

Experimentation of Brain Based Learning and Project Based Learning Model on Mathematical Communication Abilities

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Abstract

Mathematical communication is very important because mathematics is a universal language used to explain natural phenomena, solve technical problems, and develop new theories in various fields of science and technology. This research aims to find out which one provides better mathematical communication abilities between Brain Based Learning (BBL), Project Based Learning (PjBL), and Direct Instruction (DI) models. The number of samples in this study was 92 students, the sampling technique used is Cluster Random Sampling. Hypothesis testing using one way ANOVA with different cells followed by multiple comparison tests. This research reveals that the mathematical communication abilities of students in the BBL model are equally as good as those in the PjBL model, the mathematical communication abilities of students in the BBL model are superior to those in the DI model, and the mathematical communication abilities of students in the PjBL model are superior to those in the DI model.

Keywords: Brain based learning, Mathematical communication, Project based learning.

INTRODUCTION

Mathematical communication abilities are one of the abilities that needs to be the focus of attention in mathematics learning (Samawati & Kurniasari, 2021; Umar, 2012). States that mathematical communication is important in learning mathematics because students who have good mathematical communication can organize their mathematical thinking both verbally and in writing and can easily interpret and solve problems. This is in line with the opinion Vale and Barbosa (2017) that with their mathematical communication abilities, students are able to organize, reflect and clarify ideas, relationships, mathematical thinking and mathematical arguments. According to Noer et al. (2022), during the process of learning mathematics, students communicate for various purposes (to present or justify a solution, to express a mathematical argument or to ask a question) and with different audiences (teacher, colleagues, group of students, whole class).

Students who have mathematical problem solving abilities can solve problems with the correct mathematical steps and conditions. The steps for solving problems according to Polya (in Abidin, 2015), include: a) understanding the problem; b) plan

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problem solving; c) carry out problem solving plans; d) look back at the results of problem solving. So that in the end, with the mathematical problem solving abilities that students have, the techniques for solving problems are more structured and mathematically logical. Apart from problem solving abilities, communication abilities in mathematics learning are also important to improve. The importance of having mathematical communication abilities was stated by Hendriana and Soemarmo (2016) rationally: a) Mathematics is an essential language which is not only a tool for thinking, finding formulas, solving problems, or just concluding, but mathematics also has unlimited value for expressing various ideas. clearly, thoroughly and precisely. b) Mathematics and mathematics learning are the heart of human social activities, for example in mathematics learning the interaction between teachers and students, between students and students, between mathematics learning materials and students are important factors in advancing students' potential, in mathematics communication, the participants Students have the opportunity, encouragement, support to speak, write, read and hear mathematical expressions, and they can communicate mathematically because mathematics is often given in symbolic communication, written communication and oral communication. In line with the statement (Harefa & Telaumbanua, 2020) which suggests that "Communicating mathematically is often provided in symbolic communication, written communication, and oral communication that contains mathematical ideas...". So with the mathematical communication abilities that students have through mathematics learning, it makes it easier for students to solve problems.

According to Umar (2012), students' mathematical communication abilities are how students communicate their ideas in an effort to solve problems given by the teacher, participate actively in discussions, and take responsibility for their answers to problems. There are many methods used to improve students' mathematical communication, such as those carried out by Khairani (2015) using a metacognitive approach, Merry et al. (2013) using problem posing, Karimah (2013) using the Cooperative Integrated Reading and Composition (CIRC) model, Fajri et al. (2013) using the Contextual Teaching And Learning (CTL) model, Jamilah et al. (2013) using PMR with Discovery Learning, and Hutapea (2014) through generative learning. However, there are still students' mathematical communication abilities that are relatively low. This is in line with the opinion of Rahmawati (2013) which stated that students' mathematical communication abilities are still low.

Based on the results of surveys and interviews that researchers conducted with mathematics teachers at SMA Angkasa 1 East Jakarta, students at this school had difficulty understanding mathematics learning. Students find it difficult to think critically and are too anxious when facing mathematics learning. Moreover, if students are asked to do questions, express opinions, or ask questions to the teacher, they do not provide any response. After conducting interviews with students and based on the analysis carried out by the author on the results of students' daily tests at the school. The author concluded that the students' ability to paint pictures completely and correctly and the ability to model problems correctly and then carry out calculations completely and correctly is still relatively low. These weaknesses indicate that the communication abilities of students at SMA Angkasa 1 East Jakarta are still low.

Many factors influence students' low mathematics scores, both internal and external factors. One of the internal factors that influence student learning outcomes is students' mathematical communication abilities in studying the subject matter provided, while one of the external factors is the way the teacher teaches, or the

learning model used by the teacher in classroom learning (Rahmawati & Budiyo, 2014). The low ability of students' mathematical communication is likely due to the application of learning models that are not in accordance with students' current abilities, this learning model has not been able to improve students' mathematical communication abilities. According to Kusuma (2017), the application of appropriate learning models is very possible in improving the quality of learning. One way that can be done is through cooperative learning. One of the learning models that is still widely used by teachers in schools is the DI model. DI or direct teaching is a learning model that is teacher centered (centered on the teacher). When implementing this learning model, teachers must demonstrate the knowledge and skills that will be taught to students step by step. Teachers should be able to be an interesting model for students. The results of the learning process in general, especially in mathematics lessons, are measured based on the ability of students to follow the learning activities. The success is seen if students understand and have a good final grade. Higher learning success indicates understanding and mastery of the material and learning outcomes also increase (Rahmawati & Hanipah, 2018).

Teachers as the spearhead in the success of mathematics learning certainly have an important role in efforts to educate the nation's children. Teachers must have appropriate strategies in teaching their students, so that what a teacher conveys can be understood by students. In teaching mathematics, teachers should use a variety of learning models that will make students actively participate in learning so as to improve students' mathematical communication. Among the many existing learning models, researchers chose a BBL model and PjBL model as a new learning model that can be applied in the classroom in an effort to improve students' mathematical communication.

RESEARCH METHODS

There is one independent variable in this research, namely the learning model. The learning model that researchers chose is the BBL (X_1), PjBL (X_2), and DI (X_3) model. One dependent variable, namely students' mathematical communication abilities. The research design used is the nonequivalent posttest-only control group design. In this design there are three classes that are each randomly selected. The first class was treated (X_1), the second class was treated (X_2), and the third class was treated (X_3) as a control. The two classes that were treated were called the experimental class and the third class that was treated was called the control class. Then, the three classes were given a final test (posttest).

Tabel 1. Research design

Group	Treatment	Positions
A_1	X_1 (Brain Based Learning)	Y_1
A_2	X_2 (Project Based Learning)	Y_2
A_3	X_3 (Direct Instruction)	Y_3

In this research, the population is all class X students of SMA Angkasa 1 East Jakarta for the 2019/2020 academic year. Samples were obtained using techniques Cluster Random Sampling. Samples were obtained from two different schools, namely SMA Angkasa 1 East Jakarta, and SMAS Al-Muhadjirin. The instrument used in this research uses a written test on logarithm material in the form

of a multiple choice question sheet with 35 questions which the researcher will first test for validity, discriminating power, difficulty index and reliability. The mathematical communication abilities that have been obtained are analyzed using a two-way variance analysis technique with unequal cells with the significance level of 5%. Hypothesis testing aims to find out which one provides better mathematical communication abilities between BBL, PjBL, or DI model on logarithm material in class X SMA Angkasa 1 East Jakarta.

RESULT AND DISCUSSION

Based on the instrument test calculations above, there are 15 questions that cannot be used in this research, and 20 other questions that can be used to measure students' mathematical communication abilities. After carrying out the test, data was obtained regarding students' mathematical communication abilities in the experimental class and control class as presented in Table 2.

Table 2. Sample group test results

Class	N	Mean	S	S ²	X _{max}	X _{min}
Brain Based Learning	32	82.187	11.139	124.092	100	60
Project Based Learning	32	75.625	9.397	88.306	90	50
Direct Instruction	28	67.500	11.262	126.851	85	45

Based on Table 2, it can be seen that the average value of mathematical communication abilities in classes that use the BBL model is higher than the average value of classes that use the PjBL model. Furthermore, it can be seen that classes that use the PjBL model provide a higher average score for mathematical communication abilities than classes that use the DI model. To draw conclusions from this research, a one-way Anava test was carried out with different cells, then continued with a further post-ANOVA test. Before carrying out the Anava test, a normality test and homogeneity of variance test were first carried out on the three samples.

The data normality test used the Lilliefors method with a significance level of $\alpha=0.05$. This data normality test was carried out three times, namely on groups of students who used the BBL model, groups of students who used the PjBL model, and groups of students who used the DI model. A summary of the normality test results of the data obtained is presented in Table 3.

Table 3. Summary of data normality test results

Group	N	$L_{calc.}$	$L_{crit.}$	Test Decision	Conclusion
Brain Based Learning	32	0.0826	0.1556	H_0 is accepted	Normal
Project Based Learning	32	0.1298	0.1556	H_0 is accepted	Normal
Direct Instruction	28	0.0999	0.1658	H_0 is accepted	Normal

Based on Table 3, it appears that at the significance level $\alpha=0.05$, all $L_{calc.}$ are not members of the critical area so that the H_0 test decision is accepted for each group. Based on the test results, it can be concluded that the three groups, namely the group that used the BBL model, the group that used the PjBL model, and the group that used the DI model came from a normally distributed population. The population variance homogeneity test is carried out to determine whether the populations being compared

have the same variance (homogeneous) or not. Therefore, the population variance homogeneity test was carried out once, namely by comparing the variance in experimental group I (BBL), experimental group II (PjBL), and control group (DI) to the students' mathematical communication ability test data. This test uses the Bartlett test with the conclusion that the three populations have the same variance or in other words the experimental class I, experimental class II, and control class come from a homogeneous population.

In accordance with the previously formulated research design, hypothesis testing for this study used one-way ANOVA with unequal cells. Hypothesis testing using one-way ANOVA with unequal cells was carried out after fulfilling the requirements for population normality and homogeneity of population variance. A summary of the calculation results for this test is presented in Table 4.

Table 4. Summary of one way analysis of variance

Source	Sum of Square	<i>df</i>	Mean square	$F_{calc.}$	$F_{crit.}$	<i>p</i>
Method	3223.234	2	1611.617	14.330	3.15	<0.05
Error	10009.375	89	112.464	-	-	-
Total	13232.609	91	-	-	-	-

From the calculation results, H_0 is rejected so that the three learning models do not give the same effect. Based on these results, in Table 5, it is necessary to carry out a multiple comparison test with the Scheffe' test.

Table 5. Summary of multiple comparison test decisions

Comparison	H_0	H_a	Test decision
μ_1 vs. μ_2	$\mu_1 = \mu_2$	$\mu_1 \neq \mu_2$	H_{10} accepted
μ_1 vs. μ_3	$\mu_1 = \mu_3$	$\mu_1 \neq \mu_3$	H_{20} rejected
μ_2 vs. μ_3	$\mu_2 = \mu_3$	$\mu_2 \neq \mu_3$	H_{30} rejected

Based on Table 5, it is known that H_{10} is accepted. This indicates that there are similar mathematical communication abilities among students in both the BBL and PjBL models. In terms of marginal means, the group of students with the BBL model has an average score of 82.187, while the group of students with the PjBL model has an average score of 75.625. It can be seen that the marginal mean of the group of students with the BBL model is higher compared to the mean of the group of students with the PjBL model.

Furthermore, research hypothesis H_{20} is rejected. This indicates that there is a difference in mathematical communication abilities between students in the BBL model group and the DI model group. In terms of marginal means, the group with the BBL model has an average score of 82.187, while the group of students with the DI model has an average score of 67.500. The mathematical communication abilities of students in the PjBL model are better than those of students in the DI model.

The research hypothesis H_{30} is rejected, This indicates that there is a difference in mathematical communication abilities between students in the PjBL model and the DI model. In terms of marginal means, students in the PjBL group have an average score of 75.625, while those in the DI group have an average score of 67.500. So, the mathematical communication abilities of students in the PjBL model are better than those of students in the DI model.

In this research it is concluded that the BBL model both provides good mathematical communication abilities with the PjBL model, the BBL model provides better mathematical communication abilities than the DI model, and the PjBL model provides better mathematical communication abilities than the DI model. So the appropriate learning model used in this research is the BBL and PjBL model rather than the DI model. These results are in accordance with the statement (Nahdi, 2015) that there is an increase in students' critical thinking and mathematical reasoning through the BBL model. The results of other research state that the application of PjBL learning with a collaborative character to effective mathematical communication abilities is demonstrated by achieving classical and individual mastery and increasing (Kumalaretna & Mulyono, 2017).

Based on the results of the implementation of learning models in each class, it can be concluded that the BBL model provides the same mathematical communication abilities as the PjBL model, and the BBL model and the PjBL model provide mathematical communication abilities better than the DI model. The results of this research are not in accordance with the first hypothesis that was previously formulated, namely the hypothesis which states that the application of the BBL model provides better mathematical communication abilities compared to the PjBL model on logarithm material. The results of other research also state that the average learning outcomes of students who take part in PjBL based on portfolio assessment are better than the average learning outcomes of students who take direct learning (Fitri, 2020). The results of other research (Adiansha et al., 2018), stated that mathematical communication abilities who were given BBL model treatment were higher compared to students who were given Expository model treatment in students who had high creativity.

CONCLUSION

Based on the results of research analysis and discussion and referring to the problem formulation. The conclusion of this research is that an inappropriate learning model can cause students' low mathematical communication abilities in logarithm material in class X SMA Angkasa 1 East Jakarta. Therefore, teachers can apply the BBL and PjBL model as an alternative learning model in mathematics subjects, especially in logarithm material. The results of the analysis and discussion of this research show that the mathematical communication abilities of students who use the BBL model are as good as the mathematical communication abilities of students who use the PjBL model. The mathematical communication abilities of students who use the BBL model are better than the mathematical communication abilities of students who use the DI model, while the mathematical communication abilities of students who use the PjBL model are better than the mathematical communication abilities of students who use the DI model.

Based on the conclusions that have been expressed, the researcher would like to propose several suggestions related to the implementation of the BBL and PjBL models in mathematics learning, namely: Mathematics teachers at SMA Angkasa 1 East Jakarta can apply the BBL and PjBL models as one of the one alternative learning model in mathematics subjects, especially in logarithm material and it is hoped that they can try to apply it to other appropriate subjects, in the PjBL model, at the beginning of learning the researcher is required to prepare the students' hearts and

minds before starting the lesson, therefore other researchers It is recommended to provide comfort to students while studying so that their hearts and minds are always ready to receive learning.

REFERENCES

- Abidin, Z. (2015). *Intuisi Dalam Pembelajaran Matematika*. Lentera Ilmu Cendekia.
- Adiansha, A. A., Sumantri, M. S., & Makmuri, M. (2018). Pengaruh model brain based learning terhadap kemampuan komunikasi matematis siswa ditinjau dari kreativitas. *Premiere Educandum: Jurnal Pendidikan Dasar dan Pembelajaran*, 8(2), 127-139.
- Fajri, N., Hajidin, & Ikhsan, M. (2013). Peningkatan Kemampuan Koneksi Dan Komunikasi Matematis Siswa Dengan Menggunakan Pendekatan Contextual Teaching And Learning (CTL). *Paradikma Jurnal Pendidikan*, 6(2), 149-161.
- Fitri, A. (2020). Penerapan Model Pembelajaran Project Based Learning dengan Penilaian Portofolio pada Mata Kuliah Matematika Ekonomi. *Delta: Jurnal Ilmiah Pendidikan Matematika*, 4(2), 1-8.
- Harefa, D., & Telaumbanua, T. (2020). *Belajar Berpikir dan Bertindak Secara Praktis Dalam Dunia Pendidikan kajian untuk Akademis*. CV. Insan Cendekia Mandiri.
- Hendriana, H. & Soemarmo, U. (2016). *Penilaian Pembelajaran Matematika*. PT Refika Aditama.
- Hutapea, N. M. (2014). Pencapaian Kemampuan Komunikasi Matematis Siswa SMA Melalui Pembelajaran Generatif. *Jurnal Pendidikan*, 4(2), 108-114.
- Karimah, S. (2013). Pembelajaran Matematika Model Cooperative Integrated Reading And Composition (CIRC) Untuk Meningkatkan Kemampuan Komunikasi Matematis Materi Segiempat Kelas VII. *Delta*, 1(2), 136-143.
- Khairani, M. (2015). Pendekatan Metakognitif Untuk Meningkatkan Kemampuan Komunikasi Matematis Siswa Kelas X SMAN 3 Payakumbuh. *Jurnal Ipteks Terapan*, 9(4), 253-260.
- Kumalaretna, W. N. D., & Mulyono, M. (2017). Kemampuan Komunikasi Matematis Ditinjau dari Karakter Kolaborasi dalam Pembelajaran Project Based Learning (PjBL). *Unnes Journal of Mathematics Education Research*, 6(2), 195-205.
- Kusuma, A. P. (2017). Implementasi Model Pembelajaran Student Teams Achievement Division dan Team Assisted Individualization ditinjau dari Kemampuan Spasial Siswa. *Al-Jabar: Jurnal Pendidikan Matematika*, 8(2), 135-144.
- Merry, R., Sutiarso, S., & Nurhanurawati. (2013). Pengaruh Pendekatan Problem Posing Terhadap Kemampuan Komunikasi Matematis Siswa. *Jurnal Pendidikan Matematika Unila*, 1(7), 1-10. <https://doi.org/10.14042/j.cnki.32.1309.2013.06.005>
- Nahdi, D. S. (2015). Meningkatkan kemampuan berpikir kritis dan penalaran matematis siswa melalui model brain based learning. *Jurnal Cakrawala Pendas*, 1(1), 13-22.
- Noer, S. H., Gunowibowo, P., & Triana, M. (2022). Pengaruh Kecerdasan Emosional Dan Kemampuan Awal Terhadap Kemampuan Komunikasi Matematis Siswa Dalam Pembelajaran Online. *Aksioma: Jurnal Program Studi Pendidikan Matematika*, 11(1), 482-492.
- Rahmawati, F. (2013). Pengaruh Pendekatan Pendidikan Realistik Matematika dalam Meningkatkan Kemampuan Komunikasi Matematis Siswa Sekolah Dasar. *Prosiding SEMIRATA 2013*, 1(1), 225-238.

- Rahmawati, N. K., & Budiyo, B. (2014). Eksperimentasi Model Pembelajaran T*TW dan NHT pada Materi Bangun Ruang Sisi Datar Ditinjau dari Kemampuan Komunikasi Matematis Siswa. *Jurnal Pembelajaran Matematika*, 2(10), 1042-1055.
- Rahmawati, N. K., & Hanipah, I. R. (2018). Penerapan Model Pembelajaran Kooperatif Tipe Think Pair Share (TPS) Dan Model Pembelajaran Kooperatif Tipe Student Team Achievement Division (STAD) Terhadap Hasil Belajar Matematika Siswa Pada Materi Garis Singgung Lingkaran. *NUMERICAL: Jurnal Matematika dan Pendidikan Matematika*, 2(1), 43-48.
- Samawati, I., & Kurniasari, I. (2021). Students' Mathematical Communication Skills in Solving Story Problems Based on Mathematical Abilities. *IJIET (International Journal of Indonesian Education and Teaching)*, 5(1), 61-70.
- Umar, W. (2012). Membangun Kemampuan Komunikasi Matematis Dalam Pembelajaran Matematika. *Infinity Journal*, 1(1), 1-9. <https://doi.org/10.22460/infinity.v1i1.2>
- Vale, I., & Barbosa, A. (2017). The Importance of Seeing in Mathematics Communication. *Journal of the European Teacher Education Network*, 12, 49-63.