Influence of STEM Student Worksheets to Improve Learning Outcomes and Student Interest in Reaction Rate

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Abstract: *This study aims to determine the effect of Student Worksheets STEM using Problem Based Learning (PBL) model on reaction rate material. This research was conducted at SMAN 8 Medan in the 2022/2023 school year. This type of research is a quasi-experiment with pretest posttest control group design. The population in this study were all XI MIPA classes at SMAN 8 Medan. The research sample was XI MIPA 4 class as an experimental class taught with STEM Student Worksheets using Problem Based Learning (PBL) model and XI MIPA 1 class as a control taught using Problem Based Learning (PBL) model without STEM Student Worksheets. The instruments used in this study were 20 multiple choice questions that had been tested for validity, reliability, difficulty level and differentiation, and 25 items of questionnaire statements of learning interest. The results of this study indicate that there is an effect of STEM Student Worksheets using the Problem Based Learning (PBL) model on learning outcomes with hypothesis testing sig. 0.001 < α (0.05). In addition, there is an effect of STEM Student Worksheets using the Problem Based Learning (PBL) model on learning interest with a hypothesis test sig. 0.000 < α (0.05).*

Keywords: *Student Worksheets; STEM; PBL; Reaction Rate*

INTRODUCTION

Education in Indonesia is still of low quality compared to other countries around it (Saragi & Dalimunthe, 2022). The education system must be sensitive to the dynamics of national life which now demand changes in various fields. Education in the age of knowledge demands modern and professional educational management with nuances in the use of technology (Tambunan et al., 2021). The government took action to face these challenges, namely by revising the educational curriculum to be better, which is now known as the 2013 Curriculum. The 2013 Curriculum is a curriculum that prioritizes understanding, skills and is student-centered. Students are required to understand the material, be active in discussions and presentation as well as having good manners and high discipline (Sandabunga et al., 2021).

Therefore, teachers are expected to create more learning that is not boring and can keep up with existing developments, not only continue to be given past methods to forget developments that continue to change and change (Mardhiyah et al., 2021). The learning process is inseparable from media, methods,

and learning outcomes. Media can be used as a means of providing educational material delivered by teachers to students. Media used in the teaching and learning process can be a tool to overcome the limitations of educators in delivering material and limited time in teaching (Silaban & Sianturi, 2021). A teacher as well as planning innovative and creative learning strategies and media by utilizing technology-based learning (Panggabean et al., 2021). Therefore, to improve students' mastery of science concepts, it is important to make learning innovations in changing the conventional teacher-centered learning paradigm (Nainggolan et al., 2019) PBL learning provides new knowledge to students through problems so that students are challenged to learn, interact with each other, and teach each other (Gultom et al., 2020).

Chemistry learning must pay attention to the characteristics of chemistry as a product, namely chemical knowledge in the form of facts, theories, principles, laws, and also a scientific process or performance. The characteristics of chemistry as a natural science that requires concrete examples around and scientific methods that have a series of scientific processes in order to obtain scientific concepts, laws, rules, and principles (suswati, 2021). Reaction rate is one of the subjects that most students are less interested in. The lack of student interest is caused by chemistry lessons consisting of abstract concepts. This causes most students to become passive, lazy about learning, feel bored during learning, and do not understand the concept of the material provided (Hidayat & Andromeda, 2019).

Most students experience difficulties when studying reaction rate material, namely reaction rate equations and reaction orders. This difficulty causes students to tend to be passive during the learning process because they feel that the material being studied is difficult material. In the learning process, many students still find it difficult to solve problems, to relate chemical concepts to theories correctly. There are still many students who are stuck with formulas without understanding the concept. This results in chemistry learning outcomes still being low (Herita, 2022). The low learning outcomes are influenced by several factors, including: (1) students find it difficult to understand abstract chemical concepts and a combination of conceptual understanding and application, (2) students find it difficult to apply chemical theories, (3) students are less motivated to studying chemistry, and (4) there are a large number of students who consider chemistry to be a difficult subject (Muliaman & Mellyzar, 2022).

Based on the results of interviews conducted with chemistry teachers at SMA Negeri 8 Medan, class XI still uses the 2013 curriculum. The chemistry learning process still uses demonstration and lecture methods. The model used in the learning process is the guided inquiry model. However, the shortcomings of this guided inquiry model in the learning process are that students are less active when holding group discussions and the large number of students in class makes it difficult for teachers to control student activities and success. The media used in the learning process are cellphones, learning videos, PPT and chemistry books. During the learning process, the teacher only uses the questions in the chemistry book, there is no teaching media available in the form of STEM Student Worksheets. Therefore, during the learning process students find it difficult to understand the material explained by the teacher. In the reaction rate material, the sub-material that is most difficult for students to understand is order and reaction equations because many calculations are in the form of powers which results in low learning outcomes. The practicum is carried out on reaction rate material only once a semester. The lack of practicum in the learning process results in students feeling bored and bored.

Based on research by (Amdayani et al., 2022), the STEM approach to learning outcomes in chemistry courses can improve learning outcomes in experimental classes, namely reaching 86.56%. Based on the research results of (Dalimunthe et al., 2022),

it shows that the application of STEM can improve learning outcomes with a posttest average of 89.25%. Furthermore, based on research by (Safitri et al., 2021), STEM-integrated Problem Based Learning can increase students' interest in learning and help solve students' problems in real life. Based on the research results of Haqiziah (2018) , it was found that the application of the STEM-based PBL model could increase students' interest in learning by 78.12%. Hamdayani (2022) concluded from the results of his research that the application of the STEM-based PBL model could increase students' interest in learning by 86.09%. (Sihombing et al., 2022) developed and applied STEM-based Student Worksheets on reaction rate material. Based on the research results, it was found that STEM-based Student Worksheets is suitable and ready to be used for learning activities.

The STEM approach is an approach that unites knowledge consisting of science, technology, engineering/engineering, and mathematics which is used to solve problems that often occur in everyday life. In implementing this STEM approach, a PBL learning model is needed that can enable students to solve problems in everyday life in a structured manner to form students' understanding and knowledge (Hasanah et al., 2021). Learning strategies with the STEM-Problem Based Learning approach are able to differentiate facts and opinions, be tenacious, thorough, responsible, critical, creative, innovative, democratic, communicative in designing experiments in discussions which are manifested in everyday attitudes (Adelita et al., 2017).

The application of STEM-PBL based Student Worksheets is able to make students actively involved in the learning process. This makes it easier for students to understand and can master abstract concepts and can master abstract concepts presented in chemistry learning, especially reaction rates. Student activities in solving problems in the Student Worksheets can increase students' interest and learning outcomes(Latifah & Hanik, 2023). Student Worksheets with the STEM-PBL

approach is good and suitable for use as a teaching material in delivering learning material (Sihombing et al., 2022).

METHODS

The type of research used is Quasi-experimental. The design used is Pretest-Posttest Control Group Design. The instruments used in this research are 20 multiple choice test instruments to measure learning outcomes and 25 interest questionnaire statements to measure students' interest in learning. The population in the study were all students of class XI MIPA at SMAN 8 MEDAN. The samples in this study were class XI MIPA 4 as the experimental class and class XI MIPA 1 as the control class.

The data obtained in this research is qualitative and quantitative data. Quantitative data will be analyzed using descriptive statistics to describe data on learning outcomes and students' learning interests. Meanwhile, qualitative data is analyzed by giving meaning to the data description. Statistical data analysis used is gain test, normality test, homogeneity test and hypothesis test.

The normality test is carried out to determine whether the data has a normal distribution or not. The normality test that the researcher used was the Shapiro Wilk test using SPSS 22.0 for Windows at a significance level of 5%. The homogeneity test aims to determine whether the data is homogeneous or not. Hypothesis testing was carried out to determine whether or not there was an influence of STEM Student Worksheets on learning outcomes and interest in the experimental class and control class. The gain test is used to determine the increase in student learning outcomes in the experimental and control groups by analyzing the average pretest score and the average posttest score.

Meanwhile, the interest in learning questionnaire is obtained by dividing the total score of the interest in learning questionnaire by the number of students. The

average score of student responses is obtained by dividing the total score of student responses by the number of students.

RESULTS AND DISCUSSION
1. Learning Outcome Data

Based on research that has been carried out, learning outcomes obtained from pretest and posttest data, research results can be seen in Table 1.

Table 1. Average of student pretest and posttest

Score	Experiment	Control
Pretest	31.85	46.42
Posttest	85.57	76.85

The pretest and posttest results were analyzed using the N-Gain test and hypothesis test (Independent Sample T-Test). The aim was to see whether or not there was an influence of STEM Student Worksheets on interest in learning in the experimental class and control class. The N-Gain test was carried out to see the percentage increase in students' interest in learning before and after implementing the STEM Student Worksheets using the *Problem Based Learning* (PBL) model. The presentation of the N-Gain value can be seen from Table 2 below:

Table 2. N-Gain Pretest and Posttest experimental and control class

	Posttest	Shapiro-Wilk Sig.	Information
Student learning outcome	Experimental	0.076	Normal Data
	Control	0.064	Normal Data

Based on the percentage of N-Gain values in the table above, it can be concluded that there is an increase in learning outcomes in the experimental class. This can be seen from the large percentage of students who got a high N-Gain score in the experimental class, namely 77.14 %, compared to the percentage of students who got an N-Gain score in the control class, which reached 34.28 %.

The normality test was analyzed using the SPSS version 22.0 program and the normality test for 2 classes was carried out using the *Shapiro Wilk* test. Data from the normality test results can be seen below in Table 3.

Table 3. Normality Test Data

% N-Gain	Experiment	Control
Low	5.72 %	8.58 %
Medium	17.14 %	57.14 %
High	77.14 %	34.28 %

Next, the data obtained was analyzed using the Independent Sample t- Based on the results of the normality test above, it can be seen that the posttest score for the experimental class was $0.076 > 0.05$ and the posttest score for the control class was $0.064 > 0.05$. Therefore, it can be concluded that the data from the experimental class and control class came from a population that normal distribution.

Next, a homogeneity test was carried out using experimental class posttest data and control class posttest data which was carried out with the help of the Levene test with the help of the SPSS version 22.0 program. Based on the results of homogeneity test data processing, the significance value obtained was $0.104 > 0.05$ therefore it can be concluded that the data group has the same variance (homogeneous).

Test hypothesis test with the help of the SPSS version 22.0 program. Based on the results of processing the hypothesis test data, a sig. (2-tailed) value of $0,001 > 0,005$ was obtained, so it can be interpreted that there is an influence of STEM Student Worksheets using *Problem Based Learning* (PBL) model on learning outcomes.

2. Learning Interest Data

Data on student interest in learning was obtained from filling out questionnaires by students regarding the learning process

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using Student Worksheets STEM. The student interest questionnaire instrument was given at the beginning of learning to measure students' initial interest before being given treatment and at the end of learning to measure students' final interest in learning after being given treatment. The questionnaire instrument for student interest in learning was made in the form of a Likert scale with 25 statement items, with the answer criteria being strongly agree (SS), agree (S), disagree (TS) and strongly disagree (STS). The interest in learning questionnaire was given to experimental class respondents and control of 35 students.

Based on research that has been carried out, interest in learning is obtained from initial mint data and final interest in research results can be seen in Table 4.

Table 4. Average initial interest and final interest of students

Score	Experiment	Controls
Initial interest	46.48	49.8
Final	90.02	78.8

The results of initial interest and final interest were analyzed using the N-Gain test and hypothesis test (Independent Sample T-Test). The aim was to see whether or not there was an influence of STEM Student Worksheets on interest in learning in the experimental class and control class. The N-Gain test was carried out to see the percentage increase in students' interest in learning before and after implementing the STEM Student Worksheets using the Problem Based Learning (PBL) model. The presentation of the N-Gain value can be seen from Table 5 below.

Table 5. N-Gain of initial interest and final interest of the experimental class and control class

% N-Gain	Experiment	Control
Low	5.73 %	17.58 %
Medium	11.42%	60 %
High	82.85 %	22.85 %

Based on the percentage of N-Gain values in the table above, it can be concluded

that there is an increase in interest in learning in the experimental class. This can be seen from the large percentage of interest of students who got a high N-Gain score in the experimental class, namely reaching 82.85 %, compared to the percentage of students who got an N-Gain score in the control class, namely reaching 22.85 %.

The normality test was analyzed using the SPSS version 22.0 program and the normality test for 2 classes was carried out using the Shapiro Wilk test. Data from the normality test results can be seen Table 6 below in Table 6.

Table 6. Normality Test Data

		Shapiro-Wilk Sig.	Information
	Final Interest		
Student Learning Interests	Experiment	0.196	Normal Data
	Control	0.200	Normal Data

Based on the results of the normality test above, it can be seen that the final interest value obtained for the experimental class was $0.196 > 0.05$ and the final interest value for the control class was $0.200 > 0.05$. Therefore, it can be concluded that the data from the experimental class and control class came from population with normal distribution.

Next, a homogeneity test was carried out using the final interest data of the experimental class and the final interest data of the control class which was carried out with the help of the Levene test with the help of the SPSS version 22.0 program. Based on the results of processing the homogeneity test data, the significance value obtained was $0.315 > 0.05$, therefore it can be concluded that the data group has the same variance (homogeneous).

Next, the data obtained was analyzed using the Independent Sample t-Test hypothesis test with the help of the SPSS version 22.0 program. Based on the results of the data processing of the hypothesis test, interest in learning obtained a sig value. (2-tailed) is $0.000 > 0.05$ so it can be interpreted

that there is an influence of STEM Student Worksheets using the Problem Based Learning (PBL) model on interest in learning.

The learning outcomes and interest of experimental class students who were taught with STEM Student Worksheets using Problem Based Learning (PBL) were higher as seen from the average value of learning outcomes and interest compared to the control class. This is because in learning using STEM Student Worksheets, students were able to understand the material. The reaction rate relates to science, technology, engineering and mathematics independently. Apart from that, the problems contained in the STEM Student Worksheets can also improve students' ability to solve problems related to everyday life which are related to the reaction rate.

According to researchers, this makes it easier for students to understand and can master abstract concepts and can master abstract concepts presented in chemistry learning, especially reaction rates. The problem-solving abilities contained in STEM Student Worksheets increase in the experimental class because in learning students are trained in solving a problem, namely using practical methods. Therefore, students are more involved and enthusiastic in learning because they develop their own knowledge through learning and are able to retain information. students' activities in solving problems in the Student Worksheets can increase students' interest and learning outcomes. This is in accordance with Fitriyah (2019) research which states that the application of STEM Student Worksheets in the learning process can help students improve their learning outcomes and interest in learning. students. These results are also in accordance with the opinion of Arianti (2020) that the application of STEM-based Student Worksheets can increase students' interest in learning and can improve learning outcomes.

CONCLUSION

Based on the results of research that has been done, the use of STEM-based Student Worksheets in the learning process can improve learning outcomes and student interest. Data on student learning outcomes in the experimental class on the application of Student Worksheets STEM obtained N-Gain Score of 0.77 with a high category which indicates that after the learning process using Student Worksheets STEM on reaction rate material there is an effect of Student Worksheets STEM on learning outcomes. Data on student interest in learning in the experimental class on the application of Student Worksheets STEM obtained N-Gain Score of 0.80 with a high category which indicates that after the learning process using Student Worksheets STEM on reaction rate material there is an effect of Student Worksheets STEM on learning interest. This shows that the use of Student Worksheets STEM in the learning process on the reaction rate material can improve learning outcomes and learning interest.

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