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Learning Model and Logical Thinking Ability in Redox Reaction Learning

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Abstract. The implementation of the 2013 curriculum has not been fully implemented in Private High School Angkasa Medan , because teachers do not fully understand the learning model that must be used. This has an impact on the results of student chemistry learning that not all students are able to achieve the set minimum completeness score target of 75. This study is about the application of learning models and the ability to think logically in redox learning in class X Private High School Angkasa Medan. The population consisted of 6 class X students and the sample was taken purposively by setting 2 classes for the research sample. Both classes are taught with two models, with a combination of factorial 2 X 2. Data collection is done by using tests to measure students' chemistry learning outcomes, and students' logical thinking skills. There are two factors tested, namely factor A in the form of a learning model consisting of Problem Based Learning (PBL) and Direct Instruction (DI) models, factor B: logical thinking ability high and low logical thinking ability. Data analysis techniques using 2-way ANOVA. Based on the hypothesis test at a significant level of $\alpha = 0.05$, it shows that there is an influence of the learning model and students' logical thinking ability on the learning outcomes of topic redox chemistry, and there is an interaction between the learning model and the ability to think logically towards the redox learning outcomes. The results of the BNT advanced test indicate that the Problem Based Learning Model is better than the Direct Instruction model on topic redox chemistry learning.
Keywords: Learning Models, Logical Thinking Ability, Learning Outcome, Redox

Introduction

The purpose of this study was to apply the learning model namely the Problem Based Learning and Direct Instruction models and the influence of the students 'logical thinking abilities on students' chemistry learning outcomes in the redox reaction material. This riset also purpose to see whether there is an interaction between the learning model and the ability to think logically on students' chemistry learning outcomes. Gunter and Kılınç (2017), found that Problem Based Learning (PBL) has been applied in the field of educational science in countries around the world, including Turkey. His research in this field also shows that PBL models are effective in chemistry learning that involves difficult topics and requires problem solving and application. It was also said that this model was effective in improving academic achievement. While Helling (2016) uses the Direct Instruction (DI) model in basic mathematics learning. By giving direct instruction to students who have different abilities, then students follow it, and slowly the abilities and skills that students have in themselves develop. Success in learning, besides being influenced by the learning model, can also be influenced by internal factors, one of which is the ability to think logically. Maharani and Lailasari (2016), explained that the ability to think logically possessed by key students to draw conclusions and solve existing problems in a complex way in learning. Learning by using the Problem Based Learning model makes students more active in learning, student learning activities increase, students discuss to solve problems that are given so that the ability to think logically on students has increased. The implementation of the curriculum 2013 that has not been fully implemented in Indonesia and many teachers still do not understand the learning model that can activate students, encourages researchers to apply PBL models and the ability to think logically in learning redox material.

The results of the Organization for Economic Co-operation and Development (OECD) show that there is an increasing of Indonesia's PISA values in the three competencies tested (PISA, 2016). The biggest increase was seen in scientific competence, from 382 points in 2012 to 403 points in 2015. This result is still not satisfactory, resulting in Indonesia still continuing to improve its national education curriculum. The results of observations in Private High School Angkasa Medan that implement the curriculum 2013 obtained information that the results of the chemistry exams are still not optimal, not all students are able to achieve the minimum target set value is 75. The implementation of the 2013 curriculum has not been fully implemented, teachers still do not understand the learning model must make students active in the learning process, and learning is still teacher-oriented so that it has an impact on student learning outcomes. Students find it difficult to relate concept concepts to abstract redox material because they only hear explanations from the teacher, so they need a learning model that can activate students.

One of the learning models offered in the curriculum 2013 in Indonesia is the Problem Based Learning (PBL) model. Sada (2016), PBL is one of the student-centered group learning models, the teacher is only a facilitator. Students are faced with problems and seek information and collect it so as to stimulate students' critical thinking skills in solving these problems. The leader in the PBL learning model acts as a facilitator and not a teacher, using their expertise not to transmit facts, but to provide encouragement and guidance as participants tackle the problems they have identified. The responsibilities of the facilitator in PBL include encouraging critical thinking, encouraging self-directed learning, monitoring group progress, and creating a learning environment that stimulates group members, generates thorough understanding, and promotes teamwork (Adiga and Adiga, 2016).

Abanikannda (2016) shows that PBL makes use of the problem as the focus of the investigation. Meanwhile, Keegan (2017) found that problem-based learning emphasizes active learning by guiding students to develop understanding and knowledge. Research on PBL was also carried out by Baysal (2017) which found that PBL had positive benefits for teachers in terms of learning and had a positive effect on the problem-based learning process.

Thakur, et al, (2018) wrote that PBL is a model that can help improve skills and knowledge during school, in college and in the workplace. In connection with virtual media, Sugiharti and Bastian's research, (2018) found the influence of learning models using virtual media on student learning outcomes in thermochemical material with a value of $F_{count} > F_{table}$, namely 4.015> 3.99. Likewise, Basak's research (2017) found that the use of virtual media improves learning.

In addition to PBL, other learning models that are often used are Direct Instruction (DI) learning models. Maandig, et al, (2017), explained that the DI model is centered on the teacher, the teacher and students interact, the teacher explains the subject with a planned lecture, is organized and provides training, gives instruction on learning and students do feedback. Louise C. Keegan (2017) found a positive effect for a well-implemented PBL model, where with PBL students create more choices in their learning.

In full, this study aims to determine whether there is an effect of learning models on students' chemistry learning outcomes on redox material, whether there is an effect of logical thinking ability on learning outcomes and whether there is an interaction between learning models and logical thinking skills on students' chemistry learning outcomes on redox material.

In relation to the ability to think logically, Sumarsih, et al, (2018) found that the ability to think logically can affect mathematical reasoning and the ability to think logically has a relationship with mathematical reasoning. The results of Susanti's research (2018) show that students' cognitive ability in problem solving with high logical-mathematical intelligence has the ability to remember, understand, apply, analyze, evaluate, and create well. Ranga (2018) also said that mathematical ability is a vital skill to master general concepts in chemistry learning.

Methods

This research was conducted in class X IPA Private High School Angkasa Medan Lanud Soewondo Medan which consisted of 6 classes. Samples were taken from 2 classes with purposive sampling technique. In the experimental class I as many as 16 students, learning to use the Problem Based Learning model and the experimental class II as many as 16 students, learning to use the Direct Instruction model. At the beginning of the meeting, a pre-test and a test of logical thinking skills were given to the experimental class I and the experimental class II. After the implementation of learning with the PBL model in the first experiment class and the DI model in the second experiment class, then a test post was given. The test of statistical data analysis, namely the normality test, and the homogeneity test, obtained data that was normally distributed and homogeneous, so the hypothesis test was carried out.

The research use a design of factorial 2 x 2. Data collection is done by using tests to measure students' chemistry learning outcomes, and students' logical thinking skills. Logical thinking ability test data was obtained before treatment while students' chemistry learning data were obtained after the sample was treated. Statistical tests were carried out at a significance level of 5%. Before the statistical analysis test was carried out instrument standardization. The data obtained were then analyzed descriptively. The data were analyzed using the analysis of variance (ANOVA) test at $\alpha = 0.05$ with criteria if Fcount> Ftable so Ho was rejected. In detail the design of this study is presented in Table 1.

Table 1. Factorial Design 2 X 2

Logical Thinking Ability (B)	Learning Model (A)	
	PBL Model (A_1)	DI Model (A_2)
High (B_1)	A_1B_1	A_2B_1
Low (B_2)	A_1B_2	A_2B_2

Note:
A_1B_1 = The combination of PBL model treatment and high logical thinking ability.
A_1B_2 = The combination of PBL model treatment and low logical thinking ability.
A_2B_1 = The combination of DI model treatment and high logical thinking ability.
A_2B_2 = The combination of DI model treatment and low logical thinking ability

Results and Discussion

From the results of the test of logical thinking ability obtained the results of distribution and learning outcomes as follows.

Table 2. Data Distribution of High and Low Logical Thinking Ability

Logical Thinking Ability	Total	Exp. Class1	Exp. Class 2
		Frequency	
High	16	8	8
Low	16	8	8
Total	32	16	16

Table 2 above shows that the distribution of high and low logical thinking abilities is the same.

Data on student chemistry learning outcomes in this study were obtained from post-test scores. The results of data processing experimental class 1 and experiment 2 seen from high and low logical thinking skills are presented in Tables 3 and 4.

Table 3. Posttest scores and logical thinking skills in experimental class

Posttest Kelas Eksperimen I								
Kemampuan Berpikir Logis Tinggi					Kemampuan Berpikir Logis Rendah			
No	Nama Siswa	Pre - test	$\left(X_i - \overline{X}\right)$	$\left(X_i - \overline{X}\right)^2$	Nama Siswa	Pre - test	$\left(X_i - \overline{X}\right)$	$\left(X_i - \overline{X}\right)^2$
1	S – 01	84	-3,50	12,25	S - 03	68	1.00	1,00
2	S – 05	88	0,50	0,25	S - 04	72	5.00	25,00
3	S -20	92	4,50	20,25	S - 11	60	-7.00	49,00
4	S – 22	80	-7,50	56,25	S - 12	64	-3.00	9,00
5	S – 24	84	-3,50	12,25	S - 13	68	1,00	1,00
6	S – 27	96	8,50	72,25	S - 15	68	1,00	1,00
7	S – 29	88	0,50	0,25	S - 18	68	1,00	1,00
8	S – 30	88	0,50	0,25	S - 19	68	1,00	1,00
	∑X	700	0	174	∑X	536	0	88
	$\overline{X}$	87,50	0	22	$\overline{X}$	67,00	0,00	11,00
	S^2	24,86			S^2	12,57		
	S	4,99			S	3,55		

Table 4. Posttest scores and logical thinking skills for experimental class 2

Posttest Kelas Eksperimen II								
Kemampuan Berpikir Logis Tinggi					Kemampuan Berpikir Logis Rendah			
No	Nama Siswa	Pre - test	$(X_i - \overline{X})$	$(X_i - \overline{X})^2$	Nama Siswa	Pre - test	$(X_i - \overline{X})$	$(X_i - \overline{X})^2$
1	S – 07	72	0,00	0,00	S - 02	60	1	1
2	S – 10	72	0,00	0,00	S - 04	56	-3	9
3	S – 12	72	0,00	0,00	S - 09	60	1	1
4	S – 13	76	4,00	16,00	S - 11	48	-11	121
5	S – 20	64	-8,00	64,00	S - 14	60	1	1
6	S – 21	72	0,00	0,00	S - 15	60	1	1
7	S – 26	72	0,00	0,00	S - 19	64	5	25
8	S – 30	76	4,00	16,00	S - 23	64	5	25
	∑X	576	0	96	∑X	472	0	184
	$\overline{X}$	72,00	0,00	12,00	$\overline{X}$	59,0	0,0	23,0
	S^2	13.71			S^2	26,3		
	S	3,70			S	5,13		

From Tables 3 and 4, it is found that for students taught with PBL learning models with high logical thinking skills, the average learning outcomes and standard deviations (87,50 ± 4,99), for classes taught with PBL learning models with low logical thinking skills. obtained the average learning outcomes and standard deviation (67,00 ± 3,55), for classes taught with the DI learning model with high logical thinking ability and standard deviation obtained an average (72,00 ± 3,70), and for classes taught with the DI learning model with low logical thinking skills obtained an average (59,00 ± 5,13). The details of the average chemistry learning outcomes obtained by students for each treatment combination are presented in Table 5.

Table 5. Average Student Learning Outcomes Based on the learning model

Logical Thinking Ability (B)	Learning Model (A)	
	PBL Model (A_1)	DI Model (A_2)
High (B_1)	(87,50 ± 4,99)	(72,00 ± 3,70)
Low (B_2)	(67,35 ± 3,55)	(59,00 ± 5,13)

Table 5 above shows that the average value of student learning outcomes with PBL models for students with high logical thinking ability gives the highest average than using the DI model.

The results of this study are in line with the view of Pohan (2017) which states that students who have high logical thinking skills are able to correctly solve problems from concrete to abstract symptoms. The data above also indicates that there is an influence between the choice of learning model and students' logical thinking abilities. Learning with the PBL model for students who have high logical thinking skills will also provide high learning outcomes. Merritt's (2017) study states that teaching with the PBL model is a student-centered group learning model that effectively enhances students' academic achievement in knowledge, conceptual development, and attitude.

The data were analyzed statistically using the Analysis of Variance (ANOVA) test at ɑ = 0.05 with criteria if Fcount> Ftable so Ho was rejected, a summary of statistical test results is presented in Table 6.

Table 6. List of ANOVA Combined with the Treatment of Learning Models and Logical Thinking Abilities.

Soruce of Diversity	Db	JK	KT	F cout	F(0,05,db)
Treatment	2	3461,5	-	-	-
Factor A	1	1104,5	1104,5	57,06	4,20
Factor B	1	2244,5	2244,5	115,95	4,20
Interaction AB	1	112,5	112,5	5,81	4,20
Error	28	542	19,36		
Total	31	4003,50	-	-	-

Based on the results of the data processing above it was found that there was an influence of the learning model (factor A) and the influence of the ability to think logically (factor B) on the results of students' chemistry learning. Furthermore, it can be concluded that there is an interaction between the learning model (A) with the ability to think logically (B) towards the results of students' chemistry learning. Thus it can be interpreted that factor A (learning model) and factor B (ability to think logically) can influence the learning outcomes of students chemistry.

From the data of student learning outcomes concluded that the learning model has an influence on the learning outcomes of chemistry student in the subject of redox reaction. The learning model used in this study is PBL learning model and DI learning model. PBL learning models have better results than DI learning models. This is because the presentation of problems in everyday life to students can stimulate students' curiosity about the problems presented, then students discuss to find answers to the problems given, besides, it can stimulate curiosity about other things related to the subject of redox reaction. In the DI learning model, the teacher provides learning subject afterwards giving questions to students and students discussing in groups. Based on the results of the study, it can be seen that the learning outcomes using the PBL model are higher than the DI model. But both models improve student chemistry learning outcomes in the subject of redox reaction. Improved student learning outcomes in this study are supported by several previous studies, among others.

Kartamiharja, et al. (2020) found that learning with the PBL approach can improve the process and student learning outcomes in chemistry learning. Dirmanto, et al. (2021) found that in the PBL class the percentage of students' scientific attitudes was much higher than in conventional classroom learning, as well as in terms of creativity and learning outcomes. Meanwhile, Nuswowati, et al. (2017), Herdiawan, et al. (2019) found that the application of the Problem Based Learning (PBL) model was able to improve students' creative thinking skills and creative actions.

The research of Pusparini, et al. (2018) shows that there is an effect of Problem Based Learning (PBL) learning model on students' thinking ability. The research of

Dakabesi, et al. (2019) also shows that the PBL model improves students' thinking skills. Handoyono, et al. (2021) from his research concluded that using the PBL model, creative thinking skills such as flexible, evaluative, logical and elaborative thinking will emerge.

Major (2017) states that PBL models can develop understanding in teaching practice, curriculum policy and help implement a geopolitical context. Schettino (2016) states PBL models can be used in mathematics learning by connecting mathematics with rational things in everyday life so as to increase students' interest in learning mathematics in the fields of science, technology, and engineering. Demirel and Dağyar (2016) found that problem-based learning was effective in helping students get positive attitudes towards learning. Sugiharti and Limbong (2018) found that PBL models have interactions with student learning motivation so as to improve student learning outcomes. Horak and Galluzzo (2017) stated that PBL learning models directly interact with the environment so as to stimulate students' curiosity and influence cognitive and non-cognitive domains. Ayyildiz and Tarhan (2017) found that PBL is an effective active learning approach that increases achievement and prevents the formation of conceptual difficulties and lack of knowledge. It can be concluded from the results obtained that the experimental group's average success is significantly higher than the control group. Irons and Thomas (2014) also conclude that the PBL model encourages students to work in groups to seek knowledge and further understanding of various processes, provide opportunities for students to solve realistic problems, and illustrate the relationship between science, technology and human activities. Research was also carried out by Eviyanti et al. (2017) that PBL models can improve students' mathematical problem solving abilities. Oktavia, et al. (2018) found that PBL models can improve students' critical thinking skills in physics learning by giving problems related to local wisdom from West Sumatra. This is in line with Sugiharti's research, et al. (2017) that PBL and DI models have interactions with the mathematical abilities of students so as to improve student chemistry learning outcomes.

In connection with logical thinking skills, Rojanavarakul and Jaroongkhongdash, (2017) say that logical thinking, when used in academic writing, is the process of making clear relationships between arguments and conclusions. While Haider (2017) said that the ability to think logically is needed for problem solving and mastery of concepts that exist in chemical materials, especially redox reactions. Logical thinking ability stimulates a balance between the level of students' operational thinking and instructional strategies.

Sugiharti and Hasibuan (2016), found an interaction between the learning model with the ability to think logically toward the students' chemistry learning outcomes in the subjet of rate of the reaction with an F count> F table that is 20.7645> 3.99. Thus it can be said that there is a relationship between the PBL model, the Di model, the use of virtual media and the ability to think logically in learning, especially learning redox. The research of Sukardjo & Yudiningtyas (2018) also found that there was an interaction between learning models and mathematical logical intelligence on learning outcomes.

Rakhmawan, et al. (2018) found the effect of logical thinking ability on chemistry learning. Parmin, et al. (2017) also wrote that the ability to think logically is needed by every individual to be able to solve complex problems, Meanwhile Riyanti, et al. (2018) stated that students' low logical thinking skills need to be integrated with learning models.

While research on the influence of the DI model on learning outcomes, Buchori, et al. (2017) found that the DI model improved students' cognitive learning outcomes. In connection with thinking skills, Maandig, et al., (2017) found that the DI model can improve the ability to read mathematical symbols and think critically in solving math problems. The results of research by Roman et al, (2017) found that the ability to think logically can be improved through learning and the ability to think logically is needed in every learning. Indriati, (2018) found that the ability to think logically can influence mathematical reasoning and the ability to think logically has a relationship with mathematical reasoning.

In this study, the interaction between PBL and DI learning models with the ability to think logically in improving students' learning outcomes in the subject of redox reaction. This can be seen from F (AB)> F_{table} which is 5.812> 4.20. Based on the results of research hypothesis testing can be described the interaction between learning models and the ability to think logically as Figure 1

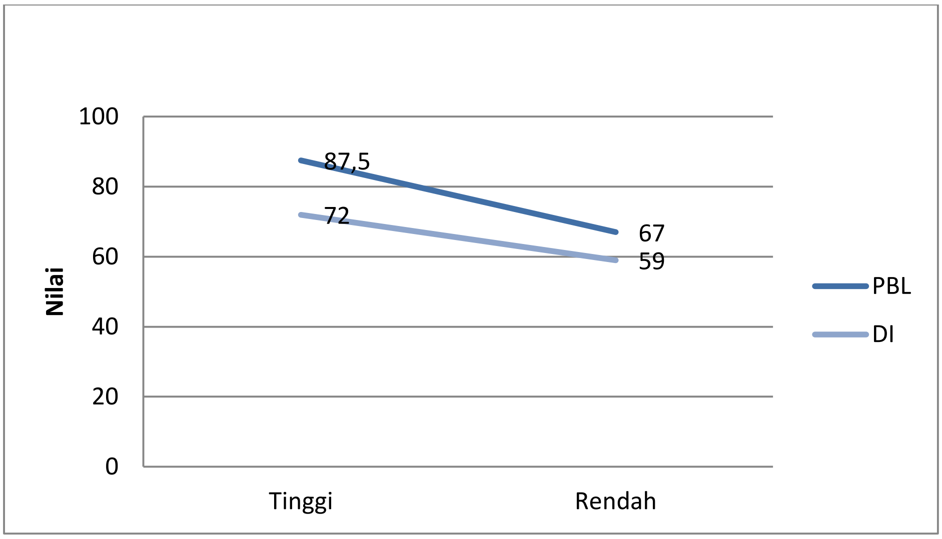

Figure 1. Forms of Interaction of Learning Model Factors (Factor A) and Logical Thinking Ability (Factor B) on student chemistry learning outcomes.

Figure 1 above shows the x axis is the PBL and DI learning model. The y-axis is to express redox learning outcomes based on high and low logical thinking abilities. The lines in figure 1 do not appear to intersect but that does not mean there is no interaction, if the two lines in the image are extended it will intersect. This graph shows that there are still interactions between PBL and DI learning models with the ability to think logically. Interactions that occur between PBL and DI learning models with the ability to think logically are still small. The average value of students with PBL models with high logical thinking ability provides the highest student learning outcomes. While teaching with the DI model with high logical thinking ability provides lower student learning outcomes, with an average score of 87.50 and 72.00. Furthermore, student learning outcomes teaching with PBL models with low logical thinking ability is higher than the learning outcomes of students who are taught using the DI model and low logical thinking skills, with an average value of 67.00 and 59.00. Chemistry learning outcomes students who have high logical thinking skills taught with PBL models provide higher learning outcomes because PBL models are learning models that give students problems in everyday life related to redox material that has a relationship with logical thinking abilities. If students have high logical thinking skills taught by PBL models students can solve the given problems, on the contrary students who have high logical thinking ability are taught with the DI model giving learning outcomes that are no better than PBL models. This is because the DI model that is the center of learning is the teacher so that students are less independent and less creative so the ability to think logically possessed by students is less aroused. While the application of the PBL model and the application of the DI model with low logical thinking ability are the same, giving the same average learning outcomes as low.

Conclusion

From the overall data analysis that has been done, it can be concluded that the following research: There is an influence of the learning model on the learning outcomes of students chemistry in the redox reaction material. There is an interaction between the learning model and the ability to think logically toward the learning outcomes of students chemistry in the subject of redox reaction. Research findings indicate that students with high logical thinking ability will get higher learning outcomes than students with low logical thinking ability both taught with PBL and DI models in the subject of redox.

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