The Implementation and Effect of Problem-Based Learning Based on Local Wisdom Toward Students' Communication and Critical Thinking Ability on Temperature and Heat Topic

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Abstract

The researcher conducted the research to determine the effect of implementing the problem-based learning model based on local wisdom on the students' communication and critical thinking ability. This type of research was quasi-experimental using a pretest-posttest nonequivalent control design. The research population was students of class XI science Senior High School 5 Jambi City with a sample of two classes, namely the experimental and control classes. The researcher used the data collected using a test instrument measuring students' written communication and critical thinking. The researcher used the observation sheet instrument to measure students' oral communication. Data analysis techniques are descriptive and inferential to test the hypothesis. Inferential analysis using independent sample t-test, paired t-test and manova test. The results of the descriptive analysis of the average pretest using 33.06 and 29.33 test questions in the experimental class while the control class on each test item is 31.71 and 24.65. The average results of post-test scores after implementing the problem-based learning model based on local wisdom on written communication and critical thinking were 59.07 and 57.06 in the experimental class, while in the control class 44.68 and 35.19. The inferential analysis of the problem-based learning model based on local wisdom has a good influence on oral, written communication and critical thinking. There are differences in students' communication and critical thinking using a problem based learning model based on local wisdom showing good results. There is a simultaneous influence on oral, written and critical thinking communication skills by implementing a problem based learning model based on local wisdom.

Keywords: problem based learning model, local wisdom, oral communication ability, writing, critical thinking

INTRODUCTION

Communication plays an essential role in education, especially in learning activities that occur in schools. The existence of good communication between teachers and students and with other students will achieve what is expected to achieve the goals of success in the learning process and help students understand the material being studied. Lessons learned must receive feedback from students. In this

feedback activity there will be communication between teachers and students in the form of oral and written communication (Sudia, Puspita & Muhammad 2020). The ability to communicate verbally can occur especially during discussions because it will lead to direct interaction in groups which aims to make each student in the team able to help, interact and communicate effectively. While written communication is communication that can be expressed ideas or opinions through writing (Iftitahurrahimah, Andayani & Idrus 2020). Oral and written communication skills involve vocabulary and mastery of skills in choosing the right words to give meaning. The learning process should combine oral and written communication skills to help improve a good impression between teachers and students in the teaching and learning process (Abdikarimov et al. 2021).

In addition to communication skills, students' critical thinking needs to be trained and developed. Critical thinking skills need to be planted in students' characters to train cognitive analysis, evaluation and creation, so that they can be applied to learning activities. The existence of critical thinking skills possessed by students can make the right decisions so that they do not receive directly all the latest sources of information obtained but need to be analyzed reflectively and produce a decision that can be trusted and applied in everyday life (Dakabesi & Luoise 2019). There needs to be an effort given to students to be able to think critically in the learning process.

Communication and students' critical thinking can occur if it is carried out with appropriate learning steps and learning materials can be understood by students, giving rise to interactions that can encourage students' communication and critical thinking skills. Physics material not only explains concepts and theories but can analyze students' abilities, the relevance of material concepts is also closely related to everyday life.

Based on the results of observations by conducting interviews in class XI science Senior High School 5 Jambi City, students' communication and critical thinking skills are still low. This is because students experience difficulties in understanding physics material. Students are not able to ask questions and provide feedback to the teacher and other students. Critical thinking skills that only a few students are able to solve physics problems individually. However, most students see on the internet the answers to questions and work with friends without analyzing and re-evaluating the material explained by the teacher with what is on the internet. Teachers use learning models that are less varied so they only tend to use discovery learning and are not linked to local wisdom which should be able to train student process skills that need to be mastered by students. The teacher does not use local wisdom because it is still challenging to identify the potential of Jambi's local wisdom which can be used as a source of science learning so that only explaining the application in everyday life, the material is abstract, only explanation.

One of the efforts to overcome the problems is to provide solutions using a problem-based learning model based on local wisdom. The application of the problem-based learning model as a student-centered approach, is designed to facilitate collaborative learning and encourage students to in-depth learning (Aslan 2021). The problem based learning model is a learning model that presents problems to students which can be helpful for investigating problem solving. Through these learning strategies, students can train to communicate effectively, develop critical thinking and problem solving skills and gain knowledge (Wilsa, Susilowati & Rahayu 2017; Deep, Salleh & Othman 2019). Problem based learning learning model has to do with communication skills and critical thinking, because students are given a problem to involve critical thinking and communication skills in learning activities.

The local wisdom-based learning model is an integrated learning of the value of local wisdom in the community linked to learning materials. Using local wisdom in student learning activities not only teaches concepts but also recognizes the value of local wisdom. Each region has a unique local wisdom containing environmental conservation values that have meaning so they can be applied in everyday life (Febriani, Sudarmin & Alimah 2020; Sriyati et al. 2021). Based on the idea above, the purpose of this research will be to determine the effect of implementing a problem based learning model based on local wisdom on students' communication and critical thinking skills on the material of temperature and heat in class XI science Senior High School 5 Jambi City.

METHODS

The research was conducted using a quasi-experimental type (quasi-experimental) using a pretest-posttest nonequivalent control group design. Based on the design, two classes were used as experimental classes with problem based learning model treatment based on local wisdom and control class only used conventional models. The population used in this study were all students of class XI science Senior High School 5 Jambi City by taking the number of samples as many as two classes, namely the experimental and control classes, with a total of 58 students.

The researchers were collecting data using test questions and observation sheets. Test questions measure the ability of written communication and critical thinking in the pretest and post-test activities-observation sheet to observe oral communication skills assessed by observers. The instruments used in the study were validated by experts and carried out trials to determine the level of validity and reliability.

The research procedure has three stages, namely the first is to analyze the results of the preliminary study, collect and analyze relevant references, develop tools, media and instruments. Validate the instrument against experts and test the instrument that has been validated to determine the validity and reliability of the instrument. The second research implementation was started by giving pretest and post-test after being given treatment with problem based learning model based on local wisdom in the experimental class and the control class was not given any treatment.

Validation of test questions and observation sheets was carried out by asking for expert judgment and testing was carried out to determine the validity and reliability of the instrument. The results of the written communication test questions 8 questions were tested and all questions were valid—critical thinking test questions of 10 questions only 8 valid questions. The reliability of the questions and the two instruments' observation sheets are reliable.

The data that has been collected is analyzed data. The data analysis techniques used in this research are descriptive and inferential analysis. Before the test, prerequisite tests were conducted, namely normality and homogeneity. Statistical analysis was conducted to determine the effect of treatment on students' communication and critical thinking. Descriptive analysis was used to analyze the percentage scores obtained from test questions and observation sheets. Inferential analysis was used to test the research hypothesis using the independent sample t-test, paired t-test, and multivariate test using the SPSS 22 software application. The independent sample t-test test aims to determine the differences in students' oral communication, written communication and critical thinking skills by implementing a problem-based learning model based on local wisdom separately in the experimental and control classes. Paired t-test was used to analyze the differences between two pairs of sample groups. In this study, the paired t-test was used to find out how the students' communication and critical thinking differed in the pretest before and after being treated in the form of a problem-based learning model based on local wisdom. The multivariate test aims to jointly examine differences in students' communication and critical thinking skills by implementing a problem based learning model based on local wisdom.

RESULTS AND DISCUSSION

Instrument Validation

Validity and reliability

The results of the validity of the students' communication and critical thinking test instruments in TABLE 1 and TABLE 2 refer to the provision criteria, namely the test instrument that the instrument is valid if the score is $r_{count} \geq r_{table}$ then the instrument is valid and suitable for use in research.

TABLE 1. Instrument validity about written communication

Test questions	r_{count}	r_{table}	Description
Question 1	0.478	0.235	Valid
Question 2	0.321	0.235	Valid
Question 3	0.439	0.235	Valid

Test questions	r_{count}	r_{table}	Description
Question 4	0.569	0.235	Valid
Question 5	0.560	0.235	Valid
Question 6	0.709	0.235	Valid
Question 7	0.512	0.235	Valid
Question 8	0.578	0.235	Valid

TABLE 2. Instrument validity about critical thinking

Test questions	r_{count}	r_{table}	Description
Question 1	0.778	0.235	Valid
Question 2	0.756	0.235	Valid
Question 3	0.410	0.235	Valid
Question 4	0.011	0.235	Invalid
Question 5	0.661	0.235	Valid
Question 6	0.220	0.235	Invalid
Question 7	0.556	0.235	Valid

Based on the results of the validity of the communication test questions, all of the eight questions tested were valid. While the critical thinking test questions, as many as ten were tested, there were only eight valid questions. The results of the reliability of the test questions and observation sheets that the value of $r_{count} \geq r_{table}$ then the instrument is reliable and following the criteria. If the instrument is valid and reliable, the researcher can use the instruments in experimental and control classes research.

Descriptive Data Analysis

Students' verbal communication skills

The students' verbal communication was measured using an observation sheet instrument referring to the indicators and assessed by observers during the learning process. The results of data analysis of students' verbal communication in the experimental and control classes increased during two meetings-the percentage of the average score of the experimental class with a higher value than the control class. The average results of students' verbal communication skills for two meetings are in TABLE 3.

TABLE 3. Observation of students' verbal communication

Observation Results	Experiment Meeting		Control Meeting	
	1	2	1	2
Average score	52.64	69.70	49.18	54.07
The highest score	65	87	61	69.75
The lowest score	45	55	39	41
Standard deviation	5.33	8.81	6.19	6.57
Total students	31	31	27	27

The experimental class was treated with a problem-based learning model based on local wisdom so that it experienced a better average score increase at meetings 1 and 2, namely 52.64 and 69.70. The control class was not given any treatment and only used a conventional model, so the average value was lower than the experimental class at meetings 1 and 2, namely 49.18 and 54.07.
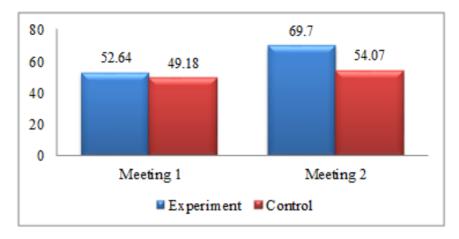
FIGURE 1. The average score of students' verbal communication

Implementing the problem-based learning model based on local wisdom in the experimental class is better than the conventional control class model to improve students' verbal communication. The research results obtained are supported by (Iftitahurrahimah, Andayani & Idrus 2020). The problem-based learning model teaches students to be responsible for mastering the material. Based on this, students are required to provide ideas and to problem-solve in the form of solutions. If students have mastered understanding the material, it can make students easier to express ideas in finding solutions to problems found on student worksheets.

Written communication skills and critical thinking

The results were obtained using test questions to measure students' written communication and critical thinking skills from pretest and post-test data after being given a problem-based learning model based on local wisdom. The results of the pretest and post-test data on students' written communication skills and critical thinking are in TABLE 4.

TABLE 4. Descriptive statistics of written communication skills and critical thinking

Description of Observation	Pretest				Posttest			
	Critical thinking		Written communication		Critical thinking		Written communication	
	(E)	(K)	(E)	(K)	(E)	(K)	(E)	(K)
Average score	29.33	24.65	33.06	31.71	57.06	35.19	59.07	44.68
The highest score	66	56	75	63	84	66	84	69
The Lowest value	0	0	0	0	25	13	19	6
Standard deviation	19.44	18.18	23.08	21.66	14.94	15.97	15.81	17.61
Total students	31	27	31	27	31	27	31	27

The results of the written communication and critical thinking pretest showed that the average results of the experimental class were higher than the control class. Based on the written communication data in the experimental class, the average was 33.06, and the control class was 31.71. The data obtained from students' critical thinking in the experimental class averaged 29.33 and the control class 24.65. The results of post-test data on written communication and critical thinking in the experimental class with an average result of 59.07 and control that is 44.68. The average value of critical thinking students in the experimental class was 57.06, and in the control class was 35.19.
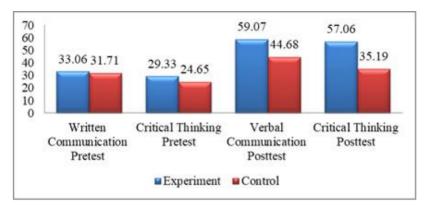
FIGURE 2. The average value of the pretest and post-test of written communication and critical thinking

Based on the average pretest and post-test percentages of written communication and critical thinking, experimental class students experienced a higher increase than the control class. The results obtained are in line with research (Fikry, Yusrizal & Syukri 2018) that using the problem-based learning model shows the average value of the experimental class is higher than the control class, so the application of the problem-based learning model is better used to improve the critical thinking skills of participants if it's compared to conventional models.

Problem-based learning is a constructivist learning model that not only guides and helps students solve problems that reflect real situations but also involves students being able to play an active role and think to solve a problem before the learning content is introduced. The advantage of PBL is that it can generate students' ideas and encourage students to argue and argue about a problem that is being discussed. So it can encourage and increase students' HOTS spontaneously (Ismail et al. 2018; Aslan 2021).

Inferential Data Analysis

Prerequisite test

Prerequisite tests must be met as a condition for testing the hypothesis by first conducting normality and homogeneity tests for each experimental and control class.

Normality test

The normality test aims to determine whether the data obtained are normally distributed and as a condition to test the hypothesis using the Kolmogorov-Smirnov test. The following are the results of the normality test in TABLE 5 and TABLE 6.

TABLE 5. Normality test of written communication and critical thinking

Activity	Class	The Significance Value of Written Communication	The Significance Value of Critical Thinking	α	Sig > α
Pretest	Experiment	0.074	0.071		
	Control	0.071	0.200	0.05	Normal Distribution
Posttest	Experiment	0.165	0.200		
	Control	0.200	0,109		

TABLE 6. Normality test of oral communication

Activity	Class	The Significance Value of Verbal Communication	α	Sig>α
Meeting 1	Experiment	0.200		
	Control	0.181	0.05	Normal Distribution
Meeting 2	Experiment	0.200		
	Control	0.200		

Homogeneity test

The results of the pretest and post-test homogeneity testing on the verbal and written communication skills and students' critical thinking are in TABLE 7 and TABLE 8.

TABLE 7. Homogeneity test of written communication and critical thinking

Activity	Class	The Significance Value of Written Communication	The Significance Value of Critical Thinking	α	Sig>α
Pretest	Experiment Control	0.699	0.547	0.05	Homogeneous
Posttest	Experiment Control	0.388	0.249		

TABLE 8. Homogeneity test of oral communication

Activity	Class	The Significance Value of Written Communication	α	Sig>α
Meeting 1	Experiment Control	0.331	0.05	Homogeneous
Meeting 2	Experiment Control	0.065		

Hypothesis Testing

Paired t-test

The paired t-test analyzed the differences in the effect of students' communication skills and critical thinking before being given the implementation treatment of the problem-based learning model based on local wisdom in two pairs of sample groups. The results of testing the research hypothesis are in TABLE 9.

TABLE 9. Output paired t-test communication and critical thinking

Observation Results	Class	T_{count}	Sig
Writing Communication	Experiment	6.235	0.000
Critical thinking	Experiment	8.931	0.000

The results of the paired t-test in TABLE 9 on written communication with a significance value of $0.000 < 0.05$ and the value of $T_{count} = 6.235 > T_{table} = 2.042$. While the paired t-test on critical thinking with a significance value of $0.000 < 0.05$ and a value $T_{count} = 8.931 > T_{table} = 2.042$. The results of the tests carried out obtained a significance value of < 0.05, so it can be concluded that the hypothesis is accepted that there is an effect of the problem-based learning model based on local wisdom on written communication and students' critical thinking.

Test independent sample t-test

An independent sample t-test was used to test differences in oral, written, and critical thinking communication skills. The results of the analysis of hypothesis testing are in TABLE 10.

TABLE 10. Output independent sample t-test post-test for oral communication, writing, and critical thinking

Observation Results	Class	T_{count}	Sig
Verbal communication	Experiment Control	7.563	0.000
Writing Communication	Experiment Control	3.280	0.002
Critical thinking	Experiment Control	5.385	0.000

The results of statistical analysis obtained the significance of oral communication as 0.000 < 0.05 with a value of t_{count} = 7.563 and t_{table} = 2.003. The significance value of written communication is 0.002 < 0.05 with a value of t_{count} = 3.280 and t_{table} = 2,003. The results of the critical thinking analysis have a significance value of 0.000 < 0.05 and the value of t_{count} = 5.385 and t_{table} = 2.003. The results of the statistical analysis of the independent sample t-test showed that the data on oral, written, and critical thinking communication had a significance value of < a and value of t_{count} > t_{table}. It can be concluded that there are differences in oral, written, and critical thinking communication by implementing a problem-based learning model based on local wisdom in the experimental class and conventional models in the control class on students' oral, written, and critical thinking communication skills.

Multivariate analysis of variance test

Multivariate test or Multivariate Analysis of Variance relates to the method simultaneously (simultaneously) by analyzing two or more variables on each object. The Manova test aims to test the differences in terms of students' oral, written, and critical thinking communication skills by implementing a problem-based learning model based on local wisdom on temperature and heat material for class XI science Senior High School 5 Jambi City in terms of variables simultaneously.

Analysis of the multivariate mean difference test obtained the result of hypothesis testing in TABLE 11.

TABLE 11. Output multivariate analysis of variance

Test of between-subject effect			Multivariate Test		
Verbal communication	Writing Communication	Critical thinking	Effect	Value	Sig
0.000	0.002	0.000	Pillai's Trace	0.577	.000
			Wilks' Lambda	0.423	.000
			Hotelling's Trace	1.362	.000
			Roy's Largest Root	1.362	.000

The results of the multivariate analysis of variance with the Pillai's Trace, Wilks' Lambda, Hotelling's Trace, and Roy's Largest Root statistical tests obtained a significance value of 0.00 < 0.05, so the hypothesis H_1 is accepted and H_0 is rejected. It can be concluded that the problem-based learning model based on wisdom has a simultaneous influence on verbal, written, and critical thinking communication skills on the material of temperature and heat in class XI science Senior High School 5 Jambi City.

The PBL model can be used as an effort to improve student's critical thinking and communication skills. This has also been proven by previous research. Based on this, the problem-based learning model emphasizes problem-solving and challenges students to work together in groups to solve a problem so that they can train students to think, analyze and solve complex problems (Zahrotin, Badarudin & Eka 2020). Students who are treated using problem-based learning have a better impact and improvement on critical thinking skills. Problem-based learning has an impact on improving critical thinking skills and student learning activities because it provides students with real problems related to everyday life that require students to think critically to find solutions to problems. In addition, students who are able to think critically can come up with new ideas or thoughts about problems, are trained to express opinions, are able to distinguish between true and false opinions, and are able to make conclusions by considering the observed facts (Rinesti, Yasa & Sujanem 2019; Sholihah 2019; Parno et al. 2019).

Using problem-based communication skills can be developed in the form of questions at the beginning of learning so that students can develop the ability to provide statements and compare ideas put forward. So that student communication can change for the better because students have been trained in the use of problem-based learning that prioritizes good communication between students in solving problems (Rafli & Yusnaidi 2018; Owen & Hite 2020; Iftitahurrahimah, Andayani & Idrus 2020).

Following learning that is oriented to local wisdom, it can realize contextual and real-life learning because it is very close to students' lives so that students more easily understand the material being studied. The lack of variety of learning media can cause new problems. Maybe the teacher can

overcome the problem by developing a learning media for temperature and heat that is integrated with technology (Ramadannisa & Hartina 2021) based on local wisdom. Natural science learning based on local wisdom can encourage students to build and connect knowledge with the reality in the environment so that it can have the potential to be used as a source of learning science (Jufrida et al. 2019). Using local wisdom-based learning models positively influences students' communication and critical thinking. The local wisdom-based learning model is one of the lessons oriented to integrating the values of a community's local wisdom into learning materials (Febriani, Sudarmin & Alimah 2020).

CONCLUSION

Based on the data obtained, the experimental class using a problem-based learning model based on local wisdom and the conventional model control class has increased the average results of the questions and observation sheets. So based on the results obtained, implementing the problem-based learning model based on local wisdom influences oral and written communication and students' critical thinking on temperature and heat material. There are differences in students' average verbal, written and critical thinking skills using problem-based learning models based on local wisdom and conventional models. There is a simultaneous influence on verbal, written, and critical thinking communication skills by implementing a problem-based learning model based on local wisdom.

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