

INCULCATING HIGHER-ORDER THINKING SKILLS IN MATHEMATICS: WHY IS IT SO HARD?

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Despite the challenges in delivering the content of the mathematics syllabus, teachers nowadays are also facing difficulties in catering for a wide range of students' abilities. Each student has the ability to learn mathematics at a different rate. However, students' potential for learning mathematics can be lost if it is not discovered and supported at the appropriate time (Borovik and Gardiner, 2006). Throughout the transformation of education in Malaysia, which emphasizes higher-order thinking skills among students, students' performance in mathematics has persistently been poor. Therefore, this study will highlight the challenges mathematics teachers face in inculcating higher-order thinking skills among students. This study was conducted with 160 mathematics teachers who were selected from secondary schools in Johor state. All the respondents were asked to give their response to the open ended questions regarding the difficulties they faced in teaching higher-order thinking skills. All the collected data were analysed by thematic analysis. The result showed that three main factors (teachers, students, and others) contribute to the challenges mathematics teachers face in inculcating higher order thinking skills. Based on the result, this study could serve as a guideline to provide intervention in addressing the corresponding challenges faced by mathematics teachers in inculcating higher-order thinking skills among students

Keywords: Challenges, Mathematics Teachers, Higher-Order Thinking Skills.

1. INTRODUCTION

Teachers have given various reactions to the current trends in the Malaysian education system, which emphasize elements of higher-order thinking skills. The Malaysian education policy focuses more on student outcome as a tool to measure the effectiveness of the transformation undertaken in education (Ministry of Education, 2014). However, despite emphasizing students' performance in language subjects, the element of higher-order thinking skills has become one of the main elements to be integrated among students (Ministry of Education, 2014). The efforts to foster higher-order thinking skills among students is aligned with the current Malaysian Education Plan 2013, which outlines the importance of higher-order thinking skills, with the aim being to produce students who are competitive, creative, critical, and able to compete at an international level (Ministry of Education, 2014).

Many reports and scientific studies have highlighted the shortcomings of the performance of Malaysian students in international assessments, such as TIMSS and PISA. It can be argued that the performance of Malaysian students in TIMSS

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and PISA should not be accepted at face value. This is because there are students who cannot perceive the importance of being involved in such assessments. Consequently, they do not put much effort into answering the questions they are given. However, the students' poor achievement in national examinations for primary and secondary school students with the increased emphasis on higher-order thinking skills questions serves as solid evidence of students' lack of mastery in higher-order thinking skills.

The weak performances of Malaysian students in international and local assessments demonstrate that the intended target set by the Ministry of Education has not yet been fully achieved. Hence, the factors that hinder students' mastery of higher order thinking skills in mathematics should be explored. Previous studies have identified various factors that lead to the poor achievement of students in mathematics, such as the students' demotivation (Zachariah, Mbugua, George and George, 2012; Abdul Halim Abdullah, Mahani Mokhtar, Noor Dayana Abd Halim, Dayana Farzeeha Ali, Lokman Mohd Tahir and Umar Haiyat Abdul Kohar, 2017), feelings of anxiety (Puteh, 2002), negative perception and attitude (Arem, 2003), mathematics phobia (Paul and Hlanganipai, 2014), and a lack of problem solving skills in mathematics (Galadima and Yusha, 2007). However, those studies have not been conducted in the specific domain of learning higher-order thinking skills in mathematics.

The nature of higher-order thinking skills, which are complex and need good analysis skills, means greater effort is required from the teachers and students in order to master the skills. Thus, teachers must show a high commitment along with positive efforts to implement best practices in teaching and learning (Norziati, 2016). Teachers must be aware of the rapid changes and challenges they need to face in order to ensure the higher-order thinking skills are implemented in accordance with the agenda set by the government (Winters, Greene and Costrich, 2008). Previous studies have been conducted by focusing on teachers' competencies to teach higher-order thinking skills. Teacher innovativeness and creativity (Hargreaves, 2003), applying good assessment methods (Chai, Koh, Tsai and Tan, 2011), and implementing appropriate strategies (Fullan, 2014) are important qualities to inculcate higher-order thinking skills. As well as identifying teachers' proficiency to teach higher-order thinking skills, there is a need to look into the factors that will affect teachers' efforts to inculcate higher-order thinking skills in students.

Based on the above issues, this study seeks to explore the challenges involved in inculcating higher-order thinking skills in teaching mathematics. Specifically, this study will critically examine the various factors regarding teachers, students, and other aspects that hinder the efforts to foster higher-order thinking skills among students.

3. METHODOLOGY

This study used a case study design. The case referred to is the respondents of this study. The sample comprised 160 secondary school mathematics teachers from 40 schools which included day schools, excellent cluster schools, and high performance schools in Johor state. All the respondents were asked to give their response to open ended questions regarding all the challenges or difficulties they faced when inculcating higher order thinking skills in students in the classrooms. All the teachers’ responses were then analysed by using thematic analysis by classifying the responses into the main common themes. Next, all the responses in the same main common theme were examined thoroughly and categorized into common sub themes. In addition, the respondents were also asked to give their opinions on the alternatives that should be considered to minimize the challenges or difficulties that they had identified.

4. RESULT

The results of the thematic analysis found that there were three main common themes regarding the challenges or difficulties faced by the teachers in order to inculcate higher order thinking skills; these involved factors regarding teachers, students, and other aspects.

4.1 Teachers’ Factors

For the teachers’ factors, there were three main sub themes identified, namely, lack of understanding and knowledge, lack of readiness, and lack of confidence as stated in Table 1.

TABLE 1: TEACHERS’ FACTORS

<i>Theme</i>	<i>Subtheme</i>	<i>Elements</i>
Teacher	Lack of Understandings and Knowledge	<ol style="list-style-type: none"> 1. Poor in developing HOTS questions 2. Poor in implementing teaching and learning (T&L) that inculcates HOTS element 3. Poor in questioning technique 4. Confuse the needs of HOTS questions 5. Cannot explain the steps in solving HOTS questions well
	Lack of Readiness	<ol style="list-style-type: none"> 1. Not interested in inculcating HOTS element to the students 2. Does not apply teaching that integrates HOTS element consistently and systematically
	Lack of Confidence	<ol style="list-style-type: none"> 1. Applies traditional teaching method 2. Teaches only the most capable students 3. Always refers to answer scheme

Many teachers stated that they still lacked the understanding needed to develop questions that fulfil the requirement of higher-order thinking skills questions. The teachers were unable to differentiate adequately the keywords specific for a particular level of higher-order thinking skills questions. Besides, the teachers were more confused when there were keywords that could be used for more than one level of higher-order thinking skills. In addition, some teachers admitted that they had poor pedagogical skills in teaching higher-order thinking skills. They could not choose the appropriate teaching approach, method, and technique that could help to enhance students' understanding. There were also teachers who still tended to use traditional methods in teaching higher-order thinking skills to the students.

Specifically, one of the teaching techniques not mastered by the teachers was the questioning technique. Some of the teachers were confused regarding the need for higher-order thinking questions. When this situation occurred, the teachers faced difficulties in posing questions to the students and found it difficult to explain the steps involved in solving those particular questions. In contrast, there was also group of teachers who could understand the requirements of the higher-order thinking skills questions. However, they were still facing the same challenges to create questions to ask the students and to describe the problem-solving steps. This is because the students' understanding was poor regarding higher-order thinking skills questions (as will be described in the section on students' factors).

The next common challenge faced by the teachers was a lack of readiness. This challenge was experienced not only by the senior teachers, but also by the newly qualified teachers. Since the emphasis on higher-order thinking skills in the Malaysian education context is still new, there were teachers who were not applying teaching that integrated the higher-order thinking skills element consistently and systematically in the classroom. Furthermore, there were teachers who had no interest in inculcating higher-order thinking skills elements in students. The poor application of teaching of higher-order thinking skills to the students could be due to the lack of exposure and training regarding this issue.

Lastly, some of teachers showed a lack of confidence in teaching higher-order thinking skills especially to low achieving students. As the teachers knew the level of students' ability they teach, they had low efficacy in delivering the learning content regarding higher-order thinking skills. As a consequence, the teachers would apply traditional teaching methods and not use any innovations in their teaching. The teachers would try to teach higher-order thinking skills only to the high achieving students. Besides, teachers who lacked sufficient confidence to teach higher-order thinking skills due to their lack of understanding were always referring to the answer scheme while teaching higher-order thinking skills questions to the students.

4.2 Students’ Factors

Regarding the students’ factors, there were three common sub themes identified, namely, lack of basic knowledge, negative perception, and lack of motivation of the students, as stated in Table 2.

TABLE 2: STUDENTS FACTORS

<i>Theme</i>	<i>Subtheme</i>	<i>Elements</i>
Student	Lack of Basic knowledge	<ol style="list-style-type: none"> 1. Poor skills of basic mathematics concepts 2. Poor skills in basic mathematics operations 3. Poor skills in basic mathematics calculation 4. Inability to understand Malay/English term in the question 5. Lacked reading skills
	Negative Perception	<ol style="list-style-type: none"> 1. Perceived HOTS questions as difficult to solve 2. Perceived themselves as unable solve the HOTS questions
	Lack of Interest /Motivation/Lazy	<ol style="list-style-type: none"> 1. Think/Solve/Read lengthy HOTS questions 2. Think/Solve/Read complex HOTS questions

Most of the respondents in this study mentioned that most students faced difficulties when answering higher-order thinking skills questions due to poor skills in basic mathematics concepts, in carrying out mathematics operations (addition, subtraction, multiplication and division), and in conducting basic mathematical calculations. Moreover, one group of students lacked the necessary reading skills or had only a poor reading ability. Some students, who came from non-Malay schools (Chinese or Indian primary schools), could not read either Malay or English. This is a major challenge to the teachers when teaching higher-order thinking skills to those particular students. Besides, another group of students, regardless of their mother tongue, sometimes could not understand some of the terms used in the higher-order thinking skills questions that were being posed.

Besides lacking knowledge, students held a negative perception of the higher-order thinking skills questions. Most of the students perceived higher-order thinking skills questions as difficult to solve, as solving them involves complex steps. This negative perception eventually induces other negative perceptions among students so they conclude that they will never get the solution for higher-order thinking skills questions easily. Students’ negative perception was also interrelated with students’ lack of motivation or interest regarding higher-order thinking skills questions. A majority of teachers stated that students were not interested and were too lazy to read lengthy and complex higher-order thinking skills questions. As a result, the students would leave the question without attempting to solve it.

5. OTHERS FACTORS

As well as the teachers' and students' factors, there were also other challenges faced by the teachers, including time constraints, students' diversity, and the lack of resources, as stated in Table 3.

TABLE 3: OTHER FACTORS

<i>Theme</i>	<i>Subtheme</i>	<i>Elements</i>
Others	Time Constraints	1. Too much learning content in syllabus 2. Too great a workload
	Students' Diversity	1. Too many students in a class 2. Students' different levels of ability
	Lack of Resources	1. Lack of teaching aids 2. Poor internet access 3. Lack of reference books 4. Limited number of HOTS items in bank

Teachers in this study mentioned that the extensive workload and excessive learning content were the other major challenges that represented a hindrance to inculcating higher-order thinking skills. In addition, teachers who were teaching low achieving students needed more time to give explanations of higher-order thinking skills questions. Next, large class sizes is an issue in a majority of day schools, as it also means students in the class have a diverse range of abilities. Therefore, teachers were unable to focus on those students who need extra attention to master higher-order thinking skills. Lastly, teachers faced problems to integrate higher-order thinking skills as the schools had limitations regarding teaching aids, infrastructure, and facilities (projector, mathematics lab, internet connection etc.). Teachers also had limited reference books, especially for questions regarding higher-order thinking skills, as there were not many books or item banks available in the market.

6. DISCUSSIONS

Teachers, students, and other contextual factors seem to be the factors that contribute to the challenges in inculcating higher-order thinking skills in the students. As an emphasis on higher-order thinking skills is the main focus in Malaysia (Ministry of Education, 2014), teacher knowledge on how to develop questions in higher-order thinking skills is very important. A lack of knowledge in developing higher-order thinking questions is one of the hindering factors in implementing teaching and learning to inculcate the higher-order thinking skills element in the classroom (Saad, Nagappan, Ratnavadiel, Yasin, Hin and Radzi, 2009; Daritas and Akdemir, 2009). Besides, knowing how to pose questions to the students is an important technique

teachers should have (Nathan Bond, 2007), as a good questioning technique is useful to attract students' attention when they are less interested or are bored in classroom. A good technique can help the students engage with the learning again (Nathan Bond, 2007). In the context of learning mathematics, some teachers seem to have poor questioning techniques especially when it comes to higher-order thinking skills questions. Teachers are still unable to choose appropriate terms or use simple sentences to give explanations to the students. In addition, teaching in class is related to good questioning techniques in order to enhance students' higher-order thinking skills.

Other problems teachers' faces in inculcating higher-order thinking skills include their confusion regarding what is needed to deal with higher-order thinking skills questions. Solving higher-order thinking skills questions requires teachers to think critically and creatively, to make judgements, and to analyze thoroughly; thus, teachers feel confused about what the questions actually require (Zohar and Dori, 2003). Teachers' confusion in identifying the requirements of higher-order thinking skills questions will eventually lead to their inability to explain the corresponding steps involved in solving the questions (Barak and Dori, 2009; Miri, Ben-Chiam and Zoller, 2007). It is exacerbated when the question can be solved using more than one procedure.

Education systems which aim to integrate elements of higher-order thinking skills in the teaching and learning process prompt different reactions in teachers. One group of teachers seemed to have a negative perception, arguing that they were not fully ready to implement this element of the syllabus; they showed no interest in inculcating higher-order thinking skills in the students. Those teachers will ignore the need to include the elements of higher-order thinking skills in their teaching (Daritas and Akdemir, 2009; Beswick, 2006). Teachers' lack of readiness tends to mean teachers did not integrate the higher-order thinking skills consistently and systematically (Singh *et al.*, 2010; Hamidah, 2004). This usually happened when the teachers are teaching the low achieving students. The teachers feel that they are wasting their time as they need to consume more time giving explanations to the students who have poor basic mathematical skills.

Besides that, lack of knowledge and readiness to inculcate higher-order thinking skills leads to a lack of confidence among mathematics teachers. When it comes to the emotional reactions of the teachers, a majority of the mathematics teachers feel that applying the traditional teaching method was the best way (Hargreaves, 2003; Daritas and Ademir, 2009; Hamidah, 2004) to cater for all the students in the classroom and to manage the low achieving students. This is because some students learn best using traditional learning methods. In addition, some of the teachers thought that teaching higher-order thinking skills is suitable for only high achieving groups of students. This is because combining mixed abilities students in a classroom

requires teachers to select a good, appropriate, and suitable teaching strategies and methods in order to attract and control all the students in classroom (Bill and Melinda, 2006). Aligned with teaching higher-order thinking skills in a classroom where students have a wide range of abilities, this represents a huge challenge to mathematics teachers when teaching the students.

The final factors that hinder mathematics teachers in inculcating higher-order thinking skills are the teachers' lack of confidence to explain to the students the steps in finding a solution to the higher order thinking questions. As a consequence, teachers tend to refer to the answer scheme while giving explanations to the students (Barak and Dori, 2009; Miri, Ben-Chiam and Zoller, 2007). Thus, the teaching and learning process becomes stiff, and teachers will not explore other possible solutions.

The major problem students' face in solving higher-order thinking skills questions is their lack of basic mathematical knowledge. As the higher-order thinking skills questions consist of various specific words, the students are unable to transform the requirements of the questions to a correct mathematical form. Students' inability to convert mathematics questions into mathematics operations and equations is due to their poor skills in basic mathematical concepts and knowledge (Singh, Rahman, and Hoon, 2010; Geary, 2004). Besides that, low achieving students with learning difficulties will face problems in understanding the Malay or English terms used in the higher-order thinking skills questions. This creates a significant problem for students who have poor reading skills (Singh *et al.*, 2010, Geary, 2004).

Poor reading skills and a poor ability to understand the higher-order thinking skills problems will eventually develop a negative attitude or perception among students. The students tend to perceive all the higher-order thinking skills questions as being difficult and feel it is impossible for them to get the correct solutions (Gomez-Chacon, 2000; Ho and Hyun, 2011; Mohd Rustam, 2016). The negative attitude will lead to the students' poor performance in answering the higher-order thinking skills questions.

On top of the students' factors that have been described, students' lack of motivation and laziness are obstacles for mathematics teachers who aim to inculcate higher-order thinking skills in the students. Students not only make no attempt to solve or think out lengthy or complex higher-order thinking skills questions, but they do not even want to read the questions.

In the context of Malaysian education, the large number of students in a class is an issue that has always been obstacles to effective teaching (Bill and Melinda, 2006). Especially at day schools, the number of students in a class sometimes exceeds 30. This situation will eventually require the teacher to cater for students with mixed mathematical abilities and performances (Bill and Melinda, 2006).

Teaching higher-order thinking in such a classroom will be a challenge to the teacher, as they will have to identify the different needs of a range of students.

Students' diversity in a class is sometimes used as an excuse for the teacher not to implement higher-order thinking skills with the students, as the teachers argue that there is too much learning content in the syllabus (Saad *et al.*, 2009); there are too many topics and subtopics that need to be taught in the mathematics curriculum. Even though teachers do not necessarily need to integrate the higher-order thinking skills in all the topics, having too great a workload besides the learning tasks will demotivated the teachers (Corry, 2015).

In addition, another problem that teachers faced in inculcating higher-order thinking skills in students is the lack of resources, such as teaching aids and poor internet access. Nowadays, technology has become a huge part of life, and it can be a resource to promote learning and attract students' attention and expand their ideas (diSessa, 2000; Wersch, 1985). Thus, poor internet access and a lack of teaching aids are factors that prevent the teachers from making the teaching and learning process more interesting in accordance with the aim of the Ministry of Education to integrate the higher-order thinking skills in the classroom. Finally, the lack of reference books that deal with higher-order thinking skills questions and the limited numbers of higher-order thinking skills items in the resource bank is a challenge for teachers wanting to inculcate higher-order thinking skills. The reference book is an important resource for the teachers to produce effective teaching, as it offers guidelines for teachers on how to teach such skills to the students (Ma, 1999; Ontario Ministry of Education, 2004). Besides, the reference books play an important role as an additional resource to the mathematics textbook for the knowledge development of mathematics teachers regarding higher-order thinking skills.

7. CONCLUSION

In order to produce human capital that can compete globally, an important element to be considered is critical and creative thinking. Thus, the Ministry of Education took the initiative to integrate elements of higher order thinking skills in the learning process. However, the aims to implement the higher-order thinking skills among students gave rise to various reactions by different parties including the teachers, students, and parents. The negative reaction shown by different parties had a negative effect and thus the effort of fostering higher order thinking skills was less effective. The negative attitudes of teachers and students can lead to the failure of efforts to increase students' performance in higher-order thinking skills.

Teachers who are not interested in fostering higher-order thinking skills to students will cause inconsistencies in teaching that involves elements of higher-order thinking skills, and there will be no innovation in their teaching methods.

These teachers are more likely to apply traditional teaching methods in the classroom. Specifically, mathematics teachers' competency in inculcating higher-order thinking skills has a huge impact on the students. The lack of interest in implementing or enhancing students' abilities to use higher-order thinking will not help students in achieving well when learning mathematics.

Besides, students who show a negative attitude towards learning that involves elements of higher-order thinking skills, such as being lazy and lacking motivation to solve the questions, will depend on their teachers to get the answer. This shows that the students will also show less initiative to answer questions and will not have confidence in themselves to solve independently problems that involve elements of higher order thinking skills.

Furthermore, the lack of facilities is also one of the hindering factors leading to the ineffectiveness in inculcating higher-order thinking skills among students. Poor facilities will cause students to be bored in class and make them less willing to participate in learning. In the current era of education, students focus on gadgets and require something interesting that can attract their attention. Thus, dull teaching methods and no innovation will make the teaching uninteresting to the students because the previous teaching methods such as chalk and talk, and drill and practice are the common methods used by the teachers and such methods cannot help to inculcate higher-order thinking skills in students.

In conclusion, the success of the increasing dominance of higher-order thinking skills requires cooperation from various parties. Therefore, all the issues discussed in this study should be emphasized so that the process of inculcating and fostering higher-order thinking skills in students can be enhanced.

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