UNIVERSITI PUTRA MALAYSIA

DEVELOPMENT OF A PROBLEM-POSING MULTIMEDIA MODULE AND ITS EFFECTIVENESS TO ENHANCE STUDENT PERFORMANCE IN FORM FOUR BIOLOGY

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Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Doctor of Philosophy

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for Doctor of Philosophy

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Faculty: Educational Studies

Learning and teaching activities in education are crucial in presenting permanent and meaningful learning to science students. This study aims to develop Problem-Posing Multimedia Module (PROPOSE-M) and to test its H I I H F W L Y H Q H V V L Q H Q K D Q F H J in Biology subject as compared to the traditional teaching method (TRAD). This study extends the Cognitive Theory of Multimedia Learning (CTML) by integrating it with the problem-posing instructional strategy (PPIS) that championed the skills of communication, collaboration, creativity, and critical thinking. This study applied Design and Development Research (DDR) approach. ADDIE model (Analyse, Design, Develop, Implement and Evaluate) was used to develop PROPOSE-M. Three research questions were formulated for this study; (1) What are the components needed to develop PROPOSE-M for teaching the concept of osmosis and diffusion among Form Four Biology Students? (2) Is there any significant difference in the mean score between the PROPOSE-M and the traditional teaching method (TRAD) group? (3) To what extent PROPOSE-M F R X O G H Q K D Q F H V W X G H Q W ¶ V F R Q F H S W X D O F K D Q J H F R answers, a sequential mixed method approach encompassing interview, survey and quasi-experimental techniques was adopted. Two groups of students from two different schools in Petaling Perdana District were involved in the study of which are the experimental group (PROPOSE-M) (n=31) and one control group (TRAD) (n=30), and both groups have equivalent characteristics. Students' performance was analysed using the mean score of pre-test, post-test and retention-test. The main findings show that the mean scores of students who were exposed to newly-developed PROPOSE-M are significantly higher to students who were exposed to TRAD in post-test with $t(47) = 2.866$, $p < .05$. The results from retention-test also revealed that PROPOSE-M has not just enhanced students' conceptual understanding but also retained students'

memory longer compared to TRAD with t (59) = 3.845, p < .05. PROPOSE-M also could enhance students' performance in both LOTS and HOTS as it builds conceptual change among students. The implication of this study can be seen in terms of practice in the school context in which it provides an alternative tool for teaching and learning Biology. Further, this study also provides an instructional model as a guideline that could benefit teacher in planning steps to be taken to encourage problem-posing in Biology curriculum.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

PEMBANGUNAN MODUL ***PROBLEM-POSING MULTIMEDIA*** DAN KEBERKESANANNYA UNTUK MENINGKATKAN PENCAPAIAN PELAJAR DI DALAM BIOLOGI TINGKATAN EMPAT

Oleh

NOR TUTIAINI BT AB. WAHID

Mei 2019

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Aktiviti pengajaran dan pembelajaran merupakan faktor penting dalam dunia pendidikan untuk menyampaikan pembelajaran yang berkesan dan bermakna kepada pelajar sains. Kajian ini bertujuan membangun satu modul pengajaran dinamakan modul Problem-Posing Multimedia (PROPOSE-M) dan menguji keberkesanan modul ini dalam meningkatkan pencapaian pelajar di dalam subjek Biologi berbanding kaedah pengajaran tradisional (TRAD). Kajian ini mengembangkan aplikasi Teori Pembelajaran Kognitif Multimedia dengan menggabungkan teori tersebut dengan strategi pengajaran problem-posing dengan memasukkan elemen komunikasi, kolaborasi, kreativiti dan pemikiran kritis. Kajian ini menggunakan pendekatan penyelidikan pembangunan (DDR). Model reka bentuk pengajaran ADDIE (Analyse, Design, Develop, Implement, Evaluate) digunakan untuk membangunkan PROPOSE-M. Tiga soalan kajian telah diformulasi iaitu (1) Apakah komponen dalam kajian yang diperlukan untuk membangunkan PROPOSE-M bagi mengajar konsep osmosis dan resapan di kalangan pelajar Biologi Tingkatan 4? (2) Adakah terdapat perbezaan skor min yang signifikan di antara kumpulan PROPOSE-M dan kumpulan TRAD? (3) Sejauh manakah PROPOSE-M berupaya meningkatkan perubahan konsep kumpulan PROPOSE-M berbanding kumpulan TRAD? Soalan kajian akan dijawab menggunakan pendekatan kuantitatif dan kualitatif secara berturutan merangkumi temubual, tinjauan dan kuasi-eksperimen. Dua kumpulan pelajar dari dua buah sekolah di Daerah Petaling Perdana iaitu kumpulan eksperimen (PROPOSE-M) (n=31) dan kumpulan kawalan (TRAD) (n=30) yang mempunyai ciri-ciri setara terlibat di dalam kajian ini. Pencapaian pelajar di analisis menggunakan skor ujian pra, ujian pasca dan ujian pengekalan. Keputusan kajian menunjukkan pelajar yang didedahkan kepada PROPOSE-M mendapat min skor yang lebih tinggi secara signifikan di dalam ujian pasca berbanding pelajar yang didedahkan kepada TRAD dengan nilai t

(47) = 2.866, $p < .05$. Keputusan ujian pengekalan juga menunjukkan modul PROPOSE-M berpotensi bukan sahaja meningkatkan pemahaman konsep tetapi membolehkan pelajar menyimpan maklumat dalam ingatan jangka panjang lebih lama berbanding strategi pengajaran TRAD dengan nilai t (59) = 3.845, $p < .05$. Implikasi kajian ini boleh dilihat dari segi praktikal di dalam konteks sekolah dimana PROPOSE-M boleh digunakan sebagai alat bantu mengajar alternatif untuk Biologi. Kajian ini juga menyediakan model strategi pengajaran yang bertindak sebagai garis panduan bagi guru untuk melaksanakan problem-posing di dalam kelas.

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Doctor of Philosophy. The members of the Supervisory Committee were as follows:

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This is to confirm that:

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LIST OF ABBREVIATIONS

MOE	Ministry of Education
HOTS	Higher Order Thinking Skills
LOTS	Lower Order Thinking Skills
CTML	Cognitive Theory of Multimedia Learning
PPIS	Problem-posing Instructional Strategy
PROPOSE-M	Problem-posing Multimedia Module
TRAD	Traditional Teaching Method
DDR	Design and Development Research
SPM	Malaysia Certificate of Education
TSTS	Thinking Skills and Thinking Strategies
ADDIE	Analysis, Design, Development, Implementation and Evaluate
RBT	Revised Bloom Taxonomy
SLR	Systematic Literature Review
PCM	Percentage Calculation Method
LOQ	Lower Order Questions
HOQ	Higher Order Questions

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Introduction

This chapter discusses the main concepts of the research. It starts by presenting the research background in problem-posing instructional strategy before addressing and associating the strategy with problems pertaining to teaching and learning Biology. Arguing the need to address the issue, the research goal and aims are discussed. In the succeeding sections, the research questions and research hypothesis are presented respectively. Later, the operational definition, significance and limitation of the study are expanded in subsequent sections. The chapter closes with a summary of the thesis organisation.

1.2 Research Background

It has been a profound global understanding that science plays a major role to promote technological innovation and to prepare competitive and marketable future students (Borrego & Henderson, 2014; Rahman, Halim, Ahmad, & Soh, 2018; Xie, Fang, & Shauman, 2015). With the advancement of technology that inevitably impacted education, science education and technology are undeniably inseparable. Looking at the urgent need to answer the demand for science-based students to accelerate the development of the nation, teachers are put in a critical role to produce quality teaching and learning aids. This demand has forced teachers to be equipped with technological-pedagogical content knowledge and skills; as it is to be used in integrating the technology to instruct students, namely, the pedagogical part, and provide students with deep meaningful learning (Kincheloe & Berry, 2004; Sousa, 2016).

To meet those challenges in science education, Malaysia, like other nations, has been witnessing series of drastic and dynamic reform in its educational system. One great example is the newly revamped curriculum specification for science subjects to fit local students (Mansor et al., 2015; Raub, Shukor, Arshad, & Rosli, 2015; Sumintono, 2013) 1 R W H Z R U W K \ V W X G H Q W V ¶ S H in science subjects has been deteriorating in the local educational system, and debates have heated up in local and international literature to pinpoint its cause. Historically, the Curriculum Development Centre, Ministry of Education (MOE) was established, and it is assigned to implement research and development, illuminated by examination syndicate reports and a vast number of research papers and literature that highlighted the issue. However, despite W K H P R G L I L F D W L R Q V D Q G H [K D X V W L Q J H I I R U W W R U H performance in science subjects kept deteriorating year after year.

The circumstance has worsened after it was found that students enrolment in science stream was in the declining rate over the years (Alias, Masek, &

Salleh, 2015; Hiong & Osman, 2013). This has created a wakeup call for the government to look into their current policy that was set in 1967, targeted to achieve a ratio of 60:40 science to non-science students at the Upper Secondary School (Hiong & Osman, 2013). This policy is set as a measure to HQFRXUDJH VWXGHQWV LQ VFLHQFH VWUHDP +RZHYHU, more than fifty decades later, instead of coming closer to that ratio, Malaysia is critically way behind to achieve the target ration.

In the Malaysian education system, the secondary education system is divided to two levels, the Lower Secondary level consists of Form One to Form Three students, and Upper Secondary level for Form Four and Form Five. During enrolment to the Upper Secondary level, they must choose at least two science subjects from these options: Chemistry, Physics or Biology. However, statistic GDWD E\ 02(KDV IRXQG WKDW VWXGHQWV¶ HQUROPHQW L lowest, compared to Physics and Chemistry. This indicates that Biology subject is the least favourable among students at Upper Secondary level. The XQDQLPRXV UHDVRQ IRU WKH GLVLQWHUHVW LV GXH WR V Biology subject as a tough subject and involves lots of memorising facts (Hasni, Roy, & Dumais, 2016; Miri, David, & Uri, 2007; Zeidan, 2010). Table VKRZV WKH VWXGHQWV¶ HQUROPHQW LQ &KHPLVWU\, 3K\VLFV DQG %LRORJ\ subjects for three consecutive years in Malaysia and Selangor state.

Table 1.1 6WXGHQWV¶ (QUROPHQW LQ 6FLHQFH 6XEMH

Students Enrolment						
	Malaysia			Selangor		
Year	Biology	Physics	Chemistry	Biology	Physics	Chemistry
2015	96,404	117,215	119,645	17,303	21,445	21,653
2016	78,540	97,141	99,225	14,130	18,220	18,440
2017	76,484	95,342	97,095	14,032	18,188	18,407

(Source: Malaysian Examination Syndicates, MOE, 2018)

$QRWKHU LQGLFDWRU IRU 0DOD\VLDQ VWXGHQWV¶ ZRUU education comes from international studies such as the Trends in International Mathematics and Science Study (TIMSS) and Programme for International Student Assessment (PISA). From TIMSS and PISA results, Malaysian VWXGHQWV¶ SHUIRUPDQFH LV EHORZ-up Call for the KLV KDV EHF Malaysian government to improve the quality of teaching in Science and Mathematics. Once again, in 2013, the Science curriculum was changed as The Malaysian Education Blueprint produced by MOE (2013) introduced the cultivation of higher order thinking skills (HOTS). This forces teachers to strategically embed these skills when planning and implementing their instructional strategy.

The decision was made upon debates fuelled in numerous platforms, including the body of literature pertaining to education, political and research

conferences, that urge the inclusion of HOTS to produce students as adaptable citizens in the challenging workforce and life (e.g. Ansari, Abd Rahman, Badgujar, Sami, & Abdullah, 2015; Cho & Brown, 2013; Nardone & Lee, 2010; Wang, Moore, Roehrig, & Park, 2011). In the perspectives of scholars and educationists, HOTS mirror the extent problem solving and critical thinking skills among many other good values, are the prerequisites for learning science subjects.

In relation to technology, as aforementioned, there are significant studies suggesting the role of technology to facilitate students learning and enhancing HOTS during teaching and learning (Aksoy, 2012; Alias et al., 2014; Hopson, Simms, & Knezek, 2001). Realising the importance of technology, witnessed the new curriculum infusing the elements of technology, or better known as ,&7 7KH LQWURGXFWLRQ RI QHZ ,&7 VXEMHFW NQR Communication Tec K Q R O R J \ / L W H U D F \ ¶ I R U) R U P 2 Q H D Q G) testament that was seen in the words of Elliot, Wilson, and Boyle (2014), that the use of technology encourages constructive and meaningful learning. Students must learn beyond receiving information, but they must manage, analyse, critique and transform the information into meaningful and usable knowledge. Hence, learning using technology as tools seems reasonable for engaging students in problem-solving and critical thinking since it serves a dual role: as the delivery mechanisms for instruction and the future platforms for VWXGHQWV ¶ DFWLYLW\

Interestingly, technology-based Biology courseware has been provided by the MOE. Nevertheless, a quick look at the software indicates that there seems to be plenty of rooms for improvements. For example, a plain 2D format presentation in the courseware content felt unfit to illustrate a complex and complicated biological process that occurs at a molecular stage, and this begs the question on how students can imagine the process and grasp the idea and concepts meaningfully.

The evolution of teaching approaches, for example, the inquiry-based learning (IBL) and problem-based learning (PBL) shows that teaching strategy also needs to evolve to adapt to the changes in the learning ecosystem. There is numerous call for educators to embed HOTS in teachings using inquiry-based learning (IBL) to promote HOTS. It is argued that IBL encourages learning by asking students to ask questions in order to solve problems, but, thus far, the statistics show not many students are brave enough to ask questions in classroom (Crippen & Archambault, 2012; Jones et al., 2012; Kojima, Miwa, & Matsui, 2013). It is found that teachers normally provide students with questions or problems to be solved to encourage HOTS (e.g.,Crippen & Archambault, 2012; Fensham & Bellocchi, 2013; Mishra & Iyer, 2015; Saido, Siraj, Nordin, & Amedy, 2015; Wang et al., 2011). With the intensifying call for HOTS-infused teaching, it is therefore timely to also reflect on the teaching aids that could be used to help teachers to teach to their students better.

One way of doing it is by shifting the role of asking questions, to students instead of the teacher as done in Mathematics (Akay & Boz, 2010; Chen, Dorn,

Krawitz, Lim, & Mourshed, 2017; Land, 2017; Leung, 2013; Rosli, Capraro, & Capraro, 2014) but is lacking in science subjects to date. Better still, with the emerging of technology trend in learning, students now can be creative in posing their own questions and solve their own problems in understanding a specific topic. Thus, it is just in time to rebrand the instructional strategy and teaching aids to teach science subjects, specifically Biology, to address the new challenges in education.

1.3 Problem Statement

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mathematics level. Many studies reported that teachers view students today do not possess the capacity to think critically and unable to solve the problem creatively (Fensham & Bellocchi, 2013; Gough, 2014; Haahr, 2005; Ritz & Fan, 2014; Siew, Amir, & Chong, 2015). Therefore, to many scholars and educationist, it seems vital to revisit the current teaching approach and strategy at school level (Fensham & Bellocchi, 2013; Gough, 2014). Critical elements are highlighted such as communication, and critical thinking, that allows for problem-solving and meaningful learning and prepare them for attainable future life and career. In this regard, science appears to be the most affected subject because the scientific skills embedded within, such as experimenting, interpreting data and making a hypothesis that encourages the ability to plan for solutions and solve problems.

Malaysian curriculum starts to embed instructional strategies that aim to nurture thinking skills in the classroom. However, there are concerns that the dominated teacher-centred practised by science teachers by just giving direct instruction to students has resulted to rote-learning method that makes students tend to memorise the facts rather than understand the concepts being taught (Fensham & Bellocchi, 2013; Hasni et al., 2016; Miri et al., 2007). This situation creates a struggle for students to apply the knowledge to solve higher order thinking problems which require HOTS such as analysing, evaluating and creating. However, it is required that students need to occupy lower order thinking skills (LOTS) such as remembering, understanding and applying prior to acquire HOTS. Thus, LOTS and HOTS needed to be reconciled during teaching and learning processes to promote meaningful learning among students.

Biology is considered as a tough subject because it consists a lot of dynamic and abstract processes and it is often misunderstood by students as the subject that requires a lot of memorising facts (Yarden & Yarden, 2010). Students face difficulties in understanding the concepts and various biological events that are unfamiliar and cannot be seen by the naked eye (Çimer, 2012). Further, it is acknowledged static illustration is not adequate to explain the dynamic and abstract concept in Biology, which leads to a misconception among students $U WX Q & R ú W X

5HVHDUFK KDV IRXQG WKDW VWXGHQWV¶ PLVFRQFHSV
experience possessed by students and their ideas and explanations of the natural world are often different from those presented by scientists (Tekkaya, 2003). It is reported that misconceptions are hard to break, especially through traditional teaching methods (Fisher, 1985). When the abstracts processes were presented to students in a way that is difficult to be understood, they will tend to ignore the new concepts and choose to stick to their beliefs that were already developed based on their own experiences. During the examination, students who are unable to grasp accurate concepts would be unable to answer HOTS questions correctly, and this subsequently would affect their performance in Biology.

This problem is further intensified by the time constraint issue faced by teachers to develop and prepare alternative tools to teach, resulting in instructional strategy to be stereotyped (Rahman et al., 2018; Seman, Yusoff, & Embong, 2017). Despite the challenges, there have been some initiatives to modify and innovate the way the topics were taught as teachers start to use multimedia in the classroom. However, not all multimedia elements can help students to have a better understanding because some of them may increase the cognitive load of students hence reducing their learning experience (Mayer, 2010). The effective multimedia module should be mindful on how it is able to HQKDQFH VWXGHQWV¶ FRJQLWLYH DELOLWLHV DQG UH students.

A study by Beal and Cohen (2012) in US found that traditional instructional practice commonly used in the classrooms provide students with questions prepared by teacher or taken from the textbook. This situation is similar to the situation in the classroom in Malaysia as described by Dewitt, Alias, & Siraj, (2016). There is an urging need to blend in problem-solving with another instructional strategy to enable students to think across the lower to the higher cognitive levels. It is noted that, in Mathematics, it is now becoming a trend to use a problem-posing strategy to engage the student in thinking activity. However, studies on problem-posing implementation in Biology subject has not been picked up intensively. Thus, more studies are needed to gauge the effectiveness of problem-posing as an instructional strategy in Biology.

Hence, this study focuses on the development of a multimedia module that can facilitate students to visualise the abstract and dynamic processes regarding the concepts and applications in Biology. This module was also designed to help teachers deliver the content of the subject without worrying about time constraint to develop teaching materials. This module integrates the cognitive theory of multimedia learning (CTML) and inquiry learning through problem-posing instructional strategy (PPIS) to deliver the topic and subsequently enhances LOTS and HOTS among students.

1.4 Research Objective

This research is designed to:

1. develop a teaching and learning module applying a problem-posing instructional strategy (PPIS) integrated into a multimedia-based presentation for teaching Biology namely as Problem-Posing Multimedia Module (PROPOSE-M).
2. compare the effectiveness of Problem-Posing Multimedia Module (PROPOSE-M) to the traditional teaching method (TRAD) with regards to lower order thinking skills (LOTS) and higher order thinking skills (HOTS) ability achievement in learning Biology.
3. explore the conceptual change on students in analysing the concept of Biology after undergoing Problem-Posing Multimedia Module (PROPOSE-M) and traditional teaching method (TRAD).

1.5 Research Question

From the objectives of this study, three main research questions (RQ) have been prepared to complete the study. Further, to fill the gaps, RQ1 and RQ2 are subdivided into the sub-research questions. Research questions (RQ) for this study are:

RQ1: What are the components needed to develop PROPOSE-M for teaching the concept of osmosis and diffusion among Form Four Biology Students?

5 4 % D V H G R Q H [S H U W V ¶ R S L Q L R Q W R Z K D W H PROPOSE-M for teaching osmosis and diffusion concepts is necessary?

RQ1.2: How do the previous studies have implemented a problem-posing instructional strategy in their studies?

RQ1.3: To what extent the validity and reliability of the module among raters achieved?

RQ2: Are there any significant difference in the mean scores between the PROPOSE-M and the TRAD group?

RQ2.1: Is there any significant difference in the mean score of pre-test, post-test and retention-test between the PROPOSE-M and the TRAD group?

RQ2.2: Is there any significant difference in the mean score of pre-test, post-test and retention-test for LOTS and HOTS questions between the PROPOSE-M and the TRAD group?

RQ3: To what extent PROPOSE- 0 F R X O G H Q K D Q F H V W X G H Q W ¶ V F R change compared to TRAD?

1.6 Hypothesis

Based on RQ2, ten hypotheses have been developed and tested through statistical analysis.

H_1: There is a significant difference in the mean score of the pre-test between PROPOSE-M and TRAD group.

H_2: There is a significant difference in the mean score of the post-test between PROPOSE-M and TRAD group.

H_3: There is a significant difference in the mean score of the retention-test between PROPOSE-M and TRAD group.

H_4: There is a significant difference in the mean score of the pre-test and post-test for PROPOSE-M group.

H_5: There is a significant difference in the mean score of the pre-test and post-test for the TRAD group.

H_6: There is a significant difference in the mean score of the pre-test LOTS questions and the pre-test HOTS questions between PROPOSE-M and TRAD group.

H_7: There is a significant difference in the mean score of the post-test LOTS questions and the post-test HOTS questions between PROPOSE-M and TRAD group.

H_8: There is a significant difference in the mean score of the retention-test LOTS questions and the retention-test HOTS questions between PROPOSE-M and TRAD group.

H_9: There is a significant difference in the mean score of pre-test, post-test and retention-test for LOTS and HOTS questions for PROPOSE-M group.

H_{10}: There is a significant difference in the mean score of pre-test, post-test and retention-test for LOTS and HOTS questions for TRAD group.

1.7 Operational Definition

1.7.1 Problem Posing Multimedia Module (PROPOSE-M)

Problem-posing is an instructional strategy where students generate their own questions based on the content taught by their teacher (Cankoy, 2014). To deliver the content of the lesson efficiently, multimedia presentation underpinned by CTML was used as the main tool during content delivery. This was then followed by hands-on activities outlined in a written module whereby students used 4C element, namely, communication, collaboration, critical thinking and creativity to complete the tasks in the module.

In this study, Problem-posing Multimedia Module (PROPOSE-M) is the module that applies problem posing instructional strategy embedded in a package of multimedia component and classroom activities. PROPOSE-M consists of two parts, multimedia module and activity module. PROPOSE-M is developed by integrating CTML with problem-posing instructional strategy (PPIS).

1.7.2 Traditional Teaching Method (TRAD)

Traditional teaching method (TRAD) is focused on rote-learning and memorisation. In this approach, a lesson is dominated by teacher-centred instruction, whereby students receive direct instruction from the teacher (Peterson, 2016). Most of the classroom time, students will learn through listening and observation (Richland & Simms, 2015) and it is majorly lecture-based by which teacher is the sole knowledge-transmitter who delivers knowledge by referring to the textbook (Çimer, 2012).

In this study, the TRAD group was taught using PowerPoint presentation that showed notes and diagrams. Students copied the notes, and at certain sessions, students worked in a group to discuss certain topic assigned by the teacher and they then present their findings.

1.7.3 The Validation of PROPOSE-M

Validation is defined as the extent to which the module is accurate to measure the content supposed to be measured during the teaching and learning processes (Marshall, Smart, & Alston, 2016). In this study, the content validity that inspected the content of the multimedia and the activity module took place before the implementation of PROPOSE-M. This process involved experts in the field of multimedia module and pedagogy. Apart from that, reliability, which is referred to as the consistency and trustworthy of the measurement tools in giving the same score to many individuals at the different time of exposure, was also executed. In this study, reliability is determined during the pilot test using one set of questionnaires with 31 items, developed based on objectives in PROPOSE-M.

1.7.4 Lower Order Thinking Skills (LOTS)

Lower order thinking skills (LOTS) are the basic thinking skills that students require before they move on to higher order thinking skills (HOTS). LOTS involve knowledge, understanding and simple application level (Fensham & Bellochi, 2013). In LOTS, students need to memorise, define, understand and repeat the information they have learned in the classroom (Chiu & Mok, 2017). In this study, students were tested using LOTS questions in the pre-test, post-test and retention-test encompassing remembering, understanding and applying as determined based on Revised Bloom Taxonomy (RBT) by Anderson and Krathwol (2001).

1.7.5 Higher Order Thinking Skills (HOTS)

Higher order thinking skills (HOTS) is a concept of education based on learning taxonomies that focus in the idea that some types of learning will require more cognitive processing than others and this requires different learning and teaching methods than the learning of LOTS (Fensham & Bellochi, 2013; Chiu & Mok, 2017). Higher-order thinking involves the learning of complex

judgmental skills such as problem-solving and critical thinking that are usable in other situations outside the learning context (Raub, Shukor, Arshad, & Rosli, 2015). In this study, students were tested using HOTS questions that involve higher-level cognitive processes in the pre-test, post-test and retention-test encompassing analysing, evaluating and creating skills which required them to solve problems, plan and create solutions.

1.7.6 6WXGHQWV¶ 3HUIRUPDQFH

6WXGHQWV¶ SHUIRUPDQFH FDQ EH GHILQHG DV WKH academic performance meets the standards stipulated earlier in the curriculum, which is demonstrated in their assignments, homework or written report (Lepp, Barkley, & Karpinski, 2015; Haahr, 2005). IQ WKLV VWXG\ VWXGHQWV¶ S is represented by their scores in the pre-test, post-test and retention test. The questions were separated into two levels: LOTS and HOTS questions. The questions were marked and scored according to the marking scheme provided by Malaysian Examination Syndicates.

1.7.7 Conceptual Change

Conceptual change can be defined as restructuring and modifying an old concept into a new concept that can be logically entire, plausible and fertile (Franke & Bogner, 2011). Students will learn and accept new concepts when they feel unsatisfied with the old concepts that they understand previously (Johnson & Sinatra, 2014). The new concepts than will become their new beliefs and students will adopt these new beliefs in the lesson and in a daily situation. In this study, the reconstruction of the information about osmosis and diffusion between students exposed to PROPOSE-M and TRAD was explored. The conceptual change occurs among students was explored through a clinical interview conducted with students that have the highest gained score in pre-test and post-test.

1.8 Significance of Study

Problem-posing is widely used as a pedagogical approach in mathematics education (Singer & Voica, 2013) to promote critical thinking skills among students. However, the usage is still at infant stage in Biology education. Through previous studies pertaining to Mathematics, it is posited that through problem-posing, students can use higher order thinking skills in completing the challenging tasks. Therefore, it is believed that, by using problem-posing in Biology, students will demonstrate similar capabilities.

Besides, to date, attempts to integrate multimedia presentation and problem-posing in one instructional package is still at an infant stage in Malaysia. Theoretically, this study aims to extend the literature by integrating a unique problem-posing instructional strategy (PPIS) with the cognitive theory of multimedia learning theory (CTML) to teach Biology subject.

Methodologically, this study took a different avenue by integrate DDR Type 1 and Type 2 which explained both: the systematic process to develop the PROPOSE-M and simultaneously, focusing on the experimental design to test the effectiveness of the module to the real respondents. This study perhaps will enrich the literature review on how the integrating of DDR Type 1 and Type 2 can be done in one study.

Practically, this study potentially will provide an alternative tool to promote LOTS and HOTS in the Biology classroom. This study would also provide an alternative module for a Biology teacher to teach Biology in their classroom and subsequently can overcome the time constraint issue to prepare teaching material. This study would also provide a framework that acts as a guideline for teachers on how they want to perform problem-posing activity in their classroom. As past literature has shown that problem-posing will produce promising proven results among students (Çildir & Sezen, 2011; Gonzales, 1998; Kojima et al., 2013; Sung, Hwang, & Chang, 2013), this study would provide an empirical explanation for the effects of problem-posing to students' academic performance in Biology.

1.9 Limitations of Study

The samples for this study involved students from two equivalent daily schools in Petaling Perdana district. This study involves Form Four students who were enrolled in the Biology subject. The focus of this study is students' performance that acts as the dependent variable of this study, and the variable is based on the test score gained during the pre-test, post-test and retention-test that was administered to students from both schools. Further, the conceptual change that occurs among students was explored based on the basic and specific concepts of osmosis and diffusion, which were pre-determined according to the curriculum.

The topic covered in this study is Movement of Substances across the Plasma Membrane. This topic has been chosen because it contains fundamental concepts of osmosis and diffusion that need to be applied later in other topics across the curriculum in Biology. Based on study needs, the cognitive theory of multimedia learning (CTML) by Mayer and Moreno (2002) was employed and was integrated with the problem-posing instructional strategy theory. The types of problem-posing activities employed in this study would only focus on semi-structured and structured problem-posing because the students involved in this study is considered as novice students.

1.10 Thesis Structure

This thesis is organised into five chapters. Chapter 1 introduces the issue related to the topic under investigation. Chapter 2 critically reviews the relevant literature in the research area, by particularly highlighting the absence of studies which focus on the problem-posing instructional strategy with the aid of the multimedia in Biology. To overcome this gap, a multimedia module embedding problem-posing strategy is justified. It is then followed by an explanation of how the significant variables are determined and included in the framework.

Chapter 3 elaborates on the research methodology adapted to develop PROPOSE-M, encompassing the theory that underpins the development, how the tests were selected and executed for the hypothesis testing, including the procedures for the quasi-experiment and clinical interview. While in Chapter 4, elaborates on the module development processes encompassing five phases of ADDIE. Chapter 5 drawing upon the implementation phase of the module, interpretation of the empirical results is expanded. Chapter 5 also discusses the qualitative findings to support the quantitative data and discusses the overall findings of the research. Chapter 6 summarises the research implication, provides recommendations for future research and draws conclusions.

1.11 Conclusion

This chapter introduces the issue related to the topic under investigation. Particularly, this chapter briefly explains the current scenario in the issue of problem-posing strategy in the related area, hence rooms for addressing the issues pertaining to Biology. Based on the argument presented, the research objectives, the expected contributions, the operational definition and the overall structure of this research are outlined. The next chapter offers discussion on the existing literature and detailed explanation of the underpinning theories and issues surrounding problem-posing strategy.

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Journal:

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Conference:

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Nor Tutiaini Ab. Wahid , Othman Talib, Tajularipin Sulaiman, & Mohd Hazwan Mohd Puad, (2018). Problem-Posing Multimedia Module (PROPOSE-M) in Kolokium Pendidikan Peringkat Kebangsaan (2018). 1st December 2018. District Education Officer Machang, Kelantan.

Award:

Gold Medal

Nor Tutiaini Ab. Wahid , Othman Talib, Tajularipin Sulaiman, & Mohd Hazwan Mohd Puad. Problem-Posing Multimedia Module (PROPOSE-M) in Pertandingan Inovasi dan Rekacipta (i-Reka) Peringkat Kebangsaan (2018). 21st November 2018. Ayer Keroh Country Resort, Melaka.

Silver Medal

Nor Tutiaini Ab. Wahid , Othman Talib, Tajularipin Sulaiman, & Mohd Hazwan Mohd Puad. Problem-Posing Multimedia Module (PROPOSE-M) in Pertandingan K-NOVASI (2019). 23rd ± 24th January 2019. Universiti Kebangsaan Malaysia, Bangi, Selangor.

Best Presenter

Nor Tutiaini Ab. Wahid . International Conference on Islamic Research in Management, Education, Social Science & Technology (2019). 22nd February 2019. Tanjung Malim, Perak.

Copyright:

1. Problem-Posing Multimedia Module (PROPOSE-M) (LY2018005851)
2. Problem-Posing Multimedia Module (PROPOSE-M) Booklet (LY2018005852)
3. Problem-Posing Multimedia Module (PROPOSE-M) Instructional Strategy Model (LY2018005650)
4. Conceptual Framework of Problem-Posing Multimedia Module (PROPOSE-M) (LY2018005849)

Other:

Represent UPM as Finalist in National 3MT Competition (2018). Social Science Category. Problem-Posing Multimedia Module (PROPOSE-M). 25th ± 27th June 2018. Universiti Teknologi Petronas, Seri Iskandar, Perak.

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