

CONCEPT MAP AS AN ALTERNATIVE ASSESSMENT IN LABORATORY ACTIVITIES

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1.1 INTRODUCTION

The rapid development of the world's technological advances, economy competition, scientific innovation generally have claim to the transformation of the educational system as a whole (Koh, Tan, Ng, 2012).

The transformation done in science, math, technology and engineering in the 21st century is emphasized to the formation of students who can demonstrate higher thinking skills with confidence, such as critical thinking and creative, innovative thinking and problem solving (Evren, Bati & Yilmaz, 2012). This is of concern not only to provide a workforce that is ready to compete at the global level, but more importantly for the development of self as individuals more successful (Ministry of education, 2012).

The transformation of education in the 21st century involves extensive changes in terms of curriculum, pedagogy and assessment system (Koh, Tan, Ng, 2012). In this regard, through the Malaysian educational development plan 2013-2025, the Ministry will undertake implementation of integrated curriculum and conducting a holistic assessment with an emphasizes on in-depth knowledge and higher-order thinking skills of students in the assessment system and in particular (Ministry of education, 2012).

1.2 THE IMPORTANCE OF ASSESSMENT ACTIVITIES OF TEACHING AND LEARNING PROCESS

Assessment of students' ideas and conceptual understanding is the core of the curriculum, as well as learning and teaching environment activities (Ruiz Primo et al, 2001; Kaya, 2008; Bak Kibar, Yemen & Ayas, 2013). The role of assessment for teaching and learning activities is not only to determine the marks or grades of students, but rather to improve the quality of teaching and learning activities itself (Kumaran & Sankar, 2013). Many experts in the field of education assessment and learning theories agree that evaluation is part of the process of teaching, and assessment activities should be used to support and assist students' learning in the classroom teaching and learning process from day to day (Shepard 2000; Koh, Tan, Ng, 2012). Appropriate assessment activities should be done to acquire high-level thinking skills process than just acquire the basic skills and knowledge.

In addition, the assessment is important in identifying problems of students' science and mathematics learning, helping to overcome the problem in making the learning and teaching process more appropriate (İngeç, 2009). If the teacher does not build the test according to the procedures for the correct measurement, information about students' level of mastery of a concept is likely to be less accurate. Such things can not be the result of an assessment used for the purpose of improving teaching and learning in the classroom (Phang, Abu Ali & Ali, 2012).

The issues is, does the practice of teaching, learning and assessment strategies of science laboratory activities nowadays provide in-depth understanding to encourage high-level thinking skills of students? In reality, assessment and evaluation in science laboratory has been continuously carried out using traditional methods such as laboratory reports and quizzes (Hofstein & Lunetta, 2004; Kaya, 2008; Dogan & Kaya, 2009; Özmen, Demircioğlu, & Coll, 2007; Bak Kibar et al., 2013). The traditional method has been questioned because of the less

favorable active participation of students in the assessment process and provide students with low-level thinking skills (Zoller & Pushkin, 2007; Dochy, Segers, Van den Bossche, & Gijbels, 2003; Dogan & Kaya, 2009). Traditional or conventional assessments of student learning outcomes are generally focused on the production of knowledge of facts and skills of a student alone (Koh et al., 2012).

1.3 CONCEPT MAP AS AN ALTERNATIVE ASSESSMENT

A variety of alternative assessment tool that has been used in many science education studies including posters, portfolio, concept map, vee map, and integration of ICT (Aksela, 2005). However, one alternative assessment tool that has been widely recognized in improving students' conceptual understanding is the use of concept maps (Bak Kibar et al., 2013; Ruiz-primo & Shavelson, 2010; Kaya, 2008; Moni & Moni, 2008; Harris & Zha, 2013). Previous studies also have linked the concept map with the higher-order thinking skills (Moni & Moni, 2008; Kumaran & Sankar, 2013; Bramwor-lalaor et al, 2014). In addition, many previous research have also discussed about the importance of concept map in chemistry education (eg Markow & Lonning, 1998; Aksela, 2005; Kaya, 2008, Theodoros vachliotis, Katerina Salta, Petroula Vasiliou, 2011; Correia, 2012; Bak Kibar et al., 2013).

Concept map is a visual thinking tool that was developed by Joseph Novak and his colleagues at Cornell University in 1979. The development of a concept map requires students to organize their thoughts on the concepts learned by writing or labeling the relationship between these concepts. This visual graphic can represent students with a deep conceptual understanding thus helps students to critically evaluate their own ideas and to compare their ideas with other students. It also provides opportunities for teachers to assess understanding, conceptions and misconceptions of students on the topic of learning (Novak, 2010).

Students who are experiencing deep learning will produce a

concept map that has more new concepts, more links and branches compared to students who experience rote learning. This is in line with the findings made by Hilbert & Renkl (2008) in which more accurate labeled links can be generated, more effective knowledge can be integrated. Martin (2011) emphasizes the importance of the relationship between the maximum concepts that can be produced during the construction of the concept map because it gives the best impression of a deep understanding. Three types of concept maps that 'spoke', 'chain' and 'net' have been identified by Kinchin, Hay, and Adams (2000) in his study, where he concluded that the concept map in the form of net (with the most level of the hierarchy than the others) is more representative of the presence of meaningful learning.

In addition, the construction of a concept map is also regarded as a strategy to facilitate the students to develop critical and creative thinking (Harris & Zha, 2013), as well as promoting higher level of cognitive process if its construction is done correctly (Novak, 2010). Concept map allows the assessment of high-level cognitive development (Kinchin et al., 2000) in Bloom's taxonomy, especially when students have to pick and choose the most appropriate linking phrase during its construction (Kumaran & Sankar, 2013). The use of linking phrases to describe the relationship between the concepts has made concept map is better than the other visual graphics techniques to translate knowledge and information (Correia, 2012).

According to Hilbert & Renkl (2008), the cognitive processes that occur during concept maps' construction related to the effective learning is through two processes, namely, the process of labeling the relationship between the two concepts (construction of the linking phrase) and the process of planning and controlling the process of construction. Students will express difficulty to label the line that connects the two concepts if they don't understand the relationship that exists between the two concepts as well as the correct word to characterize the relationship between these concepts. . If students have already started to focus on producing words that can characterize the relationship between

the two concepts, they will begin to see the relationship between all the concepts to determine the most appropriate cross link. This process involves a high cognitive level (Bloom, 1956), known as evaluation and synthesis of knowledge (Novak, 2010).

Many studies have diversified the concept mapping technique that can be used to show students ' cognitive structure. According to Ruiz Primo (1996), assessment using concept maps can be categorized based on how much information can be given to a student by a teacher who refers to the degree of directedness. Figure 1 shows the degree of directedness involved in the construction of the concept map-based assessment.

Element of a concept map	Degree of directedness	
	High	Low
	Provided by	
Concept	Assessor/Teacher	Student
Linking line	Assessor/Teacher	Student
Linking phrase	Assessor/Teacher	Student
Map structure	Assessor/Teacher	Student

Table 1: Degree of directedness involved in the construction of a concept map by Ruiz Primo et al. (1996)

Type of concept map can be classified into a continuous range of map that has a high degree of directedness to low degree of directedness. Concept map that has the highest degree of directedness means the students have been provided with the concept, connecting lines, phrases and structure maps relationships while concept map that has a low degree of directedness allows students to decide for themselves how many of the concepts that should be used and how these concepts are related. Low degree of directedness of a concept map is said to be able to foster and evaluate the higher level of students thinking (Yin, Vanides, Ruiz-Primo, Ayala & Shavelson, 2005). Giving those element to

students only will prevent the spread of knowledge and understanding of the student, thus contributing to low cognitive skills (Kaya, 2008).

Concept map is a good assessment tool, able to give an overview of a students' prior knowledge before studying a unit or topic, as well as formative assessment that occurs during learning activities (Kumaran & Sankar, 2013). When students are creating or translating a concept map, the new knowledge will exist and then assimilated into the students' prior knowledge. It can also provide a clearer picture of the structure of knowledge is built in the mind of a student than traditional assessment tools (Soika, Reiska, & Mikser, 2010). According to Stoddart, Abrams, Gasper, & Canaday (2000), concept map has been chosen as an alternative assessment tool because it can be used in a wide scope of fields and at all levels of students. Therefore, it is appropriate to use concept maps as an assessment tool for teaching and learning (Novak, 1990; Slotte & Lonka, 1999; Kinchin et al., 2000; Kaya, 2008; Özmen et al., 2009; Bramwell lalor et al., 2014).

In addition, the concept map has also been reported to improve students' abilities in problem solving, and help for collaborative learning (Moni Moni, 2008), making this strategy is very suitable to use in laboratory activities, which often involves group activities. Furthermore, the characteristics of concept maps as a very suitable strategy to promote students' conceptual understanding in science and chemistry in particular (Bunce, Francisco, Nakhleh, Nurrenbern, & Miller, 2002; Aydin, Aydemir, Boz, Cetin-Dindar, & Bektas, 2009) can help students make conceptual connections during learning activities conducted in laboratory (Markow & Lonning, 1998; Özmen et al., 2009).

1.4 CONCLUSION

The discussion above makes the selection of concept map as a potential strategy to assess and promote the exploration of deep understanding thus helps in stimulating higher-order thinking skills of students in laboratory activities. Therefore, it is appropriate for

this study to be conducted in order to contribute in the search for alternative learning strategies and assessments that can be applied in the transformation of the curriculum of the 21st century. This is important to produce individuals who are knowledgeable in depth and have the skills of higher order thinking to be competitive in an era of more challenging world.

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