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The Application of the Accelerated Learning Cycle, Brain-based Learning Model, and Direct Instruction Model toward Mathematical Reasoning in Terms of Mathematical Communication

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Abstract

The students' mathematical reasoning and mathematical communication abilities are influenced by several factors such as the use of learning models used by teachers in learning. The use of appropriate learning models can increase students' mathematical communication abilities and reasoning. This study aims to determine the effect of the Accelerated Learning Cycle, Brain-based learning model and Direct Instruction learning models on students' mathematical reasoning abilities seen from their communication abilities. This is a quasi-experimental research. The data were analyzed using analysis of variance with unequal cells. This study concludes that, first, Accelerated Learning Cycle provides better mathematical reasoning abilities than the Brain-based learning model and the Direct Instruction learning model and Brain-based learning model provide better mathematical reasoning abilities than the Direct Instruction learning model. Second, students who have high mathematical communication abilities have better mathematical reasoning than students with moderate or low mathematical communication abilities, students who have medium communication abilities have better mathematical reasoning than students with low mathematical communication abilities.

Keywords: Accelerated Learning Cycle; Brain-based learning model; Mathematical Communication; and Mathematical Reasoning Ability.

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Introduction

Mathematics is one of the subjects taught from primary, secondary, and tertiary education (Syazali, 2015). Mathematics has become an important element in developing science and technology (Wulandari, Mujib, & Putra, 2016). However, students still think that learning mathematics is boring (Sari, Farida, & Syazali, 2016). The teacher-centered learning process does not provide an opportunity for students to be active in teaching and learning activities (Badrun & Hartono, 2013). Difficulties in learning mathematics are seen when students are given questions in the form of reasoning. The level of mastery of the material regarding reasoning is still categorized as low. This means that mathematics lessons related to the ability to recognize and communicate still need special attention because students can exchange ideas and at the same time clarify the understanding and knowledge they gain in learning.

In building reasoning and strategic thinking, teachers must pay attention to in learning mathematics, namely: the type of mathematical thinking must be relevant to the students, the type of teaching materials, class management, the role of the teacher, as well as student autonomy in thinking and doing activities. The application of an appropriate learning model is possible to improve the reasoning ability of students. Currently, the learning model used at the schools known as the direct learning model (Direct Instruction). Using this model, teacher activities dominate the teaching and learning activities while students tend to be passive. Cooperative learning is a learning model based on students actively involved in sharing ideas and working together to complete academic tasks (Zakaria & Ihsan, 2007). The cooperative models used in this research were Accelerated Learning Cycle, Brain-based learning model, and Direct Instruction. Accelerated Learning Cycle has the principle that learning also involves the whole mind and body, learning is creative not consuming, cooperation can help the learning process well, learning takes place at many levels simultaneously, learning comes from doing the work itself, supporting positive emotions that help to learn, as well as the brain that can absorb information directly and automatically. This is the principle of a good learning model to apply. This study aimed to describe which is better between the Accelerated Learning Cycle, Brain-based learning model, and Direct Instruction on students' mathematical reasoning in terms of mathematical communication.

Several previous studies have discussed how to apply the models (Amelia, 2015; Awaliyah, 2016) and research in improving mathematical reasoning abilities and mathematical communication (Adesty, Nurhanurawati, & Widyastuti, 2014; Ambarwati, Dwijanto, & Hendikawati, 2015; Andrianti, Irawati, & Sudin, 2016; Ariany & Dahlan, 2017; Atsnan, 2015; Diandita, Johar, & Abidin, 2017; Hapizah, 2015; Hartati & Suyitno, 2015; Indriani, 2018; Khamid & Santosa, 2016; Nopitasari, n.d., 2015; Nurhayati, 2018; Nuriadin, 2015; F. G. Putra, 2016; R. W. Y. Putra, 2015; Setiawan, 2016; Solekha, Noer, & Gunowibowo, 2013; Sumartini, 2018; Supriadi & Damayanti, 2016; Wibowo, 2017; Harahap, 2014). Research comparing the application of Accelerated Learning Cycle, Brain-based learning model and Direct Instruction on mathematical reasoning abilities in terms of students' mathematical communication abilities. Based on previous research, the novelty of this research was focused on the influence of the Accelerated Learning Cycle, Brain-based learning model, and Direct Instruction on students' mathematical reasoning abilities seen from their communication abilities. So, the purpose of this study was to determine the effect of the Accelerated Learning Cycle, Brain-based learning model, and Direct Instruction on students' mathematical reasoning abilities seen from the students' communication abilities.

the Research Methods

The research method used was quasi-experimental research. This study used a 3x3 factorial design through a two-way ANAVA technique with unequal cells because this study intended to examine simultaneously the 3 treatments of learning models in groups that were different in terms of mathematical communication abilities levels. The research design can be seen in Table 1.

Table 1. the Design of 3 × 3 Factorial Research

Leaning Model	Mathematical Communication Abilities		
	High (y_1)	Medium (y_2)	Low (y_3)
Accelerated Learning Cycle	xy_{11}	xy_{12}	xy_{13}
Brain-based learning model	xy_{21}	xy_{22}	xy_{23}
Direct Instruction	xy_{31}	xy_{32}	xy_{33}

With xy_{ij} is the value of the learning model (i) and the mathematical communication ability (j), i = 1, 2, 3 and j = 1, 2, 3.

The documentation method was used to investigate the students' mathematics data in the previous year. The test was also used to collect reasoning ability data and mathematical communication abilities in the form of multiple-choice tests which consisted of 25 items for the mathematical reasoning test and 7 items the mathematical communication test. The mathematical reasoning ability test scores were analyzed using a two-way analysis of variance with unequal cells with an error level of 5%. Hypothesis testing was aimed at finding out whether there is an influence between each learning model, each ability category of students' mathematical communication, and interactions between the two can be seen in the results of mathematical reasoning abilities.

the Results of the Research and the Discussion

The results of the prerequisite test allowed the use of two-way ANOVA with unequal cells with a significance level of 5%. The result of hypothesis testing can be seen in Table 2.

Table 2. The Results of Two-Way ANOVA

Source	JK	dk	RK	F_{obs}	F_{α}
Learning model (X)	5618.16	2	2809.08	12.99	3.00
Communication ability (Y)	7856.34	2	3928.17	18.16	3.00
Interaction (XY)	2606.31	4	651.58	3.02	2.37
Error (G)	62541.38	289	216.42		
Total	78622.15	297			

The results of the calculation of F_{obs} for H_{0X}, H_{0Y}, and H_{0XY} shown in Table 2 can be concluded were rejected. Based on the test decision, it can be concluded that: (1) learning model influences mathematical reasoning ability, (2) mathematical communication ability influences mathematical reasoning, (3) there is an interaction between learning models and mathematical communication ability on mathematical ability. Since the H_{0X}, H_{0Y}, and H_{0XY} were rejected, it is necessary to do a post-ANOVA test using the Scheffe' method, namely inter-row average comparison test, inter-column average comparison test, and inter-cell average comparison test. The results are presented in Table 3.

Table 3. The Summary of Inter-row Double Comparisons

H_0	F_{obs}	$2F_{\alpha;v}$	Decision
$\mu_{1.} = \mu_{2.}$	10.49	(2) (3.00) = 6.00	H_0 is rejected
$\mu_{2.} = \mu_{3.}$	34.33	(2) (3.00) = 6.00	H_0 is rejected
$\mu_{1.} = \mu_{3.}$	6.20	(2) (3.00) = 6.00	H_0 is rejected

By comparing F_{obs} with critical value, it appears that there are significant differences between the $\mu_{1.}$ and $\mu_{2.}$, μ_3 and μ_3. By paying attention to the marginal average, it can be concluded that: (1) the Accelerated Learning Cycle is better than the Brain-based learning model and Direct Instruction and the Brain-based learning model is better than Direct Instruction. The result of the inter-column multiple comparison test is presented in Table 4.

Table 4. The Summary of Inter-Column Double Comparisons

H_0	F_{obs}	$2F_{\alpha;v}$	Decision
$\mu_{.1} = \mu_{.2}$	14.59	(2) (3.00) = 6.00	H_0 is rejected
$\mu_{.2} = \mu_{.3}$	38.53	(2) (3.00) = 6.00	H_0 is rejected
$\mu_{.1} = \mu_{.3}$	7.13	(2) (3.00) = 6.00	H_0 is rejected

By comparing F_{obs} with critical values, it appears that there is a significant difference between $\mu_{.1}$ and $\mu_{.2}$, $\mu_{.2}$and $\mu_{.3}$, as well as $\mu_{.1}$ and $\mu_{.3}$. By paying attention to the marginal mean of each column, it can be concluded that: (1) students with high mathematical communication abilities have better mathematical reasoning abilities than students with moderate mathematical communication abilities because the average scores of students with high mathematical communication abilities were 69.17 while the average scores of students with moderate mathematical communication abilities were 61.12. (2) students with high mathematical communication abilities have better mathematical reasoning abilities than students with low mathematical communication abilities because the average scores of the student with high mathematical communication abilities were 69.17 while the average scores of students with low mathematical communication abilities were 55.71, and (3) students with moderate mathematical communication abilities have better mathematical reasoning abilities than students with low mathematical communication abilities because the average scores of the student with moderate mathematical communication abilities were 61.12 while the average scores of students with low mathematical communication abilities were 55.71.
In the double cell intercomparison test the results are obtained as presented in Table 5.

Table 5. The Summary of Inter-cell Double Comparisons

H_0	F_{obs}	$8F_{\alpha;v}$	Decision
$\mu_{11} = \mu_{21}$	14.05	(8) (1.95) = 15.6	H_0 is accepted
$\mu_{11} = \mu_{31}$	4.04	(8) (1.95) = 15.6	H_0 is accepted
$\mu_{21} = \mu_{31}$	1.23	(8) (1.95) = 15.6	H_0 is accepted
$\mu_{12} = \mu_{22}$	1.00	(8) (1.95) = 15.6	H_0 is accepted
$\mu_{12} = \mu_{32}$	3.69	(8) (1.95) = 15.6	H_0 is accepted
$\mu_{22} = \mu_{32}$	0.80	(8) (1.95) = 15.6	H_0 is accepted
$\mu_{13} = \mu_{23}$	2.05	(8) (1.95) = 15.6	H_0 is accepted
$\mu_{13} = \mu_{33}$	22.44	(8) (1.95) = 15.6	H_0 is rejected
$\mu_{23} = \mu_{33}$	9.83	(8) (1.95) = 15.6	H_0 is accepted
$\mu_{11} = \mu_{12}$	11.12	(8) (1.95) = 15.6	H_0 is accepted
$\mu_{11} = \mu_{13}$	12.3	(8) (1.95) = 15.6	H_0 is accepted
$\mu_{12} = \mu_{13}$	0.07	(8) (1.95) = 15.6	H_0 is accepted
$\mu_{21} = \mu_{22}$	0.26	(8) (1.95) = 15.6	H_0 is accepted
$\mu_{21} = \mu_{23}$	1.61	(8) (1.95) = 15.6	H_0 is accepted
$\mu_{22} = \mu_{23}$	0.62	(8) (1.95) = 15.6	H_0 is accepted
$\mu_{31} = \mu_{32}$	5.38	(8) (1.95) = 15.6	H_0 is accepted
$\mu_{31} = \mu_{33}$	24.55	(8) (1.95) = 15.6	H_0 is rejected
$\mu_{32} = \mu_{33}$	12.06	(8) (1.95) = 15.6	H_0 is accepted

Based on the test in Table 5, it can be concluded that: (1) $H_0: \mu_{11} = \mu_{21}$, $H_0: \mu_{11} = \mu_{31}$, and $H_0: \mu_{21} = \mu_{31}$, the test decision declares that H_0 is accepted. This means that at high mathematical communication abilities, the Accelerated Learning Cycle, Brain-based learning model, and Direct Instruction provide equally good mathematical reasoning abilities, (2) at

$H_0: \mu_{12} = \mu_{22}$, $H_0: \mu_{12} = \mu_{32}$, and $H_0: \mu_{22} = \mu_{32}$, the test decision declares that H_0 is accepted. This means that in the medium mathematical communication abilities, the Accelerated Learning Cycle, Brain-based learning model, and Direct Instruction provide equally good mathematical reasoning abilities, (3) at $H_0: \mu_{13} = \mu_{23}$ and$H_0: \mu_{23} = \mu_{33}$, the test decision declares that H_0 is accepted. This means that at low mathematical communication abilities, the Accelerated Learning Cycle, Brain-based learning model, and Direct Instruction provide the same mathematical reasoning ability, and (4) at $H_0: \mu_{13} = \mu_{33}$, the test decision declares that H_{0s} is rejected. This means that at low mathematical communication abilities, the Accelerated Learning Cycle provides better mathematical reasoning ability than Direct Instruction because by looking at the average of each cell, the Accelerated Learning Cycle is at 63.66 while in the Direct Instruction is at 46.84. (5) At $H_0: \mu_{11} = \mu_{12}$, $H_0: \mu_{11} = \mu_{13}$, and $H_0: \mu_{12} = \mu_{13}$, the test decision declares that H_0 is accepted. This means that in the Accelerated Learning Cycle, students with high, medium, and low mathematical communication abilities have the same good mathematical reasoning abilities, (6) at $H_0: \mu_{21} = \mu_{22}$, $H_0: \mu_{21} = \mu_{23}$, and $H_0: \mu_{22} = \mu_{23}$, the test decision declares that H_0 is accepted. This means that in the Brain-based learning model, students with high, medium, and low mathematical communication abilities have the same mathematical reasoning abilities, (7) at $H_0: \mu_{31} = \mu_{32}$ and$H_0: \mu_{32} = \mu_{33}$, the test decision declares that H_0 is received. This means that in the Direct Instruction, students with high mathematical communication abilities have the same mathematical reasoning abilities as students with moderate mathematical communication abilities and students with moderate mathematical communication abilities have the same mathematical reasoning abilities as students with low mathematical communication abilities, (8) at $H_0: \mu_{31} = \mu_{33}$, the test decision declares that H_0 is rejected. This means that in the Direct Instruction, students with high mathematical communication abilities have better mathematical reasoning abilities than students with low mathematical communication abilities because by looking at the average of each cell, the students with high mathematical communication abilities are at 67.78 while students with low mathematical communication abilities are at 46.84.

The result of this research is relevant with several studies which indicate that there is an effect of Accelerated Learning Cycles on the ability to solve mathematical problems for all students ($p = 0{,}000$, $p < 0.05$) and all initial mathematical abilities categories (Amelia, S., 2015). Other researchers also state that students who learn mathematics learning through the Accelerated Learning Cycle are better than students who learn mathematics through conventional models (Muligar, R., 2016). The results of other studies also explain the use of a Brain-based learning model that can improve students' critical thinking abilities (Wisudawati, A., 2014). According to the results of other studies, the Brain-based learning model increases student learning motivation and students' mathematical connection abilities.

The results of the study are following the second hypothesis that students with high mathematical communication abilities have better learning outcomes than students with moderate and low mathematical communication abilities and students with moderate mathematical communication abilities have better learning outcomes than students with low mathematical communication abilities. It is supported by other research that shows students with high mathematical communication abilities have better learning outcomes than students with moderate and low mathematical communication abilities and students with moderate mathematical communication abilities have better mathematics learning outcomes than students with low mathematical communication abilities. The results of other studies are relevant to the third hypothesis which states that there is an interaction between learning models and students' mathematical communication abilities and learning outcomes although not all are relevant to the third hypothesis.

Conclusion and Suggestion

Based on the results of research and discussion, it can be concluded that: (1) the Accelerated Learning Cycle results in better mathematical reasoning abilities than the Brain-based learning model and Direct Instruction learning models and the Brain-based learning model provides is better than the Direct Instruction, (2) students with high mathematical communication abilities have better mathematical reasoning than students with moderate and low mathematical communication abilities and students with moderate mathematical communication abilities have a better mathematical reasoning ability than students with low mathematical communication abilities.

Based on the findings obtained in this study, the Accelerated Learning Cycle and Brain-based learning model can be applied since they can improve mathematical reasoning abilities better. Besides, researchers also suggest the other researchers be able to conduct further research in the form of developing Accelerated Learning Cycle and Brain-based learning model by paying attention to the characteristics of other students adjusted to the school curriculum.

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