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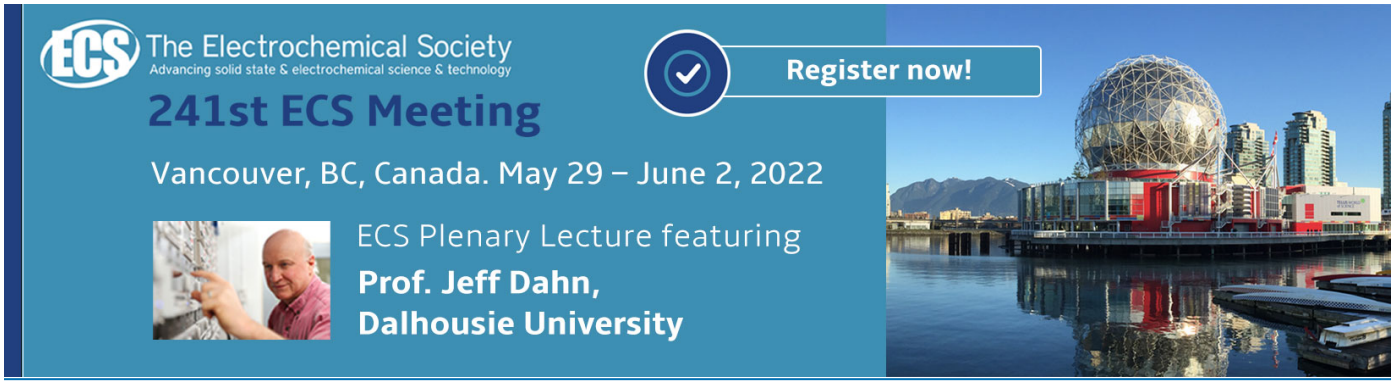

The effect of brain-based learning on students' mathematical communication ability viewed from creativities in the thematic subjects of science physics - mathematics

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Abstract. This study aims to determine the effect of Brain Based Learning on students' mathematical communication ability viewed from creativities, in the thematic subjects of science physics - mathematics. The research was carried out at SDN Pantai Harapan Jaya 01, Muara Gembong District, using experimental research on treatment with a level 2 x 2 design. The results showed that:(1) the mathematical communication ability of students who are given brain-based learning treatment is higher than students who use expository, (2) there is an interaction of learning models with creativity on students' mathematical communication ability, (3) students' mathematical communication ability with brain-based learning are morehigher than expository, this is for students who have high creativity, and (4) there is no difference in mathematical communication ability with brain based learning and expository treatment between students who have low creativity.

1. Introduction

The 2015 report from PISA (Program for International Student Assessment) with 70 countries participating in the country, Indonesia ranked 62nd[1].

Table 1.PISA results of performance in science, reading and mathematics in 2015.

No	Country	Science		Reading		Mathematics	
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62	**Indonesia**	**403**	**3**	**397**	**-2**	**386**	**4**
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70	Dominican Republic	332	M	358	M	328	M

The real that occurs in the results of mathematics learning is still very low[2–6]. A report from the 2015 TIMSS (Trends in International Mathematics and Science Study) from the International Association for Evaluation of Educational Achievement (IEA), Indonesia ranked 44th out of 56

participating countries with an average score of students' mathematics scores in grade IV namely amounting to 397 below the average score of 500 [7–9]. This shows that the ability in learning mathematics in Indonesia has not shown satisfactory results.

Overcoming this statement that needs to be improved mathematical communication skills in students that is to articulate, explain, organize and consolidate mathematical thinking [10–15]. This becomes important with the "articulation" of mathematical ideas that are explained through words can be heard by students, "explain" here means that students can explain their mathematical ideas to other students, "organize" is students can coordinate their ideas to be coherent and clear so that young people are accepted by their friends. After articulating, explaining, arranging further strengthens or connects each other about mathematical ideas. So that students are able to develop students' abilities in communicating ideas with verbal speaking, notes, symbols, tables, graphics, or other media to clarify the situation or problem.

Mathematical communication skills are very important in improving the quality of education [16–19], then in learning must be improved. The right learning to use is. Brain-Based Learning is a learning approach that is more parallel with how the brain learns best naturally based on the disciplines of neurology, biology, psychology, an understanding of the relationship between learning and the brain now leads to the role of emotions, patterns, meaning, environment, body rhythm and attitude, stress, trauma, assessment, music, movement, gender, and enrichment[3,20–31]. So as to be able to create learning that is oriented towards efforts to empower brain potential.

Mathematical communication skills are strongly influenced by students 'mathematical creativity, students' mathematical creativity is an ability that must be possessed by students in the learning process with the aim of being able to produce new ideas and ideas [32–55]. So that in the learning process, especially in mathematics learning, can increase.

After identification of the problem above, the formulation of the problem in this study is 1) Are there differences in mathematical communication skills of students who use Brain-Based Learning with class students who use Expository?; 2) Are their interactions between learning models and creativity on students' mathematical communication skills?; 3) Are there differences in mathematical communication skills between students who study with Brain-Based Learning and students who study with Expository in students who have high creativity?; 4) Are there differences in mathematical communication skills between students who study with Brain-Based Learning and students who study with Expository in students who have low creativity?

The objectives to be achieved in the study are 1) Explain the differences in mathematical communication skills of students who use Brain-Based Learning with class students who use Expository; 2) Explain the interaction between learning models and creativity on students' mathematical communication skills; 3) Explain differences in mathematical communication skills between students who learn with Brain-Based Learning and students who study with Expository in students who have high creativity; 4) Explain differences in mathematical communication skills between students who learn with Brain-Based Learning and students who study with Expository in students who have low creativity.

2. Methods

In this study, the method used in measuring the results of students' mathematical communication skills is the experimental method with 2x2 factorial by level or the two-way two-levels crossed factorial design, this means that the experiment consists of 2 factors, each of which consists of 2 levels. This design is used to assess the impact of each factor and its interaction on the response variable [56]. Research design as presented in Table 2.

Table 2. Design of experimental research

Attribute Variables Creativity (B)	Treatment Variables (A)	
	Brain Based Learning (A_1)	Ekspositori (A_2)
High Creativity (B_1)	A_1B_1	A_2B_1
Low Creativity (B_2)	A_1B_2	A_2B_2

The subjects of this study were fourth-grade students at SDN 01 Pantai Harapan Jaya Bekasi with the number for the experimental class as many as 30 students and for the control class as many as 28 students. The average age of students in the experimental class and control class is ± 9 years. Where in the experimental and control class the average has a social background having a well-off life with the parents mostly fishermen and agriculture and about 6 people per class of their parents are civil servants. The average ability after the trial test has almost the same ability of the two classes.

Implementation procedures in the study as in Table 2, namely the design used by level 2 x 2 treatments (two-way two-levels crossed factorial design) [56]. Where in the experimental class will use Brain-Based Learning while in the control class using expository learning In the expository Brain-Based Learning and Learning variables, each will be viewed from the creativity of the students so that students will find students who have high creativity and low creativity.

Furthermore, after students are given a creativity test it will be taken as a result of data analysis on students who have high creativity on the score range of 33% and students who have low creativity on the score range of 33% as well, this proportion is adapted from previous studies [57]. So that it will be obtained in the experimental class that is students who use Brain-Based Learning with high creativity (A_1B_1) as many as 10 students, and students who use Brain-Based Learning with low creativity (A_1B_2) as many as 10 students. Then in the control class is students who use expository learning with high creativity (A_2B_1) as many as 10 students, and students who use expository learning with low creativity (A_2B_2) as many as 10 students.

The sampling technique was carried out by the following processes: 1) Randomly selected SDN in Muara Gembong sub-district, Bekasi Regency and selected SDN 01 Pantai Harapan Jaya, 2) Then determined the experimental class and control class, so that IVA class students were selected as the experimental class and IVB class as a control class. Data collection techniques on students' creativity and mathematical communication skills are using essay tests with 5 questions.

3. Result and Discussion

After following the learning process using Brain-Based Learning and Expository, the results of students' mathematical communication skills in the form of scores were obtained.

Table 3. Description of Student Mathematical Communication Ability

Creativity	**Brain Based Learning**					**Ekspository**				
	N	Max	Min	Average	SD	N	Max	Min	Average	SD
High	10	80	60	71.5	6.69	10	70	45	54.5	8.32
Low	10	70	50	60.5	5.99	10	70	40	60	9.43
∑	20	80	50	66	8.37	20	70	40	57.25	9.1

Based on the results of the analysis of the normality test in the group of students who use Brain-Based Learning and Expository by using SPSS Version 24, it shows the significance value of students' mathematical communication skills in the group of students who use Brain-Based Learning shows Kolmogorov-Smimov[4] of 0.200 > 0.05, then Shapiro-Wilk shows that the significant value is 0.530 > 0.05. Then the Expository shows Kolmogorov-Smimov of 0.200 > 0.05, then Shapiro-Wilk shows that the significant value is 0.236 > 0.05. This means that the data of the mathematical communication

values of 20 samples of students given treatment with Brain-Based Learning and Expository are normally distributed.

The results of the analysis of the homogeneity test in the group of students who use Brain-Based Learning and Expository by using SPSS Version 24, it shows that significant Levene'sstatistics 0.475 > 0.05, which means that the data value of mathematical communication ability has a varianceshomogeneous. The normality test in the group of students who use Brain-Based Learning and Expository on students who have high creativity, it shows the significance value of students' mathematical communication skills in groups of students who use Brain-Based Learning with high creativity shows Kolmogorov-Smimov[4] is 0.200 > 0.05, then Shapiro-Wilk shows that the significant value is 0.466 > 0.05. Then the Expository with high creativity shows Kolmogorov-Smimovof 0.200 > 0.05, then Shapiro-Wilk shows that the significant value is 0.325 > 0.05. This means that the data of the mathematical communication value of the 10 samples of students who were treated with Brain-Based Learning and Expository in students who have the high creativity that is a normal distribution.

Then, based on the results of the analysis of the homogeneity test in the group of students who use Brain-Based Learning and Expository on students who have high creativity, it shows that the Levene'sstatistic is significant 0.591 > 0.05 which means the data value of mathematical communication skills has a varianceshomogeneous. Furthermore, the results shows the significance value of students' mathematical communication skills in groups of students who use Brain-Based Learning with low creativity shows Kolmogorov- Smimovis 0.200 > 0.05, then Shapiro-Wilk shows that the significant value is 0.691 > 0.05. Then the Expository with low creativity showed Kolmogorov-Smimovof 0.200 > 0.05, then Shapiro-Wilk showed that the significant value was 0.190 > 0.05. This means that the data of mathematical communication values from 10 samples of students given treatment with Brain-Based Learning and Expository on students who have low creativity are normally distributed.

The results of the analysis of the homogeneity test in the group of students who use Brain-Based Learning and Expository on students who have low creativity by using SPSS Version 24, it shows that significant Levene's statistics 0.282 > 0.05, which means that the data value of mathematical communication skills has a homogeneous variances.

3.1 Metamorphic Communication Ability Students who get Higher Brain-Based Learning Treatment for Students Who Get Expository Treatment.

Based on the results of hypothesis testing using two-way ANOVA analysis which shows that students who are given the Brain-Based Learning and Expository treatment get a F_{count} value of 12.84. With a significance level of 0.05 with $df_1 = 2$ and $df_2 = 18$, when viewed from F_{table}, the value of $F_{table} = 3.55$ is obtained.

Thus, that the value of $F_{count} = 12.84$ > value of $F_{table} = 3.55$, this means there is a rejection of H_0, which means that there is a difference in the value of mathematical communication skills between the two groups of students given different learning. In addition, the acceptance of H_1 means that the mathematical communication ability of the group of students given Brain-Based Learning treatment is higher than the group of students given Expository.

3.2 The interaction between Learning Model and creativity on students' mathematical communication skills.

Based on the results of the analysis using SPSS Version 24, there is an interaction between learning, namely Brain-Based Learning and expository with creativity towards mathematical communication skills. This shows that through the interaction column learning with creativity obtained significant values of 0.002 < 0.05 with a significance level of 0.05. This means that there is a significant interaction between learning used with creativity in mathematical communication skills.

3.3 Differences in Mathematical Communication Ability of Students Who Get Brain-Based Learning and Expository Treatment for Students Who Have High Creativity.

Based on the results of the analysis by t-test using SPSS Version 24 that students who were given treatment with Brain-Based Learning with high creativity and Expository with high creativity obtained a count of 5.04. With a significance level of 0.05 and a degree of magnitude 18, when viewed in t_{table}, it is obtained $t_{table}$of 2.10. Thus, that the value of t_{count} = 5.04 > the value of t_{table} = 2.10, this means that there is a rejection of H_0 which means that there is a difference in the value of mathematical communication skills between students who use different learning treatments even though both have high creativity. In addition, the acceptance of H_1 means that the mathematical communication ability of students who are given treatment using Brain-Based Learning is higher than students who use the Expository treatment which both have high creativity.

3.4 Differences in Mathematical Communication Ability of Students Who Get Brain-Based Learning and Expository Treatment for Students Who Have Low Creativity.

Based on the results of the analysis by t-test using SPSS Version 24, it shows that the results of the analysis with the t-test are students who are given treatment with Brain Based Learning with low creativity and expository with low creativity get a total of 1.42. With a significance level of 0.05 and a degree of 18, when viewed from the t_{table}, the t_{table} is 2.10. So the value of t_{count} = 1.42 < t_{table} value = 2.10 this means that there is acceptance of H_0 which means that there is no difference in the value of mathematical communication skills between students who use different learning treatments even though both have low creativity.

Overall, the results of this study indicate that there is an interesting relationship between students' mathematical communication ability and brain-based learning, which is also found to be related to students' creativity. This result is in line with the previous study[58], that mathematics learning that applies a brain-based learning approach contributes to the development of students' mathematical communication ability. When compared with conventional teaching, students' mathematical communication ability using Brain Based Learning are better than those using conventional learning approaches[59]. Brain based learning was also found to be effective on students' creative thinking skills and self-efficacy[60]. In the context of neuroscience, brain capacity directly impacts how students can understand and communicate in learning[61]. Mathematical communication is very important in the learning process. Through effective mathematical communication, students can organize their mathematical thinking in writing and communicate their understanding to others[59].

4. Conclusion

Based on the findings made by researchers, it was concluded that:(1) the mathematical communication ability of students who are given brain-based learning treatment is higher than students who use expository, (2) there is an interaction of learning models with creativity on students' mathematical communication ability, (3) students' mathematical communication ability with brain-based learning are morehigher than expository, this is for students who have high creativity, and (4) there is no difference in mathematical communication ability with brain based learning and expository treatment between students who have low creativity.

Acknowledgement

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Mathematical communication skills are very important in improving the quality of education [16]–[19], then in learning must be improved. The right learning to use is. Brain-Based Learning is a learning approach that is more parallel with how the brain learns best naturally based on the disciplines of neurology, biology, psychology, an understanding of the relationship between learning and the brain now leads to the role of emotions, patterns, meaning, environment, body rhythm and attitude, stress, trauma, assessment, music, movement, gender, and enrichment [3], [20]–[31]. So as to be able to create learning that is oriented towards efforts to empower brain potential.

Mathematical communication skills are strongly influenced by students 'mathematical creativity, students' mathematical creativity is an ability that must be possessed by students in the learning process with the aim of being able to produce new ideas and ideas [32]–[55]. So that in the learning process, especially in mathematics learning, can increase.

After identification of the problem above, the formulation of the problem in this study is 1) Are there differences in mathematical communication skills of students who use Brain-Based Learning with class students who use Expository?; 2) Are their interactions between learning models and creativity on students' mathematical communication skills?; 3) Are there differences in mathematical communication skills between students who study with Brain-Based Learning and students who study with Expository in students who have high creativity?; 4) Are there differences in mathematical communication skills between students who study with Brain-Based Learning and students who study with Expository in students who have low creativity?

The objectives to be achieved in the study are 1) Explain the differences in mathematical communication skills of students who use Brain-Based Learning with class students who use Expository; 2) Explain the interaction between learning models and creativity on students' mathematical communication skills; 3) Explain differences in mathematical communication skills between students who learn with Brain-Based Learning and students who study with Expository in students who have high creativity; 4) Explain differences in mathematical communication skills between students who learn with Brain-Based Learning and students who study with Expository in students who have low creativity.

2. Methods

In this study, the method used in measuring the results of students' mathematical communication skills is the experimental method with 2x2 treatment by level. With research design, as in Table 2 as follows.

Table 2. Design of experimental research

Attribute Variables Creativity (B)	Treatment Variables (A)	
	Brain Based Learning	Ekspositori

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	(A1)	(A2)
High Creativity (B_1)	A_1B_1	A_2B_1
Low Creativity (B_2)	A_1B_2	A_2B_2

The subjects of this study were fourth-grade students at SDN 01 Pantai Harapan Jaya Bekasi with the number for the experimental class as many as 30 students and for the control class as many as 28 students. The average age of students in the experimental class and control class is ± 9 years. Where in the experimental and control class the average has a social background having a well-off life with the parents mostly fishermen and agriculture and about 6 people per class of their parents are civil servants. The average ability after the trial test has almost the same ability of the two classes.

Implementation procedures in the study as in Table 2, namely the design used by level 2 x 2 treatments. Where in the experimental class will use Brain-Based Learning while in the control class using expository learning In the expository Brain-Based Learning and Learning variables, each will be viewed from the creativity of the students so that students will find students who have high creativity and low creativity.

Furthermore, after students are given a creativity test it will be taken as a result of data analysis on students who have high creativity on the score range of 33% and students who have low creativity on the score range of 33% as well. So that it will be obtained in the experimental class that is students who use Brain-Based Learning with high creativity (A_1B_1) as many as 10 students, and students who use Brain-Based Learning with low creativity (A_1B_2) as many as 10 students. Then in the control class is students who use expository learning with high creativity (A_2B_1) as many as 10 students, and students who use expository learning with low creativity (A_2B_2) as many as 10 students.

The sampling technique was carried out by the following processes: 1) Randomly selected SDN in Muara Gembong sub-district, Bekasi Regency and selected SDN 01 Pantai Harapan Jaya, 2) Then determined the experimental class and control class, so that IVA class students were selected as the experimental class and IVB class as a control class. Data collection techniques on students' creativity and mathematical communication skills are using essay tests with 5 questions.

3. Result and Discussion

After following the learning process using Brain-Based Learning and Expository, the results of students' mathematical communication skills in the form of scores were obtained.

Table 3. Description of Student Mathematical Communication Ability

Creativity	*Brain Based Learning*					Ekspositori				
	N	Max	Min	Average	SD	N	Max	Min	Average	SD
High	10	80	60	71.5	6.69	10	70	45	54.5	8.32
Low	10	70	50	60.5	5.99	10	70	40	60	9.43
∑	20	80	50	66	8.37	20	70	40	57.25	9.1

Based on the results of the analysis of the normality test in the group of students who use Brain-Based Learning and Expository by using SPSS Version 24, it shows the significance value of students' mathematical communication skills in the group of students who use Brain-Based Learning shows Kolmogorov-Smimov[4] of 0.200 > 0.05, then Shapiro-Wilk shows that the significant value is 0.530 > 0.05. Then the Expository shows Kolmogorov-Smimov[4] of 0.200 > 0.05, then Shapiro-Wilk shows that the significant value is 0.236 > 0.05. This means that the data of the mathematical communication values of 20 samples of students given treatment with Brain-Based Learning and Expository are normally distributed.

The results of the analysis of the homogeneity test in the group of students who use Brain-Based Learning and Expository by using SPSS Version 24, it shows that significant Levene's statistics 0.475 > 0.05, which means that the data value of mathematical communication ability has a variances

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homogeneous. The normality test in the group of students who use Brain-Based Learning and Expository on students who have high creativity, it shows the significance value of students' mathematical communication skills in groups of students who use Brain-Based Learning with high creativity shows Kolmogorov-Smimov[4] is 0.200 > 0.05, then Shapiro-Wilk shows that the significant value is 0.466 > 0.05. Then the Expository with high creativity shows Kolmogorov-Smimov of 0.200 > 0.05, then Shapiro-Wilk shows that the significant value is 0.325 > 0.05. This means that the data of the mathematical communication value of the 10 samples of students who were treated with Brain-Based Learning and Expository in students who have the high creativity that is a normal distribution.

Then, based on the results of the analysis of the homogeneity test in the group of students who use Brain-Based Learning and Expository on students who have high creativity, it shows that the Levene's statistic is significant 0.591 > 0.05 which means the data value of mathematical communication skills has a variances homogeneous. Furthermore, the results shows the significance value of students' mathematical communication skills in groups of students who use Brain-Based Learning with low creativity shows Kolmogorov- Smimov is 0.200 > 0.05, then Shapiro-Wilk shows that the significant value is 0.691 > 0.05. Then the Expository with low creativity showed Kolmogorov-Smimov of 0.200 > 0.05, then Shapiro-Wilk showed that the significant value was 0.190 > 0.05. This means that the data of mathematical communication values from 10 samples of students given treatment with Brain-Based Learning and Expository on students who have low creativity are normally distributed.

The results of the analysis of the homogeneity test in the group of students who use Brain-Based Learning and Expository on students who have low creativity by using SPSS Version 24, it shows that significant Levene's statistics 0.282 > 0.05, which means that the data value of mathematical communication skills has a homogeneous variances.

3.1 Metamorphic Communication Ability Students who get Higher Brain-Based Learning Treatment for Students Who Get Expository Treatment.

Based on the results of hypothesis testing using two-way ANOVA analysis which shows that students who are given the Brain-Based Learning and Expository treatment get a F-count value of 12.84. With a significance level of 0.05 with $df^1 = 2$ and $df^2 = 18$, when viewed from F-table, the value of F-table = 3.55 is obtained.

Thus, that the value of Fcount = 12.84 > value of F-table = 3.55, this means there is a rejection of H_0, which means that there is a difference in the value of mathematical communication skills between the two groups of students given different learning. In addition, the acceptance of H_1 means that the mathematical communication ability of the group of students given Brain-Based Learning treatment is higher than the group of students given Expository.

3.2 The interaction between Learning Model and creativity on students' mathematical communication skills.

Based on the results of the analysis using SPSS Version 24, there is an interaction between learning, namely Brain-Based Learning and expository with creativity towards mathematical communication skills. This shows that through the interaction column learning with creativity obtained significant values of 0.002 < 0.05 with a significance level of 0.05. This means that there is a significant interaction between learning used with creativity in mathematical communication skills.

3.3 Differences in Mathematical Communication Ability of Students Who Get Brain-Based Learning and Expository Treatment for Students Who Have High Creativity.

Based on the results of the analysis by t-test using SPSS Version 24 that students who were given treatment with Brain-Based Learning with high creativity and Expository with high creativity obtained a count of 5.04. With a significance level of 0.05 and a degree of magnitude 18, when viewed in t-table, it is obtained t-table of 2.10. Thus, that the value of t-count = 5.04 > the value of t-table = 2.10, this means that there is a rejection of H_0 which means that there is a difference in the value of mathematical

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communication skills between students who use different learning treatments even though both have high creativity. In addition, the acceptance of H_1 means that the mathematical communication ability of students who are given treatment using Brain-Based Learning is higher than students who use the Expository treatment which both have high creativity.

3.4 Differences in Mathematical Communication Ability of Students Who Get Brain-Based Learning and Expository Treatment for Students Who Have Low Creativity

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Based on the results of the analysis with the t-test using SPSS Version 24 shows that the results of the analysis with the t-test is that students who are given treatment with Brain-Based Learning with low creativity and expository with low creativity obtain a count of 1.42. With a significance level of 0.05 and a degree of magnitude 18, when viewed in t-table, it is obtained t-table of 2.10. Thus, that the value of t-count = 1.42 < value of t-table = 2.10, this means that there is a rejection of H_0 which means that there is a difference in the value of mathematical communication skills between students who use different learning treatments even though both have low creativity. Besides that, the acceptance of $_H1$ means that the mathematical communication ability of students given treatment using Brain-Based Learning is lower than students who use the Expository treatment which both have low creativity.

4. Conclusion

Based on the findings made by researchers, it was concluded that: (1) the mathematical communication ability of students who are given brain-based learning treatment is higher than students who use expository, (2) there is an interaction of learning models with creativity on students' mathematical communication ability, (3) students' mathematical communication ability with brain-based learning are more higher than expository, this is for students who have high creativity, and (4) mathematical communication ability of students with brain-based learning are lower than expository, this is for students who have low creativity.

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The effect of brain-based learning on students' mathematical communication ability viewed from creativitiesin the thematic subjects of science physics - mathematics

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Abstract. This study aims to determine the effect of Brain Based Learning on students' mathematical communication ability viewed from creativities, in the thematic subjects of science physics - mathematics. The research was carried out at SDN Pantai Harapan Jaya 01, Muara Gembong District, using experimental research on treatment with a level 2 x 2 design. The results showed that:(1) the mathematical communication ability of students who are given brain-based learning treatment is higher than students who use expository, (2) there is an interaction of learning models with creativity on students' mathematical communication ability, (3) students' mathematical communication ability with brain-based learning are morehigher than expository, this is for students who have high creativity, and (4) mathematical communication ability of students with brain-based learning are lower than expository, this is for students who have low creativity.

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1. Introduction

The 2015 report from PISA (Program for International Student Assessment) with 70 countries participating in the country, Indonesia ranked 62nd[1].

Table 1.PISA results of performance in science, reading and mathematics in 2015.

No	Country	Science		Reading		Mathematics	
		Mean Score	Average in3-year	Mean Score	Average in3-year	Mean Score	Average in3-year
		Mean	*Score dif*	*Mean*	*Score dif*	*Mean*	*Score dif*
1	Singapore	556	7	535	5	564	1
2	Japan	538	3	516	-2	532	1
3	Estonia	534	2	519	9	520	2
4	Chinese Taipei	532	0	497	1	542	0
5	Finland	531	-11	526	-5	511	-10
..							
62	**Indonesia**	**403**	**3**	**397**	**-2**	**386**	**4**
..							
70	Dominican Republic	332	M	358	M	328	M

The real that occurs in the results of mathematics learning is still very low[2]–[6]. A report from the 2015 TIMSS (Trends in International Mathematics and Science Study) from the International Association for Evaluation of Educational Achievement (IEA), Indonesia ranked 44th out of 56

participating countries with an average score of students' mathematics scores in grade IV namely amounting to 397 below the average score of 500 [7]–[9]. This shows that the ability in learning mathematics in Indonesia has not shown satisfactory results.

Overcoming this statement that needs to be improved mathematical communication skills in students that is to articulate, explain, organize and consolidate mathematical thinking [10]–[15]. This becomes important with the "articulation" of mathematical ideas that are explained through words can be heard by students, "explain" here means that students can explain their mathematical ideas to other students, "organize" is students can coordinate their ideas to be coherent and clear so that young people are accepted by their friends. After articulating, explaining, arranging further strengthens or connects each other about mathematical ideas. So that students are able to develop students' abilities in communicating ideas with verbal speaking, notes, symbols, tables, graphics, or other media to clarify the situation or problem.

Mathematical communication skills are very important in improving the quality of education [16]–[19], then in learning must be improved. The right learning to use is. Brain-Based Learning is a learning approach that is more parallel with how the brain learns best naturally based on the disciplines of neurology, biology, psychology, an understanding of the relationship between learning and the brain now leads to the role of emotions, patterns, meaning, environment, body rhythm and attitude, stress, trauma, assessment, music, movement, gender, and enrichment[3], [20]–[31]. So as to be able to create learning that is oriented towards efforts to empower brain potential.

Mathematical communication skills are strongly influenced by students 'mathematical creativity, students' mathematical creativity is an ability that must be possessed by students in the learning process with the aim of being able to produce new ideas and ideas [32]–[55]. So that in the learning process, especially in mathematics learning, can increase.

After identification of the problem above, the formulation of the problem in this study is 1) Are there differences in mathematical communication skills of students who use Brain-Based Learning with class students who use Expository?; 2) Are their interactions between learning models and creativity on students' mathematical communication skills?; 3) Are there differences in mathematical communication skills between students who study with Brain-Based Learning and students who study with Expository in students who have high creativity?; 4) Are there differences in mathematical communication skills between students who study with Brain-Based Learning and students who study with Expository in students who have low creativity?

The objectives to be achieved in the study are 1) Explain the differences in mathematical communication skills of students who use Brain-Based Learning with class students who use Expository; 2) Explain the interaction between learning models and creativity on students' mathematical communication skills; 3) Explain differences in mathematical communication skills between students who learn with Brain-Based Learning and students who study with Expository in students who have high creativity; 4) Explain differences in mathematical communication skills between students who learn with Brain-Based Learning and students who study with Expository in students who have low creativity.

2. Methods

In this study, the method used in measuring the results of students' mathematical communication skills is the experimental method with 2x2 treatment by level. With research design, as in Table 2 as follows.

Table 2. Design of experimental research

Attribute Variables Creativity (B)	Treatment Variables (A)	
	Brain Based Learning (A1)	Ekspositori (A2)

High Creativity (B_1)	A_1B_1	A_2B_1
Low Creativity (B_2)	A_1B_2	A_2B_2

The subjects of this study were fourth-grade students at SDN 01 Pantai Harapan Jaya Bekasi with the number for the experimental class as many as 30 students and for the control class as many as 28 students. The average age of students in the experimental class and control class is ± 9 years. Where in the experimental and control class the average has a social background having a well-off life with the parents mostly fishermen and agriculture and about 6 people per class of their parents are civil servants. The average ability after the trial test has almost the same ability of the two classes.

Implementation procedures in the study as in Table 2, namely the design used by level 2 x 2 treatments. Where in the experimental class will use Brain-Based Learning while in the control class using expository learning In the expository Brain-Based Learning and Learning variables, each will be viewed from the creativity of the students so that students will find students who have high creativity and low creativity.

Furthermore, after students are given a creativity test it will be taken as a result of data analysis on students who have high creativity on the score range of 33% and students who have low creativity on the score range of 33% as well. So that it will be obtained in the experimental class that is students who use Brain-Based Learning with high creativity (A_1B_1) as many as 10 students, and students who use Brain-Based Learning with low creativity (A_1B_2) as many as 10 students. Then in the control class is students who use expository learning with high creativity (A_2B_1) as many as 10 students, and students who use expository learning with low creativity (A_2B_2) as many as 10 students.

The sampling technique was carried out by the following processes: 1) Randomly selected SDN in Muara Gembong sub-district, Bekasi Regency and selected SDN 01 Pantai Harapan Jaya, 2) Then determined the experimental class and control class, so that IVA class students were selected as the experimental class and IVB class as a control class. Data collection techniques on students' creativity and mathematical communication skills are using essay tests with 5 questions.

3. Result and Discussion

After following the learning process using Brain-Based Learning and Expository, the results of students' mathematical communication skills in the form of scores were obtained.

Table 3. Description of Student Mathematical Communication Ability

Creativity	***Brain Based Learning***					**Ekspositori**				
	N	Max	Min	Average	SD	N	Max	Min	Average	SD
High	10	80	60	71.5	6.69	10	70	45	54.5	8.32
Low	10	70	50	60.5	5.99	10	70	40	60	9.43
∑	20	80	50	66	8.37	20	70	40	57.25	9.1

Based on the results of the analysis of the normality test in the group of students who use Brain-Based Learning and Expository by using SPSS Version 24, it shows the significance value of students' mathematical communication skills in the group of students who use Brain-Based Learning shows Kolmogorov-Smimov[4] of 0.200 > 0.05, then Shapiro-Wilk shows that the significant value is 0.530 > 0.05. Then the Expository shows Kolmogorov-Smimov[4] of 0.200 > 0.05, then Shapiro-Wilk shows that the significant value is 0.236 > 0.05. This means that the data of the mathematical communication values of 20 samples of students given treatment with Brain-Based Learning and Expository are normally distributed.

The results of the analysis of the homogeneity test in the group of students who use Brain-Based Learning and Expository by using SPSS Version 24, it shows that significant Levene'sstatistics 0.475 > 0.05, which means that the data value of mathematical communication ability has a variances homogeneous. The normality test in the group of students who use Brain-Based Learning and Expository

on students who have high creativity, it shows the significance value of students' mathematical communication skills in groups of students who use Brain-Based Learning with high creativity shows Kolmogorov-Smimov[4] is 0.200 > 0.05, then Shapiro-Wilk shows that the significant value is 0.466 > 0.05. Then the Expository with high creativity shows Kolmogorov-Smimovof 0.200 > 0.05, then Shapiro-Wilk shows that the significant value is 0.325 > 0.05. This means that the data of the mathematical communication value of the 10 samples of students who were treated with Brain-Based Learning and Expository in students who have the high creativity that is a normal distribution.

Then, based on the results of the analysis of the homogeneity test in the group of students who use Brain-Based Learning and Expository on students who have high creativity, it shows that the Levene'sstatistic is significant 0.591 > 0.05 which means the data value of mathematical communication skills has a varianceshomogeneous. Furthermore,the results shows the significance value of students' mathematical communication skills in groups of students who use Brain-Based Learning with low creativity shows Kolmogorov- Smimovis 0.200 > 0.05, then Shapiro-Wilk shows that the significant value is 0.691 > 0.05. Then the Expository with low creativity showed Kolmogorov-Smimovof 0.200 > 0.05, then Shapiro-Wilk showed that the significant value was 0.190 > 0.05. This means that the data of mathematical communication values from 10 samples of students given treatment with Brain-Based Learning and Expository on students who have low creativity are normally distributed.

The results of the analysis of the homogeneity test in the group of students who use Brain-Based Learning and Expository on students who have low creativity by using SPSS Version 24, it shows that significant Levene'sstatistics 0.282 > 0.05, which means that the data value of mathematical communication skills has a homogeneous variances.

3.1 Metamorphic Communication Ability Students who get Higher Brain-Based Learning Treatment for Students Who Get Expository Treatment.

Based on the results of hypothesis testing using two-way ANOVA analysis which shows that students who are given the Brain-Based Learning and Expository treatment get a F-count value of 12.84. With a significance level of 0.05 with $df^1 = 2$ and $df^2 = 18$, when viewed from F-table, the value of F-table = 3.55 is obtained.

Thus, that the value of Fcount = 12.84 > value of F-table = 3.55, this means there is a rejection of H_0, which means that there is a difference in the value of mathematical communication skills between the two groups of students given different learning. In addition, the acceptance of H_1 means that the mathematical communication ability of the group of students given Brain-Based Learning treatment is higher than the group of students given Expository.

3.2 The interaction between Learning Model and creativity on students' mathematical communication skills.

Based on the results of the analysis using SPSS Version 24, there is an interaction between learning, namely Brain-Based Learning and expository with creativity towards mathematical communication skills. This shows that through the interaction column learning with creativity obtained significant values of 0.002 < 0.05 with a significance level of 0.05. This means that there is a significant interaction between learning used with creativity in mathematical communication skills.

3.3 Differences in Mathematical Communication Ability of Students Who Get Brain-Based Learning and Expository Treatment for Students Who Have High Creativity.

Based on the results of the analysis by t-test using SPSS Version 24 that students who were given treatment with Brain-Based Learning with high creativity and Expository with high creativity obtained a count of 5.04. With a significance level of 0.05 and a degree of magnitude 18, when viewed in t-table, it is obtained t-tableof 2.10. Thus, that the value of t-count = 5.04 > the value of t-table = 2.10, this means that there is a rejection of H_0 which means that there is a difference in the value of mathematical communication skills between students who use different learning treatments even though both have

Commented [A2]: Sebutkan nilai apa yang anda maksudkan.

high creativity. In addition, the acceptance of H_1 means that the mathematical communication ability of students who are given treatment using Brain-Based Learning is higher than students who use the Expository treatment which both have high creativity.

3.4 Differences in Mathematical Communication Ability of Students Who Get Brain-Based Learning and Expository Treatment for Students Who Have Low Creativity.

Based on the results of the analysis with the t-test using SPSS Version 24 shows that the results of the analysis with the t-test is that students who are given treatment with Brain-Based Learning with low creativity and expository with low creativity obtain a count of 1.42. With a significance level of 0.05 and a degree of magnitude 18, when viewed in t-table, it is obtained t-table of 2.10. Thus, that the value of t-count = 1.42 < value of t-table = 2.10, this means that there is a rejection of H_0 which means that there is a difference in the value of mathematical communication skills between students who use different learning treatments even though both have low creativity. Besides that, the acceptance of $_H1$ means that the mathematical communication ability of students given treatment using Brain-Based Learning is lower than students who use the Expository treatment which both have low creativity.

Commented [A3]: Ini kesimpulan yang keliru. Thit< t tab, maka H0 harusnya diterima. Dengan demikian kesimpulannya adalah tidak ada perbedaan kemampuan komunikasi matematik antar kedua kelompok siswa.

4. Conclusion

Based on the findings made by researchers, it was concluded that:(1) the mathematical communication ability of students who are given brain-based learning treatment is higher than students who use expository, (2) there is an interaction of learning models with creativity on students' mathematical communication ability, (3) students' mathematical communication ability with brain-based learning are morehigher than expository, this is for students who have high creativity, and (4) mathematical communication ability of students with brain-based learning are lower than expository, this is for students who have low creativity.

Commented [A4]: Harus mengikuti hasil di atas

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The effect of brain-based learning on students' mathematical communication ability viewed from creativities in the thematic subjects of science physics - mathematics

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Abstract. This study aims to determine the effect of Brain Based Learning on students' mathematical communication ability viewed from creativities, in the thematic subjects of science physics - mathematics. The research was carried out at SDN Pantai Harapan Jaya 01, Muara Gembong District, using experimental research on treatment with a level 2 x 2 design. The results showed that: (1) the mathematical communication ability of students who are given brain-based learning treatment is higher than students who use expository, (2) there is an interaction of learning models with creativity on students' mathematical communication ability, (3) students' mathematical communication ability with brain-based learning are more higher than expository, this is for students who have high creativity, and (4) there is no difference in mathematical communication ability with brain based learning and expository treatment between students who have low creativity.

1. Introduction

The 2015 report from PISA (Program for International Student Assessment) with 70 countries participating in the country, Indonesia ranked 62nd [1].

Table 1. PISA results of performance in science, reading and mathematics in 2015.

No	Country	Science		Reading		Mathematics	
		Mean Score	Average in 3-year	Mean Score	Average in 3-year	Mean Score	Average in 3-year
		Mean	*Score dif*	*Mean*	*Score dif*	*Mean*	*Score dif*
1	Singapore	556	7	535	5	564	1
2	Japan	538	3	516	-2	532	1
3	Estonia	534	2	519	9	520	2
4	Chinese Taipei	532	0	497	1	542	0
5	Finland	531	-11	526	-5	511	-10
..							
62	**Indonesia**	**403**	**3**	**397**	**-2**	**386**	**4**
..							
70	Dominican Republic	332	M	358	M	328	M

The real that occurs in the results of mathematics learning is still very low [2–6]. A report from the 2015 TIMSS (Trends in International Mathematics and Science Study) from the International Association for Evaluation of Educational Achievement (IEA), Indonesia ranked 44th out of 56

participating countries with an average score of students' mathematics scores in grade IV namely amounting to 397 below the average score of 500 [7–9]. This shows that the ability in learning mathematics in Indonesia has not shown satisfactory results.

Overcoming this statement that needs to be improved mathematical communication skills in students that is to articulate, explain, organize and consolidate mathematical thinking [10–15]. This becomes important with the "articulation" of mathematical ideas that are explained through words can be heard by students, "explain" here means that students can explain their mathematical ideas to other students, "organize" is students can coordinate their ideas to be coherent and clear so that young people are accepted by their friends. After articulating, explaining, arranging further strengthens or connects each other about mathematical ideas. So that students are able to develop students' abilities in communicating ideas with verbal speaking, notes, symbols, tables, graphics, or other media to clarify the situation or problem.

Mathematical communication skills are very important in improving the quality of education [16–19], then in learning must be improved. The right learning to use is. Brain-Based Learning is a learning approach that is more parallel with how the brain learns best naturally based on the disciplines of neurology, biology, psychology, an understanding of the relationship between learning and the brain now leads to the role of emotions, patterns, meaning, environment, body rhythm and attitude, stress, trauma, assessment, music, movement, gender, and enrichment [3,20–31]. So as to be able to create learning that is oriented towards efforts to empower brain potential.

Mathematical communication skills are strongly influenced by students 'mathematical creativity, students' mathematical creativity is an ability that must be possessed by students in the learning process with the aim of being able to produce new ideas and ideas [32–55]. So that in the learning process, especially in mathematics learning, can increase.

After identification of the problem above, the formulation of the problem in this study is 1) Are there differences in mathematical communication skills of students who use Brain-Based Learning with class students who use Expository?; 2) Are their interactions between learning models and creativity on students' mathematical communication skills?; 3) Are there differences in mathematical communication skills between students who study with Brain-Based Learning and students who study with Expository in students who have high creativity?; 4) Are there differences in mathematical communication skills between students who study with Brain-Based Learning and students who study with Expository in students who have low creativity?

The objectives to be achieved in the study are 1) Explain the differences in mathematical communication skills of students who use Brain-Based Learning with class students who use Expository; 2) Explain the interaction between learning models and creativity on students' mathematical communication skills; 3) Explain differences in mathematical communication skills between students who learn with Brain-Based Learning and students who study with Expository in students who have high creativity; 4) Explain differences in mathematical communication skills between students who learn with Brain-Based Learning and students who study with Expository in students who have low creativity.

2. Methods

In this study, the method used in measuring the results of students' mathematical communication skills is the experimental method with 2x2 factorial by level or the two-way two-levels crossed factorial design, this means that the experiment consists of 2 factors, each of which consists of 2 levels. This design is used to assess the impact of each factor and its interaction on the response variable [56]. Research design as presented in Table 2.

Table 2. Design of experimental research

Attribute Variables Creativity (B)	Treatment Variables (A)	
	Brain Based Learning (A_1)	Ekspositori (A_2)
High Creativity (B_1)	A_1B_1	A_2B_1
Low Creativity (B_2)	A_1B_2	A_2B_2

The subjects of this study were fourth-grade students at SDN 01 Pantai Harapan Jaya Bekasi with the number for the experimental class as many as 30 students and for the control class as many as 28 students. The average age of students in the experimental class and control class is ± 9 years. Where in the experimental and control class the average has a social background having a well-off life with the parents mostly fishermen and agriculture and about 6 people per class of their parents are civil servants. The average ability after the trial test has almost the same ability of the two classes.

Implementation procedures in the study as in Table 2, namely the design used by level 2 x 2 treatments (two-way two-levels crossed factorial design) [56]. Where in the experimental class will use Brain-Based Learning while in the control class using expository learning In the expository Brain-Based Learning and Learning variables, each will be viewed from the creativity of the students so that students will find students who have high creativity and low creativity.

Furthermore, after students are given a creativity test it will be taken as a result of data analysis on students who have high creativity on the score range of 33% and students who have low creativity on the score range of 33% as well, this proportion is adapted from previous studies [57]. So that it will be obtained in the experimental class that is students who use Brain-Based Learning with high creativity (A_1B_1) as many as 10 students, and students who use Brain-Based Learning with low creativity (A_1B_2) as many as 10 students. Then in the control class is students who use expository learning with high creativity (A_2B_1) as many as 10 students, and students who use expository learning with low creativity (A_2B_2) as many as 10 students.

The sampling technique was carried out by the following processes: 1) Randomly selected SDN in Muara Gembong sub-district, Bekasi Regency and selected SDN 01 Pantai Harapan Jaya, 2) Then determined the experimental class and control class, so that IVA class students were selected as the experimental class and IVB class as a control class. Data collection techniques on students' creativity and mathematical communication skills are using essay tests with 5 questions.

3. Result and Discussion

After following the learning process using Brain-Based Learning and Expository, the results of students' mathematical communication skills in the form of scores were obtained.

Table 3. Description of Student Mathematical Communication Ability

Creativity	**Brain Based Learning**					**Ekspository**				
	N	Max	Min	Average	SD	N	Max	Min	Average	SD
High	10	80	60	71.5	6.69	10	70	45	54.5	8.32
Low	10	70	50	60.5	5.99	10	70	40	60	9.43
∑	20	80	50	66	8.37	20	70	40	57.25	9.1

Based on the results of the analysis of the normality test in the group of students who use Brain-Based Learning and Expository by using SPSS Version 24, it shows the significance value of students' mathematical communication skills in the group of students who use Brain-Based Learning shows Kolmogorov-Smimov[4] of 0.200 > 0.05, then Shapiro-Wilk shows that the significant value is 0.530 > 0.05. Then the Expository shows Kolmogorov-Smimov of 0.200 > 0.05, then Shapiro-Wilk shows that the significant value is 0.236 > 0.05. This means that the data of the mathematical communication

values of 20 samples of students given treatment with Brain-Based Learning and Expository are normally distributed.

The results of the analysis of the homogeneity test in the group of students who use Brain-Based Learning and Expository by using SPSS Version 24, it shows that significant Levene's statistics 0.475 > 0.05, which means that the data value of mathematical communication ability has a variances homogeneous. The normality test in the group of students who use Brain-Based Learning and Expository on students who have high creativity, it shows the significance value of students' mathematical communication skills in groups of students who use Brain-Based Learning with high creativity shows Kolmogorov-Smimov[4] is 0.200 > 0.05, then Shapiro-Wilk shows that the significant value is 0.466 > 0.05. Then the Expository with high creativity shows Kolmogorov-Smimov of 0.200 > 0.05, then Shapiro-Wilk shows that the significant value is 0.325 > 0.05. This means that the data of the mathematical communication value of the 10 samples of students who were treated with Brain-Based Learning and Expository in students who have the high creativity that is a normal distribution.

Then, based on the results of the analysis of the homogeneity test in the group of students who use Brain-Based Learning and Expository on students who have high creativity, it shows that the Levene's statistic is significant 0.591 > 0.05 which means the data value of mathematical communication skills has a variances homogeneous. Furthermore, the results shows the significance value of students' mathematical communication skills in groups of students who use Brain-Based Learning with low creativity shows Kolmogorov- Smimov is 0.200 > 0.05, then Shapiro-Wilk shows that the significant value is 0.691 > 0.05. Then the Expository with low creativity showed Kolmogorov-Smimov of 0.200 > 0.05, then Shapiro-Wilk showed that the significant value was 0.190 > 0.05. This means that the data of mathematical communication values from 10 samples of students given treatment with Brain-Based Learning and Expository on students who have low creativity are normally distributed.

The results of the analysis of the homogeneity test in the group of students who use Brain-Based Learning and Expository on students who have low creativity by using SPSS Version 24, it shows that significant Levene's statistics 0.282 > 0.05, which means that the data value of mathematical communication skills has a homogeneous variances.

3.1 Metamorphic Communication Ability Students who get Higher Brain-Based Learning Treatment for Students Who Get Expository Treatment.

Based on the results of hypothesis testing using two-way ANOVA analysis which shows that students who are given the Brain-Based Learning and Expository treatment get a F_{count} value of 12.84. With a significance level of 0.05 with $df_1 = 2$ and $df_2 = 18$, when viewed from F_{table}, the value of $F_{table} = 3.55$ is obtained.

Thus, that the value of $F_{count} = 12.84 >$ value of $F_{table} = 3.55$, this means there is a rejection of H_0, which means that there is a difference in the value of mathematical communication skills between the two groups of students given different learning. In addition, the acceptance of H_1 means that the mathematical communication ability of the group of students given Brain-Based Learning treatment is higher than the group of students given Expository.

3.2 The interaction between Learning Model and creativity on students' mathematical communication skills.

Based on the results of the analysis using SPSS Version 24, there is an interaction between learning, namely Brain-Based Learning and expository with creativity towards mathematical communication skills. This shows that through the interaction column learning with creativity obtained significant values of 0.002 < 0.05 with a significance level of 0.05. This means that there is a significant interaction between learning used with creativity in mathematical communication skills.

3.3 Differences in Mathematical Communication Ability of Students Who Get Brain-Based Learning and Expository Treatment for Students Who Have High Creativity.

Based on the results of the analysis by t-test using SPSS Version 24 that students who were given treatment with Brain-Based Learning with high creativity and Expository with high creativity obtained a count of 5.04. With a significance level of 0.05 and a degree of magnitude 18, when viewed in t_{table}, it is obtained t_{table} of 2.10. Thus, that the value of $t_{count} = 5.04 >$ the value of $t_{table} = 2.10$, this means that there is a rejection of H_0 which means that there is a difference in the value of mathematical communication skills between students who use different learning treatments even though both have high creativity. In addition, the acceptance of H_1 means that the mathematical communication ability of students who are given treatment using Brain-Based Learning is higher than students who use the Expository treatment which both have high creativity.

3.4 Differences in Mathematical Communication Ability of Students Who Get Brain-Based Learning and Expository Treatment for Students Who Have Low Creativity.

Based on the results of the analysis by t-test using SPSS Version 24, it shows that the results of the analysis with the t-test are students who are given treatment with Brain Based Learning with low creativity and expository with low creativity get a total of 1.42. With a significance level of 0.05 and a degree of 18, when viewed from the t-table, the t_{table} is 2.10. So the value of $t_{count} = 1.42 < t_{table}$ value = 2.10 this means that there is acceptance of H_0 which means that there is no difference in the value of mathematical communication skills between students who use different learning treatments even though both have low creativity.

4. Conclusion

Based on the findings made by researchers, it was concluded that: (1) the mathematical communication ability of students who are given brain-based learning treatment is higher than students who use expository, (2) there is an interaction of learning models with creativity on students' mathematical communication ability, (3) students' mathematical communication ability with brain-based learning are more higher than expository, this is for students who have high creativity, and (4) there is no difference in mathematical communication ability with brain based learning and expository treatment between students who have low creativity.

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REVIEW SUMMARY

ID Article : 002
Article Title **: The effect of brain-based learning on students' mathematical communication ability viewed from creativitiesin the thematic subjects of science physics - mathematics**

Criteria	Comment
Technical Criteria	
• Scientific merit: notably scientific rigour, accuracy and correctness.	
• Clarity of expression; communication of ideas; readability and discussion of concepts.	Terdapat kekeliruan kesimpulan hipotesis, menyebabkan kesalahan pada hasil dan kesimpulan.
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• Diagrams, figures, tables and captions: Are they essential and clear?	
• Text and mathematics: Are they brief but still clear? If you recommend shortening, please suggest what should be omitted.	

• Conclusion: Does the paper contain a carefully written conclusion, summarizing what has been learned and why it is interesting and useful?	

Recommendation:

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Best Regards,

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