The Effect of Project Based Learning Model (PjBL) Assisted by KOKAMI Media on Motivation and Learning Outcomes on Chemical Equilibrium Material

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Abstract: This study aims to determine the learning of the Project Based Learning (PjBL) Model assisted by KOKAMI media (Kotak dan Kartu Misteri) on learning outcomes, learning motivation, and the significance between learning outcomes and motivation in chemical equilibrium materials at SMA Negeri 17 Medan. The sample population of all students in grade XI and as a random sample was taken from two classes, namely class XI B as an experimental class and XI C as a control class. The initial learning was carried out in the same pre-test, then learning was carried out for the control class (using the conventional model without KOKAMI media) while the experimental class (using the PjBL model with the help of KOKAMI media). The results data were analyzed using normality, homogeneity, and linearity tests. The hypothesis was tested by simple linear regression, independent t-test, and correlation test. The average pre-test score of the experimental class was $34{,}00 \pm 8{,}17$ the control class was $33{,}14 \pm 6{,}57$ post-test (89.71 ± 3.60 ; 79.57 ± 6.36), with a higher N-Gain value (0.84 ± 0.065 ; 0.69 ± 0.016). The results of the simple linear regression test showed a significance value of $0.000 \leq (\alpha = 0.005)$ with an average learning motivation of 87.25 (high category), so that Ha was accepted. The t-test shows the value of sig. $0.000 \leq (\alpha = 0.005)$, and the third hypothesis test showed sig. $0.001 \leq (\alpha = 0.005)$, indicating a significant relationship between learning outcomes and learning motivation

Keywords: PjBL; Learning motivation; Learning outcomes; Pre-test; Post-test

Introduction

Chemical equilibrium is one of the chemistry topics taught in the even semester of grade XI in high school. To study chemical equilibrium effectively, students must possess several skills: writing chemical reactions, performing calculations, and explaining the equilibrium system concerning changes in coicentration, pressure, volume, and temperature. Understanding this material requires a significant conceptual hierarchy, as the concept of equilibrium relates to other concepts such as chemical reactions, reversibility, entropy, and free energy (Costa and Bruno, 2022; Basyiroh et al., 2022). Additionally, chemical equilibrium is crucial because it serves as a prerequisite for subsequent topics such as acid-base reactions, salt hydrolysis, buffer solutions, solubility, and the calculation of solubility products (Mufidah & Dwiningsih, 2024). The topic describes processes involving the transformation of substance molecules influenced by alterations in concentration, pressure, volume, and temperature (Nitzan, 2024).

The low student learning outcomes in chemical equilibrium can be attributed to students perceiving this material as difficult and abstract, leading to diminished interest and motivation (Ernawati et al., 2023). Furthermore, observations indicate that low learning motivation and suboptimal learning outcomes are also due to teachers applying conventional teaching methods (Khozaei et al., 2022), predominantly relying on lectures that leave students passive in the learning process. KOKAMI learning media (Mysterious Box and Card) aims to enhance learning engagement; it includes a box containing message cards, which are termed 'mysterious' because the card contents remain unknown until the envelope is opened (Rey et al., 2024). This media promotes interactive learning through game cards that convey concepts and materials, fostering greater student interest and participation (Hutagaol et al., 2023). In the context of chemical equilibrium, the PjBL learning model has shown potential to improve learning outcomes (Mariliaty & Suhery, 2024). Previous studies have reported that students often find chemical equilibrium

boring and challenging (Hardeli et al., 2022). Thus, employing KOKAMI for learning can make the experience enjoyable (Ninkeula et al., 2019).

Consequently, we believe that PjBL learning, supported by KOKAMI media, can enhance both learning motivation and outcomes in chemical equilibrium studies. We implemented chemical equilibrium lessons at SMA Negeri 17 Medan, where notable improvements in learning outcomes and student motivation were observed.

Research by (Ninkeula et al., 2019) indicated that the use of KOKAMI media (boxes and mystery cards) in atomic structure lessons yielded positive results for grade X students at SMA Negeri 5 Ambon. All students engaged with this media achieved satisfactory qualifications, with a high average score. This success is attributed to KOKAMI media's ability to stimulate curiosity, enhance student involvement, and facilitate material comprehension, enabling students to perform well on final examinations.

Achieving improved learning outcomes and student motivation is contingent upon teachers applying appropriate and effective learning models and media. The concepts of chemical equilibrium can become more tangible and simplified. Selecting media must also align with the facilities and infrastructure available in schools. Thus, the application of the PjBL learning model in teaching chemical equilibrium is anticipated to enhance students' motivation and improve their overall learning outcomes.

Method

This research was conducted at SMA Negeri 17 Medan from February to March. This type of research is quasi-experimental to see the effect of the KOKAMI-assisted PjBL model on students' learning motivation and learning outcomes. The population consists of all 11th-grade high school classes. The sampling was conducted using random sampling techniques, selecting two classes: XI B as the experimental class (using the PjBL model with KOKAMI media) and XI C as the control class (using the conventional model without KOKAMI media). Before being given treatment, a pretest was first conducted for the experimental and control classes. Next, after the learning process is completed, a post-test is given to the experimental and control classes. From the pretest and posttest data, data were obtained, which were then analyzed using descriptive and inferential statistics.

| Experiment | T_1 X T_2 |
| Control | T_1 Y T_2 |

Figure 1. Research Design (source: (Abraham & Supriyati, 2022)

Information:
T_1 = Initial ability test (Pre-test) in the experimental class and control class before being given treatment
T_2 = Final ability test (Post-test) in the experimental class and control class before being given treatment
X = Chemistry teaching with the Project Based Learning (PjBL) learning model assisted by KOKAMI media
Y = Chemistry teaching with the conventional learning model

Results and Discussion

The pre-test and post-test data from the experimental and control classes, which included a total of 20 test questions, were derived from the validation results provided by lecturers and chemistry teachers. Pre-test and post-test data can be considered follows:

Table 1. Data from the Experimental Class and the Control Class

Class		Number student	Minimum	Max	Average
Experiment	Pretest	35	20	55	34.00 ± 8.17
	Postest	35	85	95	89.71 ± 3.60
Control	Pretest	35	20	45	33.14 ± 6.57
	Postest	35	70	95	79.57 ± 6.36

From the data table above, the average pretest and posttest scores for the experimental class were recorded at 34.00 ± 8.17 and 89.43 ± 3.57, respectively. These figures indicate an improvement in learning outcomes in the study of chemical equilibrium. Meanwhile, the average pre-test and post-test scores for the control class were 33.14 ± 6.57 and 79.57 ± 6.36. The higher improvement in the experimental class can be understood because the learning was conducted using the KOKAMI-assisted PjBL model. This improvement can be understood in line with research that shows the average test scores in the experimental group are higher compared to the control group (Aminah et al., 2023).
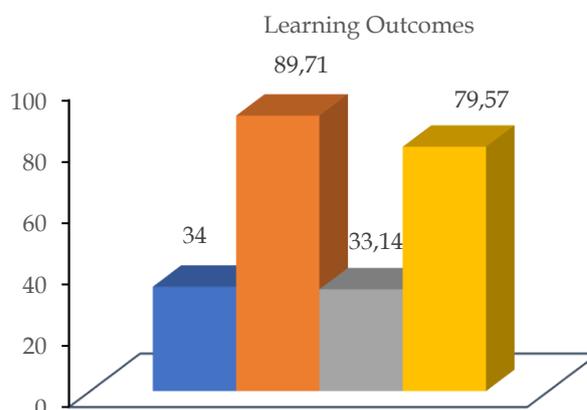
Figure 2. Diagram Average Learning Outcomes

Tabel 2. Data Analisis Motivasi Belajar Siswa

Class	Average	Criteria	Explanation
Experiment	85,33	81 – 90 : Very High 71 – 80 : High 61 – 70 : Moderate 51 – 60 : Low	Very High

From the data in table 2 above, it can be seen that the students' learning motivation obtained from the non-test instrument questionnaire data shows that each aspect of the indicators is valued in the very high category. This indicates that the XI B grade students at SMA Negeri 17 Medan have very high motivation after using the PjBL learning model assisted by KOKAMI media regarding chemical equilibrium. The calculation of the average N-Gain value is conducted to observe the improvement in students' learning outcomes after the treatment is given. Table 3 presents the N-gain values.

Table 3. Data on N-Gain Values of Learning Outcomes

Class	N-Gain	Lowest Value	Highest Value	Category
Experiment	0.84 ± 0.065	0.66	0.93	High
Control	0.69 ± 0.016	0.45	0.92	Medium

The normality test is conducted to determine whether the collected data has a normal distribution and whether the sample comes from the same population. The normality testing process was performed using the IBM SPSS Statistics 30 for Windows software, utilizing the Shapiro-Wilk method with a significance level of 0.05. According to the analysis results, a dataset is considered normal if the sig value exceeds 0.05. In contrast, the data is considered non-normal if the sig value is equal to or less than 0.05. Table 4 presents the results of the normality test on the data for students' improvement in learning outcomes.

Table 4. Normality Test of Student Learning Outcomes

Class	Learning Method	Data Source	Shapiro Wilk (sig)	Description
Experiment	PjBL experiment assisted by KOKAMI media	N-Gain	0.170	Normal
Control	Conventional Control	N-Gain	0.133	Normal

With a sig value of sig $> 0,05$, this table demonstrates the normal distribution of both data points. This finding is in line with the criterion that if the sig value is $> 0,05.$, then the data is normally distributed (Triyono et al., 2024). Table 5 presents the results of the normality test for the student learning motivation data.

Table 5. Normality Test of Student Learning Motivation

Class	Data Source	Statistic	Df	Sig.	Shapiro-Wilk Description
Experiment	after	0.942	35	0.06	Normal

The table above shows that the data on students' learning motivation scores are normally distributed with a significance value of $0,06 > 0,05$. This is in line with the criteria proposed by Anuar et al. (2021). The normality test of learning motivation data was conducted using the Shapiro-Wilk test with the criterion that if the significance value (Sig.) > 0.05, then the data is normally distributed;

The homogeneity test of the research data was conducted using the IBM SPSS Statistics 23 for Windows program with the Levene's statistic test at a significance level of 0.05. A dataset is considered homogeneous if the sig value is $> 0,05$, and if the data is not homogeneous with a sig value of 0.05 (Suryani et al., 2024). The results of the homogeneity test can be seen in table 6.

Table 6. Test of Homogeneity of Learning Outcomes

Data Source	Levene Statistik	df1	df2	Sig.	Description
N-Gain	0.234	1	68	0.07	Homogen

The linearity test shows that learning outcomes and learning motivation in the experimental class have a linear relationship. The linearity test's decision-making basis is that if the significant value of Deviation from Linearity is $> 0,05$, then the relationship between Learning Motivation (X) and Learning Outcomes (Y) is linear, and if the significant value of Deviation from Linearity is $> 0,05$, then the relationship between Learning Motivation (X) and Learning Outcomes (Y) is not linear.

Table 7 Linearity Test of Motivation with Learning Outcomes

Class	F_{Sub}	F_{table}	Sig. *Deviation from Linearity*	Description
Experiment	1.794	2.26	0.060	Linear

The data above shows that the relationship between the variable Learning Motivation (X) and Learning Outcomes (Y) is significantly linear. The analysis shows that learning outcomes and motivation are normal, and that learning outcomes have homogeneous variance. After conducting the analysis test, the hypothesis test can be formulated as follows: Hypothesis test I was conducted using a one-sample t-test with a 5% error rate and a 95% confidence level ($\alpha = 0.05$). If the sig value $\geq$ (0,05), then Ha is rejected and H0 is accepted.

Table 8 Hypothesis Test of Student Learning Motivation

Class	One Sample T-test				
	t	df	Sig. (2-tailed)	Mean	Description
Student Learning Motivation	36.165	34	0.000	85.257	Ha accepted

Table 9 Hypothesis Test II Student Learning Outcomes

	Independent sample t-test				
	T	df	Sig. (2-tailed)	Mean Difference	Description
N-Gain	7.350	68	0.000	0.151	Ha accepted

Based on Table 4.8, a Sig. (2-tailed) value of 0,00 ≤ (α = 0,05) was obtained; thus, Ha is accepted and H0 is rejected, with a mean of 85.257 falling into the very high category. It can be concluded that Ha is accepted, meaning there is a significant influence on students taught using the PjBL learning model assisted by KOKAMI media on the topic of chemical equilibrium towards students' learning motivation. The results of this study are supported by the findings of previous research conducted by Sari et al. (2024), where the TGT method assisted by KOKAMI had a significant effect on students' learning motivation with a Sig. (2-tailed) 0,000 ≤ (α = 0,05). In line with the research conducted by (Hutagaol et al., 2023). According to (Zaeriyah, 2022), KOKAMI media can increase students' learning motivation, achieving an average motivation score of 84.93, which is considered high.

The research said that using the PjBL model along with different learning media helped boost learning motivation, reaching a score of 87.25 in the second cycle. It can be said that the PjBL learning model, supported by KOKAMI media, greatly helps boost students' motivation to learn about chemical equilibrium. The findings from earlier studies and recent research show that KOKAMI media greatly improves the learning results of students who are taught chemical equilibrium using the PjBL learning model. The results of the study showed that the learning motivation of students taught using the PjBL learning model assisted by KOKAMI media were higher than those of students taught using conventional methods. Therefore, it can be said that using the PjBL model with the help of KOKAMI media is a viable alternative learning approach that can successfully raise student learning results.

In the second hypothesis test, an independent t-test was conducted with a 5% error rate and a 95% confidence level (α = 0.05). The criteria for this test are that if the sig value (0.05) is less than 0.05, then Ha is accepted, and H0 is rejected. If the sig value is 0.05, then Ha is rejected, and H0 is accepted. Table 9 displays the test results.

This test aims to determine the effect of the PjBL model assisted by KOKAMI media on students' learning outcomes. The hypothesis test results, using the independent t-test based on both classes' test results, showed a Sig. (2-tailed) value of 0.000. Based on the hypothesis testing criteria, if the sig value is ≤ α (0,05), then Ha is accepted, and H0 is rejected. This means that there is a significant influence on students taught using the PjBL model assisted by KOKAMI Media on students' learning outcomes. The research results show that the learning outcomes of students taught using the KOKAMI Media-assisted PjBL model are higher compared to the learning outcomes of students taught with the conventional model. The high student learning outcomes are due to the PjBL model, which allows students to produce a product in groups and explore in depth, and the KOKAMI media as a learning aid that can enhance students' curiosity, thereby encouraging better student learning outcomes. The results of this study are supported by research conducted by (Ninkeula et al., 2019), which indicated that the use of KOKAMI (Mystery Card Box) learning media in the learning process effectively improves student learning outcomes. This is demonstrated by the achievements of the experimental class I, where all students (100%) reached the Minimum Completeness Criteria (KKM) with an average score of 85.68, consisting of 33.33% of students with very good qualifications, 57.58% good, and 9.09% sufficient, with none failing. The KOKAMI media is capable of stimulating students' curiosity, enhancing learning motivation, and encouraging active participation in learning (Ninkeula et al., 2019).

In hypothesis test III, both the learning motivation data and learning outcomes data must first be normally and linearly distributed. A correlation test was conducted with a 5% error rate and a 95% confidence level. The criterion for this test is that if the sig value is 0.05, then Ha is accepted and H0 is rejected. If the sig value is 0.05, then Ha is rejected and H0 is accepted. The results of the data analysis can be seen in Table 10.

Table 10 Hypothesis Test III Correlation of Learning Motivation with Learning Outcomes

Class	R Square	unstandardized coefficients (B)		R	Simple Linear Regression	
		a	b		Sig.	Description
Experiment	0.258	76.31	10.63	0.508[a]	Description	Ha accepted

In hypothesis test III, both the learning motivation data and learning outcomes data must first be normally and linearly distributed. A correlation test was conducted with a 5% error rate and a 95% confidence level. For this test, we accept Ha and reject H0 if the sig value is ≤ α (0,05),. If the sig value is ≤ α (0,05), we reject Ha and accept H0. Table 10 displays the results of the data analysis.

Hypothesis testing III was done to find out if there is a relationship between learning motivation (X) and learning outcomes (Y), using a simple linear regression test at a significance level of less than < α (0,05), after confirming that the data is normally and linearly distributed. The test results showed a significant value of 0.001. The test results show a significant value of 0.001. Based on the hypothesis testing criteria, if the sig value is < α (0,05). then Ha is accepted, and H0 is rejected. This result means that there is a positive correlation between learning motivation and student learning outcomes taught using the KOKAMI media-assisted PjBL model on the topic of chemical equilibrium. The analysis results show that the R Square value is 0.272, which means that student learning motivation contributes 27.2%, while the majority, 72.8%, is influenced by other factors such as the environment, student intelligence level, and student personality. The results of this study are reinforced by findings at SDN 041 Tangambaru, Limboro District, Polewali Mandar Regency, which indicate that the use of KOKAMI media in science learning can increase students' learning motivation from an average of 22.00 to 78.00, as well as improve learning outcomes from 73.00 to 100. These findings indicate that the KOKAMI media is effective in creating interactive and enjoyable learning, thereby motivating students more and enabling them to understand the material better (Rey et al., 2024). Based on the research conducted at SMA Negeri 17 Medan, it can be concluded that learning carried out using the PjBL model assisted by KOKAMI media has a positive effect on students' learning motivation and learning outcomes.

Conclusion

Based on the research results, it was found that there is a significant influence of the Project-Based Learning (PjBL) model assisted by KOKAMI media on students' learning motivation with a significance value (2-tailed) of 0.000 (≤ α = 0.05) and an average learning motivation of 81.85, which falls into the high category. In addition, the PjBL model assisted by KOKAMI media also has a significant effect on students' learning outcomes with a significance value (2-tailed) of 0.000 (≤ α = 0.05). Furthermore, a significant positive correlation was found between students' learning motivation and their learning outcomes in the topic of chemical equilibrium, with a significance value of 0.001 (≤ α = 0.05). This finding indicates that the higher the students' learning motivation, the higher the learning outcomes

achieved through the application of the PjBL model assisted by KOKAMI media.

It is suggested that the time spent on learning activities with KOKAMI media be increased or changed based on what is needed in the field, since using this media requires students to actively explore the material, participate in group discussions, and create final products that show their understanding and work. With enough time, it is hoped that the learning goals can be met effectively and students can fully develop their potential along with their critical and creative thinking skills. With enough time, students can reach their learning goals and improve their critical and creative thinking skills.

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