

***ChemMol4*: Learning Concept of Mole via Needham's Five Phases to Overcome Students' Alternative Concepts**

Noor Dayana Abd Halim & Nurfatina Atikah Kamarudin

Department of Educational Sciences, Mathematics and Creative Multimedia, Faculty of Education, Universiti Teknologi Malaysia, 81310 Skudai, Johor, Malaysia.

noordayana@utm.my, atien_adriana@yahoo.com

Abstract - *ChemMol4* courseware has been developed based on constructivism Needham's 5 Phases to overcome students' alternative frameworks in defining the concept of mole. This courseware was developed using the ADDIE model. Learning process take place in this courseware was via adventuring, questioning and challenging. Further, a study has been conducted to investigate the effectiveness of the *ChemMol4* courseware on students' achievement. A total of 22 form four students from a school have been chosen as respondent for achieving this objective. Overall, the study found that there was a significant achievement after students learned using the developed courseware.

Keywords: Mole Concept; Courseware; Needham's 5 Phases

INTRODUCTION

Computer aided learning (CAL) is an approach that uses a computer for teaching and learning purposes (Baharuddin, 2002). The present educators absolutely should be prepared and equip themselves with various methods and techniques that can be utilized during teaching in the classroom. Therefore, a paradigm shift has to be done by educators not only in terms of attitude even in the delivery of learning materials in the classroom. According to Zaidatun (2003), this aspect is much needed by the contemporary education system that aims to create meaningful and effective learning.

The use of technology in the education system, for example CAL not only facilitate teachers in the teaching process but also can attract students interest to learn by using a new method that is more enjoyable (Nur Ain, 2010). Teaching methods with static materials are said to give less means impact on the students. Therefore, by CAL, students can master the thinking skills better and more effective (Mohd Aris, 2007).

In science, especially Chemistry, also exposed to the current technological developments in the field of education. With the advent of smart schools, CAL approach is applied in teaching and learning process. This is consistent with the role of the teacher as a facilitator for the students in getting information (Johari, 2007). Accordingly, the process of teaching and learning of Chemistry should be treated carefully in order to produce students who have the knowledge and skills in Chemistry and are able to apply this knowledge and skills based on scientific attitudes and good values in making decisions and problems solving in daily life.

PROBLEMS IN LERNING CHEMISTRY

Chemistry is a subject that is offered to students in science stream in the Malaysian Certificate of Education (SPM). Most students have the notion that Chemistry is a subject Senior Lecturer | Faculty of Education, Universiti Teknologi Malaysia

that is difficult to understand. According to Abd. Hamid (2006), despite various efforts conducted by the Ministry of Education (MOE), but the students still considers that Chemistry is a difficult subject. This is due to the concepts of Chemistry that are abstract, complex and thus require the ability to master three levels, namely level of microscopic, macroscopic, and symbolic (Abd. Hamid, 2006). Among the sub-topics in Chemistry for students who are particularly difficult to master is the concept of the mole.

Alternative framework in the concept of mole

Students are difficult to understand and apply a concept or law correctly is due to a variety of alternative frameworks that exist in their minds (Kamaru'z Zaman, 1999). Alternative framework is an impediment to understanding the concept of mole and it is inconvenient to understand the scientific facts, assimilate and organize them when needed (Krishnan and Howe, 1994).

Understanding the concept of the mole is an important fundamental in studying Chemistry in depth because it is used in the solution of other Chemistry problems such as equilibrium of acids and bases, equilibrium constants and pH, solution concentrations and electrochemistry. Among alternative frameworks that exist in students, is the difficulty in understanding the definitions and terms of mole concept, weaknesses to relate between the mass and mole, volume and number of particles as well as counting skills weaknesses and the use of the incorrect formula. However, this study focuses only to student's alternative frameworks in defining the concept of mole.

Reviews from Staver and Lumpe (1993), found that most students encounter problems in defining mole alternative framework to solve the problem. For example, students define the mole as a fixed number equivalent to 6.02×10^{23} . Here are some other alternative framework issues among students about the mole:

- Carvellati *et. al.* (1983); Novick and Menis (1976): the mole is the number of particles contained in a gram of any substance and mole of different materials is having the same mass.
- Novick and Menis (1976) : one mole equivalent of any particle in all circumstances always meet the same volume
- Carvellati *et. al.* (1982): mole is the volume of the material contains number of molecules of Avogadro.
- Friedel and Maloney (1992): mole is just proportional to the number of atoms and not to a number of other particles.

Therefore, high understanding in the definition and term of mole concept should be held firmly by the students, so that the alternative framework problems of the student can be overcome.

LEARNING STRATEGIES FOR OVERCOMING PROBLEMS IN THE CONCEPT OF MOLE

Computer aided learning (CAL), such as the use of multimedia software in particular, able to create a smart learning environment that encourages students to think critically and creatively (Ismail, 2002). This also means learning to stimulate students to use various intelligence to improve the process of generating the mind and corrosive alternative frameworks that exist, added Ismail (2002). The effectiveness of a teaching method for mastering the concept of the

mole is also depends on the ability of a teacher to address the problems experienced by students.

Therefore, effective teaching methods are very important for teachers to overcome and help students mastery the concept of the mole for better also strengthen students' mathematical skills. One of the ways to achieve effective teaching is through the application of teaching and learning theories, such as the theory of constructivism, cognitive and behaviourism. According to that, this study has developed *ChemMol4* courseware that applies constructivist theory which is 5 Phases of Needham constructivism model by Richard Needham (1987) as a teaching strategy to dominate the mole concept and also as a learning process in this courseware in order to create effective learning. The rationale of using the Needham model is because this model emphasize on students centred learning and able to make students engage in the learning process.

Constructivism Learning Theory

Learning approach of constructivism theory is able to make students actively participate in the teaching and learning process. In addition, students can construct meaning in the process of acquiring knowledge. In addition, through this theory, the importance of studying science actively than what they experienced and concerned with existing knowledge in a social context can be created (Driver *et. al.*, 1985). Further to that, the support of technology is also one of the strategies that can help to overcome alternatives framework among students. Thus, technology such as *ChemMol4* courseware is developed by integrating the 5 Phases of Needham model in addressing these issues. This model has five phases which are orientation, arcing idea, restructuring the idea, application of ideas and reflection phase. All phases also have situations and challenges that must be taken by students throughout the adventure and exploration in this *ChemMol4* courseware. Among of the *ChemMol4* courseware display are shown in figure 1 and figure 2 below.

Cabaran 1 :

Apakah maksud bagi 1 mol sebatian?

- 1 mol sebatian mempunyai 6.02×10^{23} zarah.
- 1 mol sebatian mempunyai 1 gram molekul.
- 1 mol sebatian mempunyai suatu nombor tetap bersamaan 6.02×10^{23} .
- 1 mol sebatian mempunyai isipadu yang sama dalam semua keadaan.

ARAHAN : Sila klik pada jawapan yang sesuai !!

Figure: Display of Challenge 1



Figure: Display of Early Reflection of Learning

RESEARCH METHODOLOGY

The design of this study is quantitative which using pre-experimental design for the type of One Group Pre Test Post Test by Campbell and Stanley (1963). Therefore, this study did not involve a control group. A treatment group undergoes experimental treatment process. The treatment group is tested using pre and post-test where the reliability value for the test was .865. According to Khalid Johari (2003) this pre-experimental design, is able assessing by itself the differences of the performance before and after for the same group of students using the courseware. The study sample is comprised of 22 form four science students at a school in a district of Johor Bahru.

RESEARCH FINDINGS

To measure the student achievement after using this *ChemMol4* courseware, analytical methods of paired sample t-test using Statistical Package for Social Science Version 16 (SPSS) was performed. Table 1 shows the schedule of the paired t-test conducted. With reference to Table 1 below, the Sig. (2-tailed) value was lower than 0.05 ($p < 0.05$) at 0.00. This implied that the mean scores between the two tests tested were significantly different. The conclusion from this result can be concluded that this *ChemMol4* courseware gives positive impact for addressing students' alternative framework in defining the concept of mole.

Table 1: Paired t-test for pre and post test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Pre Test – Post Test	-3.18182	1.70814	.36418	-3.93917	-2.42447	-8.737	21	.000

Based on students' achievement in the early stages of study through pre-test mole concept, majority of the students are not able to solve a given problem very well. This is likely due to the traditional way of teaching that is one way; more towards teacher-centred and lacked in engaging students in learning activities make students' understanding on this topic become difficult. Therefore, more effective and interactive teaching method is required to be implemented using a variety of teaching materials and teaching aids such as media. According to Baharuddin (2001) instructional media give an experience that involved the use of a person's vision and hearing. This means the teaching materials such as *ChemMol4* courseware plays an important role in enhancing the understanding of students by giving students a more interactive learning experience as well as to increase their performance.

In addition, the software that integrates the use of multimedia also be one of the factor in improving student achievement. According to Wan Azah *et.al*, (2003) the use of multimedia such as educational courseware absolutely the brilliant idea of giving the best method to help maximizing the concentration of students during the learning process occurs. This is because, technology assisted teaching performed is bilateral in nature which is more student-centred and less involving the teacher in learning activities. In this context, the teacher is a facilitator in the teaching and learning process. Moreover, according to Azura (2009) the use of multimedia software has also lowered the average learning time effectively by 80 percent while increasing the level of students' achievement (Azura, 2009).

Besides, the pedagogical agent contained in this courseware also can help to improve the students' achievement in learning the concept of mole. According to Juhazren and Mohd Fadzli (2006), pedagogical agents can provide guidance in the display which helps students to discuss and mediate in an electronic learning program. In a statement of Dehn and van Ülken (2000), pedagogical agents can be described as an animated character that can help the learning process in a computer-based learning environment.

Furthermore, this *ChemMol4* courseware has also integrated the 5 phases Needham model with a form of adventure process that attract students' interest to explore the said software. This factor makes *ChemMol4* software different from other CD-ROM software. The finding by Sushkin (1999) proved that the group of students who were taught using a constructivism approach of 5 phases Needham have higher achievement than group of students who were taught using traditional approaches. Review of Caprio (1994), Lieu (1997), Curtis (1998), and Nor Aini (2002), Van Drie and Van Boxtel (2003), demonstrated that the constructivism approach can help students to gain more understanding and higher achievement. Therefore, it is clear that the teaching strategies of 5 phases Needham that integrated in *ChemMol4* software were able to enhance students' achievement in learning the concept of mole.

CONCLUSION

This paper has discussed the problem in learning the concept of mole, 5-phase Needham model that is incorporated into the software and its impact on students' achievement. The results showed that technology assisted teaching by that involves the use of multimedia like *ChemMol4* courseware helps in the process of improving students' achievement. This is due to learning through technology software makes the learning process more interactive and student-centred. Integrated learning theory of constructivism through 5 phases Needham model makes the learning process more enjoyable. In addition, the integration of multimedia

elements such as audio and graphics as well as the use of pedagogical agents also make students more motivated to learn and help students in overcoming alternative framework problems in this mole concept.

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