DEVELOPMENT OF EX-MYSTERYCHEM TEACHING MODULE FOR THE LEARNING AREA POLYMER CHEMISTRY

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FACULTY OF SCIENCE AND MATHEMATICS

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THIS FINAL YEAR PROJECT SUBMITTED IN FULFILLMENT OF THE REQUIREMENT FOR THE BACHELOR'S DEGREE OF EDUCATION (CHEMISTRY) WITH HONORS

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PERAKUAN KEASLIAN PENULISAN

Perakuan ini telah dibuat pada 24 Februari 2024.

i. Perakuan Pelajar:

Saya, **AARON WEE SWEE LEE** bernombor matrik **D20201095411** dari Jabatan Kimia, Fakulti Sains dan Matematik dengan ini mengaku bahawa tesis yang bertajuk **Development Of EX-MysteryChem Teaching Module For The Learning Area Polymer Chemistry** adalah hasil kerja saya sendiri. Saya tidak memplagiat dan apa-apa penggunaan mana-mana hasil kerja yang mengandungi hak cipta telah dilakukan secara urusan yang wajar dan bagi maksud yang dibenarkan dan apa-apa petikan, ekstrak, rujukan atau pengeluaran semula daripada atau mana-mana hasil kerja yang mengandungi hak cipta telah dinyatakan dengan sejelasnya dan secukupnya.

(**AARON WEE SWEE LEE**)

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ABSTRACT

This study aims to develop EX-MysteryChem teaching module and to investigate the educators' perception on the suitability of the EX-MysteryChem teaching module for teaching and learning for the learning area of Polymer Chemistry. This study is a developmental research design (DRD) with qualitative approach. The ADDIE model is used as the instructional design model in developing the EX-MysteryChem teaching module. The instruments used in this study are content validity evaluation form and interview protocol. Two Chemistry lecturers have been appointed to validate the content validity of EX-MysteryChem teaching module and two secondary chemistry teachers have been selected as respondents for this study. The data for the content validity was analyzed using Average Congruent Percentage (ACP), while the interview protocol was analyzed using the thematic analysis technique. The result show that the overall content validity is 96.2% value of the teaching module, the findings from the thematic analysis for the both semi-structured interviews were considered as suitable for teaching the learning area of polymer chemistry, but it will require some modification in order to successfully implemented into the teaching and learning session for form 5 chemistry lessons. In conclusion, this study successfully developed a problem-based learning module with high content validity. This study implicates the development of EX-MysteryChem teaching module is capable to provide chemistry teachers a clear overview for problem-based learning teaching approach thus bridges the gap between theoretical learning and practical application about chemistry and increase the green chemistry awareness among students.

Pembangunan Modul Pengajaran EX-MysteryChem Untuk Bidang Pembelajaran Kimia Polimer

ABSTRAK

Kajian ini bertujuan untuk membangunkan modul pengajaran EX-MysteryChem dan untuk mengenal pasti persepsi pendidik terhadap kesesuaian modul pengajaran EX-MysteryChem untuk pengajaran dan pembelajaran bagi bidang pembelajaran Kimia Polimer. Kajian ini adalah Rekabentuk Kajian Pembangunan (DRD) dengan pendekatan kualitatif. Model ADDIE digunakan sebagai model reka bentuk pengajaran dalam membangunkan modul pengajaran EX-MysteryChem. Instrumen yang digunakan dalam kajian ini ialah borang penilaian kesahan kandungan dan protokol temu bual. Dua orang pensyarah Kimia telah dilantik untuk mengesahkan kesahan kandungan modul pengajaran EX-MysteryChem dan dua orang guru kimia menengah telah dipilih sebagai responden dalam kajian ini. Data untuk kesahan kandungan dianalisis menggunakan Purata Peratus Kongruen (ACP), manakala protokol temu bual dianalisis menggunakan teknik analisis tematik. Keputusan menunjukkan bahawa keseluruhan kesahan kandungan adalah nilai 96.2% bagi modul pengajaran, dapatan daripada analisis tematik untuk kedua-dua temu bual separa berstruktur dianggap sesuai untuk mengajar bidang pembelajaran kimia polimer, tetapi ia memerlukan sedikit pengubahsuaian supaya dapat digunakan dengan jayanya ke dalam sesi pengajaran dan pembelajaran bagi kelas kimia tingkatan 5. Kesimpulannya, kajian ini berjaya membangunkan modul pembelajaran berasaskan masalah dengan kesahan kandungan yang tinggi. Kajian ini memberi implikasi pembangunan modul pengajaran EX-MysteryChem dapat memberi gambaran yang jelas kepada guru kimia bagi pendekatan pengajaran pembelajaran berasaskan masalah sekali gus merapatkan jurang antara pembelajaran teori dan aplikasi amali tentang kimia dan meningkatkan kesedaran kimia hijau dalam kalangan pelajar.

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LIST OF ABBREVIATIONS

ACP	Average Congruent Percentage
DRD	Development Research Design
DSKP	Dokumen Standard Kurikulum dan Pentaksiran
KBAT	Higher Level Thinking Skills
KBSM	Integrated Curriculum for Secondary School
KPM	Kementerian Pendidikan Malaysia
PBL	Problem-Based Learning
RPH	Rancangan Pengajaran Harian
RPT	Rancangan Pengajaran Tahunan
UPSI	Sultan Idris Education University

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CHAPTER 1

INTRODUCTION

1.0 Introduction

In this 21st century, education has been brought into many significant transformations which particularly in the skills such as soft-skills that required for students to be success in a rapidly changing global landscape. There is a quote "Education in this 21st century is about developing intelligences" by Oon (2003). Intelligence in the real world involves not only learning how to do things and actually doing them, but also the ability to deal with novelty as well as the capacity to adapt, select and shape our interactions with the environment (Sternberg, 1985, 1986, 1990). Developing intelligence is learning about how to communicate, how to solve problem and how to self-manage your own talent. In Malaysia, the Ministry of Education (KPM) has recognized the

needs to develop intelligence skill with the 21st century skills to be prepared for the challenges and obstacles of the future. This effort is aimed at transforming the education system and providing the knowledge and skills of 21st century industrial players and thus, becoming the best global competitors (Zainab & Norfadila, 2021).

Science is regarded as one of the most important knowledge subjects in education (Amy, 2016). Physic, chemistry and biology are the three main subject that are taught in primary and secondary school. Chemistry is an important part in every science related field such as in biology, material science, pharmacology, medicine and health and other sciences (Lloyd & Kennedy, 2014). As a results, chemistry had involved in many other fields, and this represent that chemistry offers a lot of opportunities for gaining real-world experience that requires dealing with complicated issues which involves solving challenging problems. Many students argue that chemistry is a challenging, complex, and abstract subject that needs special intellectual abilities and excessive learning time in order to understand (Ben-Zvi, Eylon & Silberstein, 1987; Gabel, 1999; Johnstone, 1991; Nakhleh, 1992, as cited in Cardellini, 2012). Thus, in order to increase student understanding and knowledge in chemistry, 21st century teaching strategies is one of the best solutions. To address the issue of secondary students in Malaysia about the lack of understanding and knowledge in chemistry, several solutions can be implemented. In one of the solutions, educators should adopt problem-based learning as a teaching strategy to help students develop problem-solving skills

In this chapter, researcher begins with a brief introduction as an overview of the research study, which contain the context of the research purpose included in the background of the study. Following that, the operational definitions of the terms utilized

in this study, the problem statement, the purpose and research objectives, and research question are discussed. Followed by the signification and limitation of the study. Lastly, the summary of this chapter.

1.1 Research Background

Integrated Curriculum for Secondary School (KBSM) had introduced many interesting topics such as chemical bonding, rate of reaction, carbon compound, thermochemistry and polymer chemistry in chemistry subject. All of these topics have a correlation to one another and served as prior knowledge for students to advance their studies in tertiary education (Amy, 2016). Polymer chemistry is a branch of organic chemistry that dedicated to the study of polymers, which emerged as a fascinating and crucial field with profound impacts on various industries and daily life. The polymer chemistry is one of the topics included in the theme "Technology in chemistry" in Form Five Chemistry. This theme is used in teaching and learning to create awareness and understanding on the importance of chemistry application in daily life and industries in line with the current technology for the benefits of the society (DSKP Chemistry Form 5). Polymer chemistry had played a significant role in our living. It is difficult to be aware of the main role of Chemistry in the world around us; we are surrounded by a complex and ordered system of chemical reactions, present in living organisms and in the rest of matter and phenomena occurring around us (Pinto, 2003). With the use of problem-based learning (PBL) approach, students can gain more awareness about the importance and application of polymer chemistry in real-life.

Research done by Yeoh (2018) said that PBL is not a common feature in Malaysian secondary schools. One of the main reasons why PBL method is lacking in

Malaysia is because of the traditional teaching methods used in schools and universities. Another reason why PBL is not widely spread in Malaysia is the lack of training and support for teachers and lecturers. Many educators in Malaysia have not been well trained or totally nor trained in PBL methodology. The next challenge facing with the implementation of PBL in Malaysia include a lack of resources and facilities. In many Malaysian schools and universities, these resources may be limited, making it be difficult to implement PBL effectively. Despite these difficulties, PBL has several advantages that make it the best method of instruction for Malaysian institutions. PBL encourages teamwork, critical thinking, and problem-solving skills. which are crucial for success in the 21st century and overcoming future obstacles.

In order to successfully develop the 21st century learning skills among the new generation, educators need to be innovative in their teaching and learning approaches to promote these 21st century skills to enhance the participation of their students in the learning environment (Zainab & Norfadila, 2021). One of the best learning approaches to promote the 21st century skill is PBL approach. PBL is a pedagogical approach that begins with a real-world scenario or a 'problematic case' such as pollution, disaster, and so forth to be solved using scientific and mathematical knowledge or skills (Yeoh, 2018). PBL is an innovative teaching strategy which highlights a strongly on critical and problem-solving thinking. It is also well known as an effective approach for learning, and has been implemented in many countries all over the world. PBL not only benefits students but also educators and society. Interestingly, past studies prove that many studies practice this context in learning. However, despite PBL had proven success but PBL in Malaysia Education system is still lacking.

1.2 Problem Statement

In today technologically advanced and modern world, chemistry is a fundamental subject that is crucial to many industries, including industry, medicine, and agriculture. The importance of application of chemistry is always in a scarcity condition among student, which cause the level of green chemistry awareness in Malaysia is still very low (Yaacob *et al.*, 2003). This is because great majority of secondary school do not provide opportunity for students to find out how chemistry is applied to resolve practical issues, how chemistry is used and why do we need to learn chemistry. Only in the context of applications such as there can students fully appreciate the importance and usefulness of the great ideas of chemistry (Ronald, 1997). In other words, as a teacher we should provide basis for understanding and knowledge about chemistry that has been happening in the current global. There are three main branches in chemistry which includes organic chemistry, physical chemistry and inorganic chemistry. Most students found organic chemistry exceptionally challenging because of the breadth and depth of content and the rapid pace of the course, referring to it as "the infamous, dreaded 'orgo', a marathon of memorization (Paredes, Pennington, Pursell, Sloop, & Tsoi, 2010). Several important concepts, including nomenclature and structure, functional groups, isomerism, symmetry and asymmetry, reaction arrows, and synthesis organic reactions, were included in the learning process for organic chemistry (Rajakumar Ramachandran, 2022). From the study by Duis's which was supported by Levy (2008) who claimed that organic compound synthesis as one of the difficult concepts perceived by students learning organic chemistry. Polymer chemistry is one of the sub-branches of organic chemistry. This subfield of chemistry explores the science of macromolecules, which are large molecules composed of repeating subunits called monomers. Polymer chemistry is a challenging topic that necessitates an in-depth

understanding of various chemical concepts along with the way they are applied. However, traditional teaching methods always covers theoretical aspects of polymer chemistry with limited emphasis on practical application.

In Malaysia, the concept of Green Chemistry is not widely applied or integrated into the education system (Taha *et al.*, 2021). Some chemistry teachers could not even tell what green chemistry is exactly and how to practice it (Taha *et al.*, 2019). Green chemistry is a strategy for avoiding the use and manufacturing of chemicals that are hazardous for the environment and human health, which is also an approach in designing methods to inhibit the production of these substances (Tugce *et al.*, 2017), Green polymer chemistry is an extension of green chemistry to polymer science and engineering (Cheng *et al.*, 2015). From the research done by Taha *et al.* (2021), overall results obtained stated that teachers in Malaysia have a moderate level of green chemistry knowledge and practice and high awareness of green chemistry but does not seem to be translated into teaching and learning process.

According to Taha *et. al.* (2019), the nature of chemistry lessons is very unattractive to students, teachers need to manipulate investigative and research-like approaches to trigger and enhance students' awareness of the environment. In this content, poor teaching method such as traditional "chalk and talk" teaching method is not effective where students are only bribed with facts without understanding. Based on the conditions in the field, the students have not been directed to develop critical thinking skills. In addition, the test-questions made by the teachers also have not led to the mastery of critical thinking skills (Saputra *et al.*, 2018). Therefore, a comprehensive and innovative solution are needed to overcome these problems. Taha *et at.* (2021), stated that a combination of subject content and environmental awareness teaching and

learning activities in chemistry can provide knowledge and understanding of teachers and students on green chemistry practice. Thus, researcher planned adapt an approach to attract the attention of current generation students, PBL.

In recent years, PBL, a teaching and learning approach has become one of the promising innovations in higher education. From the study of Dochy *et al.*, (2003) analysed 43 empirical articles of PBL implementations across variety of fields in higher education and found a robust positive effect on students' skills albeit with a negative tendency concerning knowledge acquisition. Thus, PBL has been found to be effective in various of subject of study, including chemistry. In general, 95% of its users believe that PBL has positive impacts towards education and can be used as an alternative method at any level of education (Mohammad Ikram Zakaria *et al.*, 2019). PBL modules have been developed and used in various chemistry courses. However, there is still a gap in the existing literature regarding the development of PBL modules on Polymer Chemistry for Form 5 students in secondary school in Malaysia. Therefore, this research is conducted to develop a new module for teachers with the concept of PBL that focuses on the importance and application of polymer chemistry in real-life.

1.3 Objectives of the Study

The objectives of this study are:

1. To develop a problem-based learning teaching module EX-MysteryChem for the topic polymer chemistry with high content validity.
2. To identify educators' perceptions on the suitability of the EX-MysteryChem teaching module for teaching and learning for the topic of Polymer Chemistry.

1.6 Research Questions

The following are the research questions constructed based on the research objectives stated earlier:

1. What is the value of content validity of EX-MysteryChem teaching module?
2. What are the educators' perceptions on the suitability of the EX-MysteryChem teaching module for teaching and learning for the topic of Polymer Chemistry?

1.5 Significance of the Research

The purpose of this study is to develop EX-MysteryChem teaching module with the concept of problem-based learning related to Polymer Chemistry in the curriculum of Form 5 secondary school with high content validity. In general, the results of the study will provide positive outcomes in different perception angles. The potential of this study hopes makes the following contribution:

1.5.1 For Chemistry Students:

This type of learning approach encourage student to carry-out hands-on activities and have their own responsibility toward their learning, this will prepare them for a higher learning in polymer chemistry. Student will be able to enhance their critical thinking skill to analyse the problems from different perspectives, it can increase their interest to learn polymer chemistry which is difficult to understand. With the use of PBL module, communication and collaboration skill will become a crucial role to increase students understanding of the problem, the application of knowledge.

1.5.2 For Chemistry Teachers:

The development of problem-based learning module will provide teachers a chance to promote active learning during teaching and learning sessions in school. PBL will help to increase student's problem-solving skill which involve the use of real-world problems, this will result an increase in the understanding and knowledge about polymer chemistry. PBL which is an interaction teaching method will also motivate student and attract their attention for learning in class. Thus, learn the topic better and encourage them to become innovative in their teaching methods.

1.6 Limitations of the Research

There are some limitations emphasized in this study. Firstly, this research project only involved the production and evaluation of the suitability of problem-based learning for the learning area Polymer Chemistry. This research is carried out to identify Form 5 chemistry educator's perception for the suitability of the EX-MysteryChem teaching module from the aspects of user-friendly, content alignment and clarity, skills development, teaching effectiveness, impact and improvement. One of the limitations is the time constraint on research design. This is because due to time constraint, researcher only focused one learning area which is polymer chemistry from the 5 learning areas that contained in the syllabus of chemistry.

The population sample is also limited where it only involves two Form 5 chemistry educators in Secondary School Tanjong Malim for the evaluate of the suitability of the EX-MysteryChem Module in teaching and learning process. The research approach is qualitative approach, this approach required longer time to obtain and analyze the information and data. Thus, in order to successfully complete the data collection and analysis of data, two research sample is chosen for interview. Two sample is chosen because of qualitative approach of research design and time constraint. The development of the product has consumed a longer time than estimated. Next, secondary school that teaches chemistry using English is founded only in two school in the district Tanjong Malim. Thus, only two teachers from the specific secondary school have been chosen as the research sample. Therefore, the perception of the suitability of the EX-MysteryChem cannot be used to describe the perceptions of all teachers in Malaysia.

1.7 Operational Definition

The present study has identified several terms that are important to define in the context of the research

1.7.1 21st century skills

21st century learning skills are a set of skill that students should obtain which have been identified as a necessary for the success in the global world nowadays. Critical thinking, problem-solving, creativity, teamwork, and communication are among these abilities.

1.7.2 Module

Module is a teaching or learning resources which focuses on a specific topic or a set of related topics that are designed and arranged in a systematic manner for teaching and learning in the classroom. It typically includes a set of learning objectives, instructional material and assessment which are used to help teachers to teach effectively or to help student to understand more clearly about the topic.

1.7.3 Problem-based learning (PBL) Module

PBL is an instructional teaching and learning strategy in which students works on a specific problem or task that is designed to be authentic and relevant to real-world situation. The problem or task is normally open-minded, with no correct answer, and students are encouraged to explore the problem with variety of approach and solution. The PBL approach emphasizes on collaboration, teamwork, and communication.

1.7.4 Green Chemistry

Green chemistry is an innovative approach that focuses on reducing or avoiding the use and manufacture of hazardous chemicals that are harmful for the environment and human health. It contains the main objectives to reduce waste, prevent pollution and promote a safer and environmentally friendly alternatives.

1.7.5 EX-MysteryChem Teaching Module

EX-MysteryChem Teaching Module is a teaching aid for the teaching and learning process with the concept of PBL for teacher. This teaching module emphasize in the topic of polymer chemistry to increase the awareness and knowledge of green chemistry, green technology, importance and application of polymer chemistry. This EX represent 3 stages which are expose, explore and experience about the concept of Green Chemistry with the combination with the subject Polymer Chemistry. MysteryChem represents the complex chemistry problems related to a real-world scenario which require students collaborate and teamwork together to solve the problem by using critical thinking and problem-solving skill. This teaching module contain lesson plan (RPH), real-world scenario problem related to polymer chemistry, instruction manual, question and answer and an assessment for evaluation purpose.

1.8. Summary

In conclusion, the development of EX-MysteryChem teaching module with the concept of PBL related to Polymer Chemistry in the curriculum of Form 5 secondary school with high content validity is because PBL is an effective approach to promote the 21st century skill such as critical thinking and problem-solving, communication and collaboration, global and environment awareness, and digital literacy. Overall, these 21st century skills are considered essential for success in the modern and advance world. By presenting student with a real-world problems and scenarios, students will be able to develop essential skill and knowledge in their learning process.