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Problem-based learning module of organic insecticide for the aborigine students in Malaysia

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ABSTRACT

Problem-based learning (PBL) is a teaching model that uses real-world problems to lead students toward the learning objective of a course. It has been widely adopted in Malaysian education. However, PBL module for aboriginal people is scarce. This study aimed to provide suitable PBL activities in learning environmental problems by developing a PBL teaching module for the aborigine community and accessing its suitability. In this study, data was collected through an online validation form that was given to four validators, all of them have science or chemistry education backgrounds. The online questionnaires collected were further analyzed to investigate their responses to the module. The result has shown positive feedback (95.83%) as the responses are very encouraging. All respondents give approbation to the objectives of the module which are clearly stated and are parallel with the content. Many of them also strongly agree that the PBL model and the language used are suitable in this module. There is no doubt that PBL is a valuable tool to teach chemistry to improve students' critical thinking and problem-solving skills effectively.

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1. INTRODUCTION

Aboriginal people refer to as *Orang Asli* in Malaysia is the original people that are the inhabitants of their ancestral land, mostly in the forest [1]. They are a minority group comprised of approximately 0.6% of the Malaysian population [2]. They reside close to the forest, and they depend largely on forest resources for survival. Their lifestyle and health are engaged closely with the environment they live in [1]. Most of them still live in remote areas, in which their occupations include hunting, farming and trading of forest resources [3]. Nevertheless, most of them are marginalized communities with minimal educational opportunities, with deplorable resources [4]. Hence, they are at risk of losing income from their current jobs, especially when the environment were polluted and the aboriginal people are lacking proper environmental knowledge [5].

Meanwhile, Wahab, Jaafar, and Sunarti [6] opined that to provide the indigenous group with such knowledge, aboriginal-specific training material needed to be used. A more relevant practice module that can arouse their interest and motivate them to be more dedicated to learning is needed. Learning environmental pollution through the problem-based learning (PBL) model allows students to improve their science process skills, as it emphasizes associating concepts with real situations [7]. It helps to sharpen their ability to utilize

the knowledge learnt in solving real-world problems while making them think critically and make responsible decisions [8], [9].

Problem-based learning has been widely used in education in Malaysia and is one of the highlighted strategies considered to align the goals of learning goals in the 21st-century era [10]. According to Fredy *et al.* [7], problem-based learning is a teaching method in which students learn by solving problems facilitated by an educator or students who works together in a group. Problem-based learning was first proposed by Barrows and Tamblyn of the Milton McMaster University School of Medicine project in 1960, for medical students to see the correlation between a large number of medical textbooks and actual cases, a learning method that can stimulate students' enthusiasm for learning is developed [11]. It was then adopted in other areas of education.

Learning chemistry has not been as interesting as students expected. Teachers' lack of effective teaching methods in chemistry classes often results in students' lack of enthusiasm for chemistry and poor performance [12]. Moreover, the study from Kamaruddin *et al.* [13] found students felt anxious about learning chemistry which makes concerning about chemistry learning, especially among aboriginal students. Since the PBL learning method gives students a sense of engagement and experience while learning new concepts [14], it is used in chemistry classes to help teachers and students learn better. Active teaching-learning methodologies, including problem-based learning, are a new education method employed which allows students to play a more active and fundamental role in their learning process [15].

In PBL lessons, students are confronted with true and factual problems in their daily life [16]. It is used to learn how to work in groups and have a discussion, study issues, discover relevant information and compile the data, and get across the options available with solutions [17]. They identify their own learning goal, self-direct their study and construct their knowledge. PBL creates an environment in which students actively participate in the learning process, take responsibility for their learning, more creative and imaginative [18]–[20] Therefore, this module incorporates scientific knowledge about the environment and needed the aborigine students to solve environmental problems by carrying out projects.

Hence, this teaching module is constructed to provide suitable PBL activities in learning environmental problems by developing a PBL teaching module for the aborigine community and accessing its suitability. Which will be conducted based on the theme of the impact of insecticides on water quality in aborigine communities. The main learning difficulties are attributed to the special views of chemical phenomena, which contradict the learners' intuition and daily views in many ways [21]. As a result, the aborigine communities must link their daily view to scientific knowledge and widen their perspectives in viewing the environmental issue through their critical thinking skills [22]. However, research about PBL learning modules for aboriginal people is scarce. Through this module, it is expected that students will be trained in the following abilities: searching for relevant information about pesticides that are detrimental to the environment, understanding which components of pesticides will affect water quality, and analyzing and assessing the impact of pesticides on the environment.

This research aimed to develop a problem-based learning module on Organic Insecticide for indigenous students in Malaysia. It served as a guide for teachers in providing relevant exposure and related scientific knowledge in the context of the aboriginal community. The students will be able to deepen their scientific knowledge specifically in understanding environmental problems. In addition, this research also aimed to identify whether this module is suitable for the indigenous community in terms of objective, content, teaching and learning outcome of learning science. Therefore, the suitability of the module is identified through expert validation and the module is improved based on the suggestion provided by the validator.

2. RESEARCH METHOD

2.1. Research design

This module will use the well-known problem-based learning method to develop students' abilities to interact and present Environmental Chemistry content in a group setting, as well as their ability to collaborate to solve an environmental problem. This module uses Analysis, Design, Development, Implementation and Evaluation (ADDIE) instructional model to construct the module and employs a quantitative approach while collecting validation data. In the process of constructing this module, five stages were applied including analysis, design, development, implementation and evaluation [23], [24]. The activities are summarized in Table 1.

Table 1. The application of ADDIE for the PBL teaching module

ADDIE	Description of activities
Analysis	Content analysis is done based on the review of past literature. The authentic environmental problem, infiltration of insecticide into underground water was identified and related to relevant scientific knowledge.
Design	The design of the problem-based learning teaching module focuses on the arising of environmental problems due to the usage of insecticides. The following steps are normally involved in the PBL learning process [16], [26]: i) Students start with thinking and reasoning about the problem in the context of the environmental problem provided (water pollution) in advance to gain an initial idea and generate a hypothesis; ii) Students started the self-directed study by assigning tasks in different aspects according to their group member's abilities or interests. Each member collects resources to be presented in the group; iii) Students gathered in their groups and shared the information that they have obtained. They would revisit their problem and construct new knowledge while visualizing the problem. They will collaborate to test their hypothesis and solve the problem; iv) Learning results will be displayed to other groups and teachers creatively; v) After their presentation, they would summaries and rethink the abstract knowledge gained. Reflection on their old knowledge and mistakes would drive them further toward their learning goal. With the teacher's guidance, they would be able to utilize the appropriate cognitive skills in solving problems and adopt more suitable strategies when similar problems arise.
Development	The PBL teaching module is developed and validated by experts in the relevant field to ensure its suitability to be applied to the target students.
Implementation	The PBL teaching module is anticipated to be used by teachers who are interested in applying Problem Based Learning approach in teaching science lessons.
Evaluation	The suitability of the PBL teaching module is evaluated among experts. The evaluation of this module is conducted by validation of four validators through close and open-ended questions. The validation questions being constructed would include objective, content, learning outcomes and overall suitability. Improvement and amendment of the module have been done based on the feedback from validation.

2.2. Problem-based learning module of organic insecticide

A problem or a scenario is used to trigger students to identify their learning objectives in problem-based learning. The main focus of PBL does not solely focus on solving problems, but also on giving students appropriate scenarios to construct new knowledge and understanding [25]. Students can develop a model that helps to visualize how pollution happens. Meanwhile, they will need to construct alternative insecticides made of organic matter, present their idea, and prove their effectiveness. This module consists of an introduction with problem background, stages of PBL with suggested activities and the significance of the module. First, the students were introduced to the environmental problem: infiltration of pesticides through the infiltration model.

There are two parts of activities being designed according to the PBL learning approach. The first section consists of modelling the infiltration model to demonstrate the process of infiltration of insecticide from the soil into the underground water during rain. The water that filters out will be collected and tested on their Total Dissolved Solid (TDS) in the presence of chemical insecticides. TDS meter is required for this water quality test. After being introduced to the environmental problem, the second section requires the aborigine students to undergo five stages of PBL activities namely encounter and reason through problems, self-directed study, revisit their problems and construct new knowledge, present their ideas and summarize and rethink the knowledge gained.

Finally, this module was validated by experts which consist of science educators with 5-20 years of teaching experience to provide their comments on the objective, content, teaching and learning outcome and suitability of the module. The module has been validated by four respondents, and all the respondents have science or chemistry educational backgrounds. The questionnaires consist of 9-Likert scale questions which encompass objective, content, teaching and learning outcome and its suitability. Suggestions to improve the module have been recorded at the end of the questionnaires. The questions are: i) The objectives of the module are expressed clearly; ii) The objectives are aligned with the content; iii) The module has comprehensive teaching steps; iv) The module provides a suitable evaluation for aboriginal students; v) The proposed activities used a suitable technique to trigger the activeness of students' participation in the Chemistry classroom; vi) The content of the module could be used to allow students to address environmental problems critically; vii) The module is clear and easy to understand by aboriginal students; viii) The language used is suitable for secondary students and teachers; ix) The activities planned through each stage of problem-based learning are in a good flow and can enhance their thinking skills.

The scale used for validation has been slightly modified from Serevina *et al.* [16] and is shown in Table 2. The obtained scores are added up and the percentage is calculated by diving the total score gained. The interpretation of the Likert scale in Table 3 was used to determine the interpretation result of the experts towards this teaching module.

Table 2. Scale assessment instrument research

Answer	Score
Strongly agree	4
Agree	3
Fair	2
Not agree	1

Table 3. Interpretation of the Likert scale result

Percentage	Interpretation
0%-25%	Very unfeasible
26%-50%	Unfeasible
51%-75%	Feasible
76%-100%	Very feasible

3. RESULTS AND DISCUSSION

3.1. Objective

The module serves two objectives: to provide students with a clearer understanding of the impact of chemical pesticides on water quality; and to develop students' higher-order thinking skills by helping them to discover and create alternatives in everyday life. In questions 1 and 2, 75% of the respondents strongly agree that the objectives are expressed clearly and are aligned with the content. There were 25% of the respondent agree with the statement.

3.2. Content

In question 3, half of the respondents (50%) opine that this module is complete in terms of teaching steps. The steps of problem-based learning consist of five stages: encounter and reason through a problem; self-directed study; revisit the problem and construct new knowledge; present ideas and summaries; and rethink knowledge gained. The other half agree that the content has completed steps. Question 4 however, all respondents agreed that the module is comprehensive in terms of evaluation.

3.3. Teaching and learning outcome

In question 5, 3 out of 4 respondents (75%) strongly agree that the proposed activities used a suitable technique to trigger the activeness of students' participation in the Chemistry classroom. Furthermore, the content of the Organic Insecticide Module could be used to allow students to address environmental problems critically. It has been strongly agreed upon by all the respondents.

3.4. Suitability

In question 7, respondents agreed that the purpose of the organic insecticide module is clear and easy to understand by secondary students. They also opine that problem-based learning model is suited to be used in the Organic Insecticide Module. Moreover, a high percentage of respondents (75%) strongly agree that the language used in the Module on Organic insecticide is suitable for secondary students and educators. Finally, all the respondents strongly agreed that the activities planned through each stage of problem-based learning are suitable for students and can enhance their thinking skills.

3.5. Suggestions for improvement

Two respondents commented on the content of the module. The third respondent (R3) improvises that the content of the module is relevant to the teaching objective. Problem-based learning is significantly effective in developing students' self-directed learning in this module. Meanwhile, respondent R4 stated that the activities should be diversified into different types of insecticides being allocated to each group.

The respondents also emphasized evaluating the outcome of students and the roles of educators at the end of the activity. Respondent R1 suggested providing a questionnaire to be given to students to confirm how much they know about organic insecticides before and after class. Besides, respondent R2 highlighted that teacher must show more information and example to students at the end of the activity to provide the concept and knowledge to be instilled. Finally, respondent R3 suggested that "*In my opinion, teacher's role in guiding students to do reflection can be more clearly stated to help students to achieve the learning goal*."

3.6. Discussion

This module seeks to allow aborigines to gain a better grasp of how chemical insecticides affect water quality and encourage them to figure out alternatives that are applicable in their life. The verification of the module aimed to improve the module's suitability to be used among the aborigine community in terms of

their objectives, learning content and outcome. The respondents agreed that this module is simple to use, has a clear goal, and the stated objectives are aligned with appropriate content for the aboriginal students. It allows students to carry out learning activities and developed self-driven motivation when they know the knowledge they desired [22]. However, for teachers to assist students in achieving their learning objectives, the role of teachers in guiding students to think should be made more obvious. This is due to the difficulties in developing higher-order thinking skills of students, where the educators' role in facilitating the activities and guiding students to reflect and think effectively is crucial to be shown clearly in this module [27], [28].

When it comes to the respondents' opinions on the unit's content, all of them opine that the PBL learning has been conducted in orderly stages. It helps students to scaffold from their lower cognition (understanding and applying their knowledge of water pollution) to higher cognition (creating alternative organic insecticides). The content and languages used must be easily understandable by the target sample and covers all relevant topics in their field [29]. Nevertheless, it's suggested that we can include questions in the course design to test students' prior knowledge of insecticides, considering the aboriginal communities might have prior knowledge and life skills about their living environment [30]. Meanwhile, the activities can be diversified by encouraging students in different groups to figure out different types of insecticides for a variety of insects. Thus, a wide range of alternatives can be discussed in the presentation and discussion session to widen their perspectives and enrich their knowledge of organic insecticides. It helps them in constructing knowledge while solving problems contextually [31].

Furthermore, respondents highlighted the role of teachers to present additional information and examples to students to instill concepts and understanding at the end of activities. This inductive approach provides students with relevant scientific knowledge (harmful chemicals to the environment), they should grasp, and the implication of the activities. Aboriginal students, especially those who lived close to the water source can evaluate what they have learnt and understand how human's production or activities are detrimental to the living organism in the water. It is aligned with previous study [32], stating that PBL allows students to analyze the problem by incorporating pieces of knowledge in chemistry to overcome the real-world problem.

At the end of the validation based on the learning outcomes, many of the teachers agreed that students' interests can be heightened, and creativity will be enhanced through the PBL model. Meanwhile, it is important for educators should assess students' performance after the activities to ensure the module's efficiency. The evaluation has been proposed to include questionnaires and reflection. Not only does it help students to reflect on what they have gained after recognizing the environmental problem, but the teacher is also able to evaluate how their method of delivery and content has changed their old perspectives, resulting in changes in their lifestyle.

The findings of the study revealed that this PBL module is aligned with the objectives and the contents to be developed, highlighted in several studies [33], [34]. It is suitable to be used in introducing environmental problems to the aborigines and assisting them in developing relevant thinking skills while generating new ideas. Still, there are opportunities for improvement and review of the module's acceptance. The modules are beneficial for improving the quality of teaching if they are constructed consistently and all the gears in the modules match each other. As a result, these enhancements are improved on this organic insecticide module so that it can be more useful and effective in educating the aborigines on environmental knowledge from a scientific perspective.

4. CONCLUSION

In conclusion, the expert agreed that this module is suitable to be used in educating the aborigines on the environmental problem. It is integrated with the problem-based learning model, with the clearly stated objective, suitable language, understandable content and useful technique that can stimulate autonomous learning in the Chemistry classroom. This module has achieved a score of 95.83% from the interpretation of the Likert scale. Problem-based learning is student-centered learning which enables students to bridge the gap between scientific facts and real-life situations. Through this module, aboriginal students are expected to get a better understanding of the environmental problems and thus work for a solution to reduce the impact based on their scientific knowledge. It can be used significantly in teaching and learning science by developing problem-solving skills, science process skills as well a positive attitude towards learning science. Moreover, students are allowed to work in groups and at the same time improve their social skills during the learning process. The implementation of PBL might be challenging yet it is effective in fostering the necessary knowledge, skills and values that are more compatible with 21st-century needs. More teachers should be trained in such a way that they should realize the significance of PBL and maximize its effect of it.

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