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A CONCEPTUAL FRAMEWORK FOR ENHANCING SCIENTIFIC CREATIVITY AMONG STUDENTS

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Abstract

One of the important agenda in science education is to improve higher order thinking skills (HOTS) among students. Science teachers in particular play an active role developing students' HOTS including creativity. They are responsible for providing a medium of teaching and learning which allows students to discover things by themselves from various viewpoints so that the learning become more meaningful. Therefore this paper presents a conceptual framework that aims to help students enhancing their scientific creativity. This conceptual framework basically is formulated based on Malaysian context. The proposed framework can be divided into three main components namely analysing's students' profile, development of the instructional module and analysing the effect of the module towards students' scientific creativity. All of this components will be discussed further including the instructional model and design used.

Keywords: scientific creativity, inquiry, science education.

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Introduction

One of the important agenda in science education is to improve HOTS among students. School play an active role developing students' creativity (Alfuhaigi, 2014; Kamisah, Punia, Jizah & Adzliana, 2012). Science teachers in particular are responsible for providing a medium of teaching and learning which allows students to discover things by themselves from various viewpoints so that the learning become more meaningful and contribute towards the progress of the country. Based on a study by the American Management Association (AMA) in 2010, involving 2115 respondents, skills such as critical thinking and problem solving, communication, collaboration, and creativity and innovation will become more important to organizations in the future. While a survey run by Hart Research Associates in 2013 to over 318 employers, find that 95% of respondents said innovation and creativity is the virtue and necessity of workers in future.

The importance of creativity has been translated through the declaration of the Year of Creativity and Innovation in the European Union in the year 2009, while in Malaysia itself in 2010 (Azrina, 2011). Clearly, creativity has become a major focus in the development of national education, especially in science (Park, 2011; Chumo, 2014). Creativity in science education or scientific creativity is a stand-alone field (Mukhopadhyay, 2013). Hu and Adey (2002) defines creativity as a scientific intellectual ability to produce certain original products that have a personal or social value, designed with a specific purpose in mind using the information given. Park (2011) stated that scientific creativity consists of three dimensions: creative thinking, scientific knowledge and scientific inquiry skills.

However, the study by previous researchers play a number of issues and constraints related to scientific creativity. Among the issues are teaching and learning that less encourage creativity, type of questions that less encourage thinking and implementation of traditional laboratory. Teaching and learning science in Malaysia is focused on the memorization of facts by stressing repetition and drills (Rashimah, 2012). The task of thinking has been taken over by teachers because teachers tend to give an answer without showing process. The thinking activities regarded as an extension of the learning activities (Roslinda, 2007). In addition, the need to finish the syllabus as well as a greater emphasis on achievement of the tests (Mann, 2005; Rashimah, 2012) resulting in the creativity of the students who took the science program is at a low level (Siti Hajar, 2008).

Laboratory activities are among the important feature of science education. Laboratory activities are aimed at learning more meaningful that students not only learn the concepts but also through data from observations (Millar, 2010). However, the fact is the prevailing majority of laboratory activities carried out are traditional recipes based methods (Fenerlon & Breslin, 2012). Students often follow the guidelines given by the teacher and only confirms concepts learned through laboratory activities and they actually do not understand what they are doing (Beussman, 2007). Laboratory activities traditionally do not encourage them to think critically and creatively. As a result they fail to apply the knowledge and skills they have learned to other situations, not in the recipe book (Fenerlon & Breslin, 2012).

According to a study by Chuzairy (2013) on teachers of Chemistry found that only a few teacher encourage scientific creativity during the process of teaching and learning. Teachers prefer lecturing and the students get less opportunities to explore their learning independently. A passive attitude among the students also contributes to less encouraging creativity in teaching and learning (Kamisah et al., 2012). The next generation must not only learn about science-related knowledge but at the same time pervaded with the skills necessary to face the challenges ahead, including problem solving, innovation and creativity (Beers, 2012). Therefore, the development of scientific creativity among students will be such an effort to help the future generation in order to remain competitive in an increasingly challenging world and future needs.

Conceptual Framework

The focus of this research is to investigate student achievement on scientific creativity, to investigate student conception on chemistry based on the multiple representation and to facilitate them with constructivist 5e learning cycle adopted with Directed creativity process for learning Acid and Base. Based on this main focus, the conceptual framework is shown in Figure 1.

Input (analysing's students' profile)	**Preliminary Study** : 1) Chemistry Creativity Test 2) Chemistry Achievement Test
Process (development of the instructional module)	<u>**Instructional Model**</u> • **5E Learning Cycle** (Bybee, et.al, 2006) Engagement phase, exploration phase, explanation phase, elaboration phase and evaluation phase. • **Directed Creativity Process** (Paul Plsek, 1997) Preparation phase, Imagination phase, Development phase and action phase. <u>**Integration of technology**</u> • The use of animation in order to help students in sub-microscopic level. <u>**Instructional Design Model**</u> • **ADDIE Model** (Rosset, 1987) Analysis phase, Design phase, Development phase, implementation phase and evaluation phase. <u>**Module Content**</u> • **Acid and Base** (Chiu, 2005; Chris, 2001; Norasekin, 2008; Ozmen, 2004).
Output (analysing the effect of the module towards students' scientific creativity)	Scientific Creativity (Hu and Adey, 2002) Chemistry Conception (Johnstone, 1991)

Figure 1: A conceptual Framework for Enhancing Scientific Creativity

Based on Figure 1, it can be seen that, the proposed framework can be divided into three main components namely analysing's students' profile, development of the instructional module and analysing the effect of the module towards students' scientific creativity. Students' profile include their scientific creativity level and their conception of chemistry knowledge based on multiple representation. The research started when students were found to have low level of creativity and having difficulties in learning Acid and Base. A preliminary study was conducted by using Chemistry Creativity Test (CCT) as an instrument to determine student scientific creativity level and Chemistry Achievement Test (CAT) as an instrument to determine the student conception of Acid and Base. Both of this instrument was adapted by the previous researcher and translated into Malay Language. From the preliminary study it was found that the student have a low level of scientific creativity and average performance in chemistry conception in Acid and Base.

The second component of the framework is the development of the instructional module. Several studies have shown that a traditional classroom is less effective in providing students with the skills needed. Active and constructive learning model is expected one of the best approach to improve the skills. 5E learning cycle is among the constructive learning model that is effective in promoting the development of skills of scientific inquiry and creativity. Based on that fact, the researchers developed learning modules that promote the development of scientific creativity among students. This learning module using the 5E learning cycle model (Bybee, 2006) adopted in Directed Creativity Process by Paul Plsek (1997). As stated before, one of the dimension in scientific creativity, is scientific knowledge which in this research it's focused in chemistry knowledge. Knowledge of chemistry involves abstract concepts and it should be explained in three representative levels, namely macroscopic level, sub-microscopic level and symbolic level. Macroscopic level involves changes that can be seen by the naked eye. Symbolic level also focuses on the use of the formula for representing a compound or chemical element. While the sub-microscopic level representation is the most difficult level of representation that involves a combination of particles that are not visible to the naked eye. The successful students to master all three levels of representation is very important for students to understand and master the concept of a chemical. However, the use of laboratory activity is limited at the macroscopic level only. Therefore the learning modules will be supported with the help of animation for the purposes of understanding the sub-microscopic level. Animation can help students make an abstract concept into more concrete and to promote understanding of science concepts in depth. Figure 2 shows the adoption of 5e learning cycle and directed creativity process used in the development of the scientific creativity module.

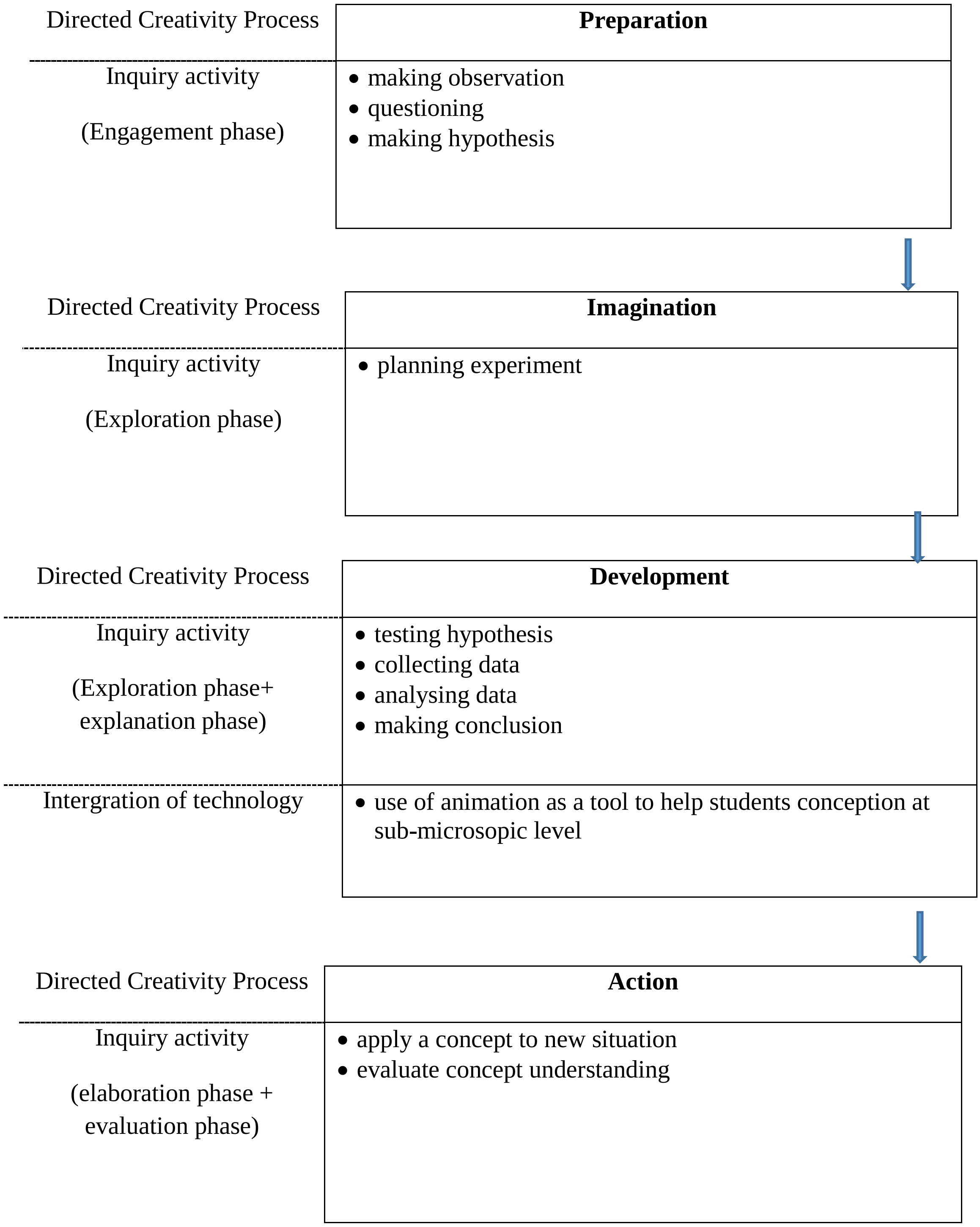

Figure 2: Adoption of 5e learning cycle and directed creativity process used in the development of the scientific creativity module.

While the last component of the framework is to analyse the effect of the module towards students' scientific creativity. In order to determine the impact of the learning module, a number of 30 of form four science students were involved in the implementation of the learning module in the chemistry laboratory. The pre and posttest questions were used to measure and compare student's scientific creativity and performance before and after the intervention. Other than that, all of the student's activity were recorded throughout the learning process. Particularly, in this study the interview method were also used to triangulate the data obtained in the research.

Conclusion

As a conclusion, this paper presented a conceptual framework that aims to help students enhancing their scientific creativity. This conceptual framework basically is formulated based on Malaysian context. The proposed framework can be divided into three main components namely analysing's students' profile, development of the instructional module and analysing the effect of the module towards students' scientific creativity. It is expected that the proposed framework that integrates the directed creativity process, 5E learning cycle and animation can help the students to understand the concepts and improving their scientific creativity as well. This framework is an effort to enrich the idea on teaching and learning and it's not only focused on knowledge but also emphasize on the key skills especially creativity. In addition, this framework also provides an opportunity for students to learn in an active and constructive atmosphere and feel the experience on how scientists work.

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