International Journal of Education, Humaniora, and Social Studies
Vol. 1, No. 1, pp. 17-22, 2024
e-ISSN 3032-1271 | p-ISSN 3032-4467
https://journal.dpipublish.com/index.php/ijehss/

The Influence of the Integrated Problem-based Learning (PBL) Model of High Order Thinking Skills (HOTS) on the Critical Thinking Ability and Science Creativity of High School Students

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Received 03 December 2023 | Revised 08 January 2024 | Accepted 14 February 2024
doi: 10.63895/j30321271.2024.v1.i1.pp17-22

Abstract

This study was conducted to determine the influence of the integrated high-order thinking skills (HOTS) integrated problem-based learning (PBL) model on the critical thinking ability and science creativity of SMA Negeri 8 Palu Students on Redox Material and the great influence of the Integrated Problem Based Learning (PBL) high order thinking skills (HOTS) learning model (Towards Critical Thinking Skills and Science Creativity of SMA Negeri 8 Palu Students on Redox Material). The research method used is quantitative research, which is quasi-experimental with a non-equivalent research design, one group pretest-posttest design with one independent variable, namely the PBL learning model, and two dependent variables, namely the ability to think critically and scientific creativity. The population in this study was all 64 students in grade X IPA SMA 8 Palu. Determination of samples based on purposive sampling The class selected as the sample class is X IPA, which amounts to 20 people as an experimental class, and X IPA 2, which amounts to 20 people as a control class. Data collection using critical thinking ability test instruments and science creativity observation sheets. Test the hypothesis with a logistic regression test. Test results for students' critical thinking skills showed Nagelkerke R square significance values of 0.690 > 0.05 with F-count 0.365 > F-Table, which is 54.572. The results of the experimental science creativity analysis increased from 33.75, 35.62, and 38.43 at each meeting. While in the science creativity class from 33.43, 36.43, and 36.87 each meeting. The results showed that there was an influence of the HOTS-integrated PBL learning model after being given the test, and there was also an influence on science creativity after being observed with the observation sheet.

Keywords: HOTS, integrated PBL learning model, critical thinking skills, science creativity.

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HOW TO CITE: Nurhalis, F., Nuryanti, S., & Sakung, J. (2024). The influence of the integrated problem-based learning (PBL) model of high order thinking skills (HOTS) on the critical thinking ability and science creativity of high school students. *International Journal of Education, Humaniora, and Social Studies*, *1*(1), 17-22.

Introduction

Chemistry is a branch of science that studies matter, structure, composition, changes, and the energy that accompanies them. Therefore, in the learning process, students are expected to be able to understand, choose, and apply strategies used in solving problems related to chemistry (Chang, 2003).

Community 5.0 learning is related to changes in the learning system in that era. This era of revolution is closely related to the skills of the 21st century, which are related to rapidly developing technological advances. This also has a connection with the learning system, which certainly refers to increasingly advanced technological concepts. The concept of 21st century skills focuses on skills or abilities, innovation, and using technology. Wheres the 21st century skills promoted by the Ministry of Education and Culture, as stated in the 21st century skills learning implementation guidebook, are: (1) critical thinking and problem solving skills where students can think independently, be disciplined, self-monitor, and improve their own processes; (2) communication skills where students use the ability to express their ideas, how to use spoken language in relation to the attitudes they show, how they behave in listening to other people's opinions, and the use of multiple languages; (3) creativity and innovation, namely students are expected to have the ability to develop, implement, and be able to express creative ideas conceptually and factually; (4) collaboration means being able to work together, be responsible, respect and empathize, and be able to compromise with other friends. The concept of revolution that was initiated in Japan further encourages the role of humans in overcoming the paradigm of progress in the Industrial Revolution 4.0. This means that during society 5.0, humans are required to have a greater ability, to solve complex problems, think critically and be creative.

Five indicators that examine forming critical thinking skills are: (1) providing a simple explanation (elementary clarification); (2) building basic skills (basic support); (3) making conclusions (inference); (4) making further explanations (advanced clarification); and (5) strategy and tactics. Then the information received can be conveyed to other people, so a confident attitude is needed. Confidence is an important aspect of a person's personality. The first two types of self-confidence are born, consisting of self-love, self-understanding, goals, and positive thoughts. Second, inner self-confidence consists of communication, assertiveness, self-presentation, and controlling feelings (Riyanto & Ishartono, 2022).

Kuswanto (2022) research showed that the implementation of the PBL learning model in the learning process shows an increase in student learning outcomes

who are responsive in solving problems related to learning material actively, think critically, creatively, and independently in answering questions. In this research, the PBL model is also used so that learning becomes innovative and which can increase students' interest in learning in class.

Research by Khairani et al. (2022); is quasi-experimental research carried out by providing learning using the PBL model in redox material, which can have a positive influence on students' mastery of scientific concepts and attitudes. In this research, it was carried out in a control class. The research subjects were 64 students, and a two-tier test was carried out to determine the students' mastery of concepts.

Based on this description, it is clear that learning using the PBL model begins with a problem (which can be raised by students or teachers), and then students deepen their knowledge about what they already know and what they need to know to solve the problem. Students can choose problems that are considered interesting to solve so that they are encouraged to play an active role in learning. Problem-based learning is not designed to help teachers provide as much information as possible to students, but it is developed to help students develop thinking abilities, problem-solving skills and intellectual skills, learn various adult roles through their involvement in real-life experiences, and become independent and creative.

Methods

This type of research is quantitative and quasi-experimental in nature. The research design used is a non-equivalent one-group pretest-posttest design, using classes that are thought to have the same conditions, in this case the same based on the level of intelligence. This research was carried out using two classes. The first was a control class with a total of 20 students consisting of 9 male and 11 female, while the experimental class had 20 students consisting of 10 male and 10 female. This research design carried out one measurement at the pre-test before any treatment, then another measurement at the post-test (Abraham & Supriyati, 2022). The research instruments used were tests in the form of essay questions with seven numbers and observation questionnaires. Data analysis techniques were carried out in three stages, namely the normality test, the homogeneity test, and the hypothesis test. This research was carried out in the even semester in redox chemistry lessons at SMA N 8 Palu, which is located at Jalan Ragigu N. 3, Palu City, Tipo Village, Ulujadi District, Palu City, Central Sulawesi Province.

Results and Discussion

The research results showed that the average initial test for the control class was 19.20, and the final test was 62.30. The average initial test for the experimental class was 20.00, and the final test was 76.10. The final test average is higher than the initial test average. The following are the pretest and posttest graphs for the control class and experimental class. Based on Table 1, it can be seen the amount of data, minimum value, maximum value, average value, and standard deviation value from the experimental class pretest, experimental class posttest, control class pretest, and control class posttest.

Based on the data in the initial test, the average of the experimental class is higher than that of the control class, and the average of the final test of the experimental class is much higher than that the control class. The pretest normality results on critical thinking skills for the experimental class and control class show that all data from the experimental group and control group, as well as the pretest and posttest, show that the sig value of the data in the Shapiro table will be > 0.05, so the conclusion from this data is that it is normally distributed. experimental class. Based on the Table 1, it is known that the significance (sig) based on the mean value is 0.549 > 0.05, so it can be concluded that the variance of the experimental class post-test group and the control class post-test group is the same or homogeneous. Thus, one of the conditions of the independent sample t test can be fulfilled.

Table 1. Average and significant critical thinking ability of control and experiment classes.

Class	Pretest	Posttest
Experiment	20.00	76.10
Control	19.20	62.30

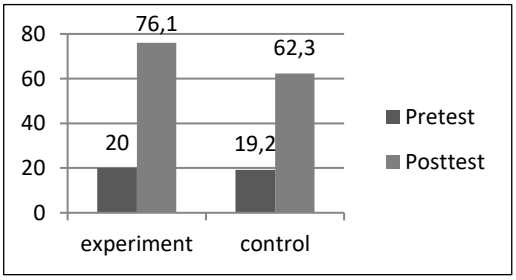

Figure 1. Results of critical thinking ability for the experimental class and the control class.

Based on the output above, the Sig value is known. Levene's Test for Equality of Variances is 0.549 > 0.05, so it can be interpreted that the data variance between the experimental group and the control group is homogeneous or the same. So the interpretation of the Independent Samples Test output table above is guided by the values contained in the " Equal variances assume " table. Based on the " Independent Samples Test " output table in the " Equal variances assumed " section, it is known that the sig. (2-tailed) is 0.00 < 0.05, so as the basis for decision-making in the independent sample t test, it can be concluded that Ho is rejected and Ha is accepted.

Table 2. Posttest normality results of critical thinking ability in the experimental class and the control class.

Class Results	Shapiro-Wilk		
	Statistics	df	significant
pre_experiment	.966	20	0.660
post_experiment	.984	20	0.975
Pre_control	.957	20	0.491
post_control	.971	20	0.771

From the results of the data above, it can be seen from the Nagelkerke R square that the value is 0.690. So it can be concluded that 0.690 > 0.05. This can show that the HOTS-integrated PBL model in the experimental class

and the PBL model in the control class also have an influence.

To measure the magnitude of the influence of the HOTS integrated PBL learning model on the experimental class, see Table 6 Coefficient of Determination for the Experimental Class. The R (square) result is 0.690, so the R value obtained shows a very weak correlation. It was concluded that using the HOTS-integrated PBL model had an influence on the critical thinking abilities of class X Science 1 students on redox material. This is supported by the statement from Ghozali (2018) that the coefficient of determination in logistic regression is seen from the Nagelkerke R square, because the Nagelkerke R square value can be interpreted like the R Square value in multiple regression. Nagelkerke R Square is a modification of the Cox and Snell coefficient to ensure that the value will vary from 0 (zero) to 1 (one). A Nagelkerke R square value close to zero indicates that the ability of the variables to explain the dependent variable is very limited, while a Nagelkerke R square value close to one indicates that the independent variable is able to provide all the information needed to predict the variability of the dependent variable.

Table 3. Science creativity in experiment class and control class

Meeting	Experiment	Category	Control	Category
1	33.75	Less Creative	33.43	Less Creative
2	35.62	Less Creative	36.43	Less Creative
3	38.43	Less Creative	36.87	Less Creative

The results of the analysis of students' scientific creativity in the experimental class at each meeting that experienced an increase can be seen in Table 6. Based on the data above, the experimental class experienced an increase from 33.75 to 35.62 to 38.43 in the less creative category. Meanwhile, the creativity score in the control class at each meeting also increased from 33.43 to 36.43 to 36.87 in the less creative category. In the independent t test on the control and experimental classes, on the pretest for independent there is no difference in pretest between the control class and the experimental class on problem solving ability. This shows that there is no difference in problem solving ability between the control class and the experimental class or have the same initial ability. While in the independent t test postest there is a difference in the average value after using the problem-based learning model assisted by Open-ended worksheet on problem solving skills. This shows that there is an effect of the problem-based learning model assisted by open-Ended worksheet on problem solving ability. To see how big the impact of the problem-based learning model has been tested using the effect size test based on the effect size test, the impact of the problem-based learning model assisted by Open-ended worksheet on problem solving ability is 5.4 in the large category. This shows that problem solving ability can be influenced by the problem-based learning model assisted by open-ended worksheet. While the effect of the problem-based learning model assisted by worksheet on problem solving ability is 5.0 in the high category. This shows the problem solving ability of experimental and control classes in the large category. However, in the experimental class is greater than the control class, this is due to the difference in worksheet which is the use of worksheet commonly used by the school and open-ended worksheet differs in questions to find steps to do the practicum, when using open-ended worksheet students are given questions to guide the practicum while in the control class worksheet there are steps about doing the practicum. Therefore, students are less in exploring the ability to solve because there are already steps that can be followed without having to look for the steps again.

In addition, the factor that affects problem solving ability is the use of problem-based learning model. This success is in accordance with the advantages of the Problem Based Learning model, which can train students to design a discovery, students have the ability to think and act creatively, students can solve a real problem, students can also identify and evaluate investigations, and can stimulate the development of students' thinking progress to solve a problem faced appropriately. In addition, the success of problem solving in the experimental class is supported by the use of Open-ended worksheet which is still rarely used so that students are encouraged to solve and find their own questions in the worksheet so that they can improve problem solving skills.

This is in accordance with, research conducted by Firmansyah at al. (2022) the use of the Problem Based Learning learning model has a significant effect on the ability of students to solve physics problems in the cognitive domain. Meanwhile, according to research by Sumiantari et al. (2019) the results showed that students who studied with the PBL model had better problem solving skills than students who studied with the STAD type cooperative model. In addition, research conducted by Togatorop and Sinuraya (2019) shows that the Problem Based Learning model affects the problem solving ability of students. Research conducted by. Meanwhile, in Ramadhani et al.'s (2019) research mathematics learning with a flipped-problem based learning model with LMS-Google Classroom has a significant effect in improving math learning outcomes. Surur et al. (2020) research shows that there are differences in the use of problem based learning models on problem solving abilities.

The ability to ask questions in the experimental class is for the first session, namely 65% in the good category, the second session is 60.8% in the good category and the third session is 69.5% in the good category. While in the control class for the first meeting, 61.9% in the good category, the second meeting was 52.38% in the good enough category and the third meeting was 57% in the good enough category. Based on the results above, it is appropriate to show that the use of a problem-based learning model assisted by open-ended worksheet on the ability to ask students in a good category. This is because in the open-ended worksheet experimental class given questions to find practicum steps so that students ask more often compared to the control class which is given steps so that students do not ask. In addition, although the quantity of questions is categorized as quite good in terms of the quality of questions for the control class and experimental class, students are still in the low category where at the cognitive level C1 and C2 in the control class and C1, C2 and C3 in the experimental class.

The ability to ask students is still classified as low-level cognitive, namely C1-C3, this is due to the lack of two-way communication between teachers and students and

students with students. Although the teacher has used the Problem Based Learning model in class where students in their learning activities are directed to discussion activities to stimulate the ability to ask questions. But in reality, most learners are less interested in problem-based discussion activities so that the quality of questions asked is only classified at a low cognitive level. Only a few learners are active in conducting discussions, most learners are less interested. This was due to: 1) learners who are individualistic in character, 2) learners still tend to be shy to ask questions, and 3) the willingness to have active discussions is still small.

The relationship between problem solving ability and questioning ability of the control class analyzed by Paerson's correlation test shows that there is a relationship between problem solving ability and questioning ability of the control class. The relationship between problem solving ability and questioning ability in the experimental class shows that if problem solving ability and questioning ability have a strong relationship.

Conclusions

Learning in the experimental class with the HOTS integrated PBL model has a significant effect on the critical thinking abilities and creativity of class X SMA N 8 Palu students in redox material. Learning with the control class PBL model has a significant effect on the critical and creative thinking abilities of class X SMA N 8 Palu students on redox material.

Acknowledgments

The author would like to thank and appreciate those who supported this research, especially the head of SMA 8 Palu and the students who have donated their time to provide research material.

Conflicts of Interest

All authors declare that they have no conflicts of interest.

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International Journal of Education, Humaniora, and Social Studies, March 2024 Volume 1 Number 1, pp 17-22