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The Effect of Problem-Based Learning and E-Modules on Student Motivation and Learning Outcomes in Hydrocarbons

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Abstract: *This research conducted at SMA Negeri 2 Doloksanggul aims to: (1) determine the effect of the Problem-Based Learning (PBL) model assisted by E-Modules (4D) on improving student learning outcomes in hydrocarbon topics; (2) assess the influence of this model on increasing student learning motivation; and (3) examine the correlation between learning motivation and improved learning outcomes. Student learning outcomes in Experimental Class I improved by 82.29%, while in Experimental Class II, the improvement was 78.06%. Motivation scores averaged 79.94% in Experimental Class I, compared to 74.89% in the control class. The correlation test revealed a significant positive relationship between motivation and learning outcomes, with rtable < rcount (0.674 < 0.744), thus confirming that increased motivation contributes to improved academic performance. These findings support the use of E-Module-assisted PBL as an effective approach to enhance both student motivation and learning outcomes.*

Keywords: *problem based learning; motivation; e-module; hydrocarbon*

INTRODUCTION

Based on Law No. 20 of 2003, it has been mandated that education must be carried out consciously and planned to create a conducive and communicative learning atmosphere and process, and students actively develop their potential to have religious spiritual strength, self-control, responsible personality, creativity, intelligence, noble character, talented, and have the necessary skills for himself, the community, the nation and the state, to realize this, there needs to be a renewal effort in the teaching and learning process (Muliaman & Mellyzar, 2020). In an effort to reform the learning process, the implementation of the independent curriculum is one of the options with the main goal of encouraging quality improvement and recovery from the learning crisis (Hehakaya & Pollatu, 2022). The Independent Curriculum provides opportunities for teachers to explore with various methods, so that the content in learning will be more optimal and students have enough time to explore concepts and strengthen competencies. The Merdeka Curriculum is present as a new curriculum

designed to provide students with the opportunity to learn more relaxed and stress-free, so that they can show their natural abilities more optimally (Rahayu et al., 2022). Therefore, teachers have the flexibility to update the learning process by choosing various methods, visual video media, teaching materials in the form of e-Modules, learning models and other learning tools in accordance with the needs of teaching and learning and the interests of students (Pujiarti et al., 2023). Hydrocarbon chemistry occurs in everyday life and many consider that hydrocarbon chemistry lessons are less interesting because they relate to abstract ideas or concepts and require high reasoning. This can cause students to feel bored quickly and lack enthusiasm in learning if the learning process is not interesting. The difficulty in learning hydrocarbon material lies in the gap that occurs between the understanding of the concept and its application so that there is a difficult assumption to learn it. There are three characteristics of chemistry learning, namely, macroscopic, sub-macroscopic and symbolic, where the three levels (levels) are interrelated, so that if students have difficulties at one level, it will affect the next level (Sirhan, 2007). Hydrocarbons have a very broad and abstract concept that contains many and varied terms. Learning hydrocarbon materials requires the ability to solve problems so that students are able to identify, analyze and describe abstract chemical concepts and principles into concrete miscellaneous (Zafirah et al., 2021). Based on the results of research that has been conducted, The application of e-Chemistry modules to hydrocarbon materials can have a better influence in improving student learning outcomes because they can be used anywhere and anytime. It can be seen from the learning results of the experimental class that were learned using e-Module that were higher than the control class that was learned with the package book (Afriani et al., 2022). In addition, based on the research conducted, there was an increase in the learning outcomes of students in the experimental class through the application of problem-based e-Modules in learning the PBL model on hydrocarbon chemistry materials (Pane & Sugiharti, 2022). Problem-based learning (PBL) starts by incorporating and presenting new information. In the PBL educational framework, educators and learners work together to address issues in small teams. Arends describes problem-based learning as a pedagogical approach that prompts students to tackle challenges to enhance their comprehension, critical and creative thinking skills, as well as self-awareness (Fadhilah & Nainggolan, 2024). The PBL model enables students to recognize issues, discover causal links, and utilize concepts relevant to the problem. The PBL model can develop students' critical thinking abilities to address real-world issues encountered. Students' ability to think critically when solving science problems is essential for developing their HOTS (Tambunan & Damanik, 2024). The problem-oriented learning model, or problem-based learning, is characterized by starting the learning process with real-life issues that are commonly faced. This learning approach is collaborative, communicative, and cooperative, as it helps students develop the ability to discuss and tackle the selected problems effectively (Rachmawati & Hidayah, 2024).

The problem-oriented learning model, or problem-based learning, is characterized by starting the learning process with real-life issues that are commonly faced. This learning approach is collaborative, communicative, and cooperative, as it helps students develop the ability to discuss and tackle the selected problems effectively(Munthe & Suyanti, 2024).

There are 3 objectives of this study, namely:(1) to determine the effect of the Problem Based Learning Model assisted by E Module (4D) on the improvement of student learning outcomes on hydrocarbon materials; (2) to determine the influence of the Problem Based Learning Model assisted by e-module on increasing learning motivation; (3) to determine the correlation between the improvement of learning outcomes and the

learning motivation of students learned with the e-module assisted Problem Based Learning Model.

LITERATURE REVIEW

Digital electronic modules are learning packages needed for the learning of certain subjects that allow students to learn independently equipped with videos, audio, simulations, quizzes, etc. Electronic modules are learning materials that are systematically designed based on a specific curriculum and packaged in the form of specific units of time that are displayed using electronic devices such as computers or androids. Electronic modules are learning tools or learning facilities that contain systematic and interesting materials, methods, limitations, and evaluation methods designed to achieve the expected competencies according to the level of complexity electronically (Aisyah et al., 2021). The advantages of using e-Module are as follows:

1. E-Modules are able to foster motivation for students.
2. Assessments in e-Modules allow teachers and students to find out which parts have not been completed and have been completed.
3. The material in the e-Module can be divided equally into one semester.
4. The e-Module teaching materials are arranged according to the academic level.
5. Electronic Modules can make modules more interactive and dynamic than static print modules.
6. Images, video, audio, and animation can be used to reduce the language or language elements of the print module (Laili et al., 2020).

The disadvantages of using e-Module are as follows:

1. The cost of developing e-Modules is quite high in a short time.
2. Not everyone can operate an e-Module creation application.
3. Teachers as facilitators need longer time to monitor the student learning process.
4. Devices such as laptops, smartphones, or computers connected to the internet are required to access the e-Module and not all students have such facilities (Ningsih et al., 2020).

PBL (Problem Based Learning) is an educational approach that assists students in improving the skills needed in today's global world. This educational model poses real challenges for students at the beginning of the learning process, which is addressed through investigation and implemented with problem-solving strategies. In this scenario, learners are directly confronted with complex problems in an actual context, the principle behind Problem Based Learning (PBL) is an educational teaching technique by presenting situations that lead to problems that students must solve. It's not just a way for students to find the right answer (Ginting & Purba, 2024). Often the problem is that there is no one "right" answer. Instead, learners will learn through the act of trying to solve problems. Learners will interpret the questions, gather additional information, create possible solutions based on discussion activities, evaluate options to find the best solution, and then present conclusions (Rahmadani, 2019).

Problem-based learning includes the following characteristics:

1. A problem becomes the *starting point* in learning, the problem raised is a problem that exists in the real world that is unstructured.
2. A problem requires multiple *perspectives.*
3. Problems challenge the knowledge, attitudes, and competencies possessed by students, which then this problem will require the identification of learning needs and new areas of learning.
4. The use of knowledge sources with various uses, and the evaluation of

information sources are important processes in Problem Based Learning.

5. Learning is collaborative, communicative, and cooperative. Synthesis and integration of learning processes.

PBL involves evaluating and *reviewing* students' experiences and learning processes. In the PBL model, students are faced with real-life problems in the environment and students are asked to be able to solve problems through the five steps of the PBL model contained in it (Sudria et al., 2019).

Table 1. Step Problem-Based Learning Model

No	PBL Model Syntax	Teacher Activities/Activities
1	Student orientation to problems	The teacher explains the learning objectives, explains what logistics requires, proposes phenomena or stories to raise the problem, and motivates students to engage in problem-solving activities.
2	Organizing students to learn	The teacher helps students determine and organize study assignments related to the problem.
3	Guiding individual and group investigations	The teacher encourages students to gather the right information, conduct experiments, to get explanations for problem solving.
4	Develop and present works	Teachers assist students in planning and preparing appropriate work such as reports, videos, models, and help them share assignments with their friends.
5	Analyze and evaluate the problem-solving process	Teachers help students to reflect or evaluate their investigations and the processes they use.

(Shofiyah & Wulandari, 2018)

Advantages and disadvantages of the Problem Based Learning model. The advantages of the PBL model are as follows.

1. Students are trained to have real-life problem-solving skills.
2. Students have the ability to build their own knowledge through learning activities.
3. Learning focuses on the problem so that unrelated material does not need to be studied by students. This reduces the burden on students by memorizing or storing information.
4. There are scientific activities for students through group work.
5. Students are used to using sources of knowledge, both from the library, the internet, interviews, and observations.
6. Students have the ability to assess their own learning progress.
7. Students have the ability to conduct scientific communication in discussion activities or presentation of their work (Rerung et al., 2023).

There was an increase in the chemistry learning outcomes of students taught using the Problem Based Learning (PBL) and Card-mediated Scientific Approach models from an average of 27.2 pretests to 63.95 and 72.5 both in experimental classes and chemistry learning outcomes of students taught using Problem Based Learning (PBL) (Silaban et al., 2020).

METHODS

This research will be conducted at SMA Negeri 2 Doloksanggul located in JL. Pakkat Km 10, Matiti, Doloksanggul District, Humbang Hasundutan Regency, Prov. North Sumatra. in the even semester, namely in February-April 2025. The type of research used in this study is a quasi-experimental type of research by applying the syntax of the Problem Based Learning model assisted by electronic media e-modules.

The population in this study is all students of class XI MIA SMA Negeri 2 Doloksanggul which consists of 5 classes (Classes XI MIA-1 to XI MIA-5). Each class has an average of 30 students. The population in this study is students majoring in science class XI of SMA Negeri 2 Doloksanggul Academic Year 2025/2026 which consists of 2 classes with a total of 60 students, where in both classes will be given test instruments, which are multiple choices to test the initial level of students' ability without being taught using e-modules. After learning with e-modules and various package books, they were given test (multiple choice) and non-test (motivation questionnaires) to measure student learning outcomes and motivation using e-modules and with the help of package books. The sample used in this study was a randomly drawn target member. Class XI-MIA-1 was selected as the experimental class learned using the PBL model assisted by the e-module and class XI-MIA-3 was selected as the control class learned with the PBL model without the help of the e-module. Data analysis uses validity, difficulty, discriminatory, reliability, normality, homogeneity, test the relationship between learning outcomes and motivation, and hypothesis test.

RESULT AND DISCUSSION

The learning in this study is carried out based on the Problem Based Learning model which goes through several stages, namely first, orientation about problems to students. Second, organize students by dividing students into groups and directing students to pay attention to explanations from teachers through the use of media. Third, guide students to conduct investigations to solve problems in the student's worksheets and discuss with their groups. Fourth, develop and present the results of the work through instructions given to the group to present the results of the discussion in front of the class. Furthermore, the fifth stage analyzes and evaluates the problem-solving process by asking students to conclude the learning that has been given and the teacher gives an evaluation in the form of conclusions from learning activities. The implementation of the learning process with the Problem Based Learning model is accompanied by the use of e-modules and without the help of e-modules. In experimental class I, it uses the help of e-modules, while experimental class II uses e-modules. The results of hypothesis testing I were obtained by counting > ttables (2,755 > 1,995), then Ho was rejected, Ha was accepted. This means that there is an effect of problem-based e-Modules on increasing students' learning motivation on hydrocarbon materials. The average learning motivation score of experimental class I was obtained at 79.94 and experiment II at 74.89. Second, the average motivation of student learning outcomes in both experiments I and II is in the high category. The motivation value of experiment I was higher than that of experiment class II, meaning that students were more motivated to learn with the PBL model assisted by e-modules than without the help of e-modules. The influence of learning motivation from the two learning groups can be seen in the picture.

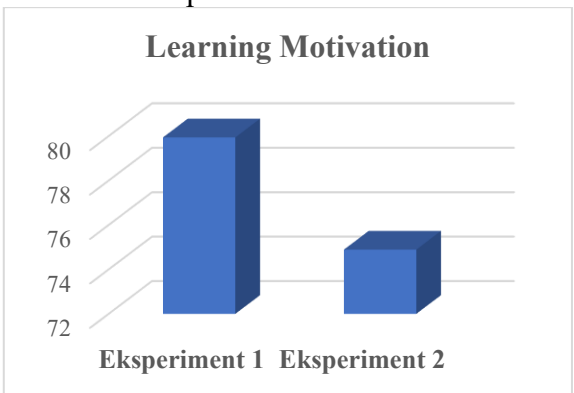

Figure 1. Average Graph of Students Learning Motivation

The results of hypothesis II testing were obtained by counting > tables (2,313 > 1,995), then Ho was rejected, Ha was accepted. This means that there is a difference in the learning outcomes of students who are taught the model with the PBL model assisted by e-learning modules and *without e-modules* on hydrocarbon materials. The average *pretest* of experiment I was 31.57 and *posttest* of 82.29 with an N-Gain of 74.42% (high). Meanwhile, the average *pretest* of experiment II was 33.61 and *posttest* was 78.06 with an N-Gain of 67.42% (moderate).

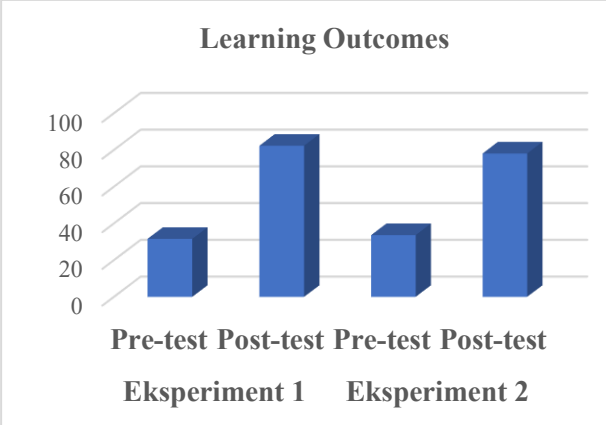

Figure 2. Average Students Learning Outcomes

The relationship between learning motivation and student learning outcomes was seen in hypothesis testing III and IV. The results of hypothesis III testing were obtained in a > rtable (0.577 > 0.334), then Ho was rejected, Ha was accepted. Thus, it can be concluded that there is a correlation between motivation and learning outcomes of students taught with the e-module-assisted PBL model on hydrocarbon materials. The relationship obtained is in the medium category. Then, the results of hypothesis IV testing were obtained in a calculation of > rtables (0.495 > 0.329), then Ho was rejected, Ha was accepted. Thus, it can be concluded that there is a correlation between motivation and learning outcomes of students who are taught with the PBL model without the help of e-modules with the category of moderate relationships.

CONCLUSION

After conducting research and data analysis, the researcher came to the following conclusions: (1).The influence of student learning outcomes learned with the e-module-assisted Problem Based Learning model and without the help of e-modules on hydrocarbon materials. The average learning outcome score of students taught with the e-module-assisted Problem Based Learning model is higher than the average learning outcome score taught without the help of e-module, which is 82.29 > 78.0. (2). There is an influence on the learning motivation of students who are taught with the Problem Based Learning model assisted by e-modules and without the help of e-modules on hydrocarbon materials. The average learning motivation of students who were taught with the Problem Based Learning model assisted by e-modules was higher than the average learning motivation value learned without the help of e-modules, which was 79.94 > 74.89.(3).There is a correlation between motivation to improve student learning outcomes learned with the e-module-assisted Problem Based Learning model with an r of 0.577 medium category.

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