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The Use of Contextual Learning to Promote Scientific Literacy in Science Classroom: From the Aspects of Higher Order Thinking Skills

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Abstract

Most studies found that Malaysian's students have problems in scientific literacy as student's ability to utilize science concepts, making conclusions and interpretation skills of scientific investigation in science classroom are still at a low level. Scientific literacy as a basic to foster complex thinking whereby formed based on the emphasis of higher order thinking skills such as problem-solving, decision making and science process. These skills encouraged students to develop concepts from variety topics and contexts of science and build a concrete relationship between the contents with their everyday context and situation. Meaningful learning is important for students to promote scientific literacy in science classroom. Thus, context based learning is said to be very relevant in learning and teaching process to develop scientific literacy among students. Context based learning emphasizes student-centered learning which underlined "need-to-know" basic to attract students to relate the concept learned with real-life context. However, only handful of studies is conducted probing into the need of context based learning approach to cultivate scientific literacy in science classroom. This study was conducted for investigate the effectiveness of contextual learning in improving scientific literacy skills from the aspects of student's higher-order thinking skills.

Key word: Scientific Literacy, Higher Order Thinking Skills, Contextual Learning

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1 Introduction

In conjunction to the challenges of education in the 21st century, science curriculum in Malaysia has emphasized the development of students' scientific literacy. Scientific literacy is an individual's ability to think scientifically, use scientific knowledge, and process skills to understand the world around us based on real facts or vice versa (Bybee, 2008; Garthwaite, France, & Ward, 2014). Furthermore, mastery of scientific literacy is seen as students' core achievement at the end of the session learning (OECD, 2012). Moreover, according to Kamisah et al. (2007), students who master and are competent in scientific literacy will be able to generate scientific literacy in building a scientific and a progressive nation.

However, the achievement of Malaysian students for the PISA assessment in 2011 had been in the bottom third group among 74 countries (OECD, 2012). This achievement projected that Malaysian students had limited knowledge of science and applied it in certain conditions only (Malaysian Education Blue Print, 2013-2025). This indicates that most of the students are poor in mastering scientific literacy. Students who fail to master science literacy would fail to master complex thinking when solving a problem (Broman and Parchmann, 2014).

Apart from that, scientific literacy is closely linked with higher-order thinking skills (HOTS), in which students who master HOTS are able to achieve a cognitive level that can solve problems associated with their lives (Bybee, McCrae and Laurie, 2009; Bybee, 2008; Hurd, 1998). Besides, in Bloom's revised taxonomy by Anderson (2001), understanding and remembering are categorized as low-level thinking skills, while the skills to analyze, evaluate, and create are categorized as higher-order thinking skills. High-level thinking skills require complex considerations, such as critical thinking, problem-solving, and decision-making

processes of science. Hence, students should be able to apply, relate, and describe knowledge in the context of their thoughts. According to King (1998), learning process that emphasizes HOTS leads students to master a variety of cognitive skills, including reasoning, critical, and creative thinking.

Hence, teachers need to implement activities that can improve students' thinking skills to master science concepts and further improve scientific literacy that involves problem solving and scientific investigation activities. This is because; scientific literacy is not something that is taught directly during learning, but it requires students to think at higher levels. Meaningful learning is able to support students to develop cognitive, knowledge, and scientific concepts in the processes of learning and teaching. The learning environment must also be focused on HOTS, as well as skills to analyze, evaluate, and create (Krathwohl, 2010).

Furthermore, contextual-based teaching and learning allows teachers to implement meaningful learning for students by providing opportunities for students to relate what they learn to the real world (Crawford, 2001). This approach is appropriate for students with different skills, interests, experiences, and cultures, in which teachers will make adaption to how students learn and how they will be evaluated (Kamaruddin et al., 2009).

In addition, contextual teaching approach is also able to stimulate students to explore ideas and construct new knowledge, decision-making, thus responsible for their own learning (Crawford, 2001). Through exploration of contextual learning, students will not only process the content of the lesson, but also search evidence for justification about the lesson content learnt across real life situation.

Meanwhile, according to Broman and Parchmann (2014), through contextual teaching approach, new knowledge is actively constructed in students who think that they will not passively absorb any knowledge that is presented by the teacher. Therefore, the students will customize the new information gained with existing knowledge to develop new knowledge in their minds with the aid of social interaction with their friends and teachers.

2 The Issues in Mastery Scientific Literacy

The 21st century nation requires an individual who is knowledgeable in dealing with issues of science and technology to develop a science-literate community (Miller, 2006) to meet the high-life dependence on technology advancements and scientific knowledge to manage various natural resources and phenomena (Turiman et al., 2012). According to OECD (2012), scientific literacy can be defined as,

“An individual’s scientific knowledge and use of that knowledge to identify questions, to acquire new knowledge, to explain scientific phenomena, and to draw evidence-based conclusions about science-related issues, understanding of the characteristic features of science as a form of human knowledge and enquiry, awareness of how science and technology shape our material, intellectual, and cultural environments, and willingness to engage in science-related issues, and with the issues of science, as a reflective citizen”.

Scientific literacy is a foundation in the process to develop complex thinking among students through the process of establishing a concrete relationship between the content of science with everyday context for problem solving process concerning a variety of topics and situations (Low & Lay, 2013). Students who master scientific literacy will be able to ask and

answer questions related to science and technology and be able to describe, as well as to explain the natural phenomena that occur (Holbrook & Rannikmae, 2009; Sarkar & Corrigan, 2014). They are also capable of identifying scientific issues based on scientific and technological knowledge, able to read and understand science in an article about current issues, and also be able to orally argue against the validity of the conclusions drawn (Miller, 2006).

Moreover, according to Low and Lay (2013), complex thinking leads to the construction of knowledge and understanding of science concepts, as well as enables students to make decisions and engage in civic, cultural, and economic productivity (Bybee, 2008; Holbrook & Rannikmae, 2009; Hahn et al., 2013). On the other hand, poor mastery of science literacy skills enable students to only provide explicit scientific explanations, but face difficulties in making inferences and interpretations of the survey tools (Malaysian Education Blue Print , 2013-2025).

3 Emphasis on Higher Order Thinking Skills (HOTS) for Fostering Scientific Literacy

Besides, Salamon (2007), in his study; proposed three methods that can be used to improve scientific literacy skills; delivery methods, learning activities, and the construction of students' thinking skills during the learning process. However, Fensham (2009) stated that the methods and the learning activities that enhance scientific literacy are not limited to a particular method, while Hurd (1998), Aksela (2005), and Smith et al., (2012) have stressed that thinking skills are the topmost feature in mastering scientific literacy. Thinking skills can be categorized into high level and low level (Anderson & Krathwohl, 2001).

According to Anderson and Krathwohl (2001), HOTS involve analyzing, evaluating, and creating skills, while Zohar and Dori (2009), and Madhuri, Kantamreddi, and Prakash (2012) stated that HOTS must be applied in the classroom for effective learning to occur (Barak & Dori, 2009). Besides, effective learning enhances students' cognitive process with non-routine problem-solving (non-algorithmic), questions with various different solutions, possesses various criteria and uncertainty, as well as highly self-directed.

Furthermore, HOTS encourage students to develop knowledge in meaningful learning (King, 2008). HOTS foster meaningful learning for students because they build knowledge through active learning process and not just a mere artifact (Bruner, 1966). Besides, nurturing HOTS can be a foundation for students to develop strong scientific concepts, as well the complex thinking among students through problem solving process of the various topics and contexts to create meaningful learning (Barak & Shakhman, 2008; Niaz, 1994). Therefore, HOTS portray an important role in the teaching and learning processes in fostering scientific literacy in particular.

On top of that, mastery of HOTS depicts that students go through challenging activities for their thinking beyond the level of understanding and application based on Bloom's taxonomy (Bloom, 1956). Moreover, low level of thinking will cause problems for the students to achieve meaningful learning process (Zohar & Dori, 2009). Besides, learning process that fails to stimulate students' thinking and reasoning will cause difficulty for students to explore more complex problem as they just focus on memorizing facts and are tied with structured problem solving.

Apart from that, dependence on teachers also can lead students to acquire knowledge only after surpassing the remembering and the memorizing levels towards higher cognitive level.

This has an effect on students' scientific literacy due to failure in mastering higher-order thinking skills and students will not be able to lead through the process of effective lifelong learning (Aksela, 2005). As a result, students will fail to comprehend science, master the concepts that contain the sciences, and subsequently apply it to real phenomena (Aksela, 2005; Hurd, 1998).

This contrasts with the challenges in the 21st century learning, in which students must take the responsibility for their learning process and strategy, effective learning methods, and learning outcomes that should be achieved in order to achieve an optimal level of scientific thinking (OECD, 2012). Therefore, teachers need to use innovative teaching approaches that can improve the HOTS by taking into account several important aspects in science teaching, such as science process skills, problem solving, and decision-making (Bernholt & Parchmann, 2011). These skills are not only important aspects of HOTS, but they can also improve students' scientific literacy.

In recent decades, a trend can has been observed in the development of teaching science curriculum with contextual approach to improve students' achievement in science and chemistry particularly (Brist, 2012; Çiğdemoğlu, 2012; Elmas, 2012; Monica, 2012; Sunar, 2013). This approach was adopted in the context of scientific content (the actual situation), which shows that students apply concepts to real life sciences (Gilbert, Bulte & Pilot, 2011), and subsequently, they clearly see the importance of science in their lives.

4 Implementation of Contextual Learning Approach for Higher-Order Thinking Skills in Malaysian Schools

The education curriculum development in Malaysia encourages meaningful learning and teacher-centered approach. Besides, contextual teaching and learning are seen as highly recommended strategies that can be applied in improving students' higher-order thinking skills (Curriculum Development Centre, 2001). Teaching and learning based on context give teachers the opportunity to convey the students' meaningful learning by providing opportunities for students to relate what they learn to the real world (Crawford, 2001; Curriculum Development Centre, 2001).

In addition, based on the strategy of contextual learning, students learn to use hands-on and minds-on methods that can enhance HOTS. According to Sugiarti and PattaBundu (2014), hands-on and minds-on activities will allow students to experience concrete learning through real experience. The best way for most of the students to receive meaningful learning is from informal contextual learning (Caine & Caine, 1991; Gardner, 1982; Kolb, 1984). Therefore, according to Kamaruddin et.al (2009), through this method, teachers are able to increase students' understanding by relating theories learned in the classroom with their daily life, and their work compared to memorizing facts from the teaching content.

Meanwhile, according to Pilot and Bulte (2006), the term "context" is reflected in various forms, including themes, situations, issues, stories, teaching practice, applications, or problems. Besides, science education has been interpreted as the teaching of "context" from the aspect of environmental, social, nutritional, health, personal, community, economic applications, technology, and industry, which can be used in developing materials for science curriculum

(Bennett, 2006). In this scientific literacy issues, contextual learning refers to teaching strategies that aim to establish the scientific concept of lifelong learners based on a concept that is common to them, such as social and environmental issues, which are considered important and closely related to their needs and circumstances of their lives (Bennett & Lubben, 2006; Berns & Erickson, 2001).

In addition, contextual learning emphasizes real-life situation significantly, where students' cognitive skills are enhanced through the connection between knowledge with real-world learning (Suryawati et al., 2010). Students are driven by high curiosity to interact with science and real world around them. Moreover, according to Fensham (2009), real-life activities enhance students' creativity in solving problems, whereby not only students understand the content of learning, but they are able to describe real-life learning around them, and thus, they can better implement what they have learned. Thus, this approach can also help students to become more independent, as well as more natural in an effort to develop their knowledge and cognitive skills (Johnson, 2001).

Besides, with contextual approach, students will integrate HOTS in creating relation with different angles of teaching contents and concepts with problem solving through investigation activities (Aksela, 2005). This is supported in a study by Broman and Parchman (2014), who found that through contextual learning, students' involvement in investigation activities based on experience is able to help them to understand, master, and apply better learning concept. Thus, indirectly, students will develop lifelong learning practices. Self-learning, which is emphasized in contextual learning, involves students' undertaking an investigation based on their experiences. As a result, they are able to understand and apply the concept for better learning (Ellis & Gabriel, 2010).

5 Conclusion

Weaknesses of students in scientific literacy have been shown in the results of PISA held in 2011. Besides, scientific literacy is very important to cultivate science among students in facing the challenges of the 21st century. Science education that is able to weave between the nature of inquiry among students with scientific knowledge becomes a platform for the establishment of the science-literate society. Furthermore, previous studies have shown that learning activities during the teaching and the learning processes associated with science concept and real-world can improve students' thinking skills. Therefore, student-centered teaching strategy should be implemented, and it is considered as a very suitable approach for contextual learning. Through contextual learning approach, students will use hands-on and minds-on processes, which will then increase their HOTS.

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