How does PBL Brainwriting Method Supplemented with Concept Mapping Effective to Improve Critical Thinking and Problem-Solving Ability?

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Abstract: This study aims to; 1) Determine the effectiveness of PBL brainwriting method supplemented with the concept on improving students' critical thinking skills; 2) Determine the effectiveness of PBL with brainwriting method supplemented with concept mapping on improving students' problem solving; 3) Determine the effectiveness of PBL brainwriting method supplemented with concept mapping on improving students' critical thinking and problem solving skill simultaneously; and 4) To determine the relationship between critical thinking and problem solving. This type of research is a quasi-experiment, sampling using a cluster sampling technique. The instruments of this study used test questions on critical thinking ability and problem-solving ability. The results of the study with the MANOVA test showed that there was a significant simultaneous effects PBL model of the brainwriting method supplemented with concept mapping on critical thinking and problem solving skills, the PBL model of the brainwriting method supplemented with concept mapping is effective in improving students' problem solving skills, the PBL model of the brainwriting method supplemented with concept mapping is effective in improving students' problem solving skills, and here is a correlation between critical thinking and problem solving skills.

Keywords: Brainwriting; Concept mapping; Critical thinking skills; PBL; Problem solving

Introduction

Entering the 21st century, human life has undergone fundamental changes and is different from the previous order of life so it is called the century of emergence or the century of spread. This is following the opinion of Pitaloka (2019), that learning in the 21st century has a very important role so that students can survive. The 21st century suggests 3 skills, namely cognitive skills (problem solving, critical thinking, systematic thinking); interpersonal skills (complex communication, social skills, teamwork, cultural sensitivity, diversity); and interpersonal skills (self-management, time management, self-development, self-adaptation, executive function) (Erdem, 2020). The ability to think critically and solve problems as the skills needed in the

21st century needs to be applied in learning biology because biology is part of science.

The results of the PISA study conducted by the Organization for Economic Cooperation and Development (OECD) in 2018 on scientific ability are known to be still below the OECD average of 396. This score should be a warning because the value of scientific ability has decreased compared to 2015, namely 403 ranked 64th out of 76 countries. In the opinion of Pitaloka (2019), the low TIMSS and PISA scores are due to the TIMSS study and the PISA study using HOTS model questions which describe students' high-level thinking abilities. These results indicate that high-level thinking skills in Indonesia are still relatively low, including critical thinking skills and problem solving.

Based on the results of observations before the study, it was found that the critical thinking skills of 40 students of SMAN 1 Panyabungan obtained information that critical thinking skills were still in the very low, low, and medium categories. The test results show that the highest indicator is the concluding indicator with a score of 52%, and the lowest indicator is solving problems with a score of 37% in the uncritical category. Overall, it is known that students' critical thinking skills are still relatively low. The same observation was also made for the ability to solve problems. The ability to solve problems is measured by four indicators, namely understanding the problem, designing a plan, implementing the plan, and re-examining the solution. Among the four indicators, the one that achieved the highest was implementing the strategy, namely achieving a score of 55%, while the indicator with the lowest achievement was re-checking the correctness of the 40% solution. Based on the test results given to 20 students, only 2 students were in the category of solving moderate problems, 15 people were in a low category, and 3 people were in the very low category. Ideally in learning, a student should have adequate critical thinking skills and problem-solving skills so that they can follow the learning process well.

This fact is also supported by information obtained from the results of the researcher's interviews with 3 Biology teachers at SMAN 1 Panyabungan. The low ability to think critically and solve problems is probably caused by the teachers' choice of models and methods. The variety of learning models recommended in implementing the 2013 Curriculum is rarely implemented by teachers in schools, except for the 5M model. The cognitive competence of students is still relatively low, and this of course already shows that the ability to think critically and solve problems of students is also still low. This was also expressed by Efrida a biology teacher (personal communication 2022), that teachers find it difficult to guide students to think critically and solve problems. This should be a serious concern for educators and students. Based on these problems, innovation is needed to support students to fully have space to practice critical thinking and problem solving. One of the innovations that need to be done is to apply a relevant learning model.

Many models are by the implementation of the 2013 curriculum based on problem solving, one of which is problem-based learning. The advantages of the PBL model include that student are required to have high-level skills so that they are able to be actively involved in solving problems, learning is more meaningful, and the problems given are related to real life so learning is more interesting. In addition, PBL can also create interactive learning conditions because learning is carried out in groups. Through this model, it is hoped that it can be able to solve problems through real contexts that are discussed with the teacher. The PBL model is also expected to be able to improve critical thinking skills. This is in line with Yennita et al. (2021) that problem-based learning is a model that presents contextual problems so that it can stimulate students to improve critical thinking skills and solve problems. In this connection, the results of research conducted by Zamroni et al. (2020) also show that PBL has a positive effect on improving critical thinking skills.

Students who actively participate in learning usually show enthusiasm when learning, which is marked by frequent asking questions to the teacher or expressing ideas related to the topics discussed. Students' ideas and ideas can be explored by adding appropriate methods of learning. Many methods can be applied by teachers, and one of them is the brainwriting method. Through brainwriting students can write down their ideas on paper, then other students can also add their ideas. Research by Tifanni et al. (2018), shows that students' problem-solving skills can be improved after implementing brainwiting.

In addition to the teacher's understanding and skills in implementing a variety of models, methods, and providing teaching material sets, skills are also needed to develop other strategies that support the effectiveness of achieving learning objectives. The elements of this strategy include concept mapping. To explore the level of students' understanding of the material that has been studied, students are individually given homework to compile a concept mapping. According to Bilik et al. (2020), concept mapping as part of a learning strategy has advantages, including making it easier for students to understand and develop, and to link between parts in a subject matter. This strategy is expected to help improve students' understanding of the material they are studying. Research by Fitarahmawati (2021) concluded that the use of concept mapping in learning can improve students' critical thinking skills and solve students' problems.

From the results of interviews with biology teachers at SMAN 1 Panyabungan, one of the topics of discussion with a low level of mastery is the Structure and Function of Animal Tissues. Therefore, one of the solutions to overcome this problem is the need to choose additional models, methods, and strategies that can increase the level of mastery of the material on this topic which is still low. The topic of Animal Structure and Function is given to class XI in 5 meetings.

Based on the description above, the main problem to be investigated is the Effectiveness of the PBL Brainwriting Method Supplemented with Concept Mapping on the Topic Structure and Function of Animal Tissues to Improve Students' Critical Thinking Ability and Problem Solving.

Method

This type of research is a quasi-experiment. Quasi experiments are used because researchers do not allow artificially creating research groups (experimental and control groups) because they can disrupt the learning process in class. The design form of the research is seen below.

Table 1. Research Design

Group	Pretest	Treatment	Posttest
EC	O1	X1	03
CC	O2	X2	04

Description:
EC : Experimental class, PBL class with the Brainwriting method supplemented with concept mapping assignments.
CC : Control class, class with 5M learning designed by the teacher.
O1 : Pretest ability to think critically and solve problems of students in the experimental class.
O2 : Pretest ability to think critically and solve problems of students in the experimental class.
O3 : Final ability test (posttest) for students' critical thinking skills and problem solving in the control class.
O4 : Final ability test (posttest) for students' critical thinking skills and problem solving in the control class.
X1 : Learning PBL with Brainwriting method supplemented with concept mapping.
X2 : Learning with the 5M model (which is usually used by teachers in schools).

This research was carried out at SMAN 1 Panyabungan, from the end of September to October 2022. In this study, the research population was all students in class XI IPA at SMAN 1 Panyabungan, while the target population included class XI IPA from other schools but had the same characteristics as the research population during the 2021/2022 school year. The sample consisted of two classes, XI IPA 1 as the experimental class and class XI IPA 3 as the control class which was randomly selected using a cluster sampling technique.

The data collection instruments used in this study are test instruments (tests of critical thinking skills and problem solving), lesson plans, syllabi, and worksheets for the control class and the experimental class. All instruments used in this study have been tested for validity and reliability. During this study, the content and construct validity of the instrument were met through expert judgment consisting of two validators; (1) a biology education expert and (2) a biology expert.

The instrument is declared valid if the test used can represent the domain of ability to be measured (Putri, 2015). Construct validity is met if each item reflects the indicator variable to be measured. Empirical validity is calculated using concurrent validity, namely by correlating tests with criteria, or standardized tests. A measuring instrument can be said to be reliable if it gives the same results on repeated measurements (Shobri et al., 2021). The reliability of critical thinking skills and problem solving instruments is based on criterion-reference interpretation. The instrument reliability coefficient was calculated using Cronbach's alpha coefficient.

The data obtained were analyzed descriptively and inferentially. Data analysis in this study consisted of the analysis of prerequisite tests and hypothesis testing. The prerequisite tests for this study were the Mahalanobis distance (multivariate), Shapiro Wilk (univariate), and the Box Test of Equality of Covariance Matrix homogeneity test. After the data is declared to be normally distributed and homogeneous, a hypothesis test is performed using Manova. Improved critical thinking skills and problem-solving skills can be seen using the N-gain test. The relationship between critical thinking ability and problem-solving ability can be tested with the Pearson Product Moment correlation test using the SPSS 20 program. The correlation value (r) ranges from 1 to -1. A positive value indicates a unidirectional relationship (X increases, Y also increases) and a negative value indicates an inverse relationship. Getting closer to 1 or -1 means the relationship between the two is getting stronger, and conversely if it is closer to 0 it means the relationship between the two variables is getting weaker.

Result and Discussion

The results of the descriptive statistical analysis of the ability to think critically and solve problems can be seen in the table below.

Table 2. The Results of Descriptive Analysis of Critical Thinking and Problem-Solving Ability

Critical Thinking Ability	Experiment		Control	
	Pretest	Posttest	Pretest	Posttest
Average	42.10	85.86	34.833	71.76
Max	60	92	55	88
Min	30	75	20	52
Problem Solving Ability	Experiment		Control	
	Pretest	Posttest	Pretest	Posttest
Average	48.23	83.53	42.17	77.96
Max	65	95	57	90
Min	40	70	30	65

Based on the table it is known that the posttest scores for critical thinking skills and problem-solving abilities in both classes, namely the experimental class and the control class have increased. The increase in the experimental class was higher when compared to the control class. Then for the lowest score, the posttest results obtained by students were also higher in the experimental class compared to the control class for problem solving skills and critical thinking skills. The results of the descriptive analysis show that after applying the PBL model learning with the brainwriting method in the additional concept mapping task in the experimental class, the ability to think critically and solve problems is higher than in the control class. More details can be seen in the following graph:
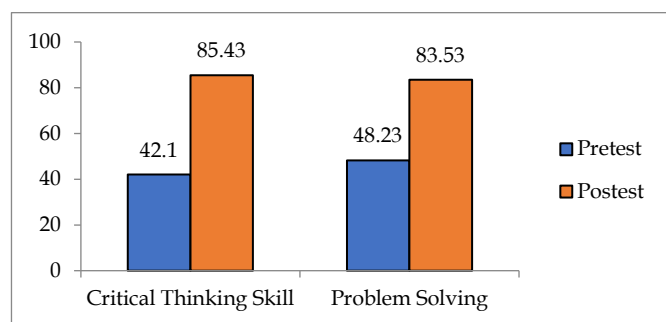

Figure 1. Graph of critical thinking and problem-solving ability

Before carrying out a hypothesis test, a prerequisite test must be carried out using the results of the pretest and posttest to find out whether it meets the requirements of the MANOVA test. Each group with the assumption of univariate normality was tested with the One Shapiro Wilk test (sample < 50) using SPSS 20.0. The results of the univariate normality test for pretest and posttest scores for critical thinking skills and problem solving skills can be seen in the following table:

Table 3. The Normality Test Results for Critical Thinking Ability

	Class	Shapiro-Wilk		
		Statistic	df	Sig.
CTA	pre_exp	.906	30	.012
	post_exp	.911	30	.016
	pre_cont	.914	30	.019
	post_cont	.920	30	.028

Based on these results showed that the significance value (Asymp. Sig.2-tailed) for the pretest and posttest classes in each of the experimental and control classes was more than 0.05. So that at the 95% confidence level, the data on critical thinking skills were normally distributed. The normality of problem solving ability data is shown in the table below.

Table 4. Data of Normality Test Results of Ability to Solve Problems

	Class	Shapiro-Wilk		
		Statistic	df	Sig.
PSA	Pre_exp	.915	30	.016
	Post_exp	.917	30	.018
	Pre_cont	.929	30	.026
	Post_cont	.939	30	.035

Based on the test results, it was known that the significance value of students' problem-solving abilities in the experimental and control classes for the pretest and posttest classes is more than 0.05. So, it can be stated that at the 95% confidence level, the data for the ability to solve the problem is normally distributed.

Then the two dependent variables together must also be normally distributed multivariate within a group. This is shown from the graph of the Mahalanobis distance with the value of qi (chi-square). If the Chi-square tends to form a straight line and is around 50%, then the Mahanabis distance value is less than or equal to the Chi-Square, then H_0 was accepted, meaning the sample comes from a normal population. Furthermore, it can also be seen from the correlation coefficient between the two data. If the correlation coefficient is greater than the r table or significance < 0.05, the correlation between the two data variables is significant. In summary, the presentation of the results of the assumption of multivariate normality data in the experimental and control classes is shown in the following table 5.

Table 5. Pretest Data Normality Assumption Test Results

Class	Correlation coefficient	Significance	Decision
Experiment	0.971	0.000	Normal
Control	0.955	0.000	Normal

Table 6. Posttest Data Normality Assumption Test Results

Class	Correlation coefficient	Significance	Decision
Experiment	0.947	0.000	Normal
Control	0.983	0.000	Normal

The correlation coefficient between the variables after being given treatment for both classes, both pretest and posttest, has a value of more than 0.05. These results indicate that the correlation coefficient for all of these classes is significant so it can also be concluded that the critical thinking skills and problem solving abilities of students in the experimental and control classes come from the normal population. Then to test the homogeneity of the covariance matrix using the Box's M test in the following table:

Table 7. Box's M Test Results

Box's M	17.653
F	1.900
df1	9
df2	154203.164
Sig.	.057

Based on the results in the table it is known that the significance value is 0.057 or more than 0.05, then H0 is accepted. So it can be concluded that there is an equality of covariance values between variables that can be considered the same (homogeneous) so that the MANOVA test can be continued.

After fulfilling all the prerequisite tests, the next test is the hypothesis test. This test was conducted to determine the effectiveness of the learning treatment using the PBL model of the brainwriting method in the additional task of concept mapping on the topic of structure and function of animal tissue in improving students' critical thinking skills and problem solving.

Table 8. Manova Test Results on Critical Thinking and Problem Solving Ability

Effect		Sig
Models_Brainwriting Methode_Supplemented with Concept Mapping	Wilks Lambda	0.000

This test was used to tell if there is a significant effect of the independent variable on all the dependent variables, or to see between the three variables simultaneously. Based on sig. Wilk's LambdA was known to give a significance value of less than 0.05 or 0.000 <0.05, which means H0 was rejected. The result of simultaneous analysis shows that there is an influence between the PBL model of the brainwriting method in the concept mapping additional task on students' critical thinking skills and problem solving.

The test results in Table 9 show the significance on the PBL model of the brainwriting method with the additional task of concept mapping with the aspect of problem solving ability showing a significant value of 0.000. The value of this coefficient indicated that value is less than 0.05, which means that there was a significant difference in students' critical thinking skills. The existence of this significant difference shows that the use of the PBL model of the brainwriting method supplemented with concept mapping task was effective in increasing the critical thinking skills of class XI SMA students.

Then the significance of the model with the ability to solve problems also produced a sig value of 0.000. This coefficient showed a value of less than 0.05, which means that there was a significant difference in the ability to solve problems. The existence of this significant

difference concluded that the use of the PBL model with the brainwriting method supplemented with concept mapping was effective in increasing the problem-solving abilities of class XI high school students.

Table 9. Results of the Test of Between – Subjects Effects Model Factors on Critical Thinking Ability (CTA) and Problem Solving Ability (PSA)

Source	Dependent Variable	Sig.
Models_Brainwriting Methode_Supplemented with Concept Mapping	Critical Thinking Ability	0.000
	Problem Solving Ability	0.000

To find out how much the ability to think critically and solve problems has increased after learning, the N-gain score was also sought. The N-gain test was obtained from the pretest and posttest values of the experimental class and the control class in the form of an essay question. The results of calculating the N-gain Score are shown in Table 10.

Table 10. Calculation Results of N-gain Score Critical Thinking and Problem Solving Ability

Measure ability	Class	Average		N-gain	Category
		Pre	Post		
Critical thinking	Experiment	42.10	85.86	0.75	High
	Control	34.33	71.76	0.57	Medium
Solve the problem	Experiment	48.23	83.53	0.72	High
	Control	42.17	77.96	0.61	Medium

Based on the results of the N-gain test above, the critical thinking skill of the experimental class has a higher N-gain score with a score of 0.75 compared to the control class. After being categorized, the score of 0.75 in the experimental class was included in the high category, while in the control class with a score of 0.57, it was included in the medium category. Therefore, based on the results of the N-gain test of the two classes, it can be concluded that the use of the PBL model with the brainwriting method in the additional concept mapping task is effective in increasing the critical thinking skills of class XI high school students.

Then the results of the N-gain score on the problem-solving ability of the experimental class were also higher than the N-gain scores in the control class, namely 0.72 > 0.61. After being categorized, the score of 0.72 in the experimental class was included in the high category, then in the control class with a score of 0.61 was also included in the medium category. Based on these results, it can be concluded that the use of PBL model with the brainwriting method supplemented with concept mapping is effective in increasing the problem-solving abilities of class XI high school students.

Then a correlation test was carried out to find out whether there is a relationship (correlation) between the two variables, namely the ability to think critically and solve problems. Correlation test results are shown in the following Table 11.

Table 11. Correlation Test Results of Critical Thinking and Problem Solving Ability

		Critical Thinking Ability	Problem Solving Ability
Critical Thinking Ability	Pearson Correlation	1	.440**
	Sig. (2-tailed)		.000
	N	60	60
Problem Solving Ability	Pearson Correlation	.440**	1
	Sig. (2-tailed)	.000	
	N	60	60

Based on table 11 it was known that the value of significance (2-tailed) < 0.05, then H_0 was rejected and Ha was accepted. This means that there was a positive and significant relationship between critical thinking skills and problem-solving abilities. In addition, it was also known that the value of Pearson Correlation (r-count) is 0.440. So based on the interpretation of the correlation level of the relationship between critical thinking skills and solving students' problems with the PBL model of the brainwriting method was quite strong. Then the significance '+' at the correlation coefficient also provided indicated that there was a unidirectional relationship between both variables, which means both of the relationships were directly proportional. The facts of this relationship are supported by the findings of Stockemer (2019) which states that the higher ability to think critically, the higher the ability to solve problems.

Based on the results of the descriptive analysis and also the results of the MANOVA hypothesis test that was carried out previously, it was known that there is a significant increase in students' critical thinking skills in the experimental class. Previous data has shown that the experimental class has a higher posttest average score than the control class. This means that learning that applies the PBL model with the brainwriting method supplemented with concept mapping task was better than learning that uses the 5M model in the control class. This statement was supported by the N-Gain score which shows that the increase in critical thinking skills in the experimental class is in the high category, while in the control class, it was in the medium category. These results were in line with research conducted by Aswan et al. (2018) which states that the application of the PBL model in learning has a positive impact on critical thinking skills, or in other words, it can improve students' critical thinking skills.

The opinion of Leasa et al. (2020) states that PBL learning students are actively involved so that they can stimulate students' abilities to think. Therefore, it is very natural that in recent years this model has been implemented in many classes. The reason is because of PBL increases student's involvement to investigate and participate in authentic and meaningful problems, then the result is the creation of knowledge and concepts based on the topics studied. The application of the PBL model in the experimental class can help improve students' critical thinking skills because in the PBL model they are trained to be accustomed to developing their critical thinking skills through giving problems, which is the core activity of the PBL model. This learning step provides opportunities for students to actively construct their knowledge and develop a mindset by expressing owned ideas using the brainwriting method.

Several stages of the PBL model are accompanied by the brainwriting method, namely problem orientation, organizing students, guiding group investigations through the brainwriting method, and developing and presenting the results. In the first stage, namely orientation to the problem, where the problem presented is an authentic problem with everyday life. Problems are given in the form of discourse to help students in bringing out their thinking skills. Some of the questions that were raised by the students after observing the pictures and reading the discourse indicated that one indicator of critical thinking was achieved, namely elementary clarification. These indicators are indicators that spur students capable of asking and answering questions. In the second step, namely organizing students. In this stage, students raise several questions controlled or guided by the teacher and some of the questions are used for problem formulation.

Then in the third stage, namely guiding group investigations using the brainwriting method. At this stage students carry out investigations by conducting independent investigations of the problems given, so that information is obtained independently with the brainwriting method. Through this method, students can develop their ideas and put them into writing. The thing of concern in this stage is how students choose the information that is appropriate to the problem to be solved so that it can hone students' ability to think critically. Through this process, it means that one of the indicators of strategic and tactical critical thinking skills can be achieved which is marked by the success of students in selecting information, formulating alternative solutions, and being able to determine what to do about the problem. This is in accordance with Julianto's idea (2018), that brainwriting generates ideas to determine the right solution.

In the fourth step, students develop and present their work using the brainwriting method. Presentation of the results of this discussion of course illustrates how students' critical thinking skills, because before presenting the results of the work students have been trained first through the stages of critical thinking. According to Suardana (2019), the activity of presentation makes students try to think so that their ideas can be well received, and able to answer by the audience it also influences their critical thinking skills. Connected to this case, it means that students have also achieved indicators of critical thinking skills, namely strategy and tactics by interacting with other people, through speech or writing. Furthermore, for the fifth stage, namely analysis, and evaluation, students explain their reflection on solving the presented and identify some that need to be evaluated. By going through all the stages in this model, inference as an indicator of critical thinking skills can be achieved followed by the conclusions obtained in the lesson.

PBL model with the brainwriting method supplemented with concept mapping task is more effective than the class with the 5M model. This is because using brainwriting in learning will produce various ideas related to the topic. In accordance with Dayu's opinion (2020), the use of brainwriting can form and grow ideas in solving a problem. According to Gilmartin et al. (2019), brainwriting is a method that generates ideas quickly and asks students to write down their ideas, then these ideas are shared with others. Learning through the brainwriting method supplemented with concept mapping task increased an average critical thinking ability in the experimental class.

The process of making concept mapping as a homework assignment will help students to practice thinking critically about the relationships between the concepts they learn. So the combination of methods and strategies will of course have a positive impact on increasing critical thinking skills. The use of this concept mapping strategy can help students to organize ideas and construct related concepts to the subject matter systematically. Cooper et al. (2020) state that concept mapping can be used to categorize knowledge so that it will encourage the development of critical thinking skills. This is also supported by the finding of Maryam et al. (2021) that the use of concept mapping has a positive effect on critical thinking skills. Researchers believe concept mapping is a useful tool helping students to develop clinical reasoning through an additional focus on logic, and possibly stimulates the use of thinking skills, such as analysis, interpretation, and evaluation. Based on these reviews, it can support the fact that through the brainwriting method, students' knowledge will further develop. Additional concept mapping assignments will help strengthen and provide opportunities to add other knowledge according to the topics being studied by students.

The ability to solve students' problems with the subject of structure and function of animal tissue using the PBL model accompanied by the brainwriting method is supplemented with concept mapping tasks in the experimental class and experienced a better improvement than learning in the control class with the 5M model. The results of this study are supported by Simamora et al. (2017) who argue that the application of the PBL model can increase learning activities and students' problem-solving abilities. This research is also supported by Hidayati et al. (2020) that the implementation of learning using PBL can improve students' problem-solving skills which are done by orienting students to problems in a classical manner.

The PBL model has the characteristics of scientific thinking that can train students to improve their ability to solve problems rationally, in the future, and thoroughly. In addition, the characteristics of scientific thinking will train students to improve their thinking skills. Every activity in a series of PBL learning models is an attempt to train students' ability to solve problems (Simamora et al., 2017).

This is also supported by the finding of Asyhari et al. (2021) stating that the PBL model provides opportunities for students to increase independence in thinking and analyzing problems. The ability to analyze this problem allows students to have the ability to solve problems given by the teacher. The ability to solve problems is a set of procedures that enable a person to increase his independence in thinking. The researcher also stated that the average post test scores in the discovery learning and problem-based learning classes were 56.1 and 72.8, respectively. These results indicate that the PBL model is more effective for improving students' problem-solving abilities.

Learning the PBL model of the brainwriting method with an additional task in the form of concept mapping can help improve students' critical thinking skills. Based on the results of research conducted by Tifanni et al. (2018) states that the brainwriting method is an appropriate method for solving problems by developing various ideas because the steps of the brainwriting method are indicators of solving problems starting from understanding the problem, planning for completion, carry out the completion plan, and recheck the completion stage. This statement is supported by Bahri (2020) which states the sig. F count is less than 0.05, thus these results indicate that the PBL model in the concept mapping additional task can improve students' mathematical communication abilities and solve problems. Concept mapping can be a source for making main ideas so that it makes it easier for students to focus

on the topic structure and function of animal tissues specifically. This concept mapping can also enable students to understand and remember some information related to learning topics.

Based on this description, it can be seen that learning the PBL model with the brainwriting method in the additional concept mapping task can improve students' critical thinking skills and problem solving and can make learning more effective and efficient. The ability to think critically and solve problems is closely related. The ability to solve problems requires the ability to think critically in exploring various alternative solutions that are appropriate to the given problem. While activities in solving problems provide problematic situations which will become triggers the development of students' critical thinking skills. This implementation shows someone using to think critically is characterized by not easily receiving information from other people, but needs to be analyzed first. Then someone who thinks critically will also be careful in formulating a solution to a problem that is considered crucial to avoid negative impacts. For this reason, it is necessary to carry out exercises that require critical thinking skills in the form of solving students' problems so that both abilities develop.

This statement is also supported by Susilowati et al. (2020) based on the regression analysis shows that the correlation r value for critical thinking skills is 0.762 and shows a very significant positive relationship between problem solving skills and critical thinking skills. This shows that the problem-solving ability variable also includes aspects in it that are then used as predictors for critical thinking.

Conclusion

Based on the results of the study, the conclusion is that the PBL with model brainwriting method supplemented with concept mapping tasks is effective in increasing critical thinking skills and problem solving simultaneously. PBL model brainwriting method supplemented with concept mapping task is partially effective in increasing critical thinking skill and problem-solving skills. This study also proves that there is a significant positive relationship between critical thinking skills and problem-solving abilities.

Acknowledgments

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