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Brain-Based Learning Vs Problem Based Learning: Mathematical Complex Thinking Skills in terms of Student Creativity?

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Abstract

This study's findings explain that the quality of education in eastern Indonesia has decreased, especially from complex mathematical thinking skills. The theory of the Brain-Based Learning model versus the Problem Based Learning model theory is the solution in this study so that the results of the analysis show that the Brain-Based Learning model theory has a positive influence on increasing complex mathematical thinking skills when compared to the Problem Based Learning model, there is an interaction between the two learning models with the creativity of students is more significant, students who have high creativity can achieve better results if given the Brain-Based Learning Model than if given the Problem Based Learning Model. The Brain-Based Learning model can be higher than the complex mathematical thinking skills of students with low creativity given the Problem Based Learning Model. The conclusion is that learning in Eastern Indonesia is very appropriate to apply Brain-Based Learning theory compared to Problem Based Learning theory on complex mathematical thinking skills in terms of student creativity.

Keywords: *Brain-Based Learning; Problem Based Learning; Mathematical Complex Thinking Skills; Student Creativity*

Introduction

The fact that the quality of education in Indonesia has decreased is based on the results of the 2018 PISA survey that Indonesia is ranked 72nd out of 78 participating countries with an average score of 379 for the category in mathematics (OECD, 2019; Schleicher, 2019). Then, the TIMSS results show that student achievement in mathematics is ranked 46 out of 51 countries with 397. Thus, the data on the quality of education in Indonesia is still far from the desired expectations.

Complex thinking skills in students can impact improving the quality of education in Indonesia, especially at the elementary school level. It can be seen showing that the condition of students must be able to see in their entirety in solving problems as a whole and intact (Dewi & Riandi, 2016; Sunardjo et al., 2016). As an example of its application in improving students' complex thinking skills, it can be seen in Figure 1.

The reality in the field is that elementary schools in Bolo District, Bima Regency, West Nusa Tenggara have complex mathematical thinking skills that are still not optimal. As in Figure 1, the initial observations have very different thinking skills. Why do complex thinking skills need to be built in every student? The indicator of complex thinking skills is that students' skills are still not maximal in solving problems, both in critical thinking and creative decision-making (Dewi & Riandi, 2016). So that in this study it directs students to be able to think complex mathematically, which requires an understanding of mathematical problem solving, both solved by critical thinking and creative thinking in a problem.

Alternatives in solving problems for increasing complex mathematical thinking skills can be done by using two learning models that are equally active in solving problems in students, namely the Brain-Based Learning model and the Problem Based Learning model. The results of previous studies said that the Brain-Based Learning model is one of the learning methods that maximize students' brain function, which is carried out scientifically in the learning process (Adiansha et al., 2018; Adiansha & Sumantri, 2017; Permana & Adiansha, 2019; Yasar, 2017). The stages of the Brain-Based Learning Model are 1) Pre-exposure, 2) Preparation, 3) Initiation and acquisition, 4) Elaboration, 5) Incubation and memory entry, 6) Verification and belief checking, and 7) Celebration and integration. Meanwhile, the Problem Based Learning Model is a learning model that is solved by solving problems in the learning process through critical thinking in acquiring knowledge (Maskur et al., 2020). The stages of the Problem Based Learning Model are: 1) Initial problems, 2) Grouping students, 3) Directing students either individually or in groups, 4) Development of learning outcomes, 5) Analyzing and evaluating learning.

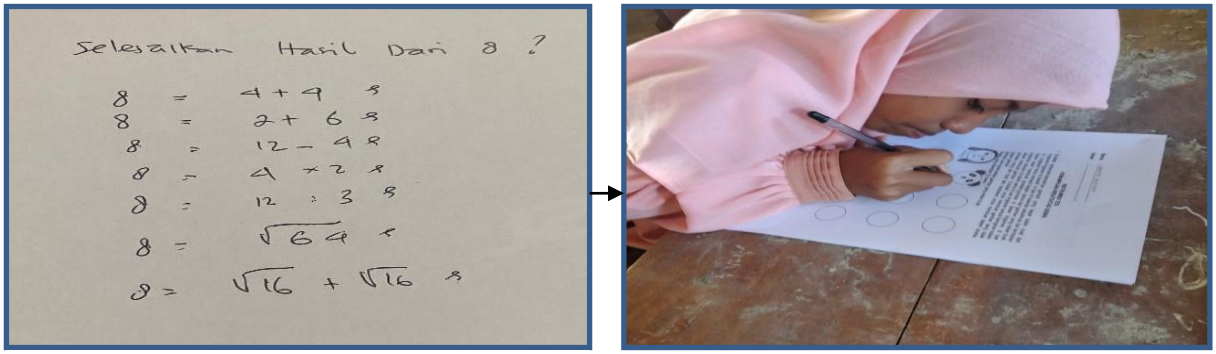

Figure 1. Students' Complex Mathematical Thinking Skills

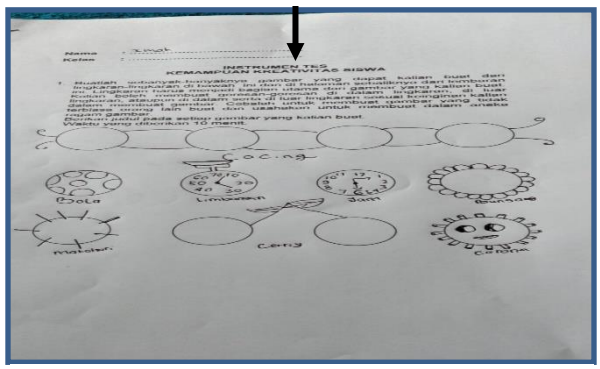

Figure 2. Student Creativity

In seeing the value of mathematical complex thinking skills in students, it is done using a student creativity test instrument first by making a research instrument through an image model so that from the image model section it will be carried out by providing assessment indicators, namely fluent, flexible, original, and elaborate. The image model is made into an image that has a name according to the results of student creativity, and the image model can be seen in Figure 3.

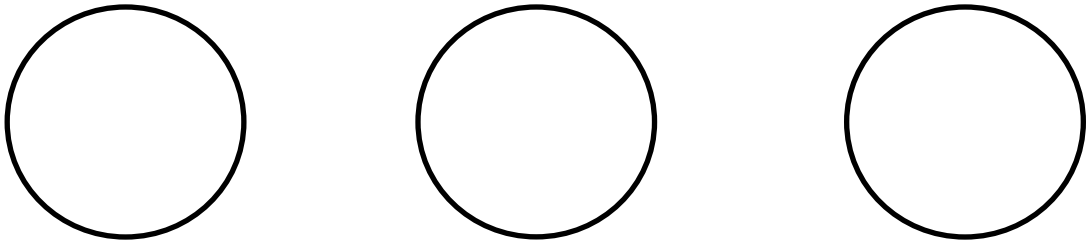

Figure 3. Tests to measure Student Creativity

The results of the research conducted by Adiansha stated that creativity is an ability that students have to give birth to the latest ideas and ideas that reflect fluency, flexibility, originality of thinking, and elaboration abilities (Adiansha et al., 2018, 2020; Adiansha & Sumantri, 2017). Furthermore, other researchers say that creativity is helping students in developing their talents to achieve achievements in learning (Haynes, 2020; Pllana, 2019).

This research is urgent because it looks at several previous studies that state that the Brain-Based Learning model has a significant favorable influence on mathematical communication skills in terms of student creativity (Adiansha et al., 2018). In addition, research conducted by (Anita & Mumpuniart, 2018) said that the Problem Based Learning model was able to positively influence students' creative thinking skills. So with some of the relevant research above, it shows a difference with the current research, namely in the research variables by comparing both learning models that have activeness in students, the situation and circumstances in the study also have differences.

The conclusion of the problem makes a title in the research that binds to the issues above, while the title of this research is the Effect of Brain-Based Learning and Problem Based Learning Models on Complex Mathematical Thinking Skills Judging from Student Creativity. The purpose of this research problem is to find out about 1) the differences in complex mathematical thinking skills treated with Brain-Based Learning and Problem Based Learning models for elementary school students; 2) Interaction between Brain-Based Learning and Problem Based Learning Models on complex mathematical thinking skills in terms of the creativity of elementary school students; 3) Differences in complex mathematical thinking skills in students who are treated with Brain-Based Learning and Problem Based Learning models who have high creativity; 4) Differences in mathematical complex thinking skills in students who are treated with Brain-Based Learning and Problem Based Learning models who have low creativity.

Method

The implementation of this research will still follow the rules and regulations during the Covid-19 Pandemic Period. The method used in this research is an experimental research method with treatment by level 2x2. The independent variables are the PBL model and the PBL model, the dependent variable is complex mathematical thinking skills, and the attribute variable is student creativity. The research design can be seen in table 1 above.

Table 1. Research Design

Creativity Attribute Variable (B)	Treatment Variable (A)	
	Brain-Based Learning Model (A1)	Problem Based Learning Model (A2)
High Creativity (B1)	A1B1	A2B1
Low Creativity (B2)	A1B2	A2B2

The population in this study was several elementary school students in Bima Regency, with a simple random sampling technique, namely by selecting schools randomly, determining the experimental class and control class, and selecting schools based on the accreditation qualifications of accredited schools.

The type of instrument used to measure student creativity is shown in Figure 1. At the same time, the complex thinking skills test is carried out in mathematics learning using essay questions that several instrument experts have validated at STKIP Taman Siswa Bima lecturers. Testing the validity and reliability of creativity and complex thinking skills using product-moment correlation and Cronbach's alpha (K.Brahim et al., 2015). Meanwhile, the data analysis technique was carried out by testing normality, homogeneity test through the Liliefors test and F test (Pramesti, 2017).

Results

Description Data

The research subjects were SDN Nggembe as the experimental school group and SDN Rada as the control school group. The research sample was taken from both high classes who have the same level of creativity measurement. The example can be seen in table 2.

Table 2. Student Research Sample

Creativity Attribute Variable (B)	Treatment Variable (A)	
	Brain-Based Learning Model (A1)	Problem Based Learning Model (A2)
High Creativity (B1)	22	22
Low Creativity (B2)	22	22

Table 3. Statistics Description of the Results of Mathematical Complex Thinking Skills

Creativity	Treatment									
	Brain-Based Learning Model					Problem Based Learning Model				
	N	Min	Max	Average	SD	N	Min	Max	Average	SD
High Creativity	22	63	92	76,27	8,58	22	42	79	60,66	10,94
Low Creativity	22	42	69	62,28	9,23	22	50	75	59,14	6,55
Total	44	42	92	68,47	11,12	44	42	79	61	8,95

The results of table 3 show the analysis of the value of complex mathematical thinking skills. The Brain-Based Learning model with high creativity gets an average score of 76.27, higher than the Problem Based Learning model with an average value of 60.66. Meanwhile, the Brain-Based Learning model with low creativity got an average score of 62.28, higher than the Problem Based Learning model with intense creativity, which brought an average score of 59.14. The conclusion from the data on the results of

complex mathematical thinking skills shows that the application of the Brain-Based Learning model has a better average value than the Problem-Based Learning model, all of which are viewed from the students' creativity.

Analysis Prerequisite Test

Test for Normality and Homogeneity of Student Groups Brain-Based Learning and Problem Based Learning Models

The normality test results obtained in the study indicate that the significance value of the data on the results of mathematical complex thinking skills in the Brain-Based Learning model is 0.502 > 0.05. It shows that the weight of mathematical complex thinking skills from 44 samples is usually distributed. Then the significance value of complex mathematical thinking skills using the Problem Based Learning model is 0.096 > 0.05, which shows that the weight of complex mathematical thinking skills from 44 samples is usually distributed.

Then, the results of the homogeneity test of mathematical complex thinking skills from 44 research samples using the brain-based learning model and the Problem Based Learning model meet a significance value of 0.0288 > 0.05, and it shows that the data on the importance of students' mathematical complex thinking skills has a high variance value. Homogeneous.

Normality and Homogeneity Test of Student Groups Treatment of Brain-Based Learning Model with High Creativity and Problem Based Learning Model with High Creativity

The results of the normality test obtained in the study indicate that the significance value of the data on the results of mathematical complex thinking skills in the Brain-Based Learning model with high creativity is 0.341 > 0.05, it shows that the weight of mathematical complex thinking skills from 22 samples is usually distributed. Then the significance value of complex mathematical thinking skills using the Problem Based Learning model with high creativity is 0.181 > 0.05, which shows that the weight of mathematical complex thinking skills from 22 samples is usually distributed.

Then, the results of the homogeneity test of mathematical complex thinking skills from as many as 22 research samples using the brain-based learning model and the Problem Based Learning model with both having high creativity scores met a significance value of 0.181 > 0.05, this indicates that the data on the importance of complex thinking skills Mathematics students have a homogeneous variance value.

Normality and Homogeneity Test of Student Groups Treatment of Brain-Based Learning Model with Low Creativity and Problem Based Learning Model with Low Creativity

The results of the normality test obtained in the study indicate that the significance value of the data on the results of complex mathematical thinking skills in the Brain-Based Learning model with low creativity is 0.449 > 0.05. This indicates that the weight of complex mathematical thinking skills from 22 samples is usually distributed. Then the significance value of complex mathematical thinking skills using the Problem Based Learning model with low creativity is 0.144 > 0.05, which shows that the weight of mathematical complex thinking skills from 22 samples is usually distributed.

Then, the results of the homogeneity test of mathematical complex thinking skills from as many as 22 research samples using the brain-based learning model and the Problem Based Learning model with both having low creativity scores met a significance value of 0.366 > 0.05, this indicates that the data on the importance of complex thinking skills Mathematics students have a homogeneous variance value.

Hypothesis Test

Differences in Mathematical Complex Thinking Skills which are treated with Brain-Based Learning Model and Problem Based Learning Model

The analysis results using two-way ANOVA showed that students treated using the Brain-Based Learning model obtained a Fcount value of 25.625, with a significance level of 0.05 and df1 = 1 and df2 = 2, so the value of Ftable = 4.3512. Thus, it is concluded that Fcount 25.625 > Ftable 4.3512 so that there is a rejection of H0, which means that there is a difference in the value of complex mathematical thinking skills from the two different learning models. Furthermore, the acceptance of H1 implies that the value of complex mathematical thinking skills given the treatment of the Brain-Based Learning model is higher than the treatment of the Problem Based Learning model.

Interaction between Learning given and Student Creativity on Complex Mathematical Thinking Skills

There is an interaction between the two learning models and students' creativity on the value of complex mathematical thinking skills. This is evidenced by a significance value of 0.003 <0.05 with a significance level of 0.05. These data show that there is a significant interaction between the learning model in terms of student creativity and the value of complex mathematical thinking skills. The interaction results also show that there is a relationship between the learning model and creativity that does not form a parallel line, meaning the line crosses. This proves that the Brain-Based Learning model in improving complex mathematical thinking skills is more suitable than the Problem Based Learning model.

Differences in Mathematical Complex Thinking Skills between Students who are given a Brain Based Learning Model and those given a Problem Based Learning Model in a Group of Students with High Creativity

The results of the analysis by t-test showed that students who were given treatment with the Brain-Based Learning model with high creativity obtained a tcount of 5.274 with a significance level of 0.05 and degrees of freedom 42, then for t-table 2.018. So it can be concluded that the value of tcount 5.274 > ttable value of 2.018 indicates a rejection of H0, which means there is a difference in the value of complex mathematical thinking skills between students who are given the behavior of the two learning models with high creativity. In addition, the acceptance of H1 means that the value of students' complex mathematical thinking skills given the Brain-Based Learning model behavior is higher than the Problem Based Learning model, both in terms of heightened creativity.

Differences in Mathematical Complex Thinking Skills between Students who are given a Brain-Based Learning Model and those given a Problem Based Learning Model in a Group of Students with Low Creativity

The results of the t-test analysis showed that students who were given treatment with the Brain-Based Learning model with high creativity obtained a t-count of 1.544 with a significance level of 0.05 and degrees of freedom 42, then for t-table 2.018. So it can be concluded that the tcount value of 1.544 > ttable value of 2.018 indicates the acceptance of H0, which means that there is a difference in the value of complex mathematical thinking skills between students given the behavior of the two learning models with high creativity. In addition, the acceptance of H1 means that the value of students' complex mathematical thinking skills given the Brain-Based Learning model behavior is no different from the Problem Based Learning model, which is both in terms of low creativity.

Discussion

In the first, second, third, and fourth hypotheses, following the significance level = 0.05, the results of the research above can be discussed with the following study:

Differences in complex mathematical thinking skills between students who are given the Brain-Based Learning Model and students who are given the Problem Based Learning Model

In testing the first hypothesis, it has been proven that there is a difference between the complex mathematical thinking skills of students who are given the Brain-Based Learning Model and students who are given the Problem Based Learning Model. The results of descriptive analysis and using t-test showed a significant difference in the value of complex mathematical thinking skills between the group of students who were given the Brain-Based Learning Model and the group of students who were given the Problem Based Learning Model. Based on data processing and analysis tests, students given the Brain-Based Learning Model tend to have higher mathematical complex thinking skills than students with the Problem Based Learning Model.

The application of the Brain-Based Learning Model shows that the learning supports the improvement of students' complex mathematical thinking skills. Each syntax contained in the Brain-Based Learning Model supports students' complex mathematical thinking skills. This is in line with research conducted by Adiansha et al., (2020) the brain-Based Learning model has a significant role in increasing students' complex mathematical thinking skills. Other studies that have similar results are researched by Putri et al. (2019) It was obtained that the complex mathematical thinking skills of students who were given the Brain-Based Learning Model were higher than students who were given direct learning. The results of the analysis are also in line with research conducted by Adiansha & Sumantri (2017) This shows an increase in communication skills in the Brain-Based Learning Model with character education nuances compared to the Problem-Based Learning Model.

By looking at the results of the analysis and discussion above, it can be concluded that the Brain-Based Learning Model plays a significant role and supports the improvement of students' complex mathematical thinking skills. In other words, the Brain-Based Learning Model has a positive effect on increasing complex mathematical thinking skills compared to the Problem Based Learning Model.

There is an interaction between the learning provided and student creativity towards students' complex mathematical thinking skills.

The results of data analysis show that there is an interaction between learning used and creativity in influencing students' complex mathematical thinking skills. Thus, it means that the teaching applied in the classroom and students' creativity significantly affect students' complex mathematical thinking skills.

The interaction shown by the research results means that in its application, the Brain-Based Learning Model and the Problem Based Learning Model depend on the level of creativity possessed by students. The Brain-Based Learning Model is thought to have a better effect than the Problem Based Learning Model when viewed from the students' creativity. Through interaction, it can be seen which group with learning has a higher average value of complex mathematical thinking skills. In this case, students with the Brain-Based Learning Model have a higher average value of complex mathematical thinking skills.

It is different from the Problem Based Learning Model, where students are less active in learning, so their mathematical complex thinking skills are difficult to improve. The learning process that does not

involve students understanding the material and only accepts explanations from the teacher is not suitable for developing complex mathematical thinking skills. However, for some students with a certain level of creativity, passive learning conditions and following what the teacher says will be easier to follow than when they have to understand the material themselves through reading and summarizing. This causes the interaction between learning and student creativity to be more significant.

Differences in Mathematical Complex Thinking Skills between Students who are given a Brain-Based Learning Model and those given a Problem Based Learning Model in a Group of Students with High Creativity

In testing the third hypothesis, Ho is rejected, which means that there is a significant difference between the Brain-Based Learning Model and the Problem Based Learning Model in students who have high creativity. The results of descriptive statistical analysis and t-test show a difference between students' complex mathematical thinking skills given the Brain-Based Learning Model and the Problem Based Learning Model in students who have high creativity. In addition, the acceptance of Hi means that the complex mathematical thinking skills of High Creativity students with the Brain-Based Learning Model are higher than the complex mathematical thinking skills of High Creativity students who are given the Problem Based Learning Model.

Based on the description above and the results of descriptive statistics and analytical tests, it can be concluded that the complex mathematical thinking skills of students with high creativity given the Brain-Based Learning Model will be higher than students with high creativity given the Problem Based Learning Model. In other words, students who have high creativity can achieve better results if they are given a Brain-Based Learning Model than if they are given a Problem-Based Learning Model.

Differences in Mathematical Complex Thinking Skills between Students who are given a Brain-Based Learning Model and those shown a Problem Based Learning Model in a Group of Students with Low Creativity

Testing the fourth hypothesis shows that Ho is accepted, which means there is no significant difference between the Brain-Based Learning Model and the Problem Based Learning Model in students who have low creativity. The results of descriptive statistical analysis and t-test showed no difference between students' complex mathematical thinking skills who were given the Brain-Based Learning Model and the Problem Based Learning Model in terms of students who had low creativity. In addition, it can also be interpreted that the complex mathematical thinking skills of students who have intense creativity with the Brain-Based Learning Model can be higher than the complex mathematical thinking skills of students with low creativity who are given the Problem Based Learning Model.

Based on the explanation above accompanied by the results of descriptive statistics and t-test, it can be concluded that the learning provided by the teacher does not have a significant effect on the ability of students who have low creativity. Students' complex mathematical thinking skills in the two groups with different learning differed significantly from intense creativity.

Conclusion

The results of the research and discussion in this study indicate that the first hypothesis says that there are differences in complex mathematical thinking skills between students who are given the Brain-Based Learning model and students who are given the Problem Based Learning model so that the Brain-Based Learning model plays a significant role and supports the improvement of complex thinking skills.

Student mathematics. In other words, the Brain-Based Learning model has a positive effect on increasing complex mathematical thinking skills compared to the Problem Based Learning model. The second hypothesis says the interaction between the learning provided and students' creativity on students' complex mathematical thinking skills. The teaching applied in the classroom and students' creativity significantly influence students' complex mathematical thinking skills. The third hypothesis says that there is a difference in mathematical complex thinking skills between students who are given the Brain-Based Learning model and those given the Problem Based Learning model in groups of students with high creativity so that the complex mathematical thinking skills of students with high creativity given the Brain-Based Learning model will be higher than those given the Brain-Based Learning model. with students with high creativity given the Problem Based Learning model. in other words, students who have high creativity can achieve better results if given a Brain-Based Learning model than if given a Problem Based Learning model. The fourth hypothesis is the difference in mathematical complex thinking skills between students who are given the Brain-Based Learning model and those given the Problem Based Learning model in groups of students with low creativity so that the learning provided by the teacher does not have a significant effect on the abilities of students who have intense creativity. Students' complex mathematical thinking skills in the two groups with different learning did not differ significantly when viewed from low creativity.

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