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The Influence of the Problem Based Learning Model on Student' Learning Outcomes and Creative Thinking Abilities in Colloid Learning

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Abstract: This study was conducted to determine the effect of the Problem Based Learning model on students' learning outcomes and creative thinking skills on colloid material. This study used a pretest and posttest control group design. The sample in this study consisted of two classes, namely class XI IPA 2 with 34 students as the experimental class and class XI IPA 1 with 34 students as the control class determined using a purposive sampling technique. The learning outcomes and creative thinking abilities of students were measured through pretest and posttest and the average value of the learning outcomes and creative thinking abilities of students in the experimental class who were taught using the Problem Based Learning model was higher than the average value of the learning outcomes and creative thinking abilities of students in the control class who were taught using conventional learning. Hypothesis testing with independent sample t-test states that the first hypothesis value is obtained T_{count} = 4.16 and it is known that T_{table} = 1.99, then tcount tabet means that there is an influence of the Problem Based Learning model on learning outcomes. Furthermore, the second hypothesis is obtained T_{count} = 10.85 and it is known that T_{table} = 1.99, then $T_{count} > T_{table}$ means that there is an influence of the Problem Based Learning model on students' creative thinking abilities. From this study it was found that the Problem Based Learning model has an influence on students' learning outcomes and creative thinking abilities on colloid material.

Keywords: Learning outcomes, creative thinking skills, Problem Based Learning.

Abstrak: *Penelitian ini dilakukan untuk mengetahui pengaruh model Problem Based Learning terhadap hasil belajar dan kemampuan berpikir kreatif siswa pada materi koloid. Penelitian ini menggunakan pretest and posttest control group design. Sampel pada penelitian ini terdiri dari dari dua kelas yaitu kelas XI IPA 2 sebanyak 34 siswa sebagai kelas eksperimen dan kelas XI IPA 1 sebanyak 34 siswa sebagai kelas kontrol yang ditentukan dengan menggunakan teknik purposive sampling. Hasil belajar dan kemampuan berpikir kreatif siswa diukur melalui pretest dan posttest dan diperoleh nilai rata-rata hasil belajar dan kemampuan berpikir kreatif siswa kelas eksperimen yang diajarkan dengan model Problem Based Learning lebih tinggi dibandingkan dengan nilai rata-rata hasil belajar dan kemampuan berpikir kreatif siswa kelas kontrol yang diajarkan dengan pembelajaran konvensional. Uji hipotesis dengan uji independent sample t-test menyatakan nilai hipotesis pertama didapatkan* t_{hitung} *= 4,16 dan diketahui* t_{tabel} *= 1,99 maka* $t_{hitung} > t_{tabel}$ *artinya terdapat pengaruh model Problem Based Learning terhadap hasil belajar. Selanjutnya, hipotesis kedua didapatkan* t_{hitung} *= 10,85 dan diketahui* t_{tabel} *= 1,99 maka* $t_{hitung} > t_{tabel}$ *artinya terdapat pengaruh model Problem Based Learning terhadap kemampuan berpikir kreatif siswa. Dari penelitian ini ditemukan bahwa model Problem Based*

Learning memberikan pengaruh terhadap hasil belajar dan kemampuan berpikir kreatif siswa pada materi koloid.

Kata kunci: *Hasil belajar, kemampuan berpikir kreatif, Problem Based Learning*

▪ INTRODUCTION

Learning has a very important role in achieving educational goals. Learning is a process of interaction between students and teachers and the elements in it. Therefore, educators are required to be able to choose an effective and efficient learning model. If the learning model used by educators is appropriate, educational goals can be achieved (Faizah & Rahmat, 2024). Learning in the 21st century focuses on learners to have special skills, knowledge and expertise in order to be able to carry out their lives in the future. In the 21st century, there are several skills that must be possessed by students known as 4C, namely critical thinking or critical thinking, collaboration or the ability to work well together, communication or the ability to communicate, and creativity or creativity (Mahrunnisya, 2023). One of the problems of education in Indonesia is the low quality of education in Indonesia which is caused by students, the role of an educator, economic conditions, facilities and infrastructure, the environment and many other factors (Kurniawati, 2022).

Based on observations and interview results that have been conducted at SMA Negeri 10 Medan, it is known that the use of innovative and varied learning models has not been optimally implemented. Most of the teachers in this school still rely on conventional learning models such as lectures that tend to be centered on the teacher. This results in a lack of active involvement of students in the learning process learning. So that the problem has an impact on the low level of student creativity and student attitudes in learning, namely students tend to be passive and rarely ask questions related to ongoing learning.

Creative thinking skills are the ability to provide solutions in solving a problem, so that it can create something new or something different from others. One of the factors that causes low creative thinking skills in students is the inability of teachers to train students' creative thinking skills (Fitriyah & Shefa, 2021). Creative thinking skills need attention in addition to memory, logical thinking, and reasoning. In solving difficult problems, students feel lazy to do it because these students are not used to being trained and directed in their creative thinking skills (Mauludin & Fitrianti, 2023).

The success of learning is greatly influenced by the role of a teacher, one of which can be realized by training students to be independent and able to think creatively, namely by selecting an interesting learning model in delivering learning materials to students (Handayani & Henny, 2021). In order for learning objectives to be achieved optimally, it is important for educators to choose a learning model that is in accordance with the characteristics of the material and the needs of students (Putri et al., 2021).

Chemistry lessons are very important lessons and are related to everyday life. However, there are still many perceptions that chemistry lessons are very difficult. This happens because the understanding of chemical concepts is not deep enough and students' lack of interest in chemistry lessons. One of the chemical materials related to everyday life is colloid material. Colloid material in chemistry learning includes various facts, concepts, and procedures and is theoretical. Colloid material requires an understanding of true solutions, colloids, suspensions, colloid properties, and how to make them (Saraha et al., 2023). In its implementation, many students still find it difficult to learn colloid

material. This happens because students tend to learn colloid material by memorizing and the learning process still emphasizes the delivery of information by the teacher, students are only taught to memorize concepts (Maimunah, 2022). In colloid learning, students have difficulty analyzing the manufacture of colloids and analyzing the properties of colloids (Djalil et al., 2023).

Based on these problems, it is necessary to apply a variety of learning models so that students tend to be active by involving students directly in their learning process. One of the innovative and creative learning models that can increase student activity in class is the Problem Based Learning model (Murtihapsari et al., 2022). The PBL learning model is problem-based learning. The PBL model is good for use in the chemistry learning process, because in the PBL model students must learn to understand the material and knowledge, so that from understanding the material students can solve the problems given (Aryani & Ahmad, 2024). There are five stages in problem-based learning: 1) introducing students to the problem; the teacher conveys the learning objectives to be achieved, checks students' perceptions by asking questions about previous material, and provides motivation; 2) organizing students for learning; the teacher organizes students to study in groups; 3) supporting independent and group investigations; the teacher encourages students to collect data and conduct experiments; 4) developing and presenting their work; the teacher provides students with opportunities to present the results of their discussions and assists in brainstorming activities; and 5) analyzing and evaluating the problem-solving process; the teacher helps students analyze and evaluate their thinking processes in investigations and the intellectual skills used in problem-solving and reflects on the learning that has been done (Rudibyani & Galuh, 2020).

One of the advantages of the Problem Based Learning model is its ability to foster social solidarity among students. Through group discussion activities and collaboration in solving problems, students are accustomed to interacting, sharing ideas, and listening to the opinions of their group members or classmates (Sulastry et al., 2023). In addition, the Problem Based Learning model is presented with problems that students will solve so that they produce new knowledge and tend to encourage students to think creatively (Handayani & Henny, 2021). It is hoped that this PBL model will influence students' learning outcomes and creative thinking abilities. Learning outcomes are the results obtained by students or college students after carrying out their learning activities, expressed in the form of numerical or letter grades. Thus, learning outcomes will provide an overview of the learning process carried out by a person (Rahim et al., 2023). Learning outcomes can be seen from the learning experiences students have received, combined with their abilities. Changes in behavior in individuals who have gone through the learning stages are the result of the learning process. These behavioral changes involve changes in knowledge, skills, values, and attitudes (Suswati, 2021). Creative thinking is the development of creative thinking. Creative thinking is not only the generation of new ideas, but also the multifaceted ways in which they can be constructed and communicated. Creative thinking can be defined as thinking that allows students to apply their imagination to generate ideas, questions, and hypotheses, experiment with alternatives, and evaluate their own and their peers' ideas, final products, and processes (Uloli, 2021). Creative thinking is a thought process that generates new ideas broadly and diversely. Creative thinking skills have four indicators: fluency, flexibility, originality, and elaboration (Nuraini & Rusly, 2022).

▪ METHOD

This research is a quantitative research. The type of research used in this study is quasi-experimental research (Quasy Experimental) where there is one control class and one experimental class. The population in this study were students of class XI IPA SMA Negeri 10 Medan. With purposive sampling technique, 34 students of class XI IPA 2 were obtained as the experimental class and 34 students of class XI IPA 1 as the control class. Purposive sampling is a sampling technique in which subjects are deliberately selected based on certain criteria deemed relevant by the researcher (Subhaktiyasa, 2024). This study uses the Pretest and Posttest Control Group Design. Data collection was carried out using test instruments in the form of pretest and posttest. The design of this study can be seen in table 1 below.

Table 1. Research design

Class	Pretest	Treatment	Posttest
Experiment	Y_1	X_1	Y_2
Control	Y_1	X_2	Y_2

Information:
Y_1 = Pretest
Y_2 = Posttest
X_1 = Treatment in the form of learning using the Problem Based Learning
X_2 = Treatment in the form of learning using conventional models

The test instruments used in this study were pretest and posttest consisting of 20 multiple-choice questions to measure student learning outcomes and 8 essay questions to measure students' creative thinking skills. Before the instrument was given to both classes, the instrument had been tested for validity, reliability, difficulty level, discrimination power and distractor test.

After the instrument was tested, a pretest was given to the experimental class and the control class to determine the initial abilities of students. Then the learning of colloid material was carried out in the experimental class using the Problem Based Learning model. In the first meeting, students observed learning activities in the form of problems presented in a powerpoint regarding the colloid system, types and properties of the colloid. Next, students were divided into several heterogeneous groups to discuss and work on the questions that had been presented in the student worksheet, and after finishing the students presented in front of the class. In the second meeting, students carried out learning activities with the sub-material of making colloids and the role of colloids. In the third meeting, students were given a posttest to determine students' abilities after being given treatment, namely with 20 multiple choice questions and 8 essays. On the other hand, the control class used a conventional learning model, where researchers played an active role in the learning process, students listened more to explanations, took notes, memorized and were given individual tasks. Furthermore, a posttest was given as in the experimental class at the end of learning to measure students' final abilities. After all the data was collected, several tests were carried out, including prerequisite tests, namely normality tests, homogeneity tests, hypothesis tests, namely independent sample T-tests, and correlation tests.

▪ RESULT AND DISCUSSION

The average value of learning outcomes in the experimental class before the Problem Based Learning model was applied was 46,18 while the average value in the control class was 40.29. After being given treatment, the average value of learning outcomes in the experimental class was 83.53 while in the control class it was 76.91. In addition to measuring learning outcomes, the pretest-posttest given also measured students' creative thinking skills and the average value of students' creative thinking skills in the experimental class before the Problem Based Learning model was applied was 38.21 while the average value in the control class was 36.35. After being given treatment in the form of the Problem Based Learning model, the average value of students' creative thinking skills in the experimental class was 84.29 while the average value in the control class was 70.50. Based on these average values, it shows that the experimental class given treatment in the form of the Problem Based Learning model is greater than the control class taught conventionally. The results of the students' pretest and posttest can be seen in figure 1 and figure 2.

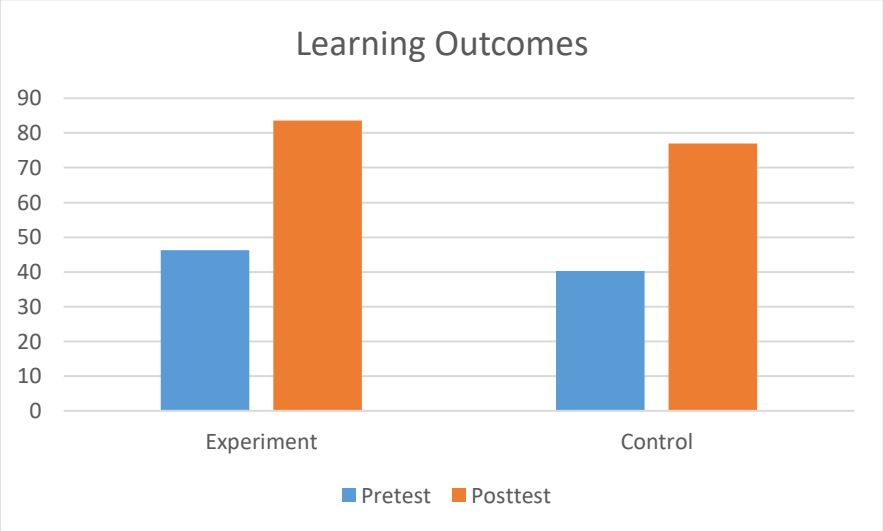

Figure 1. Average value of pretest-posttest of students' learning outcomes

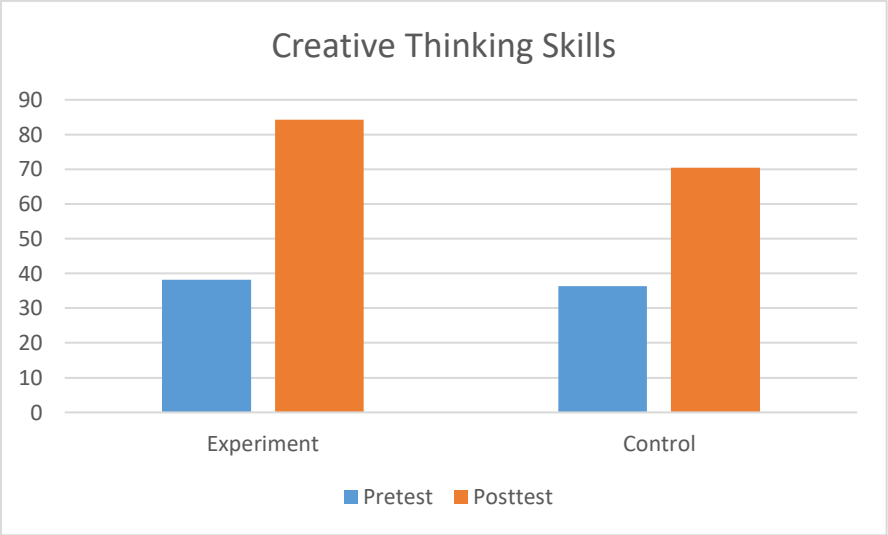

Figure 1. Average value of pretest-posttest of students' creative thinking ability

Normality Test

The normality test was conducted to determine whether the data from the pretest-posttest scores of the experimental and control class students were normally distributed or not. The normality test in this study used the chi square test with a significance level of 0.05, where the $X^2_{count} < X^2_{table}$ then the data is declared normally distributed. The results of the normality test can be seen in the table 2 and table 3.

Table 2. Results of the pretest-posttest normality test of learning outcomes

Class data		X^2_{count}	X^2_{table}	α	Information
Experiment	Pretest	4.50	7.81	0.05	Normal
	Posttest	0.68			Normal
Control	Pretest	7.55			Normal
	Posttest	1.89			Normal

Table 3. Results of the pretest-posttest normality test of creative thinking ability

Class data		X^2_{count}	X^2_{table}	α	Information
Experiment	Pretest	6.58	7.81	0.05	Normal
	Posttest	6.27			Normal
Control	Pretest	2.94			Normal
	Posttest	3.61			Normal

Based on the table above, it shows that the pretest-posttest values of the experimental class and the control class produce a table that is larger than the calculation. So it can be concluded that the pretest-posttest values of the experimental class and the control class that have been analyzed are normally distributed.

Homogeneity Test

The homogeneity test in this study used the Fisher test with a significance level of 0.05 with the criteria $F_{count} < F_{table}$ then the data is declared homogeneous. The results of the homogeneity test can be seen in the table 4 and table 5.

Table 4. Result of the pretest-posttest homogeneity test of learning outcomes

Class data	F_{count}	F_{table}	α	Information
Pretest	1.19	1.78	0.05	Homogeneous
Posttest	1.09			Homogeneous

Table 5. Result of the pretest-posttest homogeneity test of creative thinking ability

Class data	F_{count}	F_{table}	α	Information
Pretest	1.21	1.78	0.05	Homogeneous
Posttest	1.32			Homogeneous

The table above shows that the pretest-posttest values are greater than, so it can be concluded that the pretest-posttest data are homogeneous.

Hypothesis Test

The pretest-posttest data of the experimental class and the control class are known to be normal and homogeneous, so the next test is the hypothesis test. Hypothesis testing in this study used the Independent Sample t-test with a significance level of 0.05 with the criteria if $T_{count} > T_{table}$ then H_0 is rejected and H_a is accepted and if $T_{count} < T_{table}$ then H_0 is accepted and H_a is rejected. The results of the hypothesis test can be seen in the table 6 and table 7.

Table 6. Results of the first hypothesis test

Class data	T_{count}	T_{table}	Information
Posttest	4.16	1.99	H_0 is rejected and H_a is accepted

Based on the table above, it shows T_{count} (4.16) > T_{table} (1.99) then H_0 is rejected and H_a is accepted, so it can be concluded that there is an influence of the problem based learning model on student learning outcomes in colloid material.

Table 7. Second hypothesis test results

Class data	T_{count}	T_{table}	Information
Posttest	10.85	1.99	H_0 is rejected and H_a is accepted

Based on the table above, it shows T_{count} (10.855) > T_{table} (1.99) then H_0 is rejected and H_a is accepted, so it can be concluded that there is an influence of the problem based learning model on students' creative thinking abilities on colloid material.

Correlation Test

The correlation test was conducted to determine how close the relationship is between creative thinking ability and learning outcomes using the Problem Based Learning model. The results of the correlation test between creative thinking ability and learning outcomes can be seen in the table 8.

Table 8. Correlation test result

	Creative thinking ability	Learning outcomes	Information
Average	84.29	83.52	-
Correlation coefficient	0.64		Tinggi

Based on the table above, it shows that the correlation coefficient value of creative thinking ability with learning outcomes is 0.64, which means that there is a high correlation between the two variables. In addition, the calculation of the contribution of creative thinking ability to learning outcomes was carried out using the formula KD = $r^2 \times 100\%$. From this calculation, a determination coefficient of 0.42 was obtained.

- **DISCUSSION**

The treatment, which used the Problem-Based Learning model, had an impact on students' creative thinking skills. According to the achievement indicators, the experimental class performed higher than the control class. In the experimental class, the fluency indicator was relatively high because the first phase, which orients students to the problem, encourages them to express their ideas. This activity develops the fluency aspect of creative thinking skills. This aligns with research conducted by (Haerunisa et al., 2021) that found that students with fluent thinking skills can answer questions, generate ideas, and solve problems or questions. The second and third phases involve organizing students for learning. This learning organization is realized through the formation of groups. Within the groups, interaction occurs, such as exchanging opinions, sharing knowledge, and contributing ideas to solve problems. The activities carried out by members in discussion groups train fluency and flexibility. This aligns with research conducted by (Vistara et al., 2022), which states that creative thinking can be defined as a thought process that produces various possible solutions to problems or diverse ideas. In the experimental class, indicators of flexibility thinking were found to be very high compared to the control class, which did not receive the same treatment.

The activity of designing an experiment or solution to a problem can train detailed thinking skills (elaboration). Elaboration is the ability to solve problems by taking detailed steps or explaining previously presented ideas in greater detail. Therefore, the detailed thinking indicator (elaboration) in the experimental class is classified as very high. Furthermore, the experimental design developed by students is the work of a group that differs from other groups. This reflects the original thinking skills students develop through designing their own experiments. This aligns with research conducted by (Amri & Hariani, 2022) that found that students with creative thinking skills are able to enrich, develop, and generate new and unique ideas, often ones that were previously unthinkable. The originality indicator in the experimental class was relatively high compared to the control class, which did not receive the same treatment as the experimental class. Both indicators developed through the fourth and fifth phases.

The different treatments in the two classes resulted in different student behaviors during learning. The experimental class, which implemented the Problem-Based Learning model, tended to be more active because they were directly involved in the learning process, compared to the control class, which used a conventional learning model. Furthermore, the experimental class, which was faced with real-life problems, encouraged students to seek various solutions and develop creative ideas, thus improving students' creative thinking skills compared to the control class. This is consistent with the opinion (Langitsari et al., 2021) that the Problem-Based Learning model can foster activeness and enhance students' creative thinking skills in chemistry learning.

The hypothesis test used in this study is the Independent Sample t-test with a significance level of 0.05 with the criteria that if $t_{count} < t_{table}$ then H_0 is rejected and H_a is accepted and if $t_{count} < t_{table}$ then H_0 is accepted and H_a is rejected. From the first hypothesis test, it was obtained t_{count} (4.16) > t_{table} (1.99) then H_0 is rejected and H_a is

accepted, so it can be concluded that there is an influence of the problem based learning (PBL) model on student learning outcomes on colloid material. The results of this study are in line with research conducted by (Roza & Marini, 2022) which explains that there is a significant difference in the learning outcomes of students who are taught using the problem-based learning model compared to the learning outcomes of students who are taught using the conventional model on colloid material, namely the average value obtained in the experimental class was 89.83 while the control class was 85.85.

Then the second hypothesis obtained t_{count} (10.855) > t_{table} (1.99) then H_0 is rejected and H_a is accepted, so it can be concluded that there is an influence of the problem based learning (PBL) model on students' creative thinking abilities on colloid material. The results of this study are also in line with research conducted by (Ardiansyah et al., 2024) stating that the application of the problem based learning model increases students' creative thinking abilities which include aspects of fluency, flexibility, originality and elaboration, this is proven by the results of the hypothesis test with the Z test at a significant level of 5% that $Z_{count} > Z_{table}$ which indicates that the hypothesis is accepted or there is an influence of the Problem Based Learning model in improving students' creative thinking abilities.

Based on the results of the hypothesis testing conducted, it can be concluded that the research on the use of the problem-based learning model has an impact on students' learning outcomes and creative thinking abilities. This is in line with research conducted by (Handayani & Henny, 2021), which states that the problem-based learning model significantly influences learning outcomes and encourages students to hone their creative thinking skills. This is evident from the average score obtained after implementing the problem-based learning model, which was 11.22%. Therefore, H_0 is rejected, indicating that the problem-based learning model has an effect on improving creative thinking.

The relationship between creative thinking ability and learning outcomes can be determined by conducting a correlation test. The correlation test used in this study was the product moment correlation test, and the r_{count} was obtained at 0.64, which means that creative thinking ability and learning outcomes have a high correlation. Furthermore, the contribution of creative thinking ability to learning outcomes was calculated using the formula KD = r^2 x 100%. From this calculation, a coefficient of determination was obtained of 0.42. Therefore, it can be concluded that creative thinking ability contributes 0.42 with learning outcomes. This is supported by research (Safitri et al., 2023), which states that learning outcomes are closely related to creative thinking skills. The better a student's creative thinking skills, the better their learning outcomes will be.

▪ CONCLUSION

After data processing, hypothesis testing, and analysis of research results, it can be concluded that there is an influence of the Problem Based Learning model on learning outcomes in colloid material. This is proven through and independent sample t-test on the posstest results, where the calculated t_{count} (4.16) > t_{table} (1.99) at a significance level of 0.05, so H_0 is rejected and H_a is accepted. There is an influence of the Problem Based Learning model on students' creative thinking abilities in colloid material. This is proven through an independent sample t-test on the posttest results, where the calculated t_{count} (10.855) > t_{table} (1.99) at a significance level of 0.05, so H_0 is rejected and H_a is accepted.

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