JPMIPA woro 2019

by Woro Sumarni

Submission date: 08-Jan-2020 09:12AM (UTC+0700)
Submission ID: 1239922165
File name: JPMIPA_24_1_April_2019.pdf (598.44K)
Word count: 5284
Character count: 30025

Jurnal Pengajaran MIPA
Vol. 24, No. 1, April 2019, hlm. 8-16
ISSN 1412-0917 (print)/ 2443-3616 (online)
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DOI: 10.18269/jpmipa.v24i1.17332

THE EFFECTI VENESS OF BLENDED PROBLEM-BASED LEARNING FOR ENHANCING COGNITIVE AND LEARNING OUTCOMES OF STUDENTS CRITICAL THINKING SKILLS ON REDOX MATERIALS

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ABSTRAK

Penelitian ini bertujuan untuk mengetahui pengaruh *blended problem based learning* terhadap hasil belajar kognitif dan keterampilan berpikir kritis siswa kelas X MIPA SMA Negeri 1 Subah. Metode penelitian yang digunakan adalah eksperimen dengan desain penelitian *pretest-posttest control group design*. Teknik sampling yang digunakan yaitu *cluster random sampling*, dengan kelas X MIPA 4 sebagai kelas eksperimen dan X MIPA 2 sebagai kelas kontrol. Teknik analisis yang digunakan yaitu uji perbedaan rata-rata, analisis pengaruh antar variabel, dan penentuan koefisien determinasi. Hasil penelitian diperoleh rata-rata nilai hasil belajar kognitif dan rata-rata skor keterampilan berpikir kritis. Analisis pengaruh antar variabel menghasilkan nilai koefisien biserial 0,23 untuk hasil belajar kognitif dan 0,25 untuk keterampilan bepikir kritis. Perhitungan koefisien determinasi menunjukkan penerapan *blended problem based learning* berkontribusi sebesar 5,5% terhadap hasil belajar kognitif dan 6,5% terhadap keterampilan berpikir kritis. Hasil penelitian menunjukkan rata-rata nilai hasil belajar kognitif kelas eksperimen sebesar 73,71 sedangkan kelas kontrol sebesar 69,47. Rata-rata skor keterampilan berpikir kritis kelas eksperimen sebesar 29,65 sedangkan kelas kontrol sebesar 27,88. Berdasarkan hasil penelitian dapat disimpulkan bahwa penerapan *blended problem basedlearning* berpengaruh terhadap hasil belajar kognitif dan keterampilan berpikir kritis siswa kelas X MIPA SMA Negeri 1 Subah pada materi redoks.

Kata kunci : Hasil belajar kognitif, keterampilan berpikir kritis, *blended problem-based learning*, redoks.

ABSTRACT

This study aims to determine the effect of the blended problem based learning on cognitive learning outcomes and critical thinking skills in class X MIPA State Senior Highschool 1 Subah. The research method used was an experimental design with a pretest-posttest control group design. The sampling technique used was the cluster random sampling, with class X MIPA 4 as the experimental class and X MIPA 2 as the control class. The analysis technique used is the average difference test, the effect analysis between variables and the determination of the coefficient of determination. The results of the study were obtained by the average value of cognitive learning outcomes and the average score of critical thinking skills. Analysis of influence between variables resulted in a biserial coefficient of 0.23 for cognitive learning outcomes and 0.25 for critical thinking skills. Calculation of the coefficient of determination shows that the application of blended problem-based learning contributes 5.5% to cognitive learning outcomes and 6.5% to critical thinking skills. The results showed that the average value of the experimental class cognitive learning outcomes was 73.71 while the control class was 69.47. The average score of the experimental class critical thinking skills is 29.65 while the control class is 27.88. Based on the results of the study, it can be concluded that the application of blended problem-based learning affects the cognitive learning outcomes and critical thinking skills of class X MIPA State Senior Highschool 1 Subah on redox material.

***Keywords**: Cognitive learning outcomes, critical thinking skills, blended problem-based learning, redox*.

How to cite: Khasanah, A. & Sumarni. W. (2019). The Effectiveness Of Blended Problem-Based Learning For Enhancing Cognitive And Learning Outcomes Of Students Critical Thinking Skills On Redox Materials. *Jurnal Pengajaran MIPA*, 24 (1), 8-16.

INTRODUCTION

The progress of information and communication technology is one of the causes and triggers of change in the world of education. Science and technology that are now increasingly developing demand the world of education to produce good and superior quality education.21st-century education encourages students to master important and useful skills to be more responsive to changing times. The most important thing is to have a deep knowledge base and understanding (Afandi et al., 2016). Our government's efforts in facing the demands of 21st-century education, namely by implementing the 2013 curriculum as a reference for the implementation of education.

The 2013 curriculum has an important role in the superior change in Indonesian education. The 2013 curriculum aims to direct students to master and have competency in knowledge, attitudes, and skills (Kemendikbud, 2014). The learning characteristics in the 2013 curriculum emphasize learning that is scientifically approached such as the Problem based learning, Inquiry, Discovery, and Project Based Learning models. Learning models that emphasize thinking skills and science process skills so as to realize learning goals attitudes, knowledge, and skills in an effort to realize the religility of students (Rosita et al., 2014). The learning model applied is expected to be able to help students in chemistry learning.

Chemistry is a subject that is considered difficult by students and difficult to understand because it is abstract. Difficulties in learning chemistry have an adverse effect on students' understanding. This condition was revealed when researchers conducted classroom observations and interviews with chemistry teachers at Subah Senior High School 1 and Batang Senior High School 1 showed that the teaching and learning process had led to a learning model with scientific approach indicated by observing, asking, trying, elaborating, and communicate. The discussion method is applied to solve or work on the problem after the teacher explains a material. The teacher no longer starts learning by giving a lot of explanations. However, the results of observations show students still tend to memorize concepts rather than understanding concepts. This is evidenced, at the time of learning students can work on examples of questions given by the teacher but when held daily tests with different questions most students have not been able to do it corr ectly. The results of the daily redox test results show that only 50% of students complete.

Students' critical thinking skills are also not measurable because the form of questions that the teacher composes does not require students to think critically. Understanding of concepts that are still relatively low of course also has an impact on their critical thinking skills. This is in line with what was conveyed by Jufrina and Utami (2016) that the low critical thinking skills of students are due to a lack of understanding of chemical material. Students' critical thinking skills that are still low can also be seen during class observations, it seems that only certain students are actively asking or arguing. This is in line with the research findings of Widayat et al. (2017) that students still feel difficulties with a problem that requires critical thinking skills.

Critical thinking skills are skills by meeting various intellectual standards such as clarity, relevance, adequacy, and coherence (Sumarni et al., 2018). A critical thinker ideally has 12 critical thinking skills which are grouped into 5 aspects, namely: elementary clarification, basic for the decision, inference, advanced clarification, and supposition and integration (Ennis, 2011). Based on research in the learning process at PPMI Assalaam Senior High School Sukoharjo shows that the percentage of students asking about the material being taught is 14.28%, students answer questions from teachers with 9.52% appointed by previous teachers, students use limited learning resources in the form of textbooks during teaching and learning process is 85.71% and students pay less attention when teaching and learning process takes place at 19.04%. Students have not been optimally involved in learning activities such as discussion activities, analyzing problems, concluding learning activities and tend to be teacher-centered so that learning is more towards the transfer of knowledge. Learning has also not maximized the use of technological sophistication at this time, for example, online learning and online testing.

Learning objectives that are in accordance with the 2013 curriculum will be achieved if the teacher plays a role in using appropriate learning strategies, student-centered, can improve critical thinking skills and can explore learning resources (Adelita et al., 2017; Jufrina&Utami, 2016). Problem Based Learning (PBL) model is a learning model that stimulates students to think

about solving contextual problems, sharpens critical thinking skills, improves student learning outcomes, works in collaborative groups, increases self-confidence, and encourages students to learn independently (Mariani et al., 2014; Marra et al., 2014; Rachmawati et al., 2015). Problem-Based Learning (PBL) model make students think more than memorizing, understand better lessons through discussion, can improve student learning outcomes on chemical material, encourage democracy in learning effectiveness, and can develop creativity (Suharta&Luthan, 2013).

The Problem Based Learning (PBL) model can make students more active in thinking and understanding material in groups based on real problems around them. The problem based on the PBL model proposed by Hamdani (2015) is that the success of PBL requires a long time to generate interest and motivation for students to play an active role during the preparation and implementation of learning. Blended learning can be used as a solution to overcome obstacles in the PBL model. Blended learning is a learning approach that integrates face-to-face learning and distance learning that uses online learning resources (Dogan, 2017). Teachers can apply to learn using e-learning combined with face-to-face learning called blended learning. Blended PBL does not eliminate classroom teaching or direct communication. Complementary forms of communication are added which appear to have the potential to better integrate the steps of classroom learning and the period of self-learning during the PBL process (Woltering et al., 2009). For this reason, the researcher wants to know the effect of applying blended problem based learning on cognitive learning outcomes and students' critical thinking skills on redox material.

METHODS

This research is experimental research. The research was conducted at State Senior Highschool 1 Subah in the X grade MIPA in the second semester on redox material. The research design used was the pretest-posttest control group design by comparing the values of cognitive learning outcomes and the scores of critical thinking skills of the two classes after being given different treatments. The experimental class and control class were selected by cluster random sampling with class X MIPA 4 as the experimental class and X MIPA 2 as the control class. The sample was chosen by cluster random sampling technique because the population was normally distributed and homogeneous (Sugiyono, 2013). The independent variable in this study is the application of blended PBL, while the dependent variable is the results of cognitive learning and students' critical thinking skills.

The experimental class is a group with the application of Blended Problem Based Learning (BPBL), while the control class is a group with the application of Problem Based Learning (PBL). The research design is presented in Table 1.

Table 1. Research Design

Class	*Pretest*	Treatment	*Posttest*
Exp	T_1	X	T_2
Ctr	T_1	Y	T_2

X : Applied Blended Problem Based Learning (Blended PBL)
Y : Applied Problem Based Learning (PBL)
T1 : Pretest
T2 : Posttest

Online learning activities that teachers can provide through Edmodo vary. The teacher delivers discussion material using the Note menu or notes made to be shared with students. Teachers can attach learning files or website addresses to be shared with students as learning material. The teacher can make assignments for students to use the Assignment menu. Another activity that is carried out in online learning is that the teacher gives a quiz that can immediately find out the answer using the quiz menu. Students can also discuss interactively or share information with all members of online learning namely teachers and friends. Blended problem-based learning does not eliminate classroom teaching or direct communication. In contrast, blended learning is a form of complementary communication added (Woltering et al., 2009).

The application of blended problem-based learning has two stages of interconnected learning. The learning process begins with online learning via Edmodo. Students in online classes can carry out learning activities, such as reading the material, doing assignments, and discussing with teachers and other students. Learning in class, researchers organize students to learn by forming

9 groups consisting of 4 students per group. Problems given are based on problems that exist in everyday life. Each group is given a Student Worksheet containing the PBL syntax. Students discuss in groups to solve problems in the student worksheet. Giving problems, question and answer and discussion is not only done face to face but also online.

Data collection methods used in this study are test, observations, and questionnaires. The instrument of data collection includes 10 essay questions in which there are indicators of achievement of competencies and indicators of critical thinking, observation sheets of critical thinking skills, and questionnaires on students' responses to learning. Data analysis techniques used are normality test, variance test, average difference test, analysis of the influence between variables and determination of the coefficient of determination. The results of the study were in the form of pretest and posttest scores on cognitive learning outcomes, scores of critical thinking skills, and questionnaires on students' responses to learning. The results of observations of critical thinking skills are used for supporting data on critical thinking skills based on the test method.

RESULTS AND DISCUSSION

The results of the effect test of the application of the blended PBL to cognitive learning outcomes and students' critical thinking skills are presented in Table 1, Table 2, and Table 3.

Table 1. Results of Determination of the Coefficient of Determination

Data	r_{bis}	Coefficient of Determination
Cognitive Learning Outcomes	0,23	5,5%
Critical Thinking Skills	0,25	6,5%

Table 2. Average Difference Test Results

Data	t_{count}	t_{table}	Comments
X MIPA 4 (Experiment Class) X MIPA 2 (Control Class)	1,56	0,063	The average posttest value of the cognitive learning outcomes of the experimental class students is higher than the control class
	1,729		The average posttest value of the cognitive learning outcomes of the experimental class students is higher than the control class

Table 3. Results of N-Gain Calculation

Posttest Value Data	Class	*Pretest*	*Posttest*	*N-Gain*	Criteria
Cognitive Learning Outcomes	Experiment	28,09	73.71	0,63	Moderate
	Control	39,76	69,47	0,49	Moderate
Critical Thinking Skills	Experiment	13,5	29.65	0,61	Moderate
	Control	17,23	27.88	0,47	Moderate

Based on the results of the research presented in Table 1, it was found that the application of the blended problem based learning to redox material had an effect on students' cognitive learning outcomes. This is in line with the results of Hamdani's research (2015) that blended problem-based learning significantly influences the understanding of concepts. The effect of applying blended problem-based learning is also indicated by the results of the posttest analysis of the two classes. The average difference test presented in Table 2 and the N-gain calculation in Table 3, the experimental class is higher than the control class. These results indicate that the application of the blended problem based learning in the experimental class is better than the implementation of problem-based learning in the control class. These results are in accordance with Sandi (2012) and Manggabarani et al. (2016) that the average score of student learning outcomes following blended learning is higher than the average score of

learning outcomes of students who take direct learning.

The effect of applying blended problem based learning on redox material to students' cognitive learning outcomes, due to the application of the problem based learning when classroom learning accustoms students to be more active in thinking and understanding material in groups based on real problems around them (Suharta&Luthan, 2013) Problem-based learning is also more efficient than conventional learning in chemical material (Hajrić, 2015), because the implementation of group discussions in PBL blended not only during classroom learning but also conducted outside the classroom online and this proved to be very helpful for students to understand the material not yet understood in class learning and increasing student interaction in the learning process (Donnelly, 2012). This is in line with the response of students who argue that the application of blended problem-based learning can provide an opportunity to argue and exchange ideas with friends in discussions, students feel enthusiastic about participating in PBL in classes and blended learning outside the classroom. The application of blended learning also affects students' motivation and interests. Students are more interested and motivated to learn because they use technology on social networks that can be opened anywhere compared to using thick textbooks (Manggabarani et al., 2016).

In addition to the cognitive learning outcomes of students, based on Table 1, Table 2, and Table 3, it shows that the application of the blended problem based learning to redox material influences students' critical thinking skills. This is in line with the research of Fariska & Erman (2015) stating that the application of blended learning can improve students' critical thinking skills. Another study from Rachmawati et al. (2015) which states that the application of problem-based learning can improve students' critical thinking skills.

The effect of applying blended problem based learning on redox material on students' critical thinking skills is because students become more active in finding information sources for learning. This is according to Cahyadi et al. (2012) that the application of blended learning optimizes students in the use of information and communication technology sources and interactions that occur can help to develop students' critical thinking skills. This is also in line with the response of students who argue that implementing blended problem-based learning makes it active in discussions, encourages students to seek information from various sources and improve students' critical thinking skills.

A comparison of achievement indicators of competency achievement between the experimental class and the control class is presented in Figure 1.

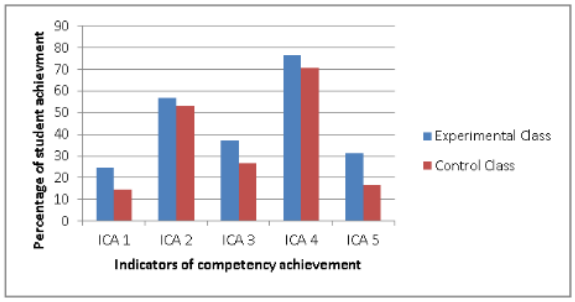

Figure 1. Percentage of Indicators of Competency Achievement between Experimental Classes and Control Classes

Information:
ICA 1: Explain redox reactions
ICA 2: Determines the oxidation number of atoms in molecules or ions
ICA 3: Distinguish redox reactions, not redox, autoredox, and proportionality
ICA 4: Determine oxidizers and reducing agents in redox reactions.
ICA 5: Analyze assumptions regarding redox events in everyday life.

The achievement of each indicator of achievement of the academic competence of the experimental class is better than the control class. Figure 1 shows that the percentage of indicators that are very good at achieving that is determining oxidizers and reducing agents in redox reactions. The percentage of achievement of these indicators is more than 75%, which is equal to 76.47% for the experimental class while the control class is in a good category because the percentage of achievement is less than 75%, which is 70.59%. Students have been able to determine oxidizers and reducing agents in redox reactions. Students have been able to distinguish which ones experience oxidation and which experience a reduction of course students can determine which oxidizer is and which one is the reducing agent.

The percentage of results can be caused because the level of questions representing the indicator determines the oxidation and reducing agent in the redox reaction at the C3 level. The level of C3 questions is a matter of application-based. The high percentage figure on this indicator proves that most students have been able to understand the material on this indicator well and are able to achieve knowledge competencies on indicators to determine oxidators and reducing agents in redox reactions. Based on these results the class with the treatment of blended problem-based learning is higher than the usualproblem-based learning treatment. In line with Hamdani's research (2015), the blended problem-based learning model (experimental class) was significantly better than the problem-solving ability test scores using ordinary Problem-based learning (control class) models. The existence of online learning outside the classroom makes students practice more questions and discuss also not only in the classroom.

The percentage of achievement in the indicator explains the reaction in the fewercategories because the percentage of achievement is less than 25%. The percentage results can be caused because the level of the questions representing the indicator explains the redox concept at the C4 level which allows students the difficulty in analyzing the problem. The indicator explains the redox concept students are asked to analyze a reaction and give a reason why the reaction is a redox reaction based on the redox concept. Students have not been able to explain the reasons based on the redox concept that has been studied, which is based on binding or releasing oxygen, binding or releasing electrons, and increasing or decreasing oxidation numbers. This is in accordance with Sumarni's research (2015) that differences in approaches or strategies used in the learning process do not significantly affect students' ability to apply accepted principles.

Comparison of indicators of achievement of critical thinking skills between the experimental class and the control class is presented in Figure 2 and Figure 3.

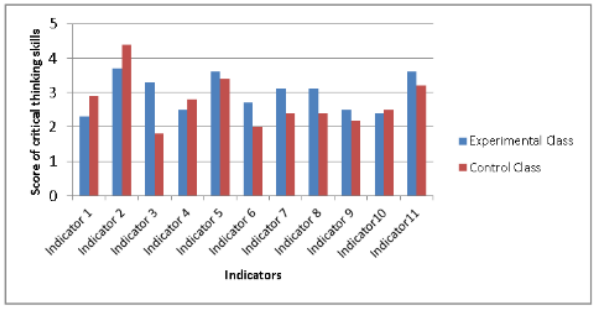

Figure 2. Achievement of Critical Thinking Skills Based on Tests

Information:
Indicator 1 : focus the question
Indicator 2 : analyze questions
Indicator 3 : ask and answer questions about an explanation
Indicator 4 : observe and consider the observation report
Indicator 5 : consider whether the source is reliable or not
Indicator 6 : make and consider the results of consideration
Indicator 7 : induce and considers induction
Indicator 8 : define terms and consider a definition
Indicator 9 : identify assumptions
Indicator 10 : determine an action
Indicator 11 : deduce and consider the results of deduction

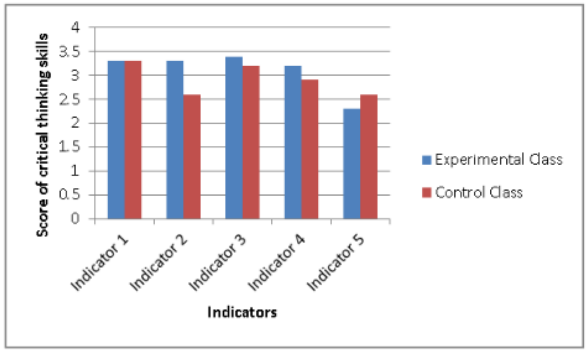

Figure 3. Achievement of Critical Thinking Skills Based on Observation

Information:
Indicator 1 : determine an action
Indicator 2 : deduce and consider the results of deduction
Indicator 3 : induce and considers induction

Indicator 4 : observe and consider the observation report
Indicator 5 : interact with other people

Based on Figures 2 and 3, the results of the study show that the average critical thinking skills of the experimental class are generally superior to the control class. The average results of the critical thinking skills of the experimental class students in the critical category while the control class in the category is quite critical. The effect of applying blended problem based learning to critical thinking skills in a very good category is that the indicators analyze questions, consider whether the source can be trusted or not, and deduce the results of deduction. The indicator of analyzing the question is one of the simple aspects of explanation (Ennis, 2011). Achievement in this indicator is the highest achievement of all indicators of critical thinking. The application of the PBL model emphasizes students to practice expressing a problem to get a solution. Students are trained to solve problems or problems both individually and in groups. The existence of Edmodo media as a tool for the blended learning model helps students practice and discuss more not only in the classroom but anywhere online. The high achievement of the simple explanation aspect is supported by Sumarni's research (2015) which revealed that the simple explanation indicator is the highest indicator because the experimental group has been accustomed to identifying problems after observing and formulating questions.

The indicators consider the sources of whether or not students can be categorized as very well. The criteria for this indicator are to consider the suitability of the appropriate sources and procedures in working on the problem. This is because the application of the Blended PBL encourages students to look for various learning resources both books and the internet. The existence of learning resources helps students in solving a problem presented. The application of blended learning makes students search for resources online, with many resources available on the internet students are trained to consider which sources are correct and reliable that are in accordance with what is in the book. This is in line with the research of Cahyadi et al. (2012) that the application of blended learning makes students more active in finding information sources for learning and able to categorize the information obtained. The indicators deduce and consider the results of the deduction of student achievement also categorized very well. The indicator is the ability of students to draw conclusions from general statements to specific (Ennis, 2011). A good achievement on this indicator is influenced by the PBL syntax, namely the phase of analyzing and evaluating the problem-solving process. The phase analyzes and evaluates the problem-solving process, namely students are assisted by the teacher reviewing the investigations conducted and evaluating whether the results of the problem solving done by the students are correct, then drawing conclusions from the learning outcomes.

Although there are several indicators of critical thinking skills that are superior to the experimental class. Based on Figure 2 the comparison of test scores of critical thinking skills between the experimental class and the control class showed that indicators 1, 4 and 10 were superior to the control class compared to the experimental class. These indicators are indicators that focus questions, observe and consider the results of the observation report, and determine an action. The results of the difference in scores haven't been so far, this is because the experimental class is not thorough and careful in understanding the questions. In addition, the difference in treatment between the experimental class and the control class is only in the application of blended learning, while learning in the classroom both use the PBL model. Based on the observation results, the average score of the critical thinking skills of the experimental class students is more than the control class. This proves that the application of blended PBL is better than ordinary PBL. These results are in line with the research of Cahyadi et al. (2012) that blended learning can improve students' critical thinking skills.

Nevertheless, the effect of applying blended PBL to cognitive learning outcomes by 5.5% and on critical thinking skills of 6.5% is classified as low, indicating that there are still many weaknesses in its application. There are still other factors that influence the achievement of cognitive learning outcomes of students' critical thinking skills that are not the focus of this study. Constraints experienced by students include unstable signals caused by natural conditions so that many students complain about the difficulty of the signal to carry out learning activities at Edmodo. This is consistent with what Pranoto et

al. (2014) that the learning process with the blended learning model and blended learning integration - PBL will be disrupted if there are problems on the server that make the signal from the hot spot area too weak.

CONCLUSION

Based on the research that has been done, the application of blended PBL affects the cognitive learning outcomes and students' critical thinking skills on redox materi. This is indicated by tcount (1.56)> ttable (0.063) that the average posttest value of cognitive learning outcomes and critical thinking skills of the experimental class students is higher than the control class. The magnitude of the effect of applying blended PBL to cognitive learning outcomes and students' critical thinking skills, namely 5.5% and 6.5%, respectively, is low because the application of blended learning is not maximal.

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