) examination are of higher order thinking questions, whereas 50% of the Sijil Pelajaran Malaysia (SPM) questions are of HOTS by 2016 in Malaysian schools (Malaysia Ministry of Education, 2012). This revolution in the mathematics assessments design means that teachers in school will give less emphasis on guessing questions and topics and are asked on the examination and drilling for content recall. Within the Malaysia education system, the steady increase in influence of HOTS is important in mathematics education.

In mathematics education, Data Handling is a crucial aspect of mathematics. Data Handling allows children to make sense of information, to identify patterns and trends and to predict and plan for the future (Griffiths, 2001). It is taught in Malaysian primary schools since students start their first year of schooling. It is an important subtopic of statistics which brings a learner out into the real world of seeing data, reflecting upon it socially or individually, and make decisions from it (Shaughnessy, 1992). However, previous results showed that Malaysian students generally performed badly in data handling in two international assessments namely: Programme for International Student Assessment (PISA) and Trends in International Mathematics and Science Assessment (TIMSS). Generally, the students did not possess HOTS in data handling.

One of the reasons for the low HOTS levels in Malaysia is that the teaching and learning process focuses on lower-level cognitive activities (Idris, 2010; Ng, 2004; Wenglinsky, 2002; Zohar, 2013). A study in the Preliminary Report of the Malaysia Education Blueprint 2013-2025 showed that in most mathematics lessons in primary schools, teachers rely on the lecture format and do not adequately engage students in constructive thinking where the traditional "chalk and talk" methods of teaching and learning were still in use. Most importantly, the learning focus is still on achieving surface-level content understanding or directed at the recalling of facts rather than cultivating HOTS (Malaysia Ministry of Education, 2012). Consequently, systematic and rigorous studies need to be carried out to develop strategies and methods for effective learning and to enhance HOTS among primary school mathematics students in Malaysia.

At the same time, the Malaysian education system is undergoing dramatic change; ICT was integrated into the education system to enhance the overall quality of education. The smart board has become one of the interactive technology tools widely used in schools to facilitate teaching and learning practice. Smart board was introduced by MOE in Malaysia in 2004 (Malaysia Ministry of Education, 2004). Empirical evidence demonstrated that smart board prepares an environment that allows students to construct their knowledge while mastering more advanced thinking skills (Beeland, 2001; Glanville, and Wildhagen, 2007; Marks, 2000; Painter, Whiting, and Wolters, 2005; Smith, Hardman, and Higgins, 2006). The integration of smart board facilitates active learning, which is fundamental to the mastery of skills. Therefore, it is crucial to identify the potential of using smart board with active learning in enhancing HOTS in Data Handling among primary school students. Findings from the data can be used to develop more strategies and activities for effective learning in order to enhance HOTS in Data Handling among primary school students in Malaysia.

2. Research Objective

The objective of this research was:

i. To evaluate the effectiveness of the Active learning using smart board programme in enhancing HOTS in Data Handling among students in Malaysian primary schools.

3. Methodology

This study used quantitative research approach to identify the potential of using smart board with active learning in enhancing HOTS in Data Handling among students in Malaysian primary schools. It was conducted in a Malaysian public primary school. Ninety year five students were involved in the study.

The selection of students in this study was based on purposive sampling. They were from different classes with average academic achievement in mathematics.The quasi-experimental design, nonequivalent control group design with pretest and posttest is used in the study. Based on a quasi-experimental research design, the students are split into three groups equally; two experimental groups and one control group, and then introduced to a change in both experimental groups, i.e., the active learning using smart board programme for one of the experimental groups and active learning instruction for the other experimental group. Meanwhile, the control group uses the conventional learning methods. Three groups are used in this study to compare, check for the significant difference and evaluate the effectiveness of each treatment. The study used pretest, posttest, and a set of rubric for cognitive domain in HOTS. All the research instruments were validated by experts who are knowledgeable in HOTS in mathematics and have many years of experience on the development and design of active learning. The quantitative data collected in this study was analysed based on the descriptive and inferential statistics using SPSS Statistics 23. One-way ANOVA is used to analyse students' scores in the pretest and posttest.

4. The Active Learning Using Smart Board Programme Activities, Active Learning Instruction Activities, and The Conventional Learning Activities

The teaching and learning process of Data Handling consists of set induction, step one, step two, step three and closure. A model of active learning (L. Dee, 2010) is used to design the active learning using smart board programme and the active learning instruction. Teachers can implement various active learning activities effectively and make learning meaningful for every student actively involved. In the other hand, conventional learning method involves the traditional teacher-centred learning with most of the students are in the passive receiver mode. Students usually listen to a lecture in a classroom. Table 1 shows the learning activities of the active learning using smart board programme, active learning instruction, and the conventional learning method.

Table 1

The Learning Activities of Each Teaching and Learning Phase

	Active Learning using Smart Board Programme	Active Learning Instruction	Conventional Learning Method
Set induction	• Experience of observing (Using visualizer and smart board software such as Flipbook, Sphere 2, as well as IQ Interactive Education Platform to demonstrate a divergent event or phenomena by showing pictures or diagrams, a short practical activity, present a problem to be thought through, a video clip or film show through internet and experiment.)	• Experience of observing (Demonstrating a divergent event or phenomena by showing pictures or diagrams, a short practical activity, present a problem to be thought through, a video clip, film show and experiment.)	Teacher demonstrating a divergent event or phenomena by showing pictures or diagrams, present a problem to be thought through.
Step 1	• Dialogue with self • Dialogue with others • Experience of observing • Experience of doing (Using visualizer and smart board software such as Flipbook, Sphere 2, as well as IQ Interactive Education Platform Discussion during experiment, discourses in small groups, brainstorming, concept mapping, practical work, practical work, question-answer session, interview of events, drawing pictures to illustrate science phenomena and presentation.)	• Dialogue with self • Dialogue with others • Experience of observing • Experience of doing (Discussion, experiment, discourse in small groups, brainstorming, concept mapping, practical work, practical work, question-answer session, interview of events, drawing pictures to illustrate science phenomena and presentation.)	Teacher shows the solutions of a problem to students.
Step 2	• Dialogue with self • Dialogue with others • Experience of observing • Experience of doing (Using visualizer and smart board software such as Flipbook, Sphere 2, and IQ Interactive Education Platform during small group discussion, project, investigations, experimentation, demonstration, practical work, simulation and presentation.)	• Dialogue with self • Dialogue with others • Experience of observing • Experience of doing (Small group discussion, project, investigations, experimentation, demonstration, practical work, simulation and presentation.)	Students' small group discussion to solve given problems. Then, teacher shows the solutions.
Step 3	• Experience of doing (Using visualizer and smart board software such as	• Experience of doing (Solving problems in various but related	Individual activities

	Flipbook, Sphere 2, and IQ Interactive Education Platform to solve problems in various but related circumstances, innovating, and worksheets.)	circumstances, innovating, worksheets and writing of individual's report on the project work.)	(worksheets for students)
Closure	• Dialogue with self • Dialogue with others (Using visualizer and smart board software such as Flipbook, Sphere 2, and IQ Interactive Education Platform during group discussion.)	• Dialogue with self • Dialogue with others (Writing of individual's report on the project work, group discussion, personal notes.)	Teaher summarise the lesson.

5. Findings of The Study

The quasi-experimental design, nonequivalent control group design with pretest and posttest design was used to identify the potential of using smart board with active learning in enhancing HOTS in Data Handling among students in Malaysian primary schools. The student were splited into three groups equally; the active learning using smart board programme for experimental group A and active learning instruction for experimental group B. Meanwhile, the control group uses the conventional learning methods. The quantitative data obtained from the pretest and posttest were analysed based on the descriptive and inferential statistics using SPSS Statistics 23. The findings from the quantitative method are presented below:

5.1 Analysis of The Mean of Each Level of The Cognitive Domain in HOTS in Data Handling among Each Student Group

Pretests and posttests were used to discuss the consequences of learning using the active learning using smart board programme, active learning instruction and conventional learning method in enhancing each level of the cognitive domain in HOTS which is applying, analysing, evaluating, and creating in Data Handling among students. The mean score of each cognitive domain between the pretest and posttest of each student group, experimental group A, experimental group B and control group was analysed to show the improvement of the level of HOTS before and after implementing the active learning using smart board programme, active learning instruction and conventional learning methods. Figure 1 shows the result of the analysis.

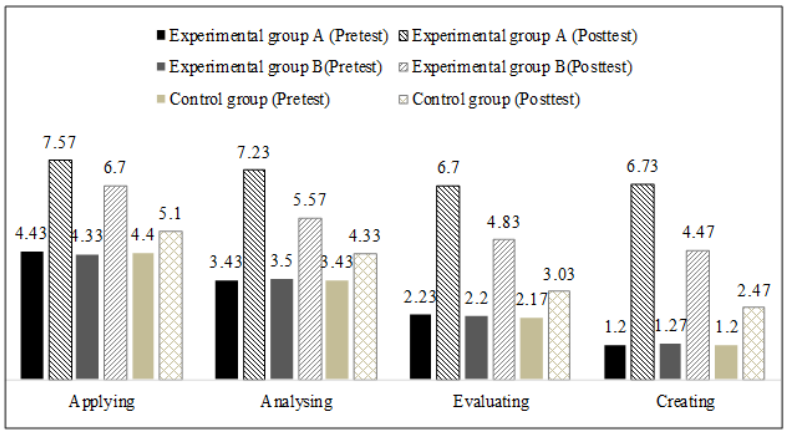

Figure 1. Comparison of The Mean Score of Each Cognitive Domain in HOTS between Pretest and Posttest among Each Student Group.

Regarding Figure 1, the mean score of each cognitive domain in HOTS for the posttest among each student group was significantly higher than the pretest which indicated improvement in HOTS in Data Handling among each student group. Experimental group A which used the active learning using smart board programme in learning Data Handling recorded the largest improvement in HOTS in Data Handling as experimental group A has the largest difference on each cognitive domain in HOTS between pretest and posttest, Applying = 3.14, Analysing = 3.8 Evaluating = 4.47, and Creating = 5.53. In the other hand, control group which used the conventional learning method in learning Data Handling recorded the smallest improvement in HOTS in Data Handling as control group has the

smallest difference on each cognitive domain in HOTS between pretest and posttest, Applying = 1.7, Analysing = 0.9, Evaluating = 0.86, and Creating = 1.27. Besides, the highest mean score is Applying from experimental group A for the pretest, 5.43 as well as posttest, 7.57. The lowest mean score is Creating from experimental group A and control group for the pretest, 1.20; control group for the posttest, 2.47. The highest improvement between the pretest and posttest is Creating from experimental group A, 5.53 and the lowest improvement is Applying from control group A, 0.7.

Next, the difference in mean value is explained by the ANOVA test. Figure 2 shows the analysis from the one-way ANOVA for mean scores of each cognitive domain in HOTS in the posttest. The results indicate that there are significant differences (sig. value = < 0.000) between the mean scores of posttest in the 95% confidence interval. The significance value is < 0.000, which is below 0.05 and therefore, we can conclude that there is a statistically significant treatment effect between the mean scores of each cognitive domain in HOTS in the posttest.

Applying

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	93.956	2	46.978	118.925	.000
Within Groups	34.367	87	.395		
Total	128.322	89			

Analysing

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	127.089	2	63.544	147.817	.000
Within Groups	37.400	87	.430		
Total	164.489	89			

Evaluating

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	201.689	2	100.844	193.106	.000
Within Groups	45.433	87	.522		
Total	247.122	89			

Creating

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	273.422	2	136.711	234.131	.000
Within Groups	50.800	87	.584		
Total	324.222	89			

Figure 2. One-way ANOVA for Mean Scores of Each Cognitive Domain in HOTS in The Posttest.

In conclusion, the findings of the quantitative analysis as discussed above indicate that the active learning using smart board programme is the best method for enhancing creating a domain in Data Handling among students compared with active learning instruction and conventional learning methods.

6. Discussion

From the mean score of each cognitive domain in HOTS between pretest and posttest among each student group as shown in Figure 1, there was an improvement of HOTS among the students. However, experimental group A which used the active learning using smart board programme in learning Data Handling recorded the largest improvement in HOTS in Data Handling. Most of the students were unable to answer the questions that were designed to evaluate their HOTS before the active learning using smart board programme was introduced to them. However, after the students went through the learning of Data Handling with the active learning using smart board programme, they were more able to solve the HOTS questions correctly compared with the students who learn Data Handling using active learning instruction and conventional learning methods. This is indicated by the improvement of the mean scores of each cognitive domain in HOTS in the posttest. A smart board as an interactive technology tool facilitates students' learning practice and enhances HOTS. A similar finding was reported by Beauchamp and Kennewell (2010) in which the interactivity in the classroom by using the smart board is influenced by the students, and when the students' engagements with the smart board change from viewer to the active user. The results from the research were also consistent with those reported by other researchers who use smart board to promote HOTS where smart board is use as an efficient tool for orchestrating the interaction and lesson, students' HOTS can be improved be improved (BECTA, 2008; Jones, Kervin, and McIntosh, 2011; Tenneille, 2012).

7. Conclusion

To put in a nutshell, the findings from this study have shown the potential of the active learning using smart board programme in enhancing each level of HOTS in Data Handling among students in Malaysian primary school. The encouraging results give positive implication to the student of learning Data Handling. Most importantly, the effectiveness of the active learning using smart board programme

has demonstrated the potential of smart board integrates with active learning in supporting learning and enhancing HOTS. Students can actively be involved in building their knowledge, use of various computer resources and effective methods to support students' learning, provides greater flexibility in the presentation of the materials, simulates the real experience and offer students to do the real thing as well as support students mastering more advanced thinking skills. It is clear that learning experiences, which improve the HOTS of the students will soon become a common practice in a rapidly changing technological society. This is of utmost importance as the development of information technology has become ubiquitous in the Malaysian education system. This humble attempt would be resourceful in offering an alternative for technology-supported learning, especially for those who intend to improve their HOTS.

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