

# The Effectiveness of Computational Thinking Based Learning (CTBL) and Problem Based Learning (PBL) Learning Models on Learning Achievements Reviewed From Brain Dominance

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## Abstract

This study aimed to determine: (1) which one is more effective between Computational Thinking Based Learning (CTBL) and Problem Based Learning (PBL) on learning achievement, (2) which one is better, students with left brain dominance or students with right brain dominance, (3) for each brain dominance, which one is better between CTBL and PBL. This study used a quasi-experimental research method with a 2x2 factorial design. The population in this study were all students of class VIII SMPN 1 Bendo in the Academic Year 2020/2021, totaling 9 classes. The research sample included 45 students (two classes) who were taken using cluster random sampling. The instrument used was a questionnaire on the students' brain dominance and a mathematics learning outcome test. From the results of this analysis, it can be concluded that CTBL was more effective to implement compared to PBL in odd semester class eight students at SMPN 1 Bendo Magetan in the Academic Year 2020/2021. There were differences in the results of mathematics learning achievement in students who were given CTBL and PBL in terms of the brain dominance of odd semester class eight students at SMPN 1 Bendo Magetan in the Academic Year 2020/2021.

**Keywords :** *computational thinking; computational thinking based learning (CTBL); problem based learning (PBL); brain dominance*

## Introduction

Lately, the world of education in various countries around the world is incessantly incorporating or carrying Computational Thinking (CT) into the lesson curriculum in schools. Including in Indonesia, the Ministry of Education and Culture (Kemendikbud) launched two new competencies in the Indonesian children's learning system. The two additional competencies are Computational Thinking and Compassion. CT has begun to be applied by several educational institutions. Even the government itself has included it in the national curriculum known in the subject of Informatics, although actually CT can be applied in almost all subjects

depending on the extent of the creativity of the teacher in making or creating questions/cases that lead to CT.

CT is one of the things proposed to complement the 4 C's (Critical thinking & problem solving, Creativity, Communication & Collaboration) which has been issued by UNESCO as a skill needed by future generations or more commonly referred to as the digital generation<sup>1-4</sup>. CT is a thought process that is needed in formulating problems and solutions, and therefore these solutions can become effective information processing agents in solving problems. Computational thinking as a basic skill for all people's analytical abilities as well as those for reading, writing, and arithmetic<sup>5-9</sup>. CT helps someone solve a problem by breaking the problem into smaller parts so that it can be easier to find solutions to solve the problem<sup>10</sup>. CT will train students in solving problems/cases that exist and they will definitely need in their lives because every human being will never be separated from a problem<sup>11-14</sup>. Students who have mastered or are

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accustomed to CT will be tougher in facing challenges in the future and are not easy to give up<sup>15,16</sup>. The way to implement Computational Thinking is to understand the problem, collect all the data, and then start looking for solutions according to the problem. In Computational Thinking, there is what is called decomposition, where we break down a complex problem into small problems to be solved. In this study, learning which implements CT is called Computational Thinking Based Learning (CTBL).

Previously, learning that was being developed especially in Indonesia was problem-based learning (PBL). Problem-based learning will certainly strengthen computational thinking in getting solutions and learning that is designed to form a team to make students more confident and able to share all the advantages of each individual<sup>17-23</sup>. A research on the PBL model that has been carried out by Ratnaningsih (2016) was learning mathematics with PBL to improve students' mathematical problem solving abilities. The results of the research concluded that the increase in mathematics problem solving abilities of students who received mathematics learning with the PBL model was better than direct learning. Furthermore, the result of research who conducted by Mashuri, Djidu, & Ningrum (2019) show that PBL be able to increase the interest to learn of students, because students be active in learning.

In learning, students use their cognition to determine the answers to the questions given by the teacher. This, of course, is inseparable from which brain dominance exist in each student. A research on brain dominance showed that different types of information are processed in the left and right cerebral hemispheres and the functions of these two cerebral hemispheres are different<sup>26</sup>. According to a research, the left cerebral hemisphere showed a more analytic approach, while the right cerebral hemisphere showed a holistic and spatial approach. Each cerebral hemisphere has special mental abilities. The left cerebral hemisphere is analytical, abstract, verbal, digital, logical, sequential, and rational, while the right cerebral hemisphere is holistic, concrete, non-verbal, visual spatial, intuitive, simultaneous and analogical<sup>26-28</sup>. The two cerebral hemispheres interact with each other under normal circumstances. However, each of them has a different basic function. The roles of the left brain and right brain are related to one another,

so it is very important to have a balance between the two brains.

So far, learning has not been found in Indonesian schools that pay attention to the dominance of the brain as the basis of learning. In addition, it is necessary to see whether learning with CTBL can be applied in Indonesia and there needs to be research on how the application of CTBL is compared to other lessons. Therefore, this study aimed to see the extent to which CTBL can be applied compared to PBL learning in terms of students' brain dominance. The dominance of the students' brain which is meant here is the dominance of the right brain and left brain.

## **Methods**

This research was conducted at SMP Negeri 1 Bendo in the odd semester of the Academic Year 2020/2021. This type of research is quasi experimental research with a 2x2 design. The population in this study were all students of class VIII SMP Negeri 1 Bendo which consisted of 9 classes. The sampling technique was carried out using cluster random sampling, because the sampling of members of the population was carried out randomly without considering the strata in the population. The research sample included 45 students consisting of 22 students (class VIII A) as the experimental group 1 which applied CTBL and 23 students (class VIII D) as the experimental group 2 which applied PBL.

The variables in this study were divided into two, namely the dependent variable and the independent variable. The dependent variable in this study was the achievement of learning mathematics in the sequence and series material, while the independent variables in this study were learning (CTBL and PBL) and brain dominance (right brain dominance and left brain dominance). Data collection techniques used questionnaires and tests. The research instrument consisted of a brain trend questionnaire called the Open Hemispheric Brain Dominance Scale (OHBDS) and a mathematics learning achievement test on sequence and series material.

The trial of the mathematics learning achievement test instrument refers to the criteria, namely validity, level of difficulty, differentiation and reliability. The number of items on the OHBDS was 20, while the number of

items in the mathematics learning achievement test was 20. The data on the students' initial ability in mathematics learning achievement were obtained from the midtest scores for the even semester of the experimental class 1 and the experimental class 2. Before conducting the experiment, the normality test, homogeneity test and balance test were carried out on the mathematics initial ability data. Mathematics learning achievement data were analyzed using two-way analysis of variance with different cells after the normality and homogeneity tests were carried out. The normality test for initial ability data and mathematics learning achievement data was carried out using the Lilliefors method and the homogeneity test of population variance using the Bartlett method. Furthermore, if the hypothesis test used two-way

analysis of variance with different cells resulting in  $H_0$  rejected, a double comparison test was carried out using the Scheffe' method.

## Results and Discussion

### 1. Prerequisite Analysis Test

#### a. Normality test

The normality test was used to determine the random data obtained by the researcher came from a normally distributed population. In this study, the researcher chose the normality test using the Lilliefors method with a significant level of  $\alpha = 0,05$ . The summary of the results of the normality test that has been carried out is as follows:

**Table 1. Summary of Normality Test**

Group	$L_{obs}$	DK	Decision	Conclusion
CTBL	0.0701	0.1437	$H_0$ Accepted	Normally distributed
PBL	0.1222	0.1477	$H_0$ Accepted	Normally distributed
Right brain dominance	0.1035	0.1419	$H_0$ Accepted	Normally distributed
Left brain dominance	0.0960	0.1498	$H_0$ Accepted	Normally distributed

From the summary of the analysis, the results of the normality test showed that the samples from the CTBL class and the PBL class came from a normally distributed population. Likewise, the sample of students who belonged to the right and left brain dominance came from population that were normally distributed.

#### b. Homogeneity Test

The homogeneity test was used to determine whether the variances of the population under study are the same or not. The homogeneity test used was the Bartlett test with a significant level of  $\alpha = 0,05$ . The summary of the results obtained from the homogeneity test is as follows:

**Table 2. Homogeneity Test Summary**

Group	$\chi^2_{obs}$	DK	Decision	Conclusion
CTBL and PBL	1.2205	3.841	$H_0$ Accepted	Both classes were homogeneous
Right and left brain dominance	1.3095	3.841	$H_0$ Accepted	Both categories were homogeneous

Based on the summary results of the homogeneity test, it showed that the data obtained in the study on the CTBL and PBL classes had homogeneous variances. Likewise, the two categories of students who have right and left brain dominance have homogeneous variances.

## 2. Hypothesis Test Analysis

Based on the prerequisite test analysis that has been carried out, it showed that the observed data in the sample taken came from a population that was normally distributed and had homogeneous variance. This means that the prerequisites for conducting hypothesis testing with the ANOVA test technique were met. The summary of the results of the hypothesis testing on ANOVA  $2 \times 2$  with a significant level of  $\alpha = 0.05$  is as follows:

**Table 3. Summary of Variance Analysis**

Source	JK	dk	RK	$F_{obs}$	$F_{\alpha}$	Conclusion
Brain Dominance (A)	4712.77	1	4712.77	41.5296	3.987	$H_0$ Accepted
Learning (B)	1963.04	1	1963.04	17.2986	3.987	$H_0$ Accepted
Interaction (A*B)	308.188	1	308.188	2.7158	3.987	$H_0$ Accepted
Galat	7943.59	70	113.48	-	-	-
Total	14927.588	73	-	-	-	-

Based on the summary of the analysis of variance, it showed that:

- There were differences in the effect between rows on the dependent variable.
- There were differences in the effect between columns on the dependent variable.
- There were no row and column interaction with the dependent variable.

## 3. Post Anava Follow-Up Test

Based on the results of the hypothesis test, it showed that  $H_{\alpha}$  was rejected,  $H_{\beta}$  was rejected and  $H_{0AB}$  was accepted. This means for  $H_{\alpha}$  and  $H_{\beta}$ , it is necessary to do a post-anava follow-up test to see the differences that occur for each category. The follow-up test used was the Shceffe test with a significant level of  $\alpha = 0.05$ . The summary of further tests obtained is as follows:

**Table 4. Sheffe Test of  $H_{0a}$  and  $H_{0b}$  Summary**

$H_0$	$F_{obs}$	$F_{0,05;1,70}$	p	Conclusion
$\mu_1 = \mu_2$	41.57	3.987	< 0.05	$H_{012}$ Rejected
$\mu_1 = \mu_2$	17.35	3.987	< 0.05	$H_{012}$ Rejected

The summary of the Sheffe test showed that the factor  $a_1$  had a significant difference in the mean with the factor  $a_2$ . Meanwhile, factor  $b_1$  also had a significant difference in mean with factor  $b_2$ .

## B. Interpretation of Data

### 1. The Differences in Students' Mathematics Learning Achievement with CTBL and PBL.

From the main research data, it was obtained that the average mathematics learning achievement of students with CTBL in the sequence and series material was 68.5526. Meanwhile, for students with PBL the average achievement test was 58.4722. Analysis of the existing data obtained value of  $t_{hitung} = 3.2425$  and the value of  $t_{tabel}$  at a significant level of 0.05 for  $n_1 = 8$  and  $n_2 = 6$  is 1.960. Because  $t_{hitung} > t_{tabel}$ , and therefore  $H_0$  was rejected, so it can be concluded that CTBL was more effective than PBL.

Based on this description, it showed that students achievement in the CTBL class was better than that of the PBL class. Then seen from the average score obtained in each class or the marginal average of each class, it can be seen that the mean score of students with CTBL was better than the average score of students with PBL. Thus, it can be concluded that the mathematics learning achievement of students who were given CTBL learning was significantly different from students who were given learning with PBL.

### 2. Differences in Students' Mathematics Learning Achievement Based on Students Brain Tendencies.

Based on the main research data, it showed that the average learning achievement of students who have a right brain dominance was 71.1538 or 71.15%, while the average learning achievement students who have

a left brain dominance was 55.2857 or 55.29%. This means that students who have a right brain dominance were able to solve the questions correctly 71.15% and students who have a left brain dominance were able to solve the questions correctly 55.29% of the 20 test questions given. Based on this description, it showed that the chances of students who have a right brain dominance to solve questions correctly were better than students who have a left brain dominance.

The result of hypothesis testing showed  $F_{obs} = 41.5296$  DK so  $H_{0a}$  was rejected. This means that there were differences in mathematics learning achievement obtained between students who have right and left brain dominance. Based on the results of the post-Anava follow-up test, it showed that the average difference in mathematics learning achievement in the hypothesis for students who have a right-brain dominance was significantly different from students with left-brain dominance.

### 3. The Differences in Students' Mathematics Learning Achievement based on CTBL and PBL

The results of the hypothesis analysis test showed  $F_{obs}$  that = 17.2989  $\in$  DK so  $H_{0b}$  was rejected. This means that there were differences in mathematics learning achievement obtained between students taught using CTBL and students taught using PBL. Based on the results of the post-Anava follow-up test, it showed that the difference in the average mathematics learning achievement in the hypothesis for students taught using CTBL was significantly different from students taught using PBL.

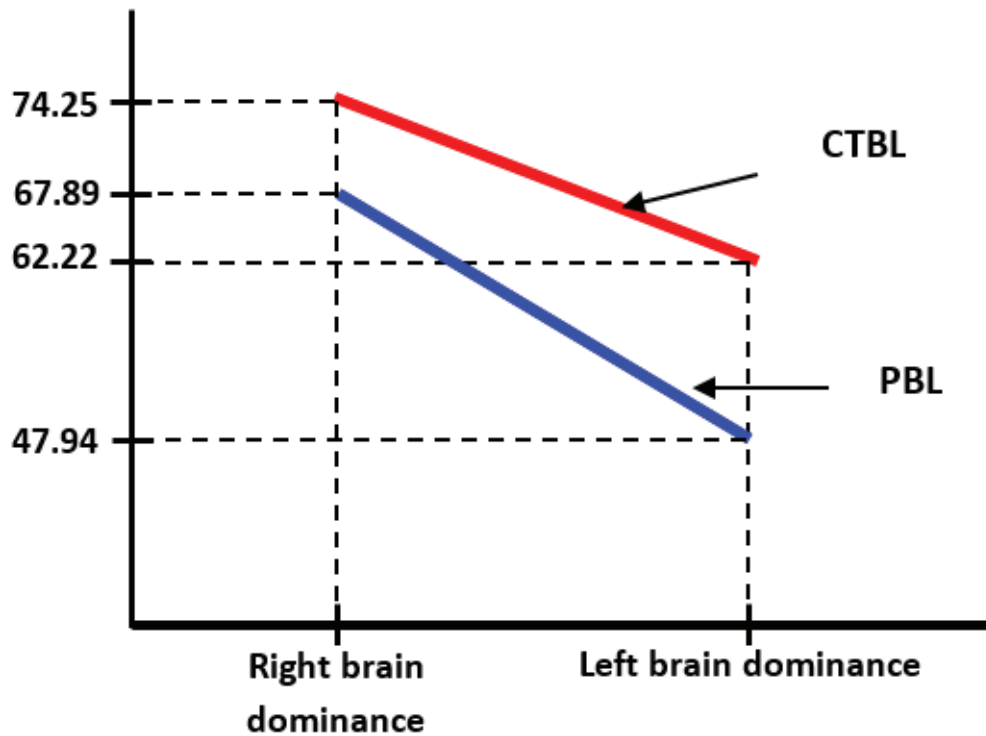


Figure 1. Learning Variables Effect Profil

E. Hypothesis Testing Conclusion

Based on the data analysis, data description and interpretation above, it can be concluded that:

1. The mathematics learning achievement of students who were given learning with CTBL was more effective than students who were given learning with PBL.

2. Mathematics learning achievement among students who were given learning with CTBL was better than students who were given learning with PBL both for students who have a right or left brain dominance.

**Conclusion**

Based on the analysis and hypothesis testing that has been carried out, it can be concluded in this study that CTBL was more effective to apply compared to PBL in class VIII students of odd semester at SMPN 1 Bendo Magetan in the Academic Year 2020/2021 year. There were differences in the results of mathematics learning achievement in students who were given CTBL and

PBL in terms of the brain dominance of odd semester class eight students at SMPN 1 Bendo Magetan in the Academic Year 2020/2021.

**Ethical Clearence:** Yes.

**Conflict of Interest:** No

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