Implementation of the Problem-Based Learning (PBL) Learning Model to Improve the Skills and Creative Thinking of Students on the Material Colligative Properties of Solutions

Anita Debora Simangunsong

Program Study Chemistry Education, University of HKBP Nommensen Pematang Siantar, Indonesia
Corresponding Email: anitadebora491@gmail.com, Phone Number: 0823 xxxx xxxx

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Abstract: One of the problematic chemicals is the solutions' colligative properties. Difficulty understanding material colligative properties of solutions can hinder students' understanding of other concepts. This research aimed to discover the increase in creative thinking skills and mastery of students' material after participating in the Problem-Based Learning (PBL) model of learning. The research method used was quasi-experimental research, with the research design being one group pretest-posttest design. In this study, the experimental class was treated using the Problem-Based Learning learning model on colligative properties of solutions. The population in this study were undergraduate students at HKBP Nommensen Pematangsiantar University. The sample in this study was Bachelor of Chemistry Education students at HKBP Nommensen Pematangsiantar University. The research results on student learning outcomes in the material Colligative Properties of Solutions using the PBL learning model increased from 42.6% of students' pretest scores and 84.16% of students' post-tests. The increase obtained was 41.56%. The research concludes that the Problem-Based Learning (PBL) learning model significantly affects students' creative thinking skills. This can be proven by the increased average value of students' creative thinking skills in the experimental class at each meeting.

Abstrak: Salah satu bahan kimia yang dianggap sulit adalah sifat koligatif larutan. Kesulitan memahami sifat-sifat larutan materi koligatif dapat menghambat pemahaman siswa terhadap konsep lain. Tujuan penelitian ini adalah untuk mengetahui peningkatan kemampuan berpikir kreatif dan penguasaan materi siswa setelah mengikuti model pembelajaran Problem Based Learning (PBL). Metode penelitian yang digunakan adalah penelitian eksperimen semu, dengan desain penelitian yang digunakan adalah one group pretest-posttest design. Pada penelitian ini, kelas eksperimen diberi perlakuan model pembelajaran Problem Based Learning pada sifat-sifat koligatif larutan. Populasi dalam penelitian ini adalah mahasiswa S1 Universitas HKBP Nommensen Pematangsiantar. Sampel dalam penelitian ini adalah mahasiswa S1 Pendidikan Kimia Universitas HKBP Nommensen Pematangsiantar. Hasil penelitian hasil belajar siswa pada materi sifat koligatif larutan dengan menggunakan model pembelajaran PBL meningkat dari pretest siswa 42,6% dan posttest siswa 84,16%, peningkatan yang diperoleh sebesar 41,56%. Kesimpulan penelitian adalah model pembelajaran Problem Based Learning (PBL) berpengaruh signifikan terhadap kemampuan berpikir kreatif siswa. Hal ini dapat dibuktikan dari rata-rata nilai keterampilan berpikir kreatif siswa kelas eksperimen pada setiap pertemuan mengalami peningkatan.

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A. Introduction

Chemistry broadly describes the characteristics of substances that differ from one another, describes the conditions in which substances interact, describes the properties and uses of the new substances produced, and explains why these changes occur (Siregar & Aghni, 2021). Learning chemistry ideally involves an understanding that cannot be separated from three levels of representation, namely macroscopic symbolic, and submicroscopic (Wabula et al., 2020). The purpose of launching the 2013 curriculum is to form a generation that is, by their beliefs, able to form creative, innovative, productive, and religious individuals and influence life. Implementation of the 2013 curriculum, students' potential is prioritized by integrating the values of national character and culture. Learning cannot be separated from the activities of teachers and students, both of whom have the same goal: high-quality education. The achievement of quality learning depends on the teacher's ability to act as an educator and teacher in specific fields of study, such as mathematics, physics, biology, chemistry, language, and social studies. One of the chemicals considered difficult is the solutions' colligative properties. Difficulty understanding material colligative properties of solutions can hinder students' understanding of other concepts (Siregar, 2022). This material is considered difficult to understand because it contains abstract concepts and many calculations. The abstractness in this material and the many calculations make students use rote memorization to overcome their difficulties. Therefore we need a learning model appropriate for each chemistry learning material. The learning model that can invite students to associate concepts with problems in everyday life is the PBL (Problem-Based Learning) model. The PBL model is an approach to learning that uses real-world problems as a context for students to acquire knowledge and concepts from learning materials (Ramadhan, 2021). This means the PBL learning model can be applied to develop the expected teaching materials.

The results of research conducted by Oktarina (in Yuliana et al., 2020) show that the PBL model is suitable for application to teaching and learning activities in tertiary institutions and is very appropriate for student-centered learning. Applying the PBL model in developing teaching materials also supports the achievement of student-centered graduates expected by SN-PT (Akbar, 2019). That is, graduate learning outcomes are achieved through a learning process that prioritizes the development of creativity, capacity, personality, and student needs, as well as developing independence in seeking and finding knowledge (Winoto & Prasetyo, 2020). No matter the circumstances, the need for education is fundamental and cannot be ignored. They observe the Constitution's mandate that education aims to enlighten society. Education's core value is that learning extends beyond the classroom. Schools are institutions of higher learning with various platforms, all of which have been held in Indonesia. The neighborhood sees the school as a structure with teachers and pupils inside. In a learning environment, the interaction between students, teachers, and learning resources constitutes the process of learning. All individuals working in the field of education must have a positive attitude.

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Creative thinking skills are unique mental processes that can produce something new, different, and original, including specific types of thinking (Hasanah & Fitria, 2021). In addition, Guilford (1995) also revealed indicators of creative thinking skills, namely: (1) fluency, (2) flexibility, (3) originality, (4) elaboration, and (5) redefinition. In addition, the results of observations made by Putra et al. (in Ariyani & Kristin, 2021) show that the learning process in several schools still needs to develop students' creative thinking skills. This is because educators transfer their knowledge using the lecture method, thus making students less creative in solving problems, teaching, and learning activities are less efficient. Ultimately, students need help to develop their creative thinking skills (Mardani et al., 2021). Therefore, a learning model with contextual characteristics is needed for students to develop creative thinking skills on material colligative properties of solutions. One learning model that has contextual characteristics is the Problem-Based Learning (PBL) model (Elizabeth & Sigahitong, 2018). The PBL learning model aims to develop student learning outcomes. This learning model emphasizes that students work in groups and are effective in the teaching and learning process. In the PBL learning model, students are organized into groups where each group member has the same responsibility for solving existing problems because more and more students participate in learning. The methods used by students in the class can be divided into groups. Each group is given a task that must be completed by the group, thus providing an opportunity for each student to give the same answer. The use of this model is expected to increase student understanding and affect the improvement of student learning outcomes.

The research results of Khotimah et al (2019) state that there are differences in students' cognitive learning outcomes in using the Problem-Based Learning (PBL) learning model with students taught by conventional learning, where there is an effect of 30%. Besides that, Djonomiarjo (2020) states that applying the PBL model can improve the quality of the learning process and learning outcomes from cycle I to cycle II. Based on these results, this research is oriented toward classroom action research (CAR). The central concept of Kurt Lewin's classroom action research includes four elements: planning, action, observation, and reflection. The survey tools used were observation sheets, questionnaires, group discussions, and end-of-session questions. As a result, the percentage of student learning completeness in session I was 60.53 percent, with an average score of 75.47. In session II, the percentage of completeness of student learning outcomes increased to 78.74 percent, with an average score of 83.00. These results indicate that learning with a problem-based learning model can improve student learning outcomes.

Students' creative thinking skills will appear with the PBL model because it is supported by a learning atmosphere centered on students, which makes students free to express ideas that arise from within themselves and a learning environment that supports the active role of students in solving existing problems.

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B. Method

The research method used was quasi-experimental research, with the research design being one group pretest-posttest design. The pretest is conducted to determine the student's initial abilities before studying the material. At the same time, the post-test is carried out to see the students' abilities after learning the material using a particular learning model.

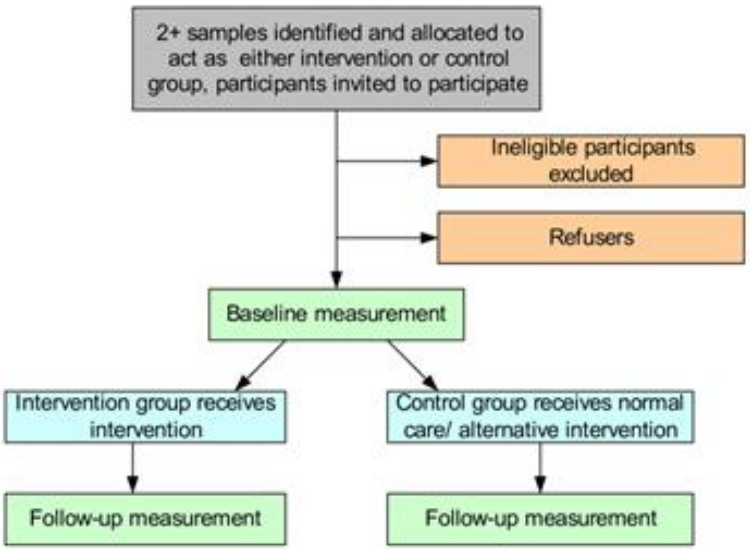

Figure 1. Design quasi-experimental research

In this study, the experimental class was treated using the Problem-Based Learning learning model on colligative properties of solutions (Farid et al., 2022). The design used can be illustrated in the table below:

Table 1. One Group Pretest-Posttest Research Design

Class	Pretest	treatment	Post-test
Experiment	O_1	Xt _	O_2

This research was conducted at HKBP Nommensen Pematangsiantar University from November 2022- January 2023. The population in this study were undergraduate students at HKBP Nommensen Pematangsiantar University. The sample in this study was Bachelor of Chemistry Education students at HKBP Nommensen Pematangsiantar University. The sample selection in this study used a purposive sampling technique. Purposive sampling is sampling carried out only based on the considerations of the researcher, who considers the desired elements already exist in the members of the sample taken (Janah et al., 2018).

This research procedure consists of three stages, namely the initial stage, the implementation stage, and the final stage.

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Pre Implementation Stage

Checking the basic competence of the material to be developed, then looking for literature studies on creative thinking skills, PBL, and determining what material will be studied. Searching for literature on the material that has been chosen, namely the colligative properties of the solution. Make a learning implementation plan with the selected essential competencies. It was making instruments used in this research, namely pretest and post-test question sheets. Validate the instruments that have been made.

Implementation Stage

A pretest was conducted in the experimental class to determine how far students understood the material to be studied. Carrying out learning, using the Problem-Based Learning (PBL) model with the material being studied, is a colligative property of solutions. Post-test activities were completed by filling out written exams with the same type and content as the pretest questions.

Post Implementation Stage

Research, obtained from the results of the pretest, post-test, and observation in the analysis so that it can answer all the formulated research questions. Make conclusions from the results of the data analysis obtained. A research instrument is a researcher's tool to collect data to answer research objectives. The instruments used are LKPD (Student Worksheets) and evaluation questions. In addition to helping researchers collect data, LKPDs help students develop their creative thinking skills. From the LKPD, we can see the real answers of students. LKPD is made based on the Implementation of Learning made by researchers. The evaluation questions consist of 20 multiple-choice questions. The preparation of the evaluation questions refers to the RPP made by the researcher, which is to develop students' creative thinking with the PBL learning model (Pebriyani & Pahlevi, 2020). Multiple choice tests are carried out to make it easier to analyze because sometimes many students are fooled. Expert lecturers will then validate the instrument in their fields, and then the evaluation questions are tested first on students who have studied the colligative properties of solutions (Syafei & Silalahi, 2019).

According to Meltzer, the percentage increase in learning outcomes can be calculated using the g factor formula (normalized gain score). The g factor formula determines the acquisition of student learning outcomes. The hypothesis test used is the one sample t-test where if the significance value is 0.00 <0.05, it indicates that H_a is accepted and H_o is rejected.

C. Result and Discussion

Research Result

Data on Learning Outcomes with the Problem-Based Learning (PBL) Learning Model

The data were obtained from the pretest and post-test results given to students. The results of the tests achieved in each test were carried out in a classical learning completeness analysis. The minimum completeness criterion value for chemistry lessons on the material

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colligative properties of solutions has been determined to be 75. The results obtained from the pretest scores were that 25 students were declared incomplete with a score obtained <75 according to the minimum completeness score (KKM), while five students the others are declared complete. To see classical learning mastery is determined by using the following formula:

KS = ST/N x 100%

KS = 5/30 x 100%

KS = 16.67%

The calculation of the classical pretest completeness value is 16.67%. By the criteria of mastery learning, the completeness of learning outcomes has yet to be achieved. For the next meeting, the lecturer and teacher must be even more active in explaining learning material, reaching out to all students, and correcting existing deficiencies so that students can better understand and understand the material presented to achieve student learning completeness. Therefore, learning using the Problem-Based Learning model is expected to improve student learning outcomes. Then, a post-test is conducted to see the learning outcomes after being treated with the Problem-Based Learning model.

The results obtained from the post-test scores were 28 students declared complete with scores > 75, while two other students declared incomplete. To see classical learning mastery is determined by using the following formula:

KS = ST/N x 100%

KS = 28/30 x 100%

KS = 93.33%

From the calculation of students' classical post-test completeness value is 93.33%. By the criteria of mastery learning, the completeness of students has been achieved.

Table 2. Students' Pretest And Posttest Scores

Student	Pretest Value	Classical	Posttest value	Classical
1	30	Not finished	85	complete
2	30	Not finished	80	complete
3	30	Not finished	75	complete
4	30	Not finished	80	complete
5	30	Not finished	70	Not Completed
6	7 5	complete	95	complete
7	35	Not finished	85	complete
8	35	Not finished	85	complete
9	30	Not finished	85	complete
10	30	Not finished	80	complete
11	3 0	Not finished	85	complete
12	7 5	Not finished	90	complete
13	3 5	Not finished	80	complete
14	35	Not finished	85	complete
15	35	Not finished	85	complete
16	3 0	Not finished	85	complete
17	35	Not finished	85	complete

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Student	Pretest Value	Classical	Posttest value	Classical
18	3 5	Not finished	85	complete
19	7 5	complete	90	complete
20	30	Not finished	80	complete
21	78	complete	95	complete
22	35	Not finished	85	complete
23	40	Not finished	85	complete
24	75	complete	90	complete
25	45	Not finished	80	complete
26	40	Not finished	90	complete
27	4 5	Not finished	85	complete
28	75	complete	90	complete
29	3 0	Not finished	7 0	Not Completed
30	45	Not finished	85	complete
∑	1278		2525	
Maximum Total Score	3000		3000	
Total Score Reached	42.6%		84.16%	

Based on the data processing results above, the increase in learning outcomes is 41.56%. This shows an increase in learning outcomes using the Problem-Based Learning (PBL) model on colligative properties of solutions.

Effect of the Problem-Based Learning (PBL) Model on Creative Thinking Skills

Data on students' creative thinking skills were obtained from the assessment of the observation sheets given at each meeting during the learning activities. The results of the average test scores for creative thinking skills in the control and experimental classes of students can be seen in Table 3 below.

Table 3. Class Creative Thinking Skill Observation Sheet Values

Class	Average value		
	Meeting 1	Meeting 2	Meeting 3
Experiment	22.65	38.02	46,61

Results of the final test hypothesis test using the t-test (independent sample t-test) with the help of SPSS 16 for windows.

Table 4. Hypothesis Test Results

Variable	Sig.
Creative Thinking Skills	0.040

Based on the table, the significance value is smaller than the significance level (α = 0.05), so the null hypothesis (H_o) is rejected. Moreover, the alternative hypothesis (H_a) is

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accepted. The conclusion is that there is a significant influence of the Problem-Based Learning learning model on students' creative thinking skills.

Discussion

Learning is a relatively sedentary change that occurs in all kinds/overall behavior of an organism as a result of experience. According to Winkel (in Kristiana & Radia, 2021), learning is a mental/psychic activity that occurs in active interaction with the environment, resulting in changes in knowledge, understanding, skills, and attitude values. The changes are relatively constant and lasting. Meanwhile, Lozanov (in Ismiyati, 2018) says the learning/teaching process is complex. Everything means every word, thought, action, and association, and to what extent you change the environment, presentation, and teaching design, that is how far the learning process goes.

Based on the definition above, learning is a behavior change experienced by individuals interacting with their environment. In every activity, humans always expect results and learning activities. Learning outcomes include activities and efforts to achieve changes in behavior that can be observed and measured.

A process of teaching and learning about a teaching material is declared successful if the results meet the specific instructional objectives. Student learning outcomes are changes in behavior resulting from learning broadly covering the cognitive, affective, and psychomotor fields. A person's learning outcomes depend on knowledge, concepts, and goals that influence interactions with the material being studied (Indriani, 2022). According to E. Siregar and H. Nara, learning success depends on several factors, namely 1) internal factors, namely factors that come from within the child/student himself. 2) External factors come from outside the child/student. Internal factors include learning materials, attitudes, feelings, emotions, and intelligence. At the same time, external factors include learning materials, teaching methods, educational media, and the environment in and outside the classroom (Pidrawan et al., 2022).

Maimonah (in Royantoro et al., 2018) suggests that the Problem-Based Learning (PBL) model is a learning method in which real problems characterize it as a context for students to think critically and have problem-solving skills. The real problems discussed are based on everyday life that is commonly encountered. This means that in addition to discussing a problem, students can solve existing problems. Finally, students gain knowledge. The essence of understanding the PBL model is a learning model that requires total student activity to solve the attitude problems students face independently by constructing the knowledge and understanding they have.

The PBL model is a learning that emphasizes giving real problems in everyday life, which students must solve through independent investigation so that students find solutions to these problems as the proper knowledge and concepts from learning (Herwina, 2021). Similarly, according to Nafiah & Suryanto (in Hasanah et al., 2021), the PBL Model is an approach to learning that uses real-world problems as a context for students to acquire knowledge and concepts from learning materials. Darmawanto (in Wulandari & Suparno,

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2020) suggests that in the PBL model, students are required to ask questions and express opinions, that Students are also required to find relevant information from hidden sources or look for various (alternative) ways to get solutions to existing problems and find effective ways to solve a problem.

The PBL model is student-centered learning, and students use existing problems around them to understand the subject matter. Students can study independently to find information about existing problems and collaborate in solving problems in the subject matter studied and sourced from teachers or other students (Santika et al., 2020). Group discussions focused on existing problems and the role of teaching staff, both teachers and lecturers here, as facilitators who supervise students and make learning more interesting (Asrifah et al., 2020).

At the beginning of learning using the Problem-Based Learning (PBL) model, students are given a problem. Students formulate problems, analyze problems (compile problems), find solutions based on existing problems, and make conclusions. Based on the table, the significance value is smaller than the significance level ($\alpha = 0.05$), so the null hypothesis (H_o) is rejected. Moreover, the alternative hypothesis (H_a) is accepted. The conclusion is that there is a significant influence of the Problem-Based Learning learning model on students' creative thinking skills.

D. Conclusion

The problem-based learning model is student-centered learning. Students use the problems around them to understand the subject matter, learn independently to find information about existing problems, and work together to solve problems that exist in the subject matter being studied. Sourced from the teacher or other students

Based on the results and discussion, this study concluded that student learning outcomes in the material colligative properties of solutions using the PBL learning model increased from 42.6% of students' pretest scores and 84.16% of students' pretest scores to students' post-test scores, the increase obtained was 41.56%.

The Problem-Based Learning (PBL) learning model significantly affects students' creative thinking abilities. This can be proven by the average value of the creative thinking skills of the experimental class students at each meeting has increased. This can also be proven through hypothesis testing (independent sample t-test), where the significant test value is less than the significant value of 0.040 <0.05.

Based on the results of the research that has been concluded above, to improve the quality of education, it is necessary to put forward the following suggestions It is expected that lecturers and teachers can apply the PBL learning model in the learning process because the application of the PBL learning model is proven effective in increasing student learning achievement and makes students more motivated, think more creatively, and have good social interaction and to achieve quality teaching and learning outcomes, it is hoped that lecturers and teachers will train process skills in students by providing opportunities for students to play an active role. It is also hoped that lecturers and teachers can choose more

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varied learning models and media that are by the characteristics of the participant's students and the type of material to be taught.

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