# THE APPLICATION OF I-THINK MAPS TO PROMOTE HIGHER ORDER THINKING SKILLS AND SUTDENTS' ACHIEVEMENT IN MATHEMATICS

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## ABSTRACT

**Purpose** – This case study investigated the effectiveness of i-Think thinking map as a learning tool to enhance students' knowledge of two topics in Mathematics which are Statistics and Measurement.

**Methodology** – A cross-sectional study was participated by 18 Semester Two students who were randomly selected from Kolej Kemahiran Tinggi MARA in Negeri Sembilan. The students' achievement in the two topics, Statistics and Measurement were determined based on pre- and post-test assessment. Further to that, the students' ability to draw i-Think maps was also assessed based on a rubric. Teaching and learning interventions were carried out in the classroom using i-Think maps, firstly for the topic Statistics and then, followed by Measurement.

**Findings** – The findings of the study showed that there are significant differences in the mean scores of the pre-test and post-test of the students for the topics of Statistics and Measurement. However, the mean score differences of the students for these two topics were not significant. Findings also showed that there is a significant difference in the students' ability to draw i-Think maps in Statistics and Measurement topics. The scores were higher in the Measurement topics which indicated improvement of using i-Think maps for higher order thinking skills in the second intervention.

**Significance** – It is recommended that future studies should explore the use of i-Think maps in teaching other contents or topics of Mathematics. These findings conclude the benefits of i-Think map as a teaching and learning tool in the classroom for the students. Students achieve better with the use of i-Think maps in their mathematical classroom.

Keywords: i-Think maps, HOTS, students' achievement, mathematics

The transformation process of education outlined in the Malaysia Education Blueprint (MEB) 2013-2025 intends to strengthen basic education and improve capabilities to boost the performance of the national education system. The first transformational wave in the first three years was aimed at improving the performance of the education system through increased support for teachers and students to enhance basic skills (Ministry of Education, 2013). Malaysia also envisions higher student achievement in international assessment such as Trends in International Mathematics and Science Study (TIMSS) and the Program for International Assessment (PISA). Ganapathy and Kaur (2014) stated that the blueprint aims to promote the acquisition of specific skills and attributes comprising of cognitive skills, creative and innovative thinking, and good reasoning. Zulkarami (2011) added that the national education advocates the improvement of students' thinking skills, particularly in higher order thinking skills (HOTS). In the 21st century and particularly in preparing the nation for Industry 4.0 revolution, HOTs are crucial for the success of students. The fourth industrial revolution reflects the advances in internet technology called the Internet of Things (IoT) which are transforming how people communicate with devices, machines and sensors (Meylinda, Faaizah & Naim, 2016). Thus, preparing

learners as active 21st century critical thinker becomes crucial (Ratnaningsih, 2016) so that they are able to deal with challenges brought by these changes.

Creative and critical thinking skills are part of HOTS to ensure learners are capable of solving problems in the 21st century (Brookhart, 2010; Retnawati, Djidu, Kartianon, Ezi & Risqa, 2018). Based on the Bloom taxonomy, HOTS reflect the top three level of cognitive dimension (analyzing, evaluating and creating) and the top three level of knowledge dimension (conceptual, procedural and metacognitive (Thompson, 2008). Students' familiarity with HOTS activities could help them to solve new problems, acclimatize themselves in new environment and making decision about a specific issue (Retnawati et al., 2018). HOTS were identified as one of the student's characteristics of gaining success globally (Mohd Nazri, Ramlee, Nik Azmah & Rosnidar, 2017). The Malaysian primary and secondary education curriculum has emphasized on thinking skills since 1989 (Shamilati, Wan Mazwati & Rahimah, 2017). In fact, the Primary School Assessment (UPSR), the Lower Secondary Assessment (PMR) and the Malaysian Certificate of Education (SPM) have incorporated questions requiring HOTS (Lembaga Peperiksaan Malaysia, 2013). By 2016, 50%, 80% and 75% of questions in the UPSR, Form 3 Based Assessment (PT3) and SPM respectively applied HOTS (Shamilati et al., 2017). Due to these changes, HOTS have become a prominent feature in classroom teaching.

One of the means of promoting the use of HOTS in the classroom is through the application of i-Think Maps. The i-Think Program was introduced by the Ministry of Education to encourage thinking maps as learning tools (Ainon, Haniff & Goh, 2016). According to Muhamad Lintang (2018), i-Think Map improves the students' ability on critical, creative, innovative and analytical skills so that they could adapt and cope with future challenges. Zulnaidi and Zakaria (2010) stated that information mapping strategy like i-Think improve students' conceptual knowledge. It is evident from past studies such as Olarewaju and Awofala (2011) that mapping helps students to master concepts in mathematics. According to Tripto, Assaraf and Amit (2013), the analyzing and synthesizing abilities were strengthened using a concept map. Zaini, Mokhtar and Nawawi (2010) added that the students' comprehension, performance and motivation in learning were improved with the use of graphic organizers. Moreover, a study by Amiruniza (2012) found based on students' feedback on mind map, all of them like to learn using mind maps. Hence, i-Think map is a relevant tool to promote students' ability for HOTS (Siti Ruzila, Roslinda & Effandi, 2016). In this study, the effectiveness i-Think map in promoting the acquisition of conceptual knowledge about Statistics and Measurement, which are two topics of Mathematics was determined among students.

## THE I-THINK MAP CONCEPT

The thinking map or i-Think is a visual tool enambling students to enhance and promote their skills of thinking (Norma, Radzuwan and Noormaizatul Akmar, 2018). It was introduced as a collaboration between the Ministry of Education and the National Innovation Agency to school in Malaysia since 2012 (Siti Ruzila et al., 2016). Hyerle and Yeager (2007) who developed the concept explained that its use in the classroom would generate the thinking and reasoning process as the students complete the map using critical thinking skills. There are eight different kinds of i-Think Maps: The Circle Map, Bubble Map, Double Bubble Map, Tree Map, Brace Map, Flow Map, Multi-Flow Map, and Bridge Map. These thinking maps are used to encourage different thinking processes such as circle map to define in context, bubble map to describe qualities, double bubble map for comparing and contrasting, tree map for classifying, brace map to distinguish part-whole, flow map for sequencing, multi-flow map for showing cause and effect, and bridge map for seeing analogies.

The Bloom's Taxonomy of Thinking explains the distinction of lower order thinking skills (knowledge, comprehension and application) and the higher order thinking skills (analysis, synthesis

and evaluation) (Himmele & Himmele, 2017). Through the use of the eight thinking maps, the students are able to employ visual patterns of thinking to help them in conveying, negotiating and evolving meanings with other students (Hyerle, 2009). The visual-spatial and non-linguistic form of the thinking maps intensify the capacity of students' thinking across content areas (Hyerle & Alper, 2014). Ainon, et al. (2016) explained that by comparing and contrasting, classifying, making inductive and deductive conclusions, and analyzing relationships, the students create values for the content areas that they are trying to understand and reason with.

Based on past studies (Alper, Williams and Hyerle, 2012; Lopez, 2011; Mapeala & Sopiah, 2016; Woodford, 2015), Mansoor, Zahraan and Ahmed (2018) concluded that thinking maps were able to link previous knowledge with newer ones. The learners were able to relate concepts to the activities and organize the content of the lesson as they analyze and categorize ideas. In Malaysia, the application of i-Think to teach various subjects like Mathematics, languages, sciences and others has been encouraged among teachers and numerous studies have been carried out to determine its effectiveness of use in the classroom. According to a study by Muhammad Sidek and Ahamad (2012) on 290 students at Gaal Pasir Puteh Secondary School, it was clearly demonstrated that i-Think map was effective in making students more positive and diligent. Khoo (2017) assessed the effectiveness of using i-Think map in solving mathematics problems in sentences among Year Five pupils in a primary school in Perak. The study involved 55 pupils selected using cluster sampling. Findings of this study showed that pupils in the treatment group scored significantly higher in the post-test, thus implying that the use of i-Think map had improved the pupils' ability to solve mathematics problems presented in sentence format. Mansoor et al. (2018) used thinking maps to teach algebra and assessed its impact on cognitive achievement of second year preparatory students in Saqulta. Using a sample of 110 students who were divided into control and experimental groups, this study has shown that the levels of knowledge, comprehension and application were higher among students in the experimental group compared to the control group. Hence, these studies showed that the students received significant benefits from using I-Think map in learning in the classroom.

## RESEARCH METHOD

This case study was conducted for a period of four months beginning September 2018 to February 2019. A total of 18 Semester 2 students were selected using random sampling from a college, Kolej Kemahiran Tinggi MARA (KKTM) in Negeri Sembilan, Malaysia. These students were taught the topics of Statistics and Measurement of Mathematics using i-Think map as a learning tool. Two research instruments were used to assess the students' performance after being exposed to using i-Think map in their classroom teaching. The first research instrument is the pre and post-tests to determine their understanding of the topics before and after the intervention with i-Think map respectively, and the second research instrument is a drawing task that assesses the students' ability of using and completing the thinking map. These research instruments were validated by three experts with extensive skills and experience in this field. The assessment on content was done by two experts, a MARA lecturer and the head of the Mathematics Panel while assessment on language was done by the head of the English Panel at the college.

The intervention was done twice: Firstly, to teach the Statistics and secondly, to teach the Measurement using i-Think Map. The students' understanding of the concepts for Statistics and Measurement were assessed using pre-test before each intervention and the post-test after the intervention. The pre- and post-test for Statistics consisted of seven subjective questions while Measurement had 20 subjective questions. The test paper was developed based on the Mathematics Syllabus for KKTM. The duration of time given to the students to answer the questions in the test paper was 40 minutes. The students' ability to complete the i-Think map was also assessed after the intervention. The concept map was graded using a rubric. According to Bartels (1995), rubrics are

scoring tools that used a predetermined set of standards to assess criteria that are complex and subjective. The rubrics shown provide the criteria and standards that the instructor uses to evaluate students' work. The students were given the opportunity to choose any one of the i-Think maps and drew them on a given piece of blank paper as a way of assessing their higher order thinking skills.

## RESULTS AND DISCUSSION

The findings of the study were based on the assessment of 18 students (four males and 14 females) who participated in the teaching and learning intervention using i-Think map for the topic of Statistics and Measurement.

### First Intervention on Statistic Topic

Table 1 shows the summary of scores of the students in the pre- and post-test for Statistics. The average score in the pre-test and post-test were 56.51% and 77.40% respectively. The score range in the pre-test was between 23 and 95% while in the post-test was between 30 and 95%. The average score difference was 20.78%.

**Table 1. Summary of Scores for Pre- and Post-Tests for the Statistics Topic**

| Statistics | Pre-Test (%) | Post-Test (%) |
|---|---|---|
| Mean | 56.61 | 77.40 |
| Standard Deviation | 19.46 | 17.26 |
| Range | 72.00 | 65.00 |
| Minimum | 23.00 | 30.00 |
| Maximum | 95.00 | 95.00 |
| Mean of Score Difference | 20.78 | |

A paired sample t-test compared the scores in the pre- and post-test. Table 2 shows there is a significant difference of the mean scores in the pre-test and the post-test ($t = -4.541$, $p < 0.05$). Therefore, this shows that the students were able to improve their understanding of Statistics with the aid of i-Think map in their learning process.

**Table 2. Paired Sample t-Test for the Statistics Topic**

| Test | Mean | Standard Deviation | t | p |
|---|---|---|---|---|
| Pre-Test | 56.61 | 19.46 | -4.541 | 0.000 |
| Post-Test | 77.40 | 17.26 | | |

The assessment of the students' higher order thinking skills based on their ability to draw i-Think Map for Statistics is shown in Table 3. The result shows that the average score of the students is 69.67% with a range between 24 and 56%.

**Table 3. Summary of Scores on i-Think Map Drawings for the Statistics Topic**

| Statistics | Percentage Values |
|---|---|
| Mean | 69.67 |
| Standard Deviation | 6.145 |
| Range | 24.00 |
| Minimum | 56.00 |

| | |
|---|---|
| Maximum | 80.00 |

**Second Intervention on Measurement Topic**

In the second phase of intervention, the students used i-Think map to learn Measurement. Table 4 presents the result of the summary of their scores for the pre- and post-test for of the Measurement topic. The mean scores in the pre-test and post -test were 56.22% and 73.33% respectively. The range of scores in the pre-test was between 29 and 82% while in the post-test, the score range was between 30 and 100% with a mean score difference of 17.11.

**Table 4. Summary of Scores for Pre- and Post-Tests for the Measurement Topic**

| Statistics | Pre-Test (%) | Post-Test (%) |
|---|---|---|
| Mean | 56.22 | 73.33 |
| Standard Deviation | 17.66 | 17.97 |
| Range | 53.00 | 61.00 |
| Minimum | 29.00 | 39.00 |
| Maximum | 82.00 | 100.00 |
| Mean of Score Difference | 17.11 | |

Table 5 shows the result of the paired sample t-test for the Measurement. There is a significant difference in the mean scores of the students in the pre-test and post-test for Measurement ($t = -8.282$, $p < 0.05$). Hence, it concludes that students were able to improve their understanding of the concept of Measurement with the use of i-Think map.

**Table 5. Paired Sample t-Test for the Measurement Topic**

| Test | Mean | Standard Deviation | t | p |
|---|---|---|---|---|
| Pre-Test | 56.22 | 17.66 | -7.282 | 0.000 |
| Post-Test | 73.33 | 17.97 | | |

The assessment of students' higher order thinking skills based on their i-Think map drawing for Measurement is presented in Table 6. The result shows that the mean score of the students for drawing i-Think map for the Measurement topic was 74%.

**Table 6. Summary of Scores on i-Think Map Drawings for the Measurement Topic**

| Statistics | Percentage Values |
|---|---|
| Mean | 74.00 |
| Standard Deviation | 5.53 |
| Range | 24.00 |
| Minimum | 60.00 |
| Maximum | 84.00 |

**Comparison of Students' Improvement for Statistics and Measurement Topics**

The score difference for the topics of Statistics and Measurement indicates the improvement of the students from the pre-test (before intervention) and post-test (after intervention). A comparison on the score difference for these two topics was done using paired sample t-test. The result as shown in Table 7 shows that there is no significant difference in the mean score difference of the students for the Statistics and Measurement topics ($t = 0.619$, $p > 0.05$). Hence, this shows that i-Think map can improve students' performance in both topics.

**Table 7. Paired Sample t-Test for Comparing Score Difference in the Statistics and Measurement Topics**

| Topics | Mean | Standard Deviation | t | p |
|---|---|---|---|---|
| Statistics | 20.78 | 19.41 | 0.619 | 0.544 |
| Measurement | 17.11 | 9.97 | | |

**Comparison of Students' Drawing of i-Think Map for the Statistics and Measurement Topics**

The students' scores for drawing the I-Think map for the topics of Statistics and Measurement were compared using paired sample t-test. The result as shown in Table 8 shows that there is a significant difference in the mean score of the students for i-Think Map drawing for the Statistics and Measurement topics ($t = -7.657$, $p < 0.05$). The significant difference may be contributed by the students' greater experience of using and drawing i-Think map in the second intervention when they learned Measurement after learning Statistics in the first intervention.

**Table 8. Paired Sample t-Test for Comparing Scores of i-Think Drawing in the Statistics and Measurement Topics**

| Topics | Mean | Standard Deviation | t | p |
|---|---|---|---|---|
| Statistics | 69.67 | 6.15 | -7.657 | 0.000 |
| Measurement | 74.00 | 5.53 | | |

The result of this study shows that using i-Think as a learning tool in the classroom was able to enhance students' understanding of the concepts of Statistics and Measurement in Mathematics effectively. This agrees with findings of past studies which had also shown positive improvement of the students' achievement for learning other topics in Mathematics (Muhammad Sidek & Ahmad, 2012; Khoo, 2017; Mansoor et al., 2018). These findings also implied that the use of thinking maps in the mathematics classroom was able to foster the students' thoughts (Kumari and Kumari, 2013). Based on the students' scores of drawing the i-Think map for both the topics of Statistics and Measurement, it was shown that the students were able to use a variety of ways using their HOTS (Hyerle, 2011). The use of i-Think is versatile and adaptive to variation in contents (Long & Carlson, 2011; Muhammad Lintang, 2018). Therefore, its use as a teaching and learning tool in the classroom is indeed beneficial to the teachers and students. This leads to the practical implications that teachers must develop their skills and become well-adept to using thinking maps in the classroom. By using i-Think maps, the teachers are able to enhance and promote critical thinking skills in the teaching and learning process, and thus contributing significantly to the preparation of the students to face the challenges of the 21$^{st}$ century. Learning with the aid of effective tools like i-Think gets the students to explore their world. Eventually the skills they learn using the thinking map can be transferred to cope with problem solving and decision-making in daily life. Wahidah (2011) added that the use of an effective learning strategy can boost the academic excellence as envisioned in the MEB 2013-2025.

## CONCLUSION

This study concludes that i-Think map is an important learning tool in the classroom to learn abstract topics in Mathematics like Statistics and Measurement. Its continuous use in the classroom equips the students with the skills to draw i-Think map which can help them in developing their higher order thinking skills. The complexity of contents and problems in mathematics require the students to develop their HOTS so they gain mastery of the subject. In summation, this study confirms findings from past studies that showed the effectiveness of i-Think to improve students' performance in Mathematics. Further studies should explore whether similar results can be generated for any topics in Mathematics.

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