Implementation of Higher Order Thinking Skills in Teaching Of Science: A Case Study in Malaysia

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***Abstract* — Higher order thinking skills (HOTS) is a skill that should be present in every teaching. Teaching science particularly require teachers to be skillful in planning learning activities that can inculcate thinking skills among students. This study aims to explore the perceptions of science teachers in the implementation higher order thinking skills in teaching science. This is a qualitative case study involving three science teachers who teaches in government school, private school and private tuition center respectively. Data were collected through interviews only. Data were then categorized to form themes for the study. The focus of the study was teachers' perspective, towards HOTS, its application, assessment of HOTS and the constraints. The results show that the teachers are aware and they are applying HOTS in their teaching. However, they believe they are hindered by some constraints. Therefore this study concluded that knowledge and competence are crucial to ensure quality the implementation of HOTS.**

***Keywords* — Teaching efficacy, Evaluation, Teaching Science, Thinking skill**

I. Introduction

Higher Order thinking Skills (HOTS) refers to the ability to apply knowledge, skills and values in reasoning, reflection, problem solving, decision making, innovating and creating something new (Ministry of Education [MOE], 2013). In the 21st century pedagogy, teachers are expected to inculcate HOTS elements to encourage deeper thinking activities among students. This is in line with the aspiration of the Malaysian Education Blueprint 2013-2025. Thinking skills which is the most basic skills that can be developed in the classroom and is the key to high achievement for all students (Nessel & Graham, 2007). The concept of higher order thinking (HOT) originated from the Bloom (1956) taxonomy of cognitive domain (Forehand, 2010), these cognitive domains involves knowledge and the development of intellectual skills and in hierarchically ordered from concrete knowledge to abstract (Pappas et al., 2012). Now, HOTS comprise of logical thinking, critical thinking and reasoning skills which are the basic skills for daily life, apart from the academic achievements (Marshall & Horton, 2011).

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Application of HOTS in pedagogy and assessment for example, through inquiry-based learning and high-level questioning in pedagogy and assessment, could promote HOTS among students and directly improve student achievement (Boaler & Staples, 2008; Franco, Sztajn, & Ramalho, 2007). Accordingly, learning process could only be beneficial to students if they are directly involved in the thinking process (Vygotsky, 1962; 1934). Consequently, teaching and learning in the 21st century should focus more on student-centered and independent learning, project-based learning and collaborative learning, as well as authenthic assessment (Şener, Türk, & Taş, 2015). These approaches promote the use of higher order thinking skills as well as cognitive development. Among others, teachers could apply various strategies, such as questioning techniques, problem solving activities, project-based learning, thinking tools, simulations, discussions, role play and gradual increment of the level of difficulties of tasks. For example, student-centred learning (SCL) has been an effective approach to enhance the learning experience for students (Weimer, 2002) by applying various methods, assignments or assessment to understand a single issue (Bishop, Caston, & King, 2014) and this is suitable to grasp the science concept "an environment that allows students to take some real control over their educational experience and encourages them to make important choices about what and how they will learn" (Doyle, 2008).

Bloom categorized intellectual behavior into six levels of thinking, knowledge, comprehension, application, analysis, synthesis and evaluation (Yahya, Toukal, & Osman, 2012; Clark, 2010). The hierarchical progression identifies the lower level to higher level of cognitive processing (Clark, 2010); the first three levels of Bloom's taxonomy require basic recognition such as knowledge, comprehension and application, while the other three levels require students to use higher order thinking skills (Yahya et al., 2012; Forehand, 2010). So, science experiments are an avenue where higher order thinking skills of analyses, synthesis and evaluation are applied by students in their learning process. Gradually, through that experience, students become problem solver, thoughtful decision maker and life-long learner because "higher order cognition helps them to become independent learners" (Noor, 2008). This process enables students to incorporate the new knowledge with the existing ones for deeper understanding in a meaningful way. This is possible because ability to think impacts students' cognition, achievement and attitude (Higgins, Hall, Baumfield, & Moseley, 2005).

In conclusion, it is crucial for teachers to acquire skills in infusing HOTS in science teaching and learning. In this regard, this study aims to explore the teachers' perspective, their practice and the constraints they faced in implementing HOTS in their respective science classrooms.

II. METHODOLOGY

This is a qualitative case study to explore and understand the phenomenon of how teachers infuse HOTS in science classrooms (Creswell, 2003). Three teachers participated in the study and they were chosen by purposive sampling, based on the criteria that they are applying HOTS in their lessons, at least one year of teaching experience and their willingness to participate. Data was collected through three interviews, which each session lasting for about forty minutes. Interviews were transcribed, categorized and, finally themes were formed based on the categories. Triangulation was used for cross-checking and verification of the data (Passi & Mishra, 2004).

III. THE PARTICIPANTS

The three respondents were science teachers who taught in three different settings; a government school teacher, an international school teacher and a private tutor. They were referred to as Miss D, Miss V and Miss R respectively. Miss D was a young teacher who has been working as private science tutor for a year. She has been teaching biology and chemistry for secondary Form 4 students. She carried out her teaching sessions in face to face and one to one sessions with the students. On the other hand, Miss V was a middle aged teacher who teaches in an International School in Kuala Lumpur. She has been teaching science for Year 7 till Year 11 students for 6 years. Her class comprised of 25 students. Miss R was also a middle age teacher in a Public government school in Selangor area. She has five year experience of teaching science for secondary 3, 4 and 5. Her class size was between thirty to forty students.

IV. FINDINGS

Findings are based on the focus of the study; teachers' perspective, application of HOTS in teaching, the evaluation of HOTS and the implementation constraints.

A. Teachers' Perspective

Generally the participants have three main perspectives about HOTS. Firstly they have a positive view of the implementation of HOTS in teaching and learning because "it is beneficial to their real life (Miss D). Since life have lots of challenges, "students could be trained to think critically and creatively (Miss R). However, they were worried about the ability of teachers to execute HOTS effectively because "teachers are still not competent to carryout HOTS in class" (Miss D) and teachers need to be given exposure and training on the application of HOTS in lessons" (Miss R).

B. Application of HOTS in Science Teaching

Respondents put forwards several effective strategies on the application of HOTS in science classrooms. The participants believe questioning is the best strategy because "through questioning teachers can ask higher order questions about science concepts" (Miss R). Teachers can also ask students based on real life situation" (Miss D). They also believe teaching strategies could help because "planning an investigation or a practical work help students apply HOTS" (Miss V). Thinking tools also help students to grasp HOTS, such as "I-Think and mind mapping can help students to analyze the concepts and make learning easier for them" (Miss R). Participants also believe learning activities contribute to inculcate HOTS among students because "problem solving activity and construction of model help students to use their creativity" (Miss R). For all the strategies to be implemented, participants employ two main teaching approaches. "Problem-based learning (Miss R & Miss V) and project-based learning provide rooms for teachers to apply HOTS (Miss V).

C. Evaluation of Learning

Participants use several ways to assess learning. Teachers use specific form to evaluate creativity and critical thinking. They assess students based on their "analyzing skill, following procedure, interpreting data and making conclusion" (Miss V). Teachers also use qualitative assessment. They do this by "making observation, discussion and interview with students to assess their level of thinking" (Miss R). This process is carried out "during the process of teaching and learning, based on teacher's observation (Miss R). To ensure learning take place "feedbacks by teacher should be constructive and meaningful to students" (Miss D). Assessment can also be done through "multiple choices, semi-structured and a short essay question at the end of the lesson" (Miss R).

D. Constraints

There are three main constraints in the implementation of HOTS in science classrooms. The main constrain is the "different level of students' ability to grab the concept" (Miss V & Miss R). The size of class, also play a great role. "Small class size will be rather easy to use HOTS, bigger class take so much time" (Miss V). When the class is big "teacher should use appropriate method or approach, but it is not that easy" (Miss R). Finally, "teachers' understanding towards HOTS and their skills to apply are very important" (Miss D).

V. DISCUSSION

Teachers are aware about HOTS and this is in line with the aspiration of Malaysian Education Blueprint 2013-2025. Generally teachers understand that HOTS need to be infused through lessons for students' better achievement. This finding is in line with Nessel and Graham (2007). They also tried to infused HOTS for academic and real life purposes as proposed by Marshall and Horton (2011), Hung (2008),

Boaler and Staples (2008), and Franco, Sztajn, and Ramalho (2007). They also have positive perspective towards teaching approaches and strategies that promote HOTS as suggested by (Vygotsky, 1962; 1934).

Respondents put forwards several effective strategies on the application of HOTS in science classrooms. They use questioning and concept-maps were the main strategies. They also applied student-centered and problem-based approaches in their teaching (Harland, 2002; Gordon et al., 2001). These approaches created the avenue for students to think and challenge themselves in the learning processes (Bissell & Lemons, 2006; Thomas, 2000). The application these approaches by teachers, in tandem with other relevant strategies promote critical and creative thinking among students (Bishop, Caston, & King, 2014; Weimer, 2002; Copland, 2000; Rangachari & Crankshaw, 1996). It seems there is a bright chance of advancement in the infusion of HOTS in science teaching.

The teachers' means of assessment seemed practical too. They have both quantitative and qualitative forms of assessment. They used multiple-choice quiz and semi-structured questions and occasional short essay to assess students learning. Qualitative way of assessment is through observation, interview and discussion with student to assess the learning process. The qualitative form of assessment seems in line with authentic assessment (Şener, Türk, & Taş, 2015). These two means of assessment have the potential of improving students thinking and learning processes and overtime could result in creating independent learners (Noor, 2008).

However, to ensure smooth progress several constraints need to be addressed. Mixed ability must be addressed effectively. This can be done pedagogically by raising teachers' knowledge skills and disposition. Effective and continuous in-service training programme should be meticulously designed (Zohar, 1997). Consequently, teachers would be more able to improvise various settings and strategies to suit the students' needs (Saido, Siraj, Nordin, & Al Amedy, 2015). Effort to reduce class size should be addressed too. Too many students in a class definitely lessen the effectiveness of a teacher. A reasonable and logical class size must be decided. If Malaysia truly wants the philosophy behind HOTS to materialize, continuous and serious monitoring and improvement of the program must be undertaken.

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