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Implementation of Problem Based Learning (PBL) Electronic Module Teaching Materials to Increase Student Interest and Learning Outcomes in Reaction Rate Material

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Abstract: Implementation of Problem Based Learning (PBL) Electronic Module Teaching Materials to Increase Student Interest and Learning Outcomes in Reaction Rate Material. This implementation research is to determine the comparison of the improvement of learning outcomes and interest of students taught by using electronic module teaching materials based on Problem Based Learning and students taught by using high school chemistry textbook teaching materials and to determine the relationship between interest and the improvement of student learning outcomes in reaction rate material class XI at SMA Negeri 14 Medan. This research is a pure experimental research with pretest-posttest control group desaign design. Samples in the study were taken 2 classes using random sampling technique, namely class XI IPA 5 as an experimental class taught using PBL-based electronic module teaching materials and class XI IPA 2 as a control class taught using high school chemistry textbook teaching materials. This study used a test instrument of 20 multiple choice questions and 25 non-test instruments in the form of a student interest questionnaire. The application of electronic module teaching materials is measured through the difference in the average n-Gain of student learning outcomes and interest, both in the experimental and control classes. The results showed that the increase in student learning outcomes and interest in the experimental class was higher than in the control class. The average increase in learning outcomes in the experimental class was 0.71 with an increase in interest of 0.54 and an increase in learning outcomes in the control class was 0.478 with an increase in interest of 0.31. Then, there is a correlation between interest and the improvement of student learning outcomes taught using PBL-based electronic module teaching materials of 0.764 with a high category.

Keywords: PBL-based electronic modules, learning outcomes, learning interest

Abstrak: Implementasi Bahan Ajar Modul Elektronik Berbasis Problem Based Learning(PBL) untuk Meningkatkan Minat dan Hasil Belajar Siswa pada Materi Laju Reaks. *Penelitian implementasi ini untuk mengetahui perbandingan peningkatan hasil dan minat belajar siswa yang diajarkan dengan menggunakan bahan ajar modul elektronik berbasis Problem Based Learning dan siswa yang diajarkan dengan menggunakan bahan ajar buku paket Kimia SMA serta mengetahui hubungan antara minat dengan peningkatan hasil belajar siswa pada materi laju reaksi kelas XI di SMA Negeri 14 Medan. Penelitian ini merupakan penelitian eksperimen murni dengan desain pretest-posttest control group desaign. Sampel pada penelitian diambil 2 kelas dengan menggunakan teknik random sampling yaitu kelas XI IPA 5 sebagai kelas eksperimen yang diajarkan dengan menggunakan bahan ajar modul elektronik berbasis PBL dan kelas XI IPA 2 sebagai kelas kontrol yang diajarkan dengan menggunakan bahan ajar buku paket kimia SMA. Penelitian ini menggunakan instrumen tes sebanyak 20 butir soal pilihan berganda dan 25 intrumen nontes yaitu berupa angket minat belajar siswa. Penerapan bahan ajar*

modul elektronik diukur melalui perbedaan rata-rata n-Gain hasil dan minat belajar siswa, baik pada kelas eksperimen maupun kelas kontrol. Hasil penelitian menunjukkan bahwa peningkatan hasil dan minat belajar siswa pada kelas eksperimen lebih tinggi dibandingkan pada kelas kontrol. Rata-rata peningkatan hasil belajar pada kelas eksperimen sebesar 0,71 dengan peningkatan minat sebesar 0,54 dan peningkatan hasil belajar kelas kontrol sebesar 0,478 dengan peningkatan minat sebesar 0,31. Kemudian, terdapat korelasi antara minat dengan peningkatan hasil belajar siswa yang diajarkan dengan menggunakan bahan ajar modul elektronik berbasis PBL sebesar 0,764 dengan kategori tinggi.

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Kata Kunci: *modul elektronik berbasis* PBL*, hasil belajar, minat belajar*

▪ INTRODUCTION

Chemistry is one of the specialization subjects at the SMA/MA level in the 2013 curriculum. Chemistry is a branch of science that studies the structure, properties, and changes in matter. Chemistry is one of the important subjects taught to students, because chemistry can improve students' thinking skills and can stimulate students' creative thinking patterns. However, in reality there are still many students who experience difficulties when learning chemistry. This is because in chemistry there are many abstract and complex concepts that require a deep understanding to (Novita, 2019; Rachman, 2017; Sariati, 2020). In addition to this, there are also factors that cause students to experience difficulties in learning chemistry, namely factors from themselves (internal) and factors from outside themselves (external). One of the factors that comes from within students (internal) is interest in learning (Priliyanti et al., 2021).

Interest is a sense of liking or interest in something that students learn, so that students have determination in learning. According to Gie, high interest in learning greatly affects student learning outcomes. To increase students' interest in learning chemistry, teachers must be more creative in creating a pleasant learning atmosphere and utilizing technological developments to achieve better learning (AH et al., 2019; Syahputra, 2020).

One of the chemistry lessons that students find difficult is reaction rate material. Susanti et al., (2019) revealed that students find it difficult to learn the reaction rate because the reaction rate is conceptual, algorithmic and graphic material. Students have experimental data. The same thing was also stated in the research of Sholihah et al., (2019)that chemistry subjects on reaction rate material is a subject matter with concepts and calculations that can be an obstacle for students in participating in chemistry learning. This obstacle will continue if the conceptual reaction rate material is not taught with the help of the right media and models.

Based on interviews with chemistry teachers at SMA Negeri 14 Medan, it is known that student learning outcomes in chemistry subjects, especially in reaction rate material are still very low. This is due to the low interest in learning and understanding of students' concepts about the reaction rate. The teacher stated that students had difficulty in understanding the concept of reaction rate, determining the order and rate of reaction. The learning model used by the teacher is also dominant in the lecture, discussion, and assignment learning model and the media used is the student handbook. The student handbook distributed at school presents complex material and uses language that is difficult to understand, so students feel bored and less interested in thick textbooks and long explanations, and the formulas presented in the book are relatively complicated. This results in a lack of student interest in the learning process, where students tend to only

take notes and listen to the teacher's explanation, even some students are less focused in paying attention to the teacher's explanation and prefer to chat with friends around them.

One strategy that can be done to increase students' interest and concept knowledge is to use innovative teaching materials that are in accordance with the reaction rate material, namely teaching materials in the form of modules. Module is a learning media in printed form that is arranged systematically, which contains learning materials, methods, learning objectives based on basic competencies or indicators of competency achievement, and independent learning activities (Basri, 2015). However, along with the rapid development of technological progress and information, learning media has experienced a very significant development, namely the transition of learning media from book form to electronic form. Electronic module is an interactive ICT-based module that includes images, audio, video, and animation, as well as formative quizzes/tests to activate student feedback. The advantages of electronic modules over printed modules are that they can be accessed anywhere and anytime, contain video, audio, animation, and interactive features and do not require the cost of printing. Electronic modules are considered innovative because they can display interesting and interactive learning materials with superior cognitive functions so that they can spur student interest in learning (Nada Fadhilah Antris & Andromeda, 2023).

According to research conducted by Hasbiyati & Khusnah, (2017) the implementation of e-books can increase students' interest in learning, where the results of the study were obtained at 88.61% with a very good category and a Gain test score that was included in the high category of 0.703. The same thing was also stated by Samosir & Nainggolan, (2022) that the application of E-modules can improve student learning outcomes. The results showed that the increase in student learning outcomes in the experimental class taught using E-modules was higher than the increase in student learning outcomes in the control class taught using student reference books. The average increase in student learning outcomes in the experimental class reached 72.54% with a high category, while in the control class it reached 68.45% with a medium category.

The learning process using teaching materials will not be effective without the learning model used. Therefore, a learning model is needed that is in accordance with the characteristics of the reaction rate material. One of the learning models that is in accordance with the characteristics of the reaction rate material is the problem-based learning model (Problem Based Learning). Problem-based learning is a learning model that places students to think critically about problems that arise in the learning process and are able to solve these problems in groups or individually (Saragi & Dalimunthe, 2022). The Problem Based Learning Model is a model that invites students to reconstruct their own knowledge and can develop their skills (Pratiwi, 2020). According to Nyoman Kartini (2020) the Problem Based Learning learning model is problem-based and based on cognitive psychology so that the focus of learning lies on what students think. In addition, the teacher acts as a guide and facilitator so that students can actively solve their problems independently.

Based on previous research,Purba et al., (2022) learning using Problem Based Learning on reaction rate material can improve student learning outcomes and interest, where an increase in student learning outcomes is obtained by 81.82% and get positive responses from students in the learning process. Aminah's research (2021) using the Problem Based Learning learning model can effectively improve student learning outcomes, where there is an increase in the percentage of completeness of student learning outcomes from cycle I to cycle II, namely from 27% to 64% so that there is an increase

of 37%. Then in cycle III the percent of student completeness increased from 64% to 80%. Furthermore, research conducted by (Suswati, 2021)found that the application of the Problem Based Learning (PBL) learning model can improve student learning outcomes, especially in Chemistry subjects. This is reinforced by the research of Dalimunthe & Ginting, (2022) which states that there is an increase in student learning outcomes of 75.43% with learning using PBL-based module teaching materials. This study aims to determine the comparison of the improvement of learning outcomes and interest of students taught by using PBL-based electronic module teaching materials and students taught by using high school Chemistry textbook teaching materials and to determine the relationship between interest and increased student learning outcomes in reaction rate material.

▪ METHOD

In this development research, the 4D development method (four-D method) was used as proposed by Thiagarajan, Semmel, and Semmel (1974). The target in this study is the development of problem solving-based e-LKPD on acid and base materials that aim to train students' critical thinking skills. The samples in this study were students of class XI MIPA 2 who had received acid and base materials with heterogeneous skill levels.

The method in this study is true experiment, because with this method the researcher can control all external variables that affect the course of the experiment (Batubara et al., 2023)The design used in this study was pretest-posttest control group desing. This research was conducted in November-December 2023 at SMA Negeri 14 Medan. The population in this study were all students of class XI IPA SMA Negeri 14 Medan consisting of 5 classes with a total of 180 students. The samples in this study were XI IPA 5 class as an experimental class of 30 students and XI IPA 2 class as a control class of 30 students selected by random sampling technique. The experimental class was taught using PBL-based electronic module teaching materials and the control class was taught using high school chemistry textbook teaching materials.

The procedure in this study was organized in three stages, namely: 1) preparation stage, including: interview, preparation of lesson plans, preparation and validation of test and non-test instruments; 2) implementation stage, including: determining the sample, conducting pretests and giving interest questionnaires, implementing learning, conducting posttests and giving interest questionnaires; 3) data analysis stage, including: processing or analyzing data, testing hypotheses, and making conclusions.

The instruments used in this study were in the form of interview sheets, pretest and posttest questions totaling 20 multiple choice questions and student interest questionnaires totaling 25 statements. Before the instrument was used, the researcher first compiled 40 multiple choice question grids and 25 interest questionnaire grids. Then the grids were validated by expert lecturers and then the test instruments were tested on students. after the test was carried out, validity, reliability, difficulty level, distinguishing power, and distractors were tested.

Data analysis techniques performed using Microsoft Excel include prerequisite analysis consisting of normality test and homogeneity test. Then hypothesis testing was carried out using the right party t test, and the correlation test between interest and increased learning outcomes.

▪ RESULT AND DISCUSSION

The result in this study are describe as follows:

1. Data on student learning outcomes and interest in learning

The data obtained were pretest, posttest, interest before and after treatment as well as gain in learning outcomes and interest. The average data in the experimental class and control class can be seen in the following figure.

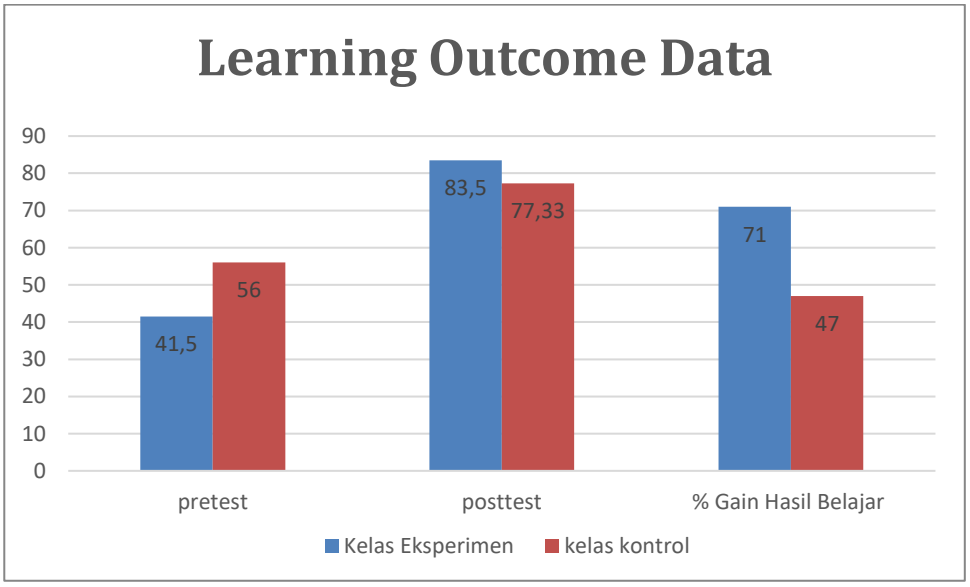

Figure 1. Average graph of Data on Student Learning Outcomes

The graph in figure 1 shows the average pretest of the experimental class of 41.5, the average posttest score of 83.5 and the percentage increase in learning outcomes of 71%. While in the control class the average pretest score was 56, the average posttest score was 77.33, and the percentage increase in student learning outcomes was 47%.

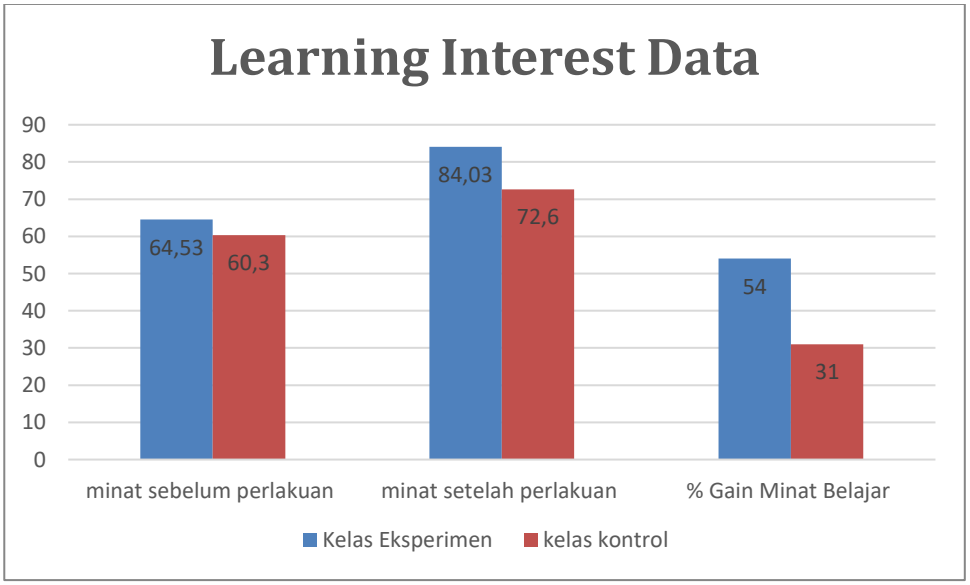

Figure 2. Average graph of Data on Student Learning Interest

The graph in figure 2 shows the average interest before the experimental class treatment of 64.53, the average interest value after treatment of 84.03 and the percentage increase in interest in learning by 54%. While in the control class the average interest before treatment was 60.3, the average interest after treatment was 72.6, and the percentage increase in student interest in learning was 31%.

2. Data Normality Test

Normality was measured using the chi squared test at a significance level of $\alpha = 0.05$. The test results can be seen in the table below:

Table 1. Data Normality Test

Class	data	(X^2) Count	(X^2)Table	Description
Experiment	Pretest	6,25	11,07	Normally distributed
	Posttest	3,35	11,07	Normally distributed
	n-gain	2,45	11,07	Normally distributed
Conrol	Pretest	2,8	11,07	Normally distributed
	Posttest	7,55	11,07	Normally distributed
	n-gain	6,45	11,07	Normally distributed
Eksperimen	interest before treatment	3,25	11,07	Normally distributed
	interest after treatment	8,05	11,07	Normally distributed
	n-gain	5	11,07	Normally distributed
Control	interest before treatment	10,25	11,07	Normally distributed
	interest after treatment	10,05	11,07	Normally distributed
	n-gain	6,15	11,07	Normally distributed

The data in Table 1 shows that the learning outcomes and students' interest in learning are normally distributed.

3. Data Homogeneity Test

The results of the homogeneity test in this study can be seen in table 2 below.

Table 2. Data Homogeneity Test

Data	F_{Count}	F_{table}	Description
Pretest	1,481	1,858	Homogeneous
Posttest	1,406	1,858	Homogeneous
n-gain	1,517	1,858	Homogeneous
Interest before treatment	1,753	1,858	Homogeneous

Interest after treatment	1,751	1,858	Homogeneous
n-gain	1,45	1,858	Homogeneous

The data in table 2 shows that the data on learning outcomes and interest in learning are homogeneous.

4. Hypothesis Test

Hypothesis testing is done with one-party t test (right side) and correlation test. Hypothesis testing is explained as follows:

Table 1. Hypothesis Test I (Learning Outcomes)

Class Data		t_{count}	t_{tabel}	α	Description
Eskperiment	Control				
$\bar{X}$ = 0,71	$\bar{X}$ = 0,48				Ha accepted
n1 = 30	n1= 30	7,24	1,67	0,05	Ho denied
S^2 = 0,123	S^2 = 0,0182				

Based on the data in table 3 shows that the value of tcount> ttable (7.24> 1.67). So Ho is rejected and Ha is accepted, this means that the increase in student learning outcomes taught using electronic module teaching materials based on Problem Based Learning is higher than the increase in student learning outcomes taught using high school chemistry book teaching materials on reaction rate material.

Table 2. Hypothesis Test II (Learning Interests)

Class Data		t_{count}	t_{table}	α	Description
Eskperiment	Control				
$\bar{X}$ = 0,54	$\bar{X}$ = 0,31				Ha accepted
n1 = 30	n1= 30	7,61	1,67	0,05	Ho denied
S^2 = 0,0159	S^2 = 0,0110				

Based on the data in table 4 shows that the value of $t_{count}t > t_{table}$ (7.61> 1.67). So Ho is rejected and Ha is accepted, this means that the increase in student learning interest taught using electronic module teaching materials based on Problem Based Learning is higher than the increase in student learning interest taught using high school chemistry book teaching materials on reaction rate material.

Tabel 3. Hypothesis Test III (Correlation of interest with increased learning outcomes)

Class	Class Data	r_{count}	r_{table}	Description
Eksperimen	$\sum X$ = 2521 $\sum X^2$ = 212335 $\sum Y$ = 16,15 $\sum Y^2$ 9155 $\sum XY$ = 1368,6	0,764	0,361	Ha, acception Ho, denied

N = 30

Based on the data in table 5 shows that the value of titung>ttabel (0.764> 0.361). So Ho is rejected and Ha is accepted, this means that there is a positive and significant correlation between student interest in learning with an increase in student learning outcomes in the implementation of electronic module teaching materials based on Problem Based Learning.

In this study, the learning process was carried out using the Problem Based Learning learning model using different teaching materials. The experimental class was taught using Problem Based Learning-based electronic module teaching materials while the control class was taught using high school chemistry textbook teaching materials.

In hypothesis testing I obtained t_{count} greater than t_{table} (7.24>1.672) this means Ha is accepted, it can be concluded that the increase in student learning outcomes taught using electronic module teaching materials based on Problem Based Learning is higher than the increase in student learning outcomes taught using high school chemistry book teaching materials on reaction rate material. The average n-gain value of learning outcomes in the experimental class was obtained at 0.71 and the average n-gain of learning outcomes in the control class was 0.48. The increase in student learning outcomes in the experimental class taught using electronic module teaching materials is higher than the increase in student learning outcomes taught using high school chemistry textbook teaching materials. This is because the Problem Based Learning learning model has the advantage that problem-based learning is a pretty good technique to better understand learning, besides that it can also challenge students' abilities and provide satisfaction to discover new knowledge for students. In addition, problem solving can also help students to understand the nature of learning as a way of thinking not just understanding and memorizing the learning delivered by the teacher based on teaching materials. The results of this study are in accordance with research conducted by Sinulingga & Nainggolan, (2023) on the application of E-modules can improve student chemistry learning outcomes. In this research, it is known that the increase in learning outcomes in the experimental class is higher than the control class. The increase in learning outcomes in the experimental class was 0.77, while in the control class it was 0.71. Likewise, the results of Purba's research (2022) show that the use of the Problem Based Learning learning model can improve student learning outcomes and interest, where an increase in learning outcomes of 81.82% is obtained and get a positive response from students in the learning process.

In hypothesis II test obtained t_{count} greater than t_{table} (7.61>1.672) this means Ha is accepted, it can be concluded that the increase in student learning interest taught using electronic module teaching materials based on Problem Based Learning is higher than the increase in student learning interest taught using high school chemistry book teaching materials on reaction rate material. The average n-gain value of learning interest in the experimental class was obtained at 0.54 and the average n-gain of learning interest in the control class was 0.0159. The increase in student interest in learning in the experimental class taught using electronic module teaching materials is higher than the increase in

student interest in learning taught using high school chemistry textbook teaching materials. This is because the experimental class using electronic module teaching materials can attract students' attention so that students feel excited when participating in learning. In addition, the electronic model is also able to display innovative learning materials presented in digital form that contain images, audio, animations, and videos that only by clicking the link the video will play as well as interesting and communicative learning concepts that can be accessed anywhere and anytime so that students can repeat lessons that are less understood or missed. The results of this study are in accordance with previous research conducted by Hasbiyati & Khusnah, (2017) that the application of e-books can increase student interest in learning, where the results of the study obtained an increase in student interest of 88.61% with a very good category. Then strengthened by the research of Najuah and Sidiq (2020) states that e-module teaching materials can build, trigger, strengthen interest in learning independently and the learning process is more effective and efficient so that it can improve the quality of learning.

In hypothesis III, the correlation test, based on the calculation obtained r_{count} greater than r_{table}, namely 0.764>0.361, thus Ha is accepted, which means that there is a significant correlation between interest in learning and improving student learning outcomes taught using Problem Based Learning-based electronic module teaching materials on reaction rate material. This is supported by previous research, namely according to Ginting & Ginting, (2023) which states that there is a positive relationship between student learning outcomes and interest.

▪ CONCLUSION

Based on the results of the study, it can be concluded that the increase in learning outcomes and interest of students taught using PBL-based electronic module teaching materials is higher than the increase in learning outcomes and interest of students taught using high school chemistry textbook teaching materials. There is a significant relationship between interest and the improvement of student learning outcomes taught using electronic module teaching materials based on Problem Based Learning on reaction rate material.

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