ISSN 2303-0992
ISSN online 2621-3176
Matematika dan Pembelajaran
Volume 8, No. 2, December 2020, p. 112-121.

THE EFFECT OF MODIFIED COGNITIVE LOAD THEORY PROBLEM BASED LEARNING MODELS TO PROBLEM SOLVING STUDENTS IN CILEGON

Wafa Azimah[1], Aan Hendrayana[2], Abdul Fatah[3]

[1,2,3]*Mathematics Education, University of Sultan Ageng Tirtayasa, Indonesia*

wafa.azimah@gmail.com

Abstract

The aim of this study is to determine the effect of the modified Problem Based Learning Model with Cognitive Load Theory to students problem solving abilities. This research was conducted in SMP Negeri 1 Cilegon in the academic year 2019/2020 with the sample used was class of VII A as an experimental class using CLT-modified PBL models and class of VII E as a control class that gained learning with the usual PBL models. The research method used in this study is a mix methods of the concurrent embedded model with quantitative methods as the primary method and qualitative as a secondary method. The results and discussion of the study showed that the achievement and improvement of the problem solving ability of the experimental class was better than the control class. So it can be concluded that there is a positive influence on CLT modified PBL models on students' problem solving abilities. In addition, the amount of cognitive load possessed by students while learning can be one of the main factors that can affect students' problem solving abilities. It is believed that reducing extraneous cognitive load can improve students' problem solving abilities.

Keywords: Problem Solving; Problem Based Learning; Cognitive Load Theory.

Citation: Azimah, W., Hendrayana, A., Fatah, A. 2020. The Effect of Modified Cognitive Load Theory Problem Based Learning Models To Problem Solving Students In Cilegon. *Matematika dan Pembelajaran*, 8(2), 112-121. DOI: http://dx.doi.org/10.33477/mp.v8i2.1366

INTRODUCTION

One effort to improve the quality of education is through learning mathematics. Mathematics is a subject that has an important role as a medium or an appropriate tool in achieving student competence. But in practice, learning mathematics is still often considered negative as a scary learning so that not many students are interested in learning mathematics well and mastering the material. The Program for International Student Assessment (PISA) in 2018 states the results that Indonesia's mathematical ability is ranked 72 out of 78 countries, including level 1 with a score of 329 points from an average score of 489 points (OECD, 2019). The

PISA results show that the mathematical abilities of students in Indonesia are classified as very low, where the data reveal that only 1% of Indonesian students possess high mathematical abilities which include the ability to mathematically create complex situation models, choose, compare, and evaluate appropriate problem solving strategies to deal with it.

The ability to solve problems is one of the important aspects and needs to be developed. In line with Hardini & Puspitasari (2017) that mathematics subjects need to be given to students in order to develop the ability to use mathematics in problem solving. The selection of appropriate learning methods and media that can improve students' problem solving abilities by teachers becomes very important in order to improve the quality of education, especially in the field of mathematics. The design of mathematics learning should begin with the introduction of problems that are appropriate to the situation at every opportunity. One good learning design must be oriented towards students, learning that encourages students to be active, learn to formulate problems independently, and be able to develop their thinking skills in solving real problems. Learning with design as mentioned previously is believed to be able to improve problem solving skills.

This kind of learning model is known as problem-centered learning itself, namely the Problem Based Learning (PBL) model. Shoimin (2014) states that the problem based learning model has the characteristics of real problems so students learn to think critically and are skilled in solving problems and gaining knowledge. The theory supports the argument that the PBL model can improve problem solving abilities.

However, in the implementation of PBL many students actually experience anxiety or difficulties for a variety of reasons. PBL model also allows for obstacles or obstacles. As research of Tyas (2017) shows that teachers experience long time constraints in planning and implementing learning because teachers are not familiar with PBL learning, and students's social interactions in groups are often not in line with expectations. Generally, students's limitations in receiving information often do not go into long-term memory due to various factors.

In many cases, children starting a lesson do not have enough schemes to solve the problem at hand (Hendrayana, 2018). These factors are closely related to the burden received by each student in the implementation of learning or referred to as cognitive load. This shows that Cognitive Load Theory is one of the references that must be considered by teachers in making learning designs. In addition the cognitive load theory can contribute thoughts in learning innovation as well as a tool to cover weaknesses and obstacles that might occur in problem based learning models. PBL modified in such a way based on cognitive load theory focused on reducing extrinsic cognitive load is expected to help students develop students' problem solving abilities better.

Based on data from *Pusat Penilaian Pendidikan* (Puspendik) in 2019, that the results of learning mathematics in junior high schools in Cilegon are not included in the category of good enough or less. This shows that students in the of Cilegon have not been able to master the competencies that exist in mathematics because the average material scores in Cilegon don't reach the national standard. One of these competencies is related to the ability of students to master non-routine problem cases which we call problem solving or the ability of students to solve problems, students's problem solving abilities in Cilegon are still relatively low with poor categories.

Therefore, in this study, researchers used a problem based learning model by modifying it based on cognitive load theory which is expected to be able to improve mathematical problem solving abilities (problem solving) in students in one junior high school in Cilegon.

METHOD

This research is a quantitative type of research in which the purpose of this study is to determine the effect of the model based on cognitive load modified learning on students' problem solving abilities. The research subjects consisted of a population of students in SMP Negeri 1 Cilegon and the sample used consisted of 2 classes, with class VII A as an experimental class given CLT-modified PBL model learning and class VII E as a control class that obtained the usual PBL model.

The sampling technique used is cluster random sampling. Cluster random sampling is used to determine samples when the object to be studied or data sources is very broad, often used through two stages, namely determining the sample area and then determining the people in the area by sampling as well (Sugiyono, 2018).

The method used in this research is a combination method with a concurrent embedded model. Creswell (2009) states that the combination research method is an approach to inquiry that combines or associated both qualitative quantitative forms of research. It involves philosophical assumptions the use of quantitative and qualitative approaches, and the mixing of both approached in a study. The concurrent embedded model is a combination research method that combines quantitative and qualitative research methods by mixing the two methods unbalanced (Sugiyono, 2018). In this study, the merging model used is quantitative and qualitative, where quantitative methods become primary methods, while qualitative methods become secondary methods. The purpose of choosing this method is to obtain deep and comprehensive quantitative research results supported by qualitative data.

Data collection is done through two methods, quantitatively and qualitatively. Quantitative data obtained by the test instrument in the form of an instrument to solve the problem of the chosen subject matter are the lines and angles. By using the test instrument, pretest data, posttest data and *N-gain* data were obtained. The data is then processed with the help of *Microsoft Excel 2013*, each using quantitative analysis consisting of descriptive statistical analysis and inferential analysis which includes: 1) normality testing; 2) homogeneity testing; 3) testing the difference of two averages. In addition to quantitative data, qualitative data were also collected using non-test instruments in the form of questionnaires, interviews and documentation. The qualitative data obtained is then processed using qualitative analysis. The qualitative analysis techniques for questionnaire data according to Lestari & Yudhanegara (2018) are: 1) presentation of the average questionnaire answers; 2) quantitative analysis using the Mann Whitney test. overall qualitative data is analyzed using triangulation techniques, namely by

reducing data, taking part of the data (which is needed) and discarding part of the data (which is not needed). Reducing data means summarizing, choosing the main points, focusing on the things that are important, looking for themes and patterns and discarding unnecessary ones (Sugiyono, 2018).

After datas have been analyzed using each analysis technique according to the type of data, a combination of result data is carried out by combining, comparing, and looking for relationships from the two conclusions obtained. The results of quantitative analysis are the main results of the conclusions of this study and the results of qualitative analysis serve as supporting material and information on wider knowledge of this study.

RESULTS AND DISCUSSION

The results of the study consisted of quantitative analysis results and qualitative analysis results. For quantitative analysis performed on three data, namely pretest data before treatment, posttest data after treatment, and *N-gain* data which is the acquisition of a comparison between the pretest data and the posttest data. Statistical results for the pretest data in both classes are presented in the following table 1.

Table 1. Test the Difference of Two Pre-test Data Averages Problem Solving Ability of Students

	Class	
	Experiment	Control
Varians	211.063	124.058
t_{count}	0.58	
t_{table}	2.01	

Based on Tabel 1. obtained t_{count} values is 0.58. Whereas the value of t_{table}obtained with $dk_1 = 28 - 1 = 27$ and $dk_2 = 24 - 1 = 23$ at $\alpha = 0.05$ is 2.01. Moreover, the value of t_{count} is smaller than t_{table}, based on the hypothesis testing criteria, this shows that H_0 is received or not enough evidence to reject H_0. It means at the 95% confidence level of the initial average demand for experimental class students's problem solving on the subject matter of lines and angles no more than the acceptable control class. Thus, it can be concluded that student's initial problem solving abilities are same.

The statistical results of the post-test data problem solving ability in both classes are presented in table 2 below.

Table 2. Test the Difference of Two Post-test Data Averages Problem Solving Ability of Students

	Class	
	Experiment	Control
Varians	311.238	214.928
t_{count}	3.23	
t_{table}	2.01	

Based on Tabel 2. obtained t_{count} values is 3.23. Whereas the value of t_{table}obtained with $dk_1 = 28 - 1 = 27$ and $dk_2 = 24 - 1 = 23$ at $\alpha = 0.05$ is 2.01. Moreover, the value of t_{count} is bigger than t_{table}, based on the hypothesis testing criteria, this shows that H_0 is rejected. That is, at the 95% confidence level there is a significant difference between the average final value of the problem solving ability of the experimental class students and the control class on the subject matter of lines and angles. Using the one-party t test hypothesis (right hand side) where if H_0 is rejected then $\mu_1 > \mu_2$. Thus, it can be concluded as the end of problem solving students who apply CLT-modified PBL models better than ordinary PBL models.

Statistical results from the problem solving ability of *N-gain* data in both classes are presented in table 3 below.

Table 3. Test the Difference of Two *N-gain* Data Averages Problem Solving Ability of Students

	Class	
	Experiment	Control
Varians	0.07	0.06
t_{count}	2.72	
t_{table}	2.01	

Based on Tabel 3. obtained t_{count} values is 2.72. Whereas the value of t_{table}obtained with $dk_1 = 28 - 1 = 27$ and $dk_2 = 24 - 1 = 23$ at $\alpha = 0.05$ is 2.01. Moreover, the value of t_{count} is bigger than t_{table}, based on the hypothesis testing criteria, this shows that H_0 is rejected. That is, at the 95% confidence level there is a significant difference between the average value of the *N-gain* problem solving abilities of the experimental class students and the control class on the subject matter of lines and

angles. Using the one-party t test hypothesis (right hand side) where if H_0 is rejected then $\mu_1 > \mu_2$. Thus, it can be concluded that increasing the problem solving ability of students applying CLT-modified PBL models is better than the usual PBL models.

Based on the quantitative data analysis tables above, it can be concluded that the results of achievement and improvement of students's problem solving abilities taught using CLT-modified PBL models are better than ordinary PBL models.

In addition to the statistical results of quantitative data analysis, qualitative data results were also obtained which included the results of questionnaire data analysis and interview data analysis. The questionnaire instrument used contained statements relating to activities that students normally carry out as indicators of problem solving abilities. For the questionnaire results data, an analysis was done using the average percentage of all answers. The average percentage of students' problem solving skills in the experimental and control classes were 36% and 26%, respectively. In the presentation it can be seen that the average percentage of the experimental class is higher than the control class. That is, nearly half of the students in both classes already have problem solving abilities but the overall average percentage is higher in the experimental class. Thus, this shows that the problem solving ability of students in the experimental class is better than the control class.

Then the questionnaire data was also analyzed by transforming the data into a score form so that it could be analyzed quantitatively using the Mann Whitney test. The calculation results are presented in the following table.

Table 4. Mann Whitney Data Questionnaire Test Problem Solving Ability of Students

	Class	
	Experiment	Control
$\sum R(X)$	39,340	28,907
$\sum R(x)^2$	58,316,829	36,657,210
Z_{count}	7.87	
Z_{table}	1.96	

It is seen that the value of Z_{count} is greater than Z_{table}, based on the hypothesis testing criteria of one party (right hand side), this shows that H_0 is rejected. That is, at the 95% confidence level the questionnaire data problem solving abilities of the experimental class students were better than the control class.

In this study also analyzed the results of qualitative data in the form of interview data. Interview data collection is carried out in conjunction with questionnaire data collection. The interview guide uses 6 questions that contain student responses to learning and those related to problem solving abilities. Interview data were then analyzed using descriptive analysis. Descriptive analysis of interview data produces information related to factors that can affect students 'problem solving abilities, namely cognitive load or cognitive load, from the constraints that have been presented by students in learning to show that these conditions indicate conditions that affect students' cognitive load, conclusions that students who have lower extraneous cognitive load have better problem solving abilities than students who have high extraneous cognitive load. This is also supported by student responses related to student interest in learning mathematics and student motivation in solving problems more obtained in the experimental class. In addition to all that, there are other factors that turn out to affect students' problem solving abilities, namely supporting facilities, such as learning activities outside the classroom or additional tutoring, and facilities and infrastructure used when learning but cannot be used as benchmarks.

Based on the explanation, it shows that the results of quantitative data analysis which are then supported by qualitative data analysis shows the conclusion that overall the CLT-modified PBL model can have a positive influence on the ultimate achievement and improvement of students' problem solving abilities. In line with the relevant research Hariyanto (2015) obtained results that the ability to solve class problems with the PBL model was higher than the class with the usual PBL model. Furthermore, Murtikusuma (2015) developed the PBL model of learning by using powerpoint media, obtained the results of responses and observations that showed good and positive categories. This supports the conclusion that the PBL model with modifications gets better results.

This learning model is designed to help teachers overcome the obstacles that might occur when using the ordinary PBL model. As Tyas (2017) states that the obstacles experienced by teachers using the PBL model include the difficulty of determining the right problem at the planning stage, the time constraints required for a long time of implementation, and positioning themselves as facilitators, helping to explore understanding and supporting student initiatives during implementation.

CONCLUSION

Based on the results of research, data processing, and discussion that has been described, it can be concluded as follows: 1) the achievement and improvement of problem solving abilities of students who get the learning model of the Problem Based Learning modified Cognitive Load Theory, better than students who get the learning model Problem Usual Based Learning; 2) there is a positive influence given by the learning model of Problem Based Learning that is modified by Cognitive Load Theory on students' problem solving abilities; 3) the amount of cognitive load students have when learning can be one of the main factors that can affect students' problem solving abilities; 4) by reducing extrinsic cognitive load can improve students' problem solving abilities.

Based on the results of the study and conclusions above, the researcher gives the following suggestions: 1) learning of CLT-modified PBL models should be used by the teacher as an alternative learning; 2) the teacher should need to make various preparations long before carrying out learning, so that learning objectives can be conveyed properly as they should; 3) in the implementation of learning the teacher should not only provide learning but also learn to understand students, find out what factors can be obstacles to students in learning and find out the needs of students in learning and immediately create the best solutions for each student; 4) as a professional teacher should be able to adjust various conditions that may occur in the implementation of learning, be able to master technology and utilize a variety of existing media by making innovations in learning.

REFERENCES

Creswell, J. W. (2009). *Research Design: Qualitative, Quantitative and Mixed Approaches (3rd Edition)*. (https://doi.org/10.2307/1523157)

Hardini, I., & Puspitasari, D. (2017). *Strategi Pembelajaran Terpadu*. Yogyakarta: Familia.

Hariyanto, A. (2015). Efektivitas Model Problem Based Learning Berbantuan Mind Map terhadap Kemampuan Pemecahan Masalah Fisika. *Jurnal Pendidikan Dan Kebudayaan*, *21*(3), 221. (https://doi.org/10.24832/jpnk.v21i3.188)

Hendrayana, A. (2018). *Mengatasi Cognitive Load Pada Anak*. Serang: FKIP Untirta Publishing.

Lestari, E. K., & Yudhanegara, M. R. (2018). *Penelitian Pendidikan Matematika* (3rd ed.; Anna, ed.). Bandung: PT Refika Aditama.

Murtikusuma, R. P. (2015). Pengembangan Perangkat Pembelajaran Matematika Model Problem-Based Learning Berbantuan Media Powerpoint Untuk Siswa Kelas XI SMK Materi Barisan dan Deret. *Saintifika*, *17*(2), 20–33. Retrieved from http://jurnal.unej.ac.id/index.php/STF/article/view/2733

OECD. (2019). PISA 2018 insights and interpretations. *OECD Publishing*, 64. Retrieved from https://www.oecd.org/pisa/PISA2018

Shoimin, A. (2014). *68 Model Pembelajaran Inovatif Dalam Kurikulum 2013*. Yogyakarta: Ar-Ruzz Media.

Sugiyono. (2018). *Metode Penelitian Kombinasi (Mixed Methods)* (10th ed.; Sutopo, ed.). Bandung: Alfabeta.

Tyas, R. (2017). Kesulitan Penerapan Problem Based Learning Dalam Pembelajaran Matematika. *Tecnoscienza*, *2*(1), 43–52. Retrieved from http://ejournal.kahuripan.ac.id/index.php/TECNOSCIENZA/article/view/26