JoSSEd
Journal of Science and Science Education
ISSN: 2774-1869 eISSN: 2774-2105

Implementation of Problem Based Learning Model Assisted by Electronic Student Worksheets to Improve Learning Outcomes and Learning Motivation on Reaction Rate Material

Elisa Manurung[1*], Ahmad Nasir Pulungan[1], Ajat Sudrajat[1], Susilawati Amdayani[1], Destria Roza[1]

[1]Faculty of Mathematics and Natural Science State, Chemistry Education Study Program, University of Medan, Medan, Indonesia.

Received: August 25, 2025
Revised: September 29, 2025
Accepted: October 26, 2025
Published: October 31, 2025

Corresponding Author:
Elisa Manurung
elisamanurung02@gmail.com

DOI: 10.29303/jossed.v6i2.12064

Abstract: Learning media serves to assist teachers in conveying information to students and can increase student learning motivation. This study aims to determine the application of the Problem Based Learning learning model assisted by E-LKPD to improve learning outcomes, learning motivation and the relationship between learning motivation and learning outcomes on the reaction rate material at Kartika 1-2 Medan Private High School. The type of research used is Quasy Experiment using pretest posttest. Sampling was done by purposive sampling. The sample consisted of one class, namely class XI IPA 4 as the experimental class (n = 30). Learning outcome data were processed using the Normalized Gain (N-Gain) test. The hypothesis was tested by linear regression and correlation test. The effectiveness of the Problem Based Learning learning model to improve learning outcomes and learning motivation on the reaction rate material is seen from the average posttest and pretest scores of 33.5 and 89.83, then the average N-gain value of 0.84 is included in the high category. The average value of students' initial and final learning motivation measured using a learning motivation questionnaire is 93.62, which is in the high category. These results indicate an increase in student learning outcomes after learning using the Problem Based Learning model assisted by E-LKPD. Hypothesis testing produces a value of r_{hit}= 0.71 and r_{tabel} = 0.36 at the significance level (α = 0.05) which shows that $r_{hit} > r_{tabel}$ so it can be concluded that there is a significant relationship between learning outcomes and student learning motivation.

Keywords: Electronic worksheets; Learning motivation; Learning outcomes; Problem Based Learning; Reaction rate

Introduction

Chemistry is one of the subjects taught at the high school level. Chemistry is a branch of science that studies the structure, properties, and changes of matter. One chemistry topic that students find difficult is reaction rate (Cakmakci et al., 2006; Kusumaningtyas et al., 2023). Reaction rate is considered challenging by students because it requires not only memorization, conceptual understanding, and calculations, but also requires experimental activities to demonstrate the concepts of factors that influence reaction rate, such as temperature, concentration, surface area, and catalysts (Far et al., 2023; Sari et al., 2019). Students struggle to understand reaction rate because they generally lack motivation in chemistry. In addition to this lack of motivation, reaction rate is sometimes taught using conventional methods (Padilla Martínez & Balderrama Campos, 2019; Simm et al., 2019). In the teaching and learning process at school, teachers and students are two key components. The teacher's role is not simply to transfer knowledge, but also to ensure that students truly understand the material through their own understanding. This in-depth understanding can be achieved through good collaboration between teachers and students. This collaboration will create a pleasant learning environment, making it easier for students to absorb and understand the lessons taught by the teacher (Lidiastuti et al., 2020; Nguyen et al., 2022; Pamungkas, 2022).

To ensure that teaching and learning activities align with the curriculum, an appropriate learning model is required, not only to improve student learning outcomes

How to Cite:
Manurung, E., Pulungan, A. N., Sudrajat, A., Amdayani, S., & Roza, D. (2025). Implementation of Problem Based Learning Model Assisted by Electronic Student Worksheets to Improve Learning Outcomes and Learning Motivation on Reaction Rate Material. *Journal of Science and Science Education, 6*(2), 204–209. https://doi.org/10.29303/jossed.v6i2.12064

but also to foster student motivation in the learning process. One learning model that can improve student learning outcomes is the Problem-Based Learning (PBL) model. Problem-Based Learning (PBL) is an innovative problem-based learning model that can actively engage students in the learning process, thus preventing the learning process from being teacher-centered (Aladin et al., 2024; Rehman et al., 2024; Wijnia et al., 2024). The Problem-Based Learning (PBL) model, implemented with clear, sequential learning steps and syntax, can increase student motivation (Ziplin, 2021). In addition to the role of an appropriate learning model, learning media also plays a crucial role in the learning process. Learning media serves to assist teachers in conveying information to students and can increase student motivation. Learning media comes in various forms (Abdulrahaman et al., 2020; Sari et al., 2019).

Rapid technological advances have had a positive impact on the development of technology-based learning media (Wardoyo et al., 2021). E-LKPD (Electronic Student Worksheets) are learning media in the form of systematically arranged student worksheets that can be used in the learning process in electronic form, accessible only with an internet connection. E-LKPD learning media is a transformation of printed LKPDs into electronic form, making it easier for students to learn without the constraints of space and time (Musdalifah et al., 2024; Saputri et al., 2024; Usman et al., 2024). Previous research by Indrawan & Yudiana (2022); Widyaningrum & Parmiti (2024), found that the use of E-LKPD has an impact on student learning outcomes in terms of product cognitive and process cognitive aspects. The use of E-LKPD, which includes aspects of critical thinking skills, showed good performance and showed improvement. Research indicates that Electronic Student Worksheets (E-LKPD) are a learning strategy that can be implemented as a solution to increase effectiveness and motivation according to student characteristics.

To improve student learning outcomes and motivation, teachers can use learning models and media that are appropriate to their needs and learning styles. Thus, the Problem Based Learning (PBL) learning model with the assistance of Electronic Student Worksheets (E-LKPD) media can improve students' learning outcomes and motivation.

Method

This research was conducted at Kartika 1-2 Private High School, Medan, from February to March. This study was a quasi-experimental study. The population was all 12th-grade students at Kartika 1-2 Private High School, Medan. The sample used was class XI Science 4, using a purposive sampling technique. The first step taken is to give the student a pretest to determine the student's initial abilities. Then students are taught using the Problem Based Learning model assisted by Electronic Student Worksheets on reaction rate material. Next, a posttest is carried out to determine the students' final learning abilities. Then a student learning motivation questionnaire was given to determine students' learning motivation after learning using the Problem Based Learning model assisted by electronic student worksheets on reaction rate material.

Table 1. Research Design

Pretest	Treatment	Postest
T_1	X	T_2

Description:

T1: Pretest given to the experimental class before treatment

T2: Posttest given to the experimental class after treatment

X: Learning using the PBL model assisted by E-LKPD media

Results and Discussion

Based on the posttest and pretest data conducted in the experimental class with 30 students, the results are shown in Table 2.

Table 2. Student Learning Outcomes Data

Maximum	Pretest	Postest
Minimum	20	85
Average	45	95
Maximum	33.50	89.83

Table 2 shows that the average posttest and pretest scores for student learning outcomes were 33.50 and 89.83, respectively. These data indicate an increase in student learning outcomes on reaction rate material after learning using the Problem Based Learning model assisted by E-LKPD.

Table 3. Student Learning Outcomes Data

Maximum	Final Questionnaire
Minimum	69
Average	77
Maximum	93.62

Based on the data in the table, the average score is 93.62, which falls into the high category. This indicates that student learning motivation increased after learning using the Problem Based Learning model assisted by E-LKPD on the reaction rate material (Permana et al., 2023; Putri et al., 2020; Sanova et al., 2024). These results are supported by Anggriani et al. (2022); Azmi & Muchtar

(2024); Sujana (2023), who stated that there was an increase in student learning outcomes and motivation after using the Problem Based Learning model assisted by LKPD-Electronic.

Next, an N-Gain test was conducted to determine the improvement in student learning outcomes after using the Problem-Based Learning model with the assistance of E-LKPD. The N-Gain results can be seen in Table 4.

Table 4. N-Gain Data for Student Learning Outcomes

N-Gain	Minimum Value	Maximum Value	Category
0.84	0.73	0.93	High

The N-gain calculation results show that the average N-gain score is 0.84, or 84%, which is considered high. This value has a standard deviation of 0.5093, with a minimum score of 0.73 and a maximum score of 0.93. From these results, it can be concluded that the use of the Problem-Based Learning model assisted by E-LKPD on reaction rate material can improve student learning outcomes. A normality test is conducted to determine whether the data is normally distributed. This test was conducted using IBM SPSS 23 for Windows using the Shapiro-Wilk test with a significance level of 0.05. Data is considered normal if the sig value is > 0.05 and abnormal if the sig value is ≤ 0.05.

Table 5. N-Gain Data for Student Learning Outcomes

Class	Data source	Sig	Information
Experiment	N-gain	0.198	Normal

Table 5 shows that the significance value for the data on student learning outcomes in the experimental class is 0.198. This significance value is greater than 0.05, indicating that the data are normally distributed.

Table 6. N-Gain Data on Student Learning Motivation

Class	Data source	Sig	Information
Experiment	N-gain	0.224	Normal

Table 6 shows that the significance value for the data on the increase in student learning motivation in the experimental class is 0.224. This significance value is greater than 0.05, indicating that the data are normally distributed.

The Linearity Test is used to determine whether two or more tested variables have a significant linear relationship. The criteria used for this test are: if the Deviation from Linearity value is >0.05, then there is a linear relationship between the learning motivation variable and the learning outcome variable (Agustina & Margunayasa, 2024; Suwartini et al., 2023).

Table 7. Linearity Test of Motivation and Learning Outcomes

F_{Count}	F_{table}	Sig. Deviation from Linearity	Information
1.98	2.69	0.20	Normal

Based on the data in the table, the calculated F_value is smaller than the F_table, indicating a relationship between learning motivation and learning outcomes. The Deviation from Linearity (D_L) value is 0.201 > 0.05, indicating a significant linear relationship between the learning motivation and learning outcomes.

Hypothesis

A correlation test was conducted to determine whether there is a correlation between learning motivation and student learning outcomes (Amalia, 2024; Hendrawati & Wuryandani, 2023; Humairoh et al., 2024). Before conducting the correlation test, it was necessary to ensure that the motivation and learning outcomes data were normally and linearly distributed. A simple linear regression test was conducted with a 5% error rate and a 95% confidence level (α = 0.05). The criteria for this test are: if t count > r table then Ha is accepted and H0 is rejected, and vice versa. This hypothesis test used data on learning outcome improvement (N-Gain) and learning motivation.

Table 8. Hypothesis Test of the Correlation of Motivation and Learning Outcomes

Data	Total of value (∑)	r count	r table	CD
X	2494	0.71	0.361	50%
Y	2246			
X^2	242375			
Y^2	268252			
XY	201885			
N	30			

Note: X = Learning motivation; Y = Learning outcome

Based on the calculations that have been done, it is known r hit= 0.71 while r table= 0.361 from the significance level α = 0.05 (N=30). The calculated r_hit = 0.71 is classified as high correlation. Because r_hit > r tabel it can be concluded that Ha is accepted and Ho is rejected, meaning that there is a significant correlation between student learning motivation and student learning outcomes taught using the Problem Based Learning (PBL) model assisted by E-LKPD on reaction rate material. CD value = 50%, meaning that the contribution of the Problem Based Learning (PBL) model assisted by E-LKPD to learning outcomes and learning motivation is 50%, while 50% is influenced by other factors. This means that there is a positive relationship between learning outcomes and student learning motivation. Previous research Moh Ghoizi

Eriyanto et al. (2021); Shi & Qu (2022); Tutupary et al. (2024), stated that a determination coefficient of 12.30% indicates that learning motivation contributes to learning outcomes. Afiqah et al. (2022); Yogi Fernando et al. (2024); Yudho et al. (2022), stated that students' learning motivation plays a role in every learning activity so that it influences the improvement of student learning outcomes, students who have high learning motivation are likely to achieve high learning outcomes (Asrifan et al., 2023; Jaya et al., 2024).

Conclusion

Based on research data, it can be concluded that the application of the Problem Based Learning model assisted by electronic student worksheets on the topic of reaction rate can improve student learning outcomes as seen from the N-Gain test results, namely 0.84 or 84% which is included in the high category. Apart from improving learning outcomes. Students' learning motivation was high after implementing the Problem Based Learning model assisted by E-LKPD in the reaction rate material which was seen as 93.62, which was included in the high category. Learning motivation makes a significant contribution to learning outcomes. This research shows that there is a positive correlation between learning motivation and learning outcomes in reaction rate material, based on the processed data, the calculated r is 0.71 which is greater than the r table, namely o.361 because the calculated r > r table, Ha is accepted and Ho is rejected. Therefore, the higher the learning motivation, the higher the learning outcomes achieved by students.

Acknowledgments
We would like to express our deepest gratitude to our supervisors, Dr. Ahmad Nasir Pulungan, S.Si., M.Sc, Dr. Ajad Sudrajat, M.Si, Susilawati Amdayani, S.Si., M.Pd, and Dr. Destria Roza, M.S., who have always provided guidance in completing this research. We would also like to express our gratitude to the Faculty of Mathematics and Natural Sciences, who have always assisted in completing the research administration until this research was carried out.

Author Contributions
Conceptualization.; E. M.; methodology.; A. N. P.; validation; A. S.; formal analysis; S. A.; investigation.; D. R; resources; E. M.; data curation: A. N. P.; writing—original draft preparation.; A. S.; writing—review and editing.; S. A.; visualization: D. R. All authors have read and agreed to the published version of the manuscript.

Funding
Researchers independently funded this research.

Conflicts of Interest
The authors declare no conflict of interest.

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