



## **PROBLEM SOLVING COMPETENCY FOR OPEN-ENDED PROBLEM IN LEARNING ELECTROLYSIS: A CASE STUDY OF MALAYSIAN SECONDARY SCHOOL CHEMISTRY STUDENTS**

**Suraiya Muhamad\*<sup>1</sup>, Jamalludin Harun<sup>2</sup>, Johari Surif<sup>3</sup>,  
Noor Dayana Abdul Halim<sup>4</sup>, Siti Salbiah Omar<sup>5</sup>, Muhammad Umar Khan<sup>6</sup>**

<sup>1,2,3,4,5</sup> Department of Educational Sciences, Mathematics and Creative Multimedia,  
Faculty of Education, Universiti Teknologi Malaysia, Johor Bahru, MALAYSIA.  
(E-mail: suraiyamuhamad@gmail.com, p-jamal@utm.my, johari\_surif@utm.my,  
noordayana@utm.my, sitalbiahomar@gmail.com)

<sup>6</sup> Department of Education Foundation and Social Sciences  
Faculty of Education, Universiti Teknologi Malaysia, Johor Bahru, MALAYSIA.  
(E-mail: umarkhan.gcuf@gmail.com)

### **ABSTRACT**

This paper discusses a preliminary study which was undertaken to develop a model of authentic chemistry problem solving competency in learning chemistry. Recent poor performance of Malaysian students in the Programme for International Students Assessment (PISA) on problem solving test could be due to a pervasive pattern of low application of higher order thinking skills in solving the open-ended problems in Malaysian teaching and learning scenarios. Hence, this study investigated how secondary school students solve open-ended problems in learning electrolysis and what are the underlying factors of their problem-solving competency. Five chemistry students from a secondary school in Sarawak were selected as the participants. Semi-structured interviews and think aloud protocol (TAP) were conducted to investigate their problem solving processes practice. Quite similar findings have emerged: participants that scored with good score in chemistry problem solving ability test (CPSAT) have higher scientific knowledge and problem solving skills compared to low achieving participants. Scientific knowledge competency and problem solving skills have been identified as the major independent variables to develop chemistry problem solving competency. Outcomes from this study shall be used to design a module for one selected topic in chemistry and to develop a 'Model of Authentic Chemistry Problem-solving Competency' for school students in general.

**Keywords: Problem-solving competency, Higher order thinking skills (HOTS), Open-ended problem**

## INTRODUCTION

Malaysian government aims universal access all the way through to secondary education, that will produce students who perform in the top third of international assessments, to provide equal and quality educational opportunities for all students. This is due to the rapid changes of global market which require competent citizen and hence demand a transformation in Malaysian national education. The role of formal education in school is not merely to transfer knowledge but also to apply the knowledge to produce future generation with higher order thinking skills (HOTS) to solve complicated problems in the real world especially in Malaysia. However, recent performance of Malaysian students in the Programme for International Students Assessment (PISA) on problem solving test is below to the global average score as compared to other countries [1,2]. This may be due to low application of higher order thinking skills upon solving problems in Malaysian schools as one of the factors [3]. In order to compete with the best in the world, the education system must develop young Malaysians who are knowledgeable, able to think critically, innovative and creative, have leadership qualities and problem solving skills that enable them to communicate with the rest of the world. In conjunction to this, problem-solving competency becomes a central objective within the educational programmes of many countries such as Shanghai (China), Hong Kong, Singapore, Japan and Finland because the acquisition of increased levels of problem-solving competency provides a basis for future learning, for effective participation in society and for conducting personal activities [4].

## MAIN RESULTS

### Chemistry Problem Solving Ability (CPSA)

An hour and fifteen minutes of chemistry problem solving ability test (CPSAT) was administered to determine the level of problem solving ability to solve four open-ended problems among students in learning electrolysis. Chemistry problem solving ability test was used as an instrument to measure the level of scientific knowledge and problem solving skills. The performance of the test was categorized into three levels (low, average and high) based on their score mark in percent in the test: 0-33 categorized as low, 34-66 as average and 67-100 as high achiever. Table 1 showed the result of the selected participants in this study. Therefore, the overall level of problem solving skills and scientific knowledge of the participants are lesser. Most of the participants are unable to solve the open-ended problems due to lack of scientific knowledge and poor conceptual understanding about electrolysis. This indicates that they still lack in higher order thinking skills to solve the problem in learning chemistry.

**Table 1.** Participants' score in chemistry problem solving ability test (CPSAT)

Participant	Score Mark (Percent)	Achievement Level
S1	60	Average
S2	62	Average
S3	8	Low
S4	6	Low
S5	22	Low

## Problem Solving Process

Process that is involved to solve open-ended problems will indicate the participants' cognitive ability and skill applied by the participants. Participants who scored good marks in CPSAT are able to apply problem solving skills as they comprehend the problems better, solve them by using a particular concept or principle, create and share the solution with others. Low achieving participants in CPSAT lacked the application of problem solving skills and had poor knowledge about the scientific process of electrolysis.

## Factors for Developing the Chemistry Problem-solving Competency

Participants have stated several factors that can potentially improve their problem solving competency based on their learning experience. Scientific knowledge is a core success factor to solve the open-ended problem supported by application of the appropriate problem solving skills collaboratively. At the same time, participants must be familiar in solving those open-ended problems that related to their real life context.

## CONCLUSION

Problem solving competency is crucial to generate a competent future leader to solve the real world problems specifically regarding chemistry in context. Deep understanding of scientific knowledge competencies, problem solving skills, familiarity in solving open-ended problem and solving problems collaboratively, are identified as the core factors that to develop chemistry problem solving competency. Thence, "Model of Authentic Chemistry Problem-solving Competency" was developed by integrating those variables in the authentic learning practice [5] with model of problem-solving instruction [6] and Scientific knowledge competency from PISA Science Framework [7].

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