CREATIVITY CHEMISTRY LEARNING COURSEWARE ON IMPROVING CREATIVITY OF FORM FOUR STUDENTS IN SIBU, SARAWAK.

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I hereby declare that the material in this thesis is my own except for quotations, summaries and references, which have been duly acknowledged.

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ABSTRACT

Chemistry is a subject that contains a lot of abstract, complex and difficult understanding the concepts. Teachers prefer the easy and traditional method in teaching cause students memorize the facts without truly understanding. The purpose of this research is to examine effectiveness of Creative Chemistry Learning Courseware (CCLC) with ICT aid to improve creativity of students in learning Mole topic, form Four Chemistry. The quasi-experiments design with pretest, posttest nonequivalent group design is chosen in research. Control group (n=258) is using traditional method while experimental group (n=262) is using CCLC which utilizing ICT functions. Creativity of students is measured by using TTCT tests and achievement of students is measured by Chemistry tests. Data analyzed by dependent t-test, independent t-test and Pearson Correlation. Data analysis shows both group allocated in medium creativity level however the experimental group scores higher creativity mean score in posttest TTCT. The effectiveness of CCLC convinced as there is significant different in the gain of creativity scores between two groups ($t(258) = -7.855$, $p = 0.00$). After exposed to CCLC software, students can understand the abstract concepts in Mole topic with think creatively hence increase their level of creativity. When students apply knowledge and creative thinking ability into Chemistry test more effectively, thus there is significant improvement in their performance in posttest compare to pretest. Therefore, there is significant relationship between creativity and academic achievement with Pearson correlation value $r(262) = 0.713$, $d < 0.01$. When the level of creativity increased, the achievement of students will be increased. Overall, students able to think more creatively after utilizing CCLC software with ICT aids and thus increase their achievement in Chemistry test.

LIST OF CONTENTS

CHAPTER 2: LITERATURE REVIEW

CHAPTER 3: METHODOLOGY

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ICT	-	Information and Communications Technology
CCLS	-	Creative Chemistry Learning Courseware
SPM	-	*Sijil Pelajaran Malaysia*
QCA	-	Qualification and Curriculum Authority
UNESCO	-	United Nations Educational, Scientific and Cultural Organization
RAM	-	Relative Atomic Mass
RMM	-	Relative Molecular Mass
IRC	-	Internet Relay Chat
IQ	-	Intelligence Quotient
CBAT	-	Chemical Bonding Achievement Test
CAS	-	Chemistry Attitude Scale
PCK	-	Pedagogical Content Knowledge
TPCK	-	Technological Pedagogical Content Knowledge
TTCT-F	-	Torrance Tests of Creative Thinking, Figural Edition
SS	-	Standard Score
CS	-	Creativity Score
FPSP	-	Future Problem Solving Program
MA	-	Morphological Analysis
CT	-	Abedi-Schumacher Creativity Test
VAT	-	Villa and Auzmendi Creativity Test
SPSS	-	Statistical Package for the Social Science
ISD	-	Instructional System Design
KTCPI	-	Khatena-Torrance Creative Perception Inventory
SAM	-	Something About Myself
WKOPAY	-	What Kind of Person Are You?
BPPDP	-	*Bahagian Perancangan dan Penyelidikan Dasar Pendidikan*
JPNS	-	*Jabatan Pendidikan Negeri Sarawak*
CAT	-	Consensual Assessment Technique

LIST OF APPENDIX

CHAPTER 1

INTRODUCTION

1.1 Introduction to the Study

Chemistry is one of the most important branches of secondary school science (Oloruntegbe, Ikpe and Kukuru, 2010), however, students have the problems in learning Chemistry this is because Chemistry curricula commonly incorporate many abstract concepts, which are central to further learning in both chemistry and other sciences (Taber, 2002). According to Bradley and Brand (1985), numerous reports support the view that the interplay between macroscopic, submicroscopic and symbolic worlds is a source of difficulty for many chemistry students. In the early studies, Hines (1990), Ben-Zvi, Eylon and Silberstein (1987), Lee, Eichinger, Anderson, Verkheimer and Blakeslee (1993) and Abu Hassan and Rohana (2003) reported that the problem areas in the subject, from the students' point of view, the most difficult topics being the mole, chemical formulae and equations, condensations and hydrolysis.

Because of, when these difficulties arise, creativity thinking is important in learning Chemistry subject. Guilford (1967) proposed that real problem solving involved actively seeking, constructing new ideas that fit with constraints imposed by a task, or in most instance, real problem solving involves creative thinking. Hence, the teachers' task is need to find ways to increase meaningful or creative learning, possibly by actively involving students in the process of knowledge construction (Novak and Gowin, 1984). Then, the active learning provides this construction by engaging students in higher order thinking skills and minds-on activities (Acar and Tarhan, 2009) especially the creativity thinking. That why the science education emphasizes the creative thinking.

Accordingly, science teaching should focus on facilitating scientific ways of thinking, knowing and reasoning, rather than transmission of scientific facts, concepts, and theories (Jin and Anderson, 2010) like traditional teaching methods. However, traditional teaching methods which are teacher centered and generate passive students, are generally applied in Chemistry teaching (Karsli, Usta, Ceng and Ayas, 2009). That is well known that students, who have been taught according to teacher centered traditional approach, were unable to integrate their knowledge, think critically and creatively (Acar and Tarhan, 2008; Demircioglu, 2003). Therefore, some topics in Chemistry like the mole concept, atomic structure, balancing redox equations, chemical bonding and others concepts which represents a significant challenge to novice chemistry students (Sirhan, 2007).

The creative teaching which will stimulate development of creativity in students can be achieved by using more learner-centered approaches and particularly those that employ modern information and communication technologies, ICT (Ozmen, 2008). The rapid growth of interactive ICT such as game, flash, music video, live chat, animation, 3D and movie can be seen as an example of providing a form of enhancement to creativity (Edmonds, Weakley, Candy, Fell, Knott and Pauletto, 2005). In student-centered classrooms with the aid of computers, students are able to collaborate, to use creative and critical thinking and to find alternatives solutions to problems (Jaber, 1997).

In the other hand, the Tenth Malaysia plan (2011-2015)[1] state that the national transformation framework emphasizes the critical role of a highly skilled, creative, and innovative workforce in achieving the objective of Vision 2020 for Malaysia to become a high income country that is both sustainable and inclusive. This will require an education system that nurtures creative and critical human capital[2].

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[1] Economic Planning Unit (2010a). *The Tenth Malaysia Plan 2011-2015*. Malaysia. Page 87.

[2] Malaysia Education Blueprint 2013-2025, pages 6-8.

Our previous Prime Minister, Tun Mahathir Mohamad challenged Malaysia scientist community to produce one Nobel holder when approaching year 2020 (Sachi, 2004). He believed that our generation who lived in 21th century must be critical, creative thinking and ICT literacy. Because of creative capacity is a multifaceted construct and influenced from several variables, it can be improved in many ways. Hypothetically speaking, there exist at least as many ways for encouraging creativity as the number of dimensions of creative ability.

1.2 Background to the Study

Chemistry is one of the most important subjects in science but it contains a number of abstract concepts which are not obviously applicable outside the classroom (Stieff and Wilensky, 2003; Zoller, 1990). For this reason, students often view chemistry as one of the difficult subjects to study at all levels of schooling (Sirhan, 2007). Many researchers have reported on students' conceptions of chemistry concepts revealed that when fundamental concepts are not constructed adequately, more advanced concepts that build upon the fundamentals are not fully understood (Abraham, Grzybowski, Renner andMarek, 1992; Nakhleh, 1992).

Chemistry knowledge is represented by scientists at three levels; the macroscopic, the submicroscopic and the symbolic (Johnstone, 1993; Ozmen, Ayas and Costu, 2002; Raviola, 2001). Because of interactions between molecules and atoms occur at a submicroscopic level, chemists refer to the objects and processes which they cannot observe directly at a symbolic level (Stieff and Wilensky, 2003). To understand chemistry at a sophisticated level necessitates students being able to make connection or relations among the levels. However, research suggests that students have difficulties in understanding the submicroscopic and symbolic levels.

Sirhan (2007) stated that the particulate nature of matter which related to mole concept, atomic structure, kinetic theory, thermodynamics, electrochemistry, chemical change and reactivity, balancing redox equations and stereochemistry, chemical, ionic, covalent, metallic bonding and others concepts which represents a significant challenge to students. The study titled "Learning Difficulties in Chemistry" done by Sirhan (2007) pointed out chemistry is a difficult subject for many students.

This is because chemistry topics are generally related to or based on the structure of matter.

To overcome the problems in learning Chemistry, creative and critical thinking skill need to be emphasized. The abstract nature of chemistry along with other content learning difficulties just like the mathematical nature of much chemistry means that chemistry classes require a high-level skill set (Fensham, 1988; Zoller, 1990; Taber, 2002). The creative thinking required in problem solving which involve actively seeking, constructing new ideas that fit with constraints imposed by a task (Guilford,1967). However, creative thinking in teaching and learning section always be neglected.

Creative thinking is different from critical thinking. Harris (1998) contrasted between critical thinking which is analytic, convergent, vertical, focused, objective, verbal and linear while creative thinking which is generative, divergent, lateral, diffuse, subjective, visual, associative and respectively. Critical thinking is reasonable and reflective thinking focused on deciding what to believe or what to do Ennis (1991; 1996). However, in creative thinking, it can be described as regeneration and construction, and it must include novelty, freshness, and originality (Emanuel, 1984).

The characteristics of creativity are defined as being aware of one's own unity and coherence and evaluating the conditions for uniting the knowledge the person uses in the framework of this awareness, understanding the information obtained through observations and experiments, and making it ready to be used, perceiving the problem very quickly and making decisions quickly associating it with his imagination (Ozcan, 2010). A creative person is the one who searches for the new fields, makes new observations, makes new guesses, and propose new implications. Creative people need to have the ability to think fluently, authentically, and flexibly (Emir and Bahar, 2003).

Being creative is a fundamental aspect of human nature and that all children are capable of manifesting and developing their creativity (Craft, 2003). Therefore, creativity is believed to be an inborn quality, inherited by the privileged few. However,

lately psychologists believed that everybody has the potential to be creative (Sternberg, 2004). It is like muscles of human body so creativity's "muscle" should be stretched and exercised (MacGregor, 1996). In order to stimulate creativity, continued and systematic effort has to be carried out. Creativity can be nurtured and enhanced through education. Michael D. Higgins, the former Irish Minister for Arts, Culture and Gaeltacht, Ireland said that:

> "The roots of a creative society are in basic education. The sheer volume of facts to be digested by the students of today leaves little time for a deeper interrogation of their moral worth. The result has been a generation of technicians rather than visionaries, each one taking a career rather than an idea seriously. The answer must be reform in our educational methods so that students are encouraged to ask about "know-why" as well as "know-how". Once the arts are restored to a more central role in educational institutions, there could be a tremendous unleashing of creative energy in other disciplines too."[3]

Recently, infusing creativity elements into teaching and learning process was an important movement in Asian educational reforms. The universalization of creativity in education has been influenced by the developments in creativity research and by the political contemporary scene (Simonton, 2000). According to the various study, education should support various kinds of thinking. Critical thinking is good but creative thinking probably even better. Beetlestone (1998) claimed that the best education is obtained through creative education.

For such consideration, educational professionals are increasingly coming to realize that learning and creativity go hand in hand (Moran, in press). This is especially true among socio-constructivist, cultural-historical or socio-cultural labeled researchers. In creative learning is regarded as collaborative meaning-making and knowledge construction rather than as knowledge acquisition. Such conceptions have tended to break down the old dichotomy between learning and creating. The differences between the two constructs become even more minor when we address them as collective processes (Craft, 2003; Jeffrey and Craft, 2004; Moran, in press).

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[3] Morris, 2006. *Creativity, Its Place in Education.* jpb.com, Belgium, page 2.

Based on Abu Hassan and Rohana (2003), many studies all levels of schooling to determine students' ideas suggest that the learning difficulties in chemistry is caused by the teachers' traditional teaching methods such as simple lecturing or "Chalk and Talk". Such teaching requires students to sit passively and does not much engage students actively in learning (Morgil, Oskay, Yavuz and Arda, 2003). These pedagogical approaches may then influence students' attitudes, cognitive development and achievement in science education (Cepni and Kose, 2006). Those student who have been taught according to teacher centered traditional approach, were unable to integrate their knowledge, think critically and creatively (Acar and Tarhan, 2008; Demircioglu, 2003).

Resnick (1987) found that students will engage more easily with problems that are embedded in challenging real-world contexts that have apparent relevance to their lives. If the problems are interesting, meaningful, challenging and engaging, students tend to be intrinsically motivating. So that the teachers need to increase meaningful learning which involving students actively in the process of knowledge construction to overcome the obstacles in learning Chemistry (Novak and Gowin, 1984). Active learning provides this construction by engaging students in higher order thinking skills and minds-on activities (Acar and Tarhan, 2009) especially the creative thinking skill.

The active or meaningful teaching and learning with the aid of ICT, students are able to collaborate, to use creative and critical thinking and to find alternatives solutions to problems (Jaber, 1997). Several capabilities of ICT, such as providing individualized instruction, practice, revision, teaching and problem-solving, simulations during the applications and immediate feedback, make computers useful instructional devices for developing desired learning outcomes (Ertepınar, 1995) especially the development of creativity in students.

According to Haluk Ozmen (2008), if students are willing to utilize a wide variety of tools in learning, the possibilities to produce creative generation are indeed limitless. Especially, the contribution of ICT based learning environments can boost the students' creativity. The utilization of ICT in learning points to positive

contributions of computer based learning environments to student learning. Computers are but only one tool that students can make it use to learn. There are also countless other materials including innovative textbooks, games and manipulative to name but just a few.

Not only that, the development of students' creative thinking plays an important role in their academic success (Onda, 1994) because the structure of question in examination aimed for creativity and critical thinking skills. Hence, the cultivation of creativity in learning which will increase academic achievement and make the teaching and learning process an enjoyable experience (Kitchens, Barber and Barber, 1991) should be initiated. Therefore, researcher develops Creative Chemistry Learning Courseware (CCLC) with ICT aids to examine how probability it helps in boosting the creativity of students and make their understanding in Mole concepts easier.

1.3 Statement of the Problem

According to Johnson (2014), nearly every list of 21st century skills mentions creativity as important to success, even survival. *The Rise of the Creative Class*[4] and *A Whole New Mind*[5] pointed out that creativity as a career and readiness skill for all, not just a nice extra for those working in the arts or entertainment. However, in our country education context, almost research show the focus on development of intelligences while the aspect of cultivation in creativity still haven been emphasized and attended (Toh, 2003).

Yong (1989) who said without hesitate, *"this emphases have taken a heavy toll on the creativity of Malaysia students"* [6] reminded us about the important of critical and creative thinking skill (CCTS) in science education except from the focusing in examination as the negative effects from implementation program KBSR and KBSM. The implementation of these program require teachers use multiple

[4] R., Florida, *The Rise of the Creative Class: And How it's transforming work, leisure, community and everyday life*, New York: Perseus Book Group, 2002.
[5] Daniel H. Pink, *The Whole Mind New Mind,* Riverhead Books, 2004.

[6] L. M. S. Yong, *A study of creativity and its correlates among form four pupils.* Kuala Lumpur: University Malaya, 1989, p. 20.

performance assessments where children apply their knowledge in the context of a given task, determine what their students know and what they need to learn, based on standards developed by that school or government that will limit the development of higher level thinking ability in students especially the creative thinking.

Chemistry is one of the most important branches of science however chemistry has been regarded as a difficult subject for young students by chemistry teachers, researchers, and educators (Ozmen, 2004). According to some researcher such as Lee et al. (1993), Abu Hassan & Rohana (2003), Furio, Azcona, Guisasola and Ratcliffe (2000), Gorin (1994), and Schmidt (1994) reported the most difficult topics being the mole concept, chemical formulae and equations from the students' point of view.

The book titled "Chemistry" wrote by Dr. Yamin Yasin and Lee Saw Inn had the statistic table on the SPM chemistry questions between 2005 until 2009, shown that there were 26% of mole concepts, chemical formulae and equation questions from total 50 questions in Paper 1 SPM Chemistry examination (Yasin and Saw Inn, 2010). That is the main cause of the students can't score excellent result (1A-2A) in SPM Chemistry paper which have lot of questions require higher thinking ability especially creative thinking skill.

For the achievement of students in chemistry subjects at SPM (*Sijil Pelajaran Malaysia*) level between year 2011and 2013, the percentage of excellent result is very low as shown in table 1.1. One of the factors that cause this problem is the increasing of examination questions which require creative and critical thinking skill (Siti Hajar, 2008). "Fewer students scored A+, A and A- in SPM examination, mainly because of a change in format for questions that required a different way of thinking to answer the questions", said Director-general of Education Datuk Seri Dr Khair Mohamad Yusof (The Rakyat Post, 2015).

Table 1.1: Result examination of chemistry SPM 2011-2013

Year	Percentage Level		Total Percentage
	Excellent (1A-2A)	Honors with Pass (3B-8E)	Pass
2011	15.4	79.7	95.1
2012	16.2	76.9	93.1
2013	15.0	80.8	95.8

Source: Sin Chew Jit Poh, 2013

Datuk Amar Dr. Sulaiman Daud who announced the Minister Customer Chapter enshrined that all exam questions need to encourage the creative and critical thinking skills among students toward year 2020 (Som and Mohd Dahalan, 1998). Haluk Ozmen (2008) stated that science and chemistry teachers may need to consider the creative teaching approaches particularly for difficult and abstract concepts in Chemistry to motivate the development of creativity in students when learning. The development of students' creative thinking plays an important role in their academicals success (Onda, 1994).

However, teachers prefer to use traditional teaching methods such as simple lecturing or "Chalk and Talk" in Chemistry teaching (Abu Hassan and Rohana, 2003) that cause the learning difficulties in this subject. This is because it saves time and energy in the preparation of materials if compared to the creative teaching especially utilizing ICT pedagogy method. The weakness of traditional teaching method is "one way flow" of information. Teachers often continuously talk for half an hour without knowing students response and feedback. Students learn from memorization but not understanding make students feel bored in Chemistry class.

In order to attract students to study chemistry, teachers should adopt modern methods of flexible delivery such as multimedia, computational simulation and the Internet thus reforming the traditional 'chalk and talk' teaching approach (Baodi Gou, 2003). Employing modern information and communication technologies (ICT) in teaching and learning session not only can overcome obstacles in leaning however can boost the creativity of students in science learning (Ozmen, 2008). These learners-centered approaches technologies can facilitate knowledge-construction in

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