

## Multimedia Laboratory Module in the Learning of Electrochemistry: Needs Assessment Study

*Modul Makmal Multimedia bagi Pembelajaran Elektrokimia: Kajian Analisis Keperluan*

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### Abstract

This needs assessment study was done as a preliminary step in developing Multimedia Laboratory Module In The Learning of Electrochemmistry (MLMLE). This study involved 176 form 5 and 41 form four students to investigate the topics difficulty level of chemistry form four syllabus and the problems in the learning of electrochemistry. Results from the Topics Difficulty Level survey showed that the respondents rated Electrochemistry ( $M = 3.99$ ,  $SD = 0.821$ ) as the second most difficult topic in Chemistry form four syllabus. From the Electrochemistry Achievement Test, 65.8% of the students have poor understanding of the electrochemistry concept with the lowest mean score is for write half chemical equation ( $M = 0.24$ ,  $SD = 0.353$ ), followed by construct the electrochemical series ( $M = 0.30$ ,  $SD = 0.439$ ) and identify the flow of electron ( $M = 0.35$ ,  $SD = 0.477$ ). To overcome this problem, a MLMLE was planned to develop. This module is hope able to help the students in improving their understanding in concepts in the learning of electrochemistry with animations to support the abstract concept.

**Keywords** Laboratory module, electrochemistry, needs assessment

### Abstrak

Kajian analisis keperluan dijalankan sebagai langkah permulaan bagi pembinaan Modul Multimedia Kerja Amali Elektrokimia (MMKAE). Kajian ini melibatkan 176 orang pelajar tingkatan lima dan 41 orang pelajar tingkatan empat bagi mengenal pasti tahap kesukaran tajuk bagi sukatan pelajaran kimia tingkatan empat dan kelemahan konsep yang dihadapi dalam pembelajaran elektrokimia. Hasil soal selidik Tahap Kesukaran Tajuk menunjukkan responden mengelaskan Elektrokimia ( $M = 3.99$ ,  $SP = 0.821$ ) sebagai tajuk yang kedua paling sukar dalam sukatan mata pelajaran Kimia tingkatan empat. Dapatan dari Ujian Pencapaian Elektrokimia, 65.8% pelajar menunjukkan pemahaman yang lemah terhadap konsep elektrokimia dalam menulis persamaan kimia ( $M = 0.24$ ,  $SP = 0.353$ ), diikuti oleh membina siri elektrokimia ( $M = 0.30$ ,  $SP = 0.439$ ) dan mengenal pasti arah aliran elektron ( $M = 0.35$ ,  $SP = 0.477$ ). Bagi mengatasi masalah ini, perancangan untuk membina MMKAE telah dibuat. MMKAE ini diharap dapat membantu pelajar dalam meningkatkan pemahaman terhadap konsep dalam elektrokimia dengan dibantu oleh animasi bagi menyokong konsep yang abstrak.

**Kata kunci** Modul kerja amali, elektrokimia, analisis keperluan

## INTRODUCTION

Chemistry is a discipline in science that studies matter in to macroscopic and microscopic levels, the interactions between reactants and production and the used of substance (Kementerian Pendidikan Malaysia, 2003). The macroscopic level describe the concept on the physical level of the substances which can be seen and measured when reacted or produced in a chemical reaction, while the microscopic level refers to the concept at the level of characteristics or properties of substance that cannot be seen such as the arrangement of atoms, the structure of molecules, the energy level of the electrons and movement of electrons (Safizan, 2013). Electrochemistry is the seventh topic in chemistry form four syllabus which according to Yee, (2001) is a branch of chemistry to study about chemical change by the electric current during the electrolysis and electric current produced by a chemical reaction.

Laboratory work is a main component in electrochemistry. According to Bekar (1996), laboratory studies increase students' interest and abilities for the science subject. Although laboratory application in students' learning has a very important place in science education, it has some limits and problems, especially in developing countries (Cengiz, 2001). Cengiz (2001) and Ozdener (2005) summarized problems in doing laboratory work as follows:

1. In carrying out experiments and arranging with equipment, the laboratory activities are expensive.
2. For planning and application, it is time consuming.
3. Lack of laboratory or equipment, or insufficient lab conditions which limits the teacher to perform a simple laboratory activity.
4. Limitation of time for teacher to finish the entire syllabus for examination.
5. Students are not interested in doing the laboratory work.
6. Teachers assume some of the laboratory activities need not to be done because can be explain theoretically.
7. Some of the laboratory activities are dangerous to be done by students.

Due to the limitation of equipment, time or insufficient laboratory conditions, teachers still need to perform laboratory activities in crowded groups, or sometimes demonstration of the experiment is performed (Cengiz, 2001). This situation is opposed the basic constructivist philosophy for science which accepts that knowledge can be gained through experiences and observations (Ozdener, 2005). Chemistry teachers reported, most schools skip electrochemistry experiments in their school laboratory. The main factor electrochemistry experiments cannot be done because there is not enough electrolytic cells in laboratory. In some of the electrochemistry experiments, students need to repeat the experiments with different electrolytes which consume time. Therefore, the use of technology in the learning of electrochemistry, overcome some of the problems faced in traditional laboratory applications and make a positive contributions in reaching the objectives of an educational system (Cengiz, 2001). The objectives of this study are to investigate the topics difficulty level of form four syllabuses and to investigate the problems in the learning of electrochemistry. In this study, Multimedia Laboratory Module In The Learning of Electrochemistry (MLMLE) will be developed as a learning aid for electrochemistry as it save cost and helps students to visualize the chemical reaction

occurs at the macroscopic, microscopic and symbolic level. According to Cengiz (2001), a complex information given to the students is simplified by technology and provides them opportunities learning by doing as the module provided with animation to support the abstract concept. This MLMLE will be developed by following ADDIE Model. "ADDIE" stands for Analyze, Design, Develop, Implement and Evaluate. In the first phase, analysis process of need assessment for MLMLE was done to ensure the development process planned systematically. The results from this analysis phase will be used as a preliminary step in developing MLMLE.

## METHODOLOGY

### Design of study

The aim of this quantitative descriptive study is to investigate the students' perception on difficulty level of topics in form four chemistry syllabus and problems faced by students in the learning of electrochemistry. A questionnaire and a test were used to collect data from the respondents.

### Sample

176 form five students from Kuantan district were involved in the survey and 41 form four students were selected randomly from a school in Kuantan district to answer the Chemistry Achievement Test.

### Instruments

A Topics Difficulty Level Survey questionnaire of the chemistry form four topics was done to collect data from respondent. This instrument consists of all nine topics in form four syllabuses where respondents rated the chapters which using Likert scale.

The Electrochemistry Achievement Test is used to identify the students' understanding on the concept of electrochemistry based on macroscopic, microscopic and symbolic levels. This test consists of four structural questions on electrochemistry concept based on the learning outcomes from the Curriculum Specification (CS) published by Curriculum Development Centre, Ministry of Education Malaysia. Students were given one hour to answer all of the questions. The distribution of items in the achievement test with the concepts tested and representation levels are summarized in Table 1.

**Table 1** Items distribution in electrochemistry achievement test

No.	Concepts	Items	Representation level
1	Identify the anode and cathode	2 b	Macroscopic
2	Identify the cations and anions in an aqueous solution	1 a, 2 c, 3 c, 4 a, 4 b i), 4c	Microscopic / symbolic
3	Identify the positive terminal and negative terminal cell	3 d i)	Macroscopic
4	Identify the flow of electron	1 e, 3 a	Microscopic

**Table 1** (Cont...)

No.	Concepts	Items	Representation level
5	Identify the ions attract to anode and cathode	1 b i), 1 b ii), 2 d i), 2 d ii)	Microscopic
6	Identify the ion discharge at anode and cathode	1 c i), 1 c iii), 1 g i), 1 g iii), 2 e i)	Microscopic
7	The concept of ions selected to be discharge at anode and cathode	1 c ii), 1 g ii), 1 g iv), 1 c iv), 2 e ii) 2 h	Microscopic
8	Write half chemical equation	1 d ii), 1 d iv), 1 g vi), 1 g viii), 2 f ii), 2 f iv), 3 b i), 3 b ii), 3 b iii), 4 b ii)	Symbolic
9	Predict the products of electrolysis	1 d i), 1 d iii), 1 g v), 1 g vii), 2 f i), 2 f iii)	Microscopic
10	Predict the observations at anode and cathode	1 f i), 1 f ii), 2 g i), 2 g ii), 4 b iii)	Microscopic
11	Construct the electrochemical series	3 d ii), 3 e	Microscopic

## RESULTS

The Topics Difficulty Level questionnaire was analysed to get the students' perception on the topics difficulty level of form four chemistry syllabuses. The result in Table 2 shows that Electrochemistry ( $M = 3.99$ ,  $SD = 0.821$ ) is the most difficult topic after Salts ( $M = 4.24$ ,  $SD = 0.842$ ).

**Table 2** Mean score and standard deviation of topics difficulty level

No.	Topics	Mean	Standard Deviation
1	Introduction to Chemistry	1.84	0.563
2	The Structure of the Atom	2.27	0.618
3	Chemical Formulae and Equations	2.93	0.689
4	Periodic Table of Elements	2.98	0.623
5	Chemical Bonds	3.62	0.859
6	Electrochemistry	3.99	0.821
7	Acids and Bases	3.91	0.795
8	Salts	4.24	0.842
9	Manufactured Substance in Industry	3.42	0.929

From the Electrochemistry Achievement Test, 22 students scored between 0% - 39% and 13 students scored between 40% – 69% and 6 students scored between 70% - 100%. From this result, 53.7% of students have poor understanding on electrochemistry concept. The electrochemistry concept in each items were analyse and the result is shown in Table 3. Overall, the students' concept on electrochemistry is low with the lowest mean score is for write half chemical equation ( $M = 0.24$ ,  $SD = 0.353$ ), followed by construct the

electrochemical series ( $M = 0.30$ ,  $SD = 0.439$ ) and identify the flow of electron ( $M = 0.35$ ,  $SD = 0.477$ ).

**Table 3** Mean score and standard deviation of electrochemistry concepts

No.	Concepts	Mean	Standard Deviation
1	Identify the anode and cathode	0.76	0.431
2	Identify the cations and anions in an aqueous solution	0.76	0.431
3	Identify the positive terminal and negative terminal cell	0.62	0.492
4	Identify the flow of electron	0.35	0.477
5	Identify the ions attract to anode and cathode	0.74	0.411
6	Identify the ion discharge at anode and cathode	0.60	0.493
7	The concept of ions selected to be discharge at anode and cathode	0.42	0.465
8	Write half chemical equation	0.24	0.353
9	Predict the products of electrolysis	0.53	0.491
10	Predict the observations at anode and cathode	0.40	0.477
11	Construct the electrochemical series	0.30	0.439

## DISCUSSION

Table 2 shows that the highest mean score of topics difficulty level is for Salts ( $M = 4.24$ ,  $SD = 0.842$ ), followed by Electrochemistry ( $M = 3.99$ ,  $SD = 0.821$ ) and Acids and Bases ( $M = 3.91$ ,  $SD = 0.795$ ). Similar result was declared by Lee (2013), where the students rated electrochemistry as difficult and very difficult with a mean of 3.86. 37.5% of students assumed electrochemistry is difficult to understand, Syed Abd Kadir (2000). Teachers and students assume electrochemistry as a tough topic (Finley, Stewart & Yarroch, 1982), and (Syed Abd Kadir, 2000). From this result, Electrochemistry was chosen to develop the MLMLE instead of Salts which has highest mean score because Electrochemistry is the sixth topic in the syllabus followed by Acids and Bases the seventh topic and Salts the eighth topic. There are correlations between these three topics where students need to understand the concept at the macroscopic, microscopic and symbolic level. It is better for the students to understand and master the same concept in Electrochemistry before they learn a tougher topic such as Salts. For these three topics, students need to write the representation of the chemical reaction symbolically by using chemical equation. Besides that, students need to understand the presence of ions in the electrolyte, the flow electron through the external circuit and flow of ions in the electrolyte. These situations need them to understand the reaction microscopically. Students can understand and apply the principle of chemistry better in solving the problem if they can relate the level of macroscopic and microscopic (Virvao, Katsionis & Manos, 2005).

From the result of electrochemistry concept from the Electrochemistry Achievement Test in Table 3, most of the students were unable to write the half chemical equation at anode and cathode correctly. Some of the students have problem in writing the correct symbols for reactants and products formed in the chemical reaction. The students have problem in identifying the flow of electron through the connecting wire. The flow of electrons through connecting wire is based on the discharge of ions at the electrodes. Most

of students still have problem to differentiate between chemical cell and electrolytic cell, the energy change and process involved in both cell, (Kementerian Pendidikan Malaysia, 1996). Students confuse about the ion discharge, and they cannot explain the observation at anode and product form during the electrolysis process (Kementerian Pendidikan Malaysia, 2002). When the students have problem in writing the correct formula of products form, this cause them to have difficulties in predicting the products formed at the anode and cathode. Some of the students have problem remembering electrochemical series and how to construct it based on the concept. It is difficult for students to understand the concept of chemistry because the conventional teaching method cannot help them to visualize any condition or reaction at the microscopic and symbolic level. According to (Ward & Herron, 1980; Garnett, Garnett & Hackling, 1995) there are many chemistry concept that include the objects that cannot be seen, feel or touch such as ion, atom and molecule which cause the chemistry subject become tough.

## CONCLUSION

The need assessment study showed the students' perception on difficulty level of topics and problem faced by students in the learning of electrochemistry. This study showed electrochemistry is the second most difficult topic in form four chemistry syllabus supported by several research result which claimed that students have difficulty in learning of electrochemistry. To overcome this problem, a MLMLE was planned to develop. This multimedia laboratory module is intended to help the students in improving their conceptual and increase their motivation during electrochemistry learning.

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