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The Effect of Learning Model and Math Ability on Student Learning Outcomes on the Subject of Chemical Equilibrium

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Abstract: The Influence of Learning Models and Mathematical Abilities on Student Learning Outcomes on the Subject of Chemical Equilibrium. This research aims to determine the influence of learning models, mathematical abilities, and the interaction between learning models and mathematical abilities on student learning outcomes on the subject of chemical equilibrium. The research population was all 10 class XI students of SMA Negeri 1 Percut Sei Tuan. Samples were taken in two stages, namely: first, 2 class samples were taken randomly. In the second stage, each class was divided into 2 groups, namely the high mathematics ability group consisting of 10 students and the low mathematics ability group also 10 people so that the total sample of students used was 40 people. This research used a 2 x 2 complete random factorial design. There were two factors tested, namely factor A: Learning Model which consisted of 2 levels, namely A_1 = *Problem Based Learning* and A2 = *Discovery Learning*, and factor B: Students' mathematical abilities which consisted of 2 levels namely B1 = high mathematical ability and B2 = low mathematical ability. The combination of treatments in each class is given for a certain time according to the ATP and teaching module used. At the end of the learning process, a post-test is carried out to measure student learning outcomes in each treatment combination. Based on hypothesis testing at a significance level of $\alpha = 0.05$, it was found that Fhit (A) = 26.61 and Fhit (B) = 10.53 while Ftable = 4.11. Thus, Fhit (A) > Ftable, which means that there is an influence of the learning model on student learning outcomes on the subject of chemical equilibrium. Likewise, Fhit (B) > Ftable means that there is an influence of mathematics ability on student learning outcomes. Furthermore, Fhit (AB) > Ftable or 7.15 > 4.11 is obtained, meaning that there is an interaction between the learning model and mathematical ability on student learning outcomes on the subject of chemical equilibrium. From the hypothesis test, research results showed that students who were taught using the Problem-Based Learning learning model gave a lower average learning outcome for the group of students who had high mathematical abilities (75.5 ± 5.99) and gave a high average learning outcome for students who had low mathematical ability (62 ± 4.83). Students who are taught using the Discovery Learning learning model provide higher average learning outcomes for students who have high mathematical abilities (80 ± 6.24) and lower average learning outcomes for students who have low mathematical abilities (61 ± 6.15). In the simple influence test, students who have high mathematical abilities should be taught using the Discovery Learning learning model, while students who have low mathematical abilities should be taught using the Problem-Based Learning learning model.

Keywords: Problem-Based Learning, Discovery Learning, Mathematics Ability, Learning Outcomes, Chemical Equilibrium

Abstrak: Pengaruh Model Pembelajaran Dan Kemampuan Matematika Terhadap Hasil Belajar Siswa Pada Pokok Bahasan Kesetimbangan Kimia*. Penelitian ini bertujuan untuk mengetahui pengaruh model pembelajaran, kemampuan matematika serta interaksi antara model pembelajaran dan kemampuan matematika terhadap hasil belajar siswa pada pokok bahasan kesetimbangan kimia. Populasi penelitian adalah seluruh siswa kelas XI SMA Negeri 1 Percut Sei Tuan sebanyak 10 kelas. Sampel diambil dua tahap yaitu: pertama-tama sampel kelas diambil sebanyak 2 kelas secara random. Tahap kedua, setiap kelas dibagi menjadi 2 kelompok yaitu kelompok kemampuan matematika tinggi yang terdiri dari 10 orang siswa dan kelompok kemampuan matematika rendah juga 10 orang sehingga total sampel siswa yang digunakan sebanyak 40 orang. Penelitian ini menggunakan rancangan faktorial acak lengkap 2 x 2. Ada dua faktor yang dicobakan yaitu faktor A : Model Pembelajaran yang terdiri dari 2 taraf yaitu A_1 = Problem Based Learning dan A_2 = Discovery Learning , faktor B : Kemampuan matematika siswa yang terdiri dari 2 taraf yaitu B_1= kemampuan matematika tinggi dan B_2 = kemampuan matematika rendah. Kombinasi perlakuan di setiap kelas diberikan selama waktu tertentu sesuai dengan ATP dan modul ajar yang digunakan. Pada akhir proses pembelajaran dilakukan post-test untuk mengukur capaian hasil belajar siswa disetiap kombinasi perlakuan. Berdasarkan uji hipotesis pada taraf signifikansi $\alpha = 0,05$ diperoleh bahwa F_{hit} (A)= 26,61 dan F_{hit} (B)= 10,53 sedangkan F_{tabel} = 4,11 . Dengan demikian F_{hit} (A) > F_{tabel} yang berarti ada pengaruh model pembelajaran terhadap hasil belajar siswa pada pokok bahasan kesetimbangan kimia. Demikian juga F_{hit} (B) > F_{tabel} artinya ada pengaruh kemampuan matematika terhadap hasil belajar siswa. Selanjutnya telah diperoleh F_{hit} (AB) > F_{tabel} atau 7,15 > 4,11, artinya ada interaksi antara model pembelajaran dan kemampuan matematika terhadap hasil belajar siswa pada pokok bahasan kesetimbangan kimia. Dari uji hipotesis diperoleh hasil penelitian bahwa siswa yang dibelajarkan dengan model pembelajaran Problem Based Learning memberikan rataan hasil belajar yang lebih rendah bagi kelompok siswa yang mempunyai kemampuan matematika tinggi (75,5 $\pm$ 5,99) dan memberikan rataan hasil belajar yang tinggi bagi siswa yang mempunyai kemampuan matematika rendah (62 $\pm$ 4,83). Siswa yang dibelajarkan dengan model pembelajaran Discovery Learning memberikan rataan hasil belajar yang lebih tinggi bagi siswa yang mempunyai kemampuan matematika tinggi (80 $\pm$ 6,24) dan memberikan rataan hasil belajar yang rendah bagi siswa yang mempunyai kemampuan matematika rendah (61 $\pm$ 6,15). Pada uji pengaruh sederhana siswa yang mempunyai kemampuan matematika tinggi sebaiknya dibelajarkan dengan menggunakan model pembelajaran Discovery Learning sedangkan siswa yang mempunyai kemampuan matematika rendah sebaiknya dibelajarkan dengan model pembelajaran Problem Based Learning.*

Kata kunci: *Problem Based Learning, Discovery Learning, Kemampuan Matematika, Hasil Belajar, Kesetimbangan Kimia.*

▪ INTRODUCTION

A good education is an education that not only prepares students to get a profession or position, but also can solve the problems they face in everyday life. Efforts to improve the quality of education are an integrated part of efforts to improve human quality, both in terms of ability, personality and responsibility as citizens. Education is basically inseparable from the learning and teaching process which in its implementation requires learning, one of which is chemistry (Sitepu, 2019)

Chemistry is one of the subjects that most students are less interested in because chemistry is considered a difficult subject. During the learning process, many students are not yet able to solve problems and have difficulty in linking chemical concepts with existing theories and are stuck with formulas without understanding the concept. According to Wiseman in (Suarsani, 2019) expressed his opinion that chemistry is one of the subjects that has a high level of difficulty for most secondary students. If the

student does not have good potential in chemistry, then the student has difficulty in learning chemistry subjects. Lack of student interest in learning chemistry, resulting in low chemistry learning outcomes, especially in the subject of chemical equilibrium.

Learning outcomes are one measure of student success in school. According to Gagne and Brigss (Suprihatiningrum, 2016), learning outcomes are abilities that students have as a result of learning actions and can be observed through student performance. Students' difficulties in the learning process affect their learning outcomes, where students who have difficulty understanding the concepts taught result in low learning outcomes.

According to the National Council Teachers of Mathematics (NCTM, 2000), there are standards of mathematical abilities that students must have, namely problem solving, reasoning and proof, communication, connection and representation. Math skills are very much needed in various chemical problem solving. One of them is on the subject of chemical equilibrium (Fassenda & Yonata, 2016).

Based on the results of interviews with chemistry teachers at SMA Negeri 1 Percut Sei Tuan class XI in the 2023/2024 school year, it is said that students' understanding of chemical material, especially chemical equilibrium, is still not optimal. This is shown from the evaluation results of the Criteria for Achieving Learning Objectives (KKTP) obtained that many students have not mastered certain competencies in learning objectives, namely as many as 60% of students. It can be seen from the results of student tests which show that the level of students' problem solving skills is still in the low category.

One of the efforts that teachers can make in overcoming student difficulties in the learning process is to involve students more during the learning process by using the Discovery Learning and Problem Based Learning learning models. Problem Based Learning is not only about problem solving, but using problems to increase knowledge and understanding, so that the Problem Based Learning learning model is very suitable in maximizing the development of thinking levels and understanding to improve student chemistry learning outcomes. In contrast, the Discovery Learning model invites students to discover and understand concepts. The Discovery Learning (DL) model is a learning model that directs students to find their own knowledge to be conveyed in learning which maximally involves all students' abilities to search and investigate systematically, critically, and logically and can explain activities through discussion.

Sianturi's research (2018) on "The Effect of Discovery Learning Model on Mathematical Understanding Ability and Mathematical Problem Solving Ability of Students in Class X SMA" said that there was an effect of the Discovery Learning learning model on students' mathematical understanding and problem solving abilities in class X SMA T.P 2018/2019. Although research on the Effect of Learning Models on Student Learning Outcomes has been widely researched, research that combines the Effect of Learning Models with Mathematical Ability on Student Learning Outcomes in Chemical Equilibrium Material has not been widely studied, so this study aims to determine the effect of learning models, mathematical abilities and the interaction between learning models and mathematical abilities on student learning outcomes on the subject of chemical equilibrium.

▪ METHOD

The type of research in this study is a pseudo research using a complete randomized factorial design 2 x 2. There are two factors that are tried, namely factor A :

Learning Model which consists of 2 levels namely A1 = Problem Based Learning and A2 = Discovery Learning, factor B: Students' math ability which consists of 2 levels, namely B1 = high math ability and B2 = low math ability.

This research was conducted at SMA Negeri 1 Percut Sei Tuan which is located on Jl. Irian Barat Sampali Village No. 37, Medan Estate, Kec. Percut Sei Tuan, Deli Serdang Regency, North Sumatra in the even semester of the 2023/2024 academic year in November - March 2024.

The study population was all students of class XI SMA Negeri 1 Percut Sei Tuan as many as 10 classes. The sample was taken in two stages, namely: first, the class sample was taken as many as 2 classes randomly. The second stage, each class is divided into 2 groups, namely the high math ability group consisting of 10 students and the low math ability group is also 10 people so that the total sample of students used is 40 people.

The data collection tool used in this study is an objective test instrument in the form of multiple choice consisting of five options (a, b, c, d, e) and there is only one correct answer. This test is given to students before being given treatment (pre-test) and at the end of learning (post-test) after being given treatment which aims to determine student learning outcomes. Before the questions were tested on the treatment group (sample), the questions were first tested on students outside the research sample. The instrument trial was carried out on a sample whose characteristics were the same as the characteristics of the research sample that had been obtained through the results of the questionnaire and pre-test. Instrument trials are attempted to be the same as the actual research conditions. This aims to determine the validity, reliability, differentiation and difficulty level of the questions so as to obtain questions that meet the quality required in the preparation of test devices to be tested on the treatment group in actual research.

In this study, data analysis was carried out after the post-test process was completed in each class, the data on student learning outcomes were tabulated for each treatment combination group, then the data were processed in accordance with the stages of factorial research data processing. The data analysis used is by using normality test, homogeneity test and hypothesis testing. In the normality test, using the Chi Square (X2) test to determine whether the data is normally distributed or not. In the homogeneity test, it is carried out to determine the level of homogeneity of the data. While the hypothesis test was carried out using a two-way variance analysis.

▪ RESULT AND DISCUSSION

In this study, learning outcomes were measured by combining the treatment of learning models (Problem Based Learning and Discovery Learning) and the level of mathematical ability (High and Low). To measure student learning outcomes, multiple choice questions were given to each student at the end of the study. Based on the data analysis that has been carried out, the following factorial research data were obtained.

1. Normality Test

To determine whether the data is normally distributed or not, the Chi-Quadrat test is carried out at a significant level of $\alpha = 0.05$ with the Chi square criteria (X2) count < (X2) table, it is stated that the data is normally distributed as shown in Table 1.

Table 1. Data Normality Test Results

No	Class	*Postest*			
		KM	X^2hit	X^2tabel	Description
1	Matlanko (PBL)	High	8,2	11,07	Normal
2	Matlanko (PBL)	Low	8,2	11,07	Normal
3	Matlansos (DL)	High	10,3	11,07	Normal
4	Matlansos (DL)	Low	8,7	11,07	Normal

2. Homogeneity Test

Homogeneity test as a parametric test conducted to determine whether the math ability and student learning outcomes in both sample classes have homogeneous variance values. It is stated that the data is homogeneous if Fcount < Ftable at the significance level α = 0.05 can be seen in Table 2.

Table 2. Results of Data Homogeneity Test

NO	Math Proficiency		S2	F_{hit}	Description
	High	Low			
1	Matlanko		35,83	1,09	Normally Distributed
2	Matlansos		38,89		
3		Matlanko	23,33	1,62	Normally Distributed
4		Matlansos	37,78		

3. Uji Hipotesis

Hypothesis testing was carried out using a two-way analysis of variance (Anava) technique with the test criteria used were Fhit> Ftabel at a significant level α = 0.05 then the proposed hypothesis was accepted. Based on the data processing that has been done can be seen in Table 3.

Table 3. List of Analysis of Variance of the Number of Reactions by the Effect of Combination of Model Treatment and Math Ability

SK	DB	JK	KT	F_{hit}	F_{tabel} 0,05
Perl	3	96156,88	32052,29	14,76	2,87
A	1	57775,63	57775,63	26,61	4,11
B	1	22863,82	22863,82	10,53	4,11
AB	1	15517,43	15517,43	7,15	4,11
Galat/Sisa	36	781,50	2171,10		
Total	39	96938,38			

Based on Table 4.4, the results of Fcount (A) obtained 26.61 while Ftable = 4.11, because Fhit> Ftable, Ha is accepted, it means that there is an effect of learning models on student learning outcomes on chemical equilibrium material. Furthermore, Fhit (B)

obtained 10.53 while Ftable = 4.11, because Fhit> Ftable, Ha is accepted, it means that there is an effect of math ability on chemical learning outcomes on chemical equilibrium material. Furthermore, Fhit (AB) obtained 7.15 while Ftable = 4.11, because Fhit> Ftable, Ha is accepted, it means that there is an interaction between the learning model and math skills on student learning outcomes on chemical equilibrium material.

From the analysis of the variance table, it is obtained that Fhit (A) is 26.61 while Ftab 4.11, because Fhit> Ftabel, Ha is accepted, meaning that there is an effect of learning models on student learning outcomes on chemical equilibrium material. Furthermore, Fhit (B) obtained 10.53 while Ftable = 4.11, then Ha is accepted, meaning that there is an effect of math ability on student learning outcomes on chemical equilibrium material. Furthermore, Fhit (AB) was obtained at 7.15 while Ftable = 4.11, so Ha is accepted, meaning that there is an interaction between the learning model and math skills on student learning outcomes on chemical equilibrium material. Because there is an interaction, a further test (BNT Test) must be carried out to determine the extent of dependence between the learning model and mathematical ability, namely the simple effect test.

In testing the simple effect of math ability factors for level A1 (PBL Learning Model), the results show that Fhit = 14.11 while Ftable at the 5% level = 4.41. Because Fhit> Ftabel, Ha is accepted, which means that there is an average difference in the learning outcomes of students who have different mathematical abilities who are taught with the PBL learning model. Furthermore, the BNT test was carried out, it was found that the chemistry learning outcomes of students who had low mathematics ability (62 ± 4.83) taught using the PBL learning model were significantly different from the chemistry learning outcomes of students who had high mathematics ability (75.5 ± 5.99).

In testing the simple effect of math ability factors for level A2 (DL Learning Model), the results show that Fhit = 5.88 while Ftable at the 5% level = 4.41. Because Fhit> Ftabel, Ha is accepted, which means that there is a difference between the average learning outcomes of students who have different math abilities taught with the DL learning model. Furthermore, the BNT test was carried out, in this test it was found that the chemistry learning outcomes of students who had low mathematics ability (61 ± 6.15) were significantly different from the chemistry learning outcomes of students who had high mathematics ability (80 ± 6.24) taught using the Discovery Learning Model.

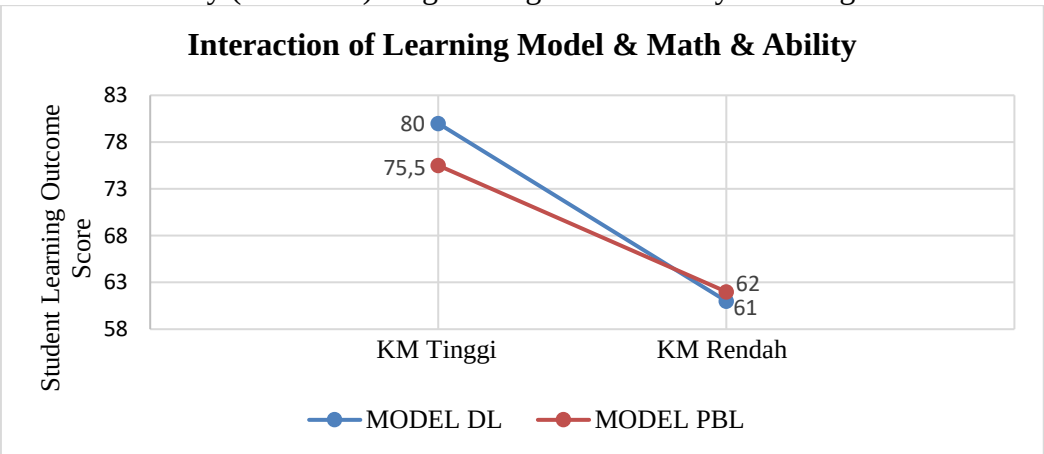

Figure 4. 1 Graph of the Interaction of Learning Model Factors and Varied Mathematical Ability Varies on Students' Chemistry Learning Outcomes

Based on the results of the study, it can be seen that the learning outcomes of students with Discovery Learning Model and high math ability are higher than students with learning models and low math ability. Where students who have high math ability have high learning outcomes = 80 than students who have low math ability = 61 who are taught using the Discovery Learning model. This can be seen from students who have high mathematical abilities who are taught using the Discovery Learning model are students who can find problems and be able to solve problems found in chemical equilibrium material. While in low mathematics ability taught with Problem Based Learning model, the teacher plays a more active role towards students and invites students to engage in discussions in solving problems found together. However, the learning model and mathematical ability are able to improve students' chemistry learning outcomes on chemical equilibrium material as evidenced by the increase in students' average score.

From the data on student learning outcomes, it can be concluded that the learning model influences student chemistry learning outcomes on chemical equilibrium material. This is because discovery learning focuses on discovery and investigation, where students play an active role directly in analyzing and looking for sources of problems and finding answers to solve problems that already exist when learning takes place so that the results obtained by students are well stored in their memories. In contrast, problem-based learning emphasizes problem solving through discussion and interaction. In contrast, the learning outcomes of students using the Discovery Learning model with low mathematics ability are lower than those of the Problem Based Learning model with low mathematics ability, presumably because most students with low mathematics ability who are taught with the Discovery Learning model have low interest in learning and during the learning process students are mostly indifferent and play gadgets, have low concentration and lack of understanding of student concepts, causing the learning outcomes of students taught with the Discovery Learning model and low mathematics ability to be lower than the learning outcomes of students taught with the Problem Based Learning model and low mathematics ability.

▪ CONCLUSION

Based on the results of the study, it is concluded that there is an effect of learning models and math skills on student learning outcomes and there is an interaction between learning models and math skills on student learning outcomes on the subject of chemical equilibrium. In addition, it is expected to chemistry teachers that in teaching chemical equilibrium material in class XI SMA, if the students' mathematical ability is low then use the Problem Based Learning model. Meanwhile, if the students' mathematical ability is high, they should use the Discovery Learning model.

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