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The Effect of Learning Model and Early Mathematical Ability on Mathematical Critical Thinking Skill of Students

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Abstract

This study aims to analyze the effect of learning model and early mathematical ability and the interaction between learning models and early mathematical ability on students' mathematical critical thinking skill. This research is a quantitative study a quasi-experimental method. This study's population were all SMP Negeri 1 Tambangan in the odd semester of the 2019/2020 school year, totaling 160 students in 6 classes. The sampling technique in this study uses Probability Sampling techniques. The type of sampling is Simple Random Sampling. We selected the research sample from two classes, namely class VIII-1, which consisted of 26 students who received the discovery learning model treatment, and class VIII-2, which consisted of 26 students by given ordinary learning. The research instrument used a mathematical critical thinking skills test. Statistical test of data using Two-Way ANOVA Test. The results showed that the learning models and early mathematical ability positively affected the mathematical critical thinking skill of students, and there was no interaction between the learning models and early mathematical ability.

Keywords: *Discovery Learning Model, Ordinary Learning, Mathematical Critical Thinking Skills, Early Mathematical Ability*.

Abstrak

Penelitian ini bertujuan untuk menganalisis pengaruh model pembelajaran dan kemampuan awal matematiks serta interaksi antara model pembelajaran dan kemampuan awal matematis terhadap kemampuan berpikir kritis matematis siswa. Penelitian ini merupakan penelitian kuantitatif dengan metode eksperimen semu. Populasi penelitian ini adalah seluruh siswa SMP Negeri 1 Tambangan semester ganjil tahun pelajaran 2019/2020 yang berjumlah 160 siswa dalam 6 kelas. Teknik pengambilan sampel dalam penelitian ini menggunakan teknik Probability Sampling. Jenis pengambilan sampel adalah Simple Random Sampling. Sampel penelitian dipilih dari dua kelas, yaitu kelas VIII-1 yang terdiri dari 26 siswa yang mendapat perlakuan model discovery learning, dan kelas VIII-2 yang terdiri dari 26 siswa yang diberi pembelajaran biasa. Instrumen penelitian menggunakan tes kemampuan berpikir kritis matematis. Uji statistik data menggunakan Uji ANAVA dua jalur. Hasil penelitian menunjukkan bahwa model pembelajaran dan kemampuan awal matematis berpengaruh positif terhadap kemampuan berpikir kritis matematis siswa, dan tidak terdapat interaksi antara model pembelajaran dan kemampuan awal matematis.

Kata kunci: *Model Discovery Learning, Pembelajaran Biasa, Kemampuan Berpikir Kritis Matematis, Kemampuan Awal Matematis*

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INTRODUCTION

Education is a necessity for everyone to maintain their life (S. N. Dewi, Wijaya, Budianti, & Rohaeti, 2018; Surya, Zulfah, Astuti, Marta, & Wijaya, 2020). Through adequate education, humans can broaden their horizons and live a better life (Kulsum, Hidayat, Wijaya, & Kumala, 2019). Education is also the key to all progress and quality development because, with education, humans can develop their potential into better abilities (Yi, Ying, & Wijaya, 2019).

Law Number 20 of 2003 concerning the National Education System Chapter I article 1 paragraph 1 explains that education is a conscious and planned effort to create an atmosphere of learning and the learning process to actively develop their potential to have religious-spiritual strength, self-control, personality. , intelligence, noble character, and skills needed by him, society, nation and state (Ministry of National Education, 2003).

The regulation of the minister of national education Number 22 of 2006 concerning Standards for Elementary and Secondary Education Unit sex plains that "mathematics is a universal science that underlies the development of modern technology which has an important role in various disciplines and advances human thinking" (Ministry of National Education, 2006). Therefore, Indonesia's education curriculum places mathematics as a compulsory subject given to students from elementary to high school and even in tertiary institutions with a higher proportion of time allocation than in other fields of study.

Implement mathematics learning in schools to be effective, it is hoped that students can achieve the objectives of learning mathematics. Manullang & Rajagukguk (2016) states that the purpose of learning mathematics is to prepare students to be able to face a world that is continuously changing and developing through training, acting based on careful, logical, rational, critical, honest, effective, and efficient thinking.

According to Widarto et al. (2012), students as educational products must have eight main competencies, namely: (1) communication skills, (2) critical and creative thinking skills, (3) inquiry/reasoning skills, (4) interpersonal skills, (5) multicultural/ multilingual literacy, (6) problem solving, (7) information/digital literacy, and (8) technological skills.

Critical thinking is one way to train students to learn (D. P. Dewi, Mediyani, Hidayat, Rohaeti, & Wijaya, 2019). Through critical thinking, students must understand concepts, apply, synthesize, and evaluate information obtained or produced to develop their knowledge. Thinking critically due to learning mathematics is a higher-order thinking ability and plays a role in moral, social, psychological, cognitive, and scientific development. It is in line with Alvino's opinion (Minarni et al., 2018), which explains that critical thinking is part of the skill or ability to think further because critical thinking includes analysis, synthesis, and evaluation of the process. According to Mahmuzah (2015), critical thinking is a process that uses analytic and reflective thinking skills to make decisions about what to believe and do.

Angelo (Haryani, 2012) identifies five systematic behaviors in critical thinking, namely:

a. Analyzing skill, is a skill to describe a structure into its components in order to know the structure organization.
b. Synthesis skill, is the skill of combining parts into a new formation or arrangement.
c. Recognizing and problem solving Skills are skills of applying concepts to several new meanings.
d. Conclusion Skills is an activity of the human mind based on the understanding or knowledge (truth) it has, can move to reach another new understanding or knowledge (truth).

e. Evaluating or assessing skills, requires careful thinking in determining the value of something with various existing criteria.

Mathematical critical thinking skills are very important for students and this is still a problem in school. It is in line with Jayadipura's research, which shows that the implementation of mathematics learning and evaluation has not emphasized critical thinking skills but instead trains students' procedural skills through routine exercises and low-level questions. Thus, the emphasis is only on students' low-level thinking skills (Herdiman, Nurismadanti, Rengganis & Maryani, 2018). The research results also support students' low ability to think critically in mathematics by Hasibuan & Surya (2016), which concluded that students' mathematical critical thinking skills are still in the low category. The results showed that 65.6% of students had mathematical critical thinking skills in the low category, and 32.3% of students had mathematical critical thinking skills in the deficient category.

Early ability is the result of learning before obtaining higher abilities. Early ability of student is a prerequisite for taking part in learning to carry out learning well. According to Hanun (2010), early mathematical ability are cognitive abilities that students have before taking mathematics lessons and are prerequisites for learning new lessons or advanced lessons.

Students' early mathematical ability can be distinguished from high, medium and low initial abilities. It is supported by Galton (Antika, Andriani & Revita 2019) who argues that from a group of randomly selected students (not specifically selected), there will be students with high, medium and low abilities who spread in a normal distribution.

Responding to the problems described above, a learning model needs to improve student skills of mathematic critical thinking. One of the learning models that are creative, innovative, and effective in enhancing students' mathematical thinking skills is the discovery learning model.

According to Lestari (Haeruman, Rahayu & Ambarwati, 2017), discovery learning is a learning model designed to enable students to discover concepts and principles through their mental processes. We need to do several stages of discovery learning, which will guide students to discover new concepts. Discovery Learning has several advantages, one of which was expressed by Suherman et al. (2001) namely 1) students are actively involved in learning activities because they use their ability to find the final result, 2) students understand learning material because they experience the process of discovering it on their own, and acquiring things in this way can help their memory last longer, 3) self-discovery will produce a sense of satisfaction, and this inner satisfaction encourages them to make more discoveries, thereby increasing their interest in learning, 4) students who acquire knowledge through the discovery method will be able better to transfer their knowledge to various contexts, 5) this method trains students to learn more on your own.

The theory that underlies the discovery learning model is Bruner's theory. Jerome S. Bruner (Lestari & Yudhanegara, 2017) sparked the theory of "free discovery learning", in theory it is said that the learning process will run well and creatively if the teacher provides opportunities for students to find a concepts, theories, rules, or understanding through examples found in life. This theory believes that the best way to learn is to understand the concepts, meanings, and relationships obtained through an intuitive process to conclude (discovery learning).

METHODS

This research is quantitative research conducted using a quasi-experimental. Russeffendi (2005) suggests that in quasi-experimental research, the subjects' group is not random, but researchers accept the subject's conditions as they are. Therefore, this study's sample grouping must not be done but based on previously formed classes without forming new classes.

The population is the whole subject/object of research. The population was all SMP Negeri 1 Tambangan in the even semester of the 2019/2020 academic year, totaling 160 students in 6 classes. Based on considering students' cognitive level who have entered the formal operational stage, namely at the age of 11 years and over, we use the students of SMP Negeri 1 Tambangan as the research population (Ruseffendi, 2006). The sample is part of the population's size and characteristics (Sugiyono, 2012). The sampling technique in this study is uses Probability Sampling. The type of sampling is Simple Random Sampling. The simple random sampling technique is the simplest because sampling members from the population is taken randomly without considering the population's existing strata (Sugiyono, 2012). The research sample was selected from two classes of students, class VIII-1 as the experimental class, namely the class treated with the discovery learning model consisting of 26 students, and class VIII-2 as the control class, given ordinary learning consisting of 26 students. This research consists of the preparation stage, implementation stage, analysis stage and report writing. Completely, research procedures can be seen in Figure 1 below.

Data collection techniques use test instruments, namely the early mathematical ability test and the mathematical critical thinking skills test. Data analysis using quantitative analysis (inferential). The early stage is descriptive analysis, namely calculating the average, standard deviation, maximum and minimum values of the mathematical early ability test data and mathematical critical thinking skills test data. The second stage is the post-test data using the prerequisite analysis test namely normality and homogenity tests, and the third stage is hypothesis testing. Statistical hypothesis test using two-way ANOVA.

Statistical hypothesis test using two-way ANOVA. Two-way ANOVA is an inferential technique used to test the difference in mean values. The statistical model of this study (Syahputra, 2016) is listed below.

$$Y_{ijk} = \mu + \alpha_i + \beta_j + (\alpha\beta)_{ij} + \varepsilon_{ijk}$$

Where: i = 1, 2; j = 1, 2, 3; k = 1, 2, …, 26

Information:

Y_{ijk} = score of mathematical critical thinking skills of k-th students, who get i-th earning , at j-th early mathematical ability.

μ = actual average score (constant value)

α_i = the additive effect of i-th learning

β_j = the additive effect of j-th

$(\alpha\beta)_{ij}$ = the interaction between the i-th learning and j-th early mathematical ability

ε_{ijk} = the effect of experimental deviation from the score of the k-th student who gets the i-th learning at the j-th early mathematical ability

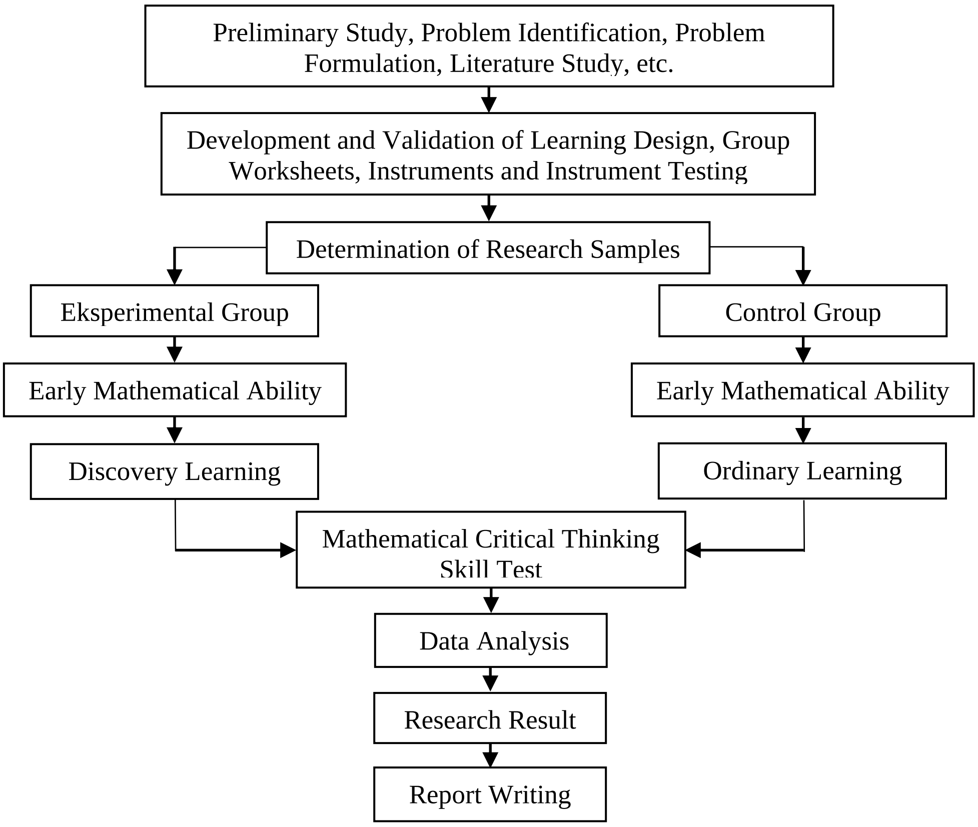

Figure 1. Research Procedure

RESULT AND DISCUSSION

The Early Mathematical Ability Test is used to determine the research sample class's equivalence and the students' abilities before the learning process is carried out. Table 1 summarizes the descriptive analysis of student Early Mathematical Ability data on the learning objectives.

Table 1. Description of the Students' Early Mathematical Ability Test

	N	Minimum	Maximum	Mean	Std. Deviation
Discovery Learning	26	20	90	48.65	21.239
Ordinary Learning	26	20	80	47.31	19.911
Valid N (listwise)	26				

Table 1 illustrates that the mean Early Mathematical Ability score for each study sample class is relatively the same. It is sufficient to fulfill the requirements to provide different treatment for each group.

Furthermore, mathematical abilities of students were grouped based on their Early mathematical Ability scores (high, medium, low). For discovery learning class $\overline{X}$ = 48.65 and SD = 8.54 so that $\overline{X} + s$ =13,978 and $\overline{X} - s$ = 5.482, while for ordinary learning class $\overline{X}$ = 9.46 and SD = 3.932 so that $\overline{X} - s$ = 13.392 and $\overline{X} - s$ = 5.528. Table 2 summarizes the grouping results of students' mathematical ability.

Table 2. Distribution of Research Samples

Research Sample Class	Student Ability		
	High	Medium	Low
Experiment Class (Discovery Learning)	6	15	5
Control Class (Ordinary Study)	5	15	6
Total (N = 52)	11	30	11

The mathematical critical thinking skills test was attended by 26 students for each class so that in the data analysis, the subjects of this study were 26 students who took the final test (post-test). After being given the discovery learning model's application, the students have done a mathematical critical thinking skill test to see how much influence the discovery learning model had after being given the treatment.

Table 3. Description of Mathematical Critical Thinking Skill Test

Statistics	Learning	
	Discovery Learning	Ordinary Learning
N	26	26
Mean	82,69	77,88
Std. Deviation	10,80	10,19

Table 3 show that students who get the discovery learning model's mathematical critical thinking skills had an average of 82.69, while the average value of mathematical critical thinking ability of students who get ordinary learning of 77.88. Therefore, students who get discovery learning models' average mathematical critical thinking skills were higher than the average mathematical critical thinking skills of students who get ordinary learning. Table 3 shows that the standard deviation of students' mathematical critical thinking skills who get the discovery learning model is 10.80. It is different from the standard deviation of students' mathematical critical thinking skills; ordinary learning is 10.19. It means that the mathematical critical thinking skills test scores of students who receive ordinary learning do not spread out than the post-test scores of students who receive the discovery learning model.

Furthermore, conducting a prerequisite analysis test for research data, namely the normality and homogeneity test to see the test data of mathematical critical thinking skill of students that are normally distributed and homogeneous. Normality test using the Kolmogorov-Smirnov test and Homogeneity test using the Homogeneity of Variance (Levene Statistic) with a sifnificance level of 5%. The calculation of normality and homogeneity uses the SPSS 21.0 program with the calculation criteria if the value of si is greater than $\alpha = 0.05$, then H_0 is accepted. Table 4 and table 5 summarize the results of the normality and homogeneity test of students' mathematical critical thinking skill.

Table 4. The Results of Normality Test Data Mathematical Critical Thinking Skill of Students

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	Df	Sig.
Discovery Learning	.133	26	.200*	.952	26	.256
Pembelajaran Biasa	.135	26	.200*	.926	26	.063

Table 5. The Results of Homogeneity Test Data Mathematical Critical Thinking Skill of Students

Levene Statistic	df1	df2	Sig.
.005	1	50	.943

Table 4 shows that the discovery learning model and ordinary learning have a significance value of 0.200> 0.05. So it can be concluded that the data on mathematical critical thinking skill of students are normally distributed. Table 5 shows that students' mathematical critical thinking skill has a significance value of 0.943 > 0.05. So it can be concluded that the test scores of students' mathematical critical thinking skill in the experimental class and the control class have the same variance (homogeneous).

The prerequisite for conducting a two-way ANOVA hypothesis test is the normality and homogeneity test of the two sample data groups. We applied the SPSS 21 program to obtain calculations on the two-way ANOVA table. The test criteria for using sig in the SPSS 21.0 program are as follows: if the sig value is more significant than $\alpha = 0.05$, then H_0 is accepted; on the other hand, if the sig value is smaller than $\alpha = 0.05$, then H_1 is accepted. Table 4 summarizes the results of the calculation using SPSS 21.0.

Table 6. Two-way ANOVA Results on Mathematical Critical Thinking Skill of Students

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	4123.798[a]	5	824.760	22.482	.000
Intercept	268158.854	1	268158.854	7309.812	.000
Learning Model	192.508	1	192.508	5.248	.027
Early Mathematical Ability	3759.071	2	1879.535	51.235	.000
Learning Model * Early Mathematical Ability	14.653	2	7.327	.200	.820
Error	1687.500	46	36.685		
Total	341015.625	52			
Corrected Total	5811.298	51			

Table 6 provides the following conclusions:

a. There is an effect of the learning model on mathematical critical thinking skill of student.
b. Early mathematical skills affect mathematical critical thinking skill of student.
c. There is no interaction effect between the learning model and the Early Mathematics Ability on a mathematical critical thinking skill.

It can graphically display whether there is an interaction between the learning model and Early Mathematics Ability. The interacting factors will show intersecting lines, while the non-interacting factors will show parallel lines.

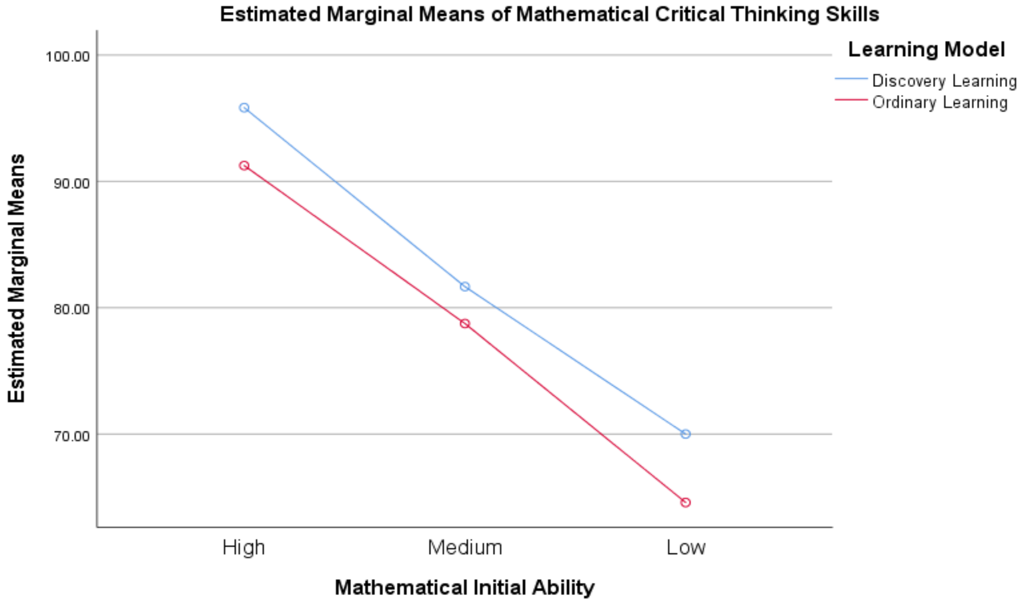

Figure 2. The Interaction between Learning Models and Early Mathematical Ability on Mathematical Critical Thinking Skill of Students

Figure 2 shown that the two lines do not intersect or parallel. It indicates no interaction between the learning model and Early Mathematical Ability on students' mathematical critical thinking skill.

Learning Model

Application of discovery learning models in mathematics learning requires students to learn to produce mathematical models and understand the concepts used to produce mathematical models of the problems given, train thinking skills and analyze and manipulate information. By giving the discovery learning model, students will learn to build knowledge based on what they already know, and through teacher guidance in the learning process, students will be more enthusiastic in learning mathematics because there is an interaction between students and teachers and teachers and students.

Ordinary learning presents a learning atmosphere that makes the teacher dominate learning activities (teacher-centered). Ordinary learning makes the teacher a learning resource for students;

The teacher plays an essential role in transferring knowledge to students; the teacher explains the knowledge learned while students calmly listen to the teacher's explanation. If students do not understand several things, the question and answer process occurs between students and teachers. Furthermore, after the teacher explains the material, the teacher provides several practice questions related to the things that have been learned.

The data analysis results in table 1 show that the experimental class test score average was 82.69, while the control class was 77.88. It shows that the average test score in the experimental class is higher than the control class. The thing that makes mathematical critical thinking skill of students in the experimental class higher than the control class is that learning goes well in the discovery learning model. Hence, it affects mathematical critical thinking skills.

It is a big difference between students who get discovery learning models and students who get ordinary learning. Students who get the discovery learning model will be more active in asking questions, more active in thinking, more actively working to construct specific knowledge; it is different with students who receive ordinary learning; they will be more likely to accept and listen to the teacher explanations, there is no demand for students to be more active think, more actively discuss or work more actively.

The research results of Leny Dhianti Haeruman (2017) reinforce the above explanation which states that the increase in mathematical critical thinking skills in students who are treated with discovery learning models and expository learning treatment has a significant difference. The data analysis results showed that students 'mathematical critical thinking skills were strongly influenced by the learning model and seen from a significant level that the increase in students' mathematical critical thinking skills who received a discovery learning model had a very significant increase.

Early Mathematical Ability

Students' early mathematical ability can be distinguished from students who have high, medium and low initial abilities. This is supported by Galton (Antika, 2019) who argues that from a group of randomly selected students (not specifically selected), there will be students with high, medium and low abilities who spread in a normal distribution.

The results of descriptive analysis of the data seen in Table 1 ow that the average scores of the students' initial mathematical abilities were 48.65 and 47.31 respectively. These scores prove that the average scores for each class of the study sample are relatively the same. This is sufficient to fulfill the requirements to provide different treatment for each group. It can be said that the results of mathematical critical thinking skills who have high early abilities are better than those who have moderate and low early mathematical ability, and students who have moderate early mathematical ability are better than those with low early mathematical ability.

Mathematical Critical Thinking Skills

Mathematical critical thinking skills are a student's thought process that aims to make rational decisions directed at deciding whether to believe or do something. This research aims to answer the problem formulation and research hypothesis (provisional assumptions), namely, to determine whether there is an effect of the discovery learning model and ordinary learning on students' mathematical critical thinking skill. Conduct the normality and homogeneity tests first before performing statistical tests on the hypothesis. The results of calculations using SPSS 21.0 are in tables 4 and 5 showing that the two groups' data are normally distributed and homogeneous.

After the treatment, descriptive data analysis showed that students who obtained discovery learning models had higher mathematical critical thinking abilities than students who received ordinary learning. This is indicated by the average test score for the experimental class, 82.69, and the control class is 77.88.

In the discovery learning model, students are given a worksheet that contains guidance to understand the material being studied by students. The given group worksheets also contain problems that are raised from students' daily lives and are more comfortable for students to understand because they are real, reachable to their imagination, and can be imagined so that it is easier for students to find the meaning of the material they are learning by using mathematical critical thinking skills—owned by students. Meanwhile, ordinary learning is rarely given problems that involve students 'daily lives but problems that are foreign to students so that it does not raise students' curiosity in solving the problems given. In ordinary learning, the teacher dominates learning. The teacher explains learning without involving students. After that, after the teacher has finished explaining the material and giving assignments to students according to the examples given so that when students face non-routine problems, it will be difficult to solve them.

Based on the explanation above, it is clear that the mathematical critical thinking skills of students who obtain discovery learning models are higher than students who receive ordinary learning. In line with the research of Yusmanto & Herman (2015) which states that the increase in mathematical critical thinking skills of students who learn using the discovery learning model is higher for students who get direct learning. This means that the learning discovery learning model significantly influences students' mathematical critical thinking skills.

Interaction Learning Model and Early Mathematical Ability to Mathematical Critical Thinking Skills

The inferential statistical analysis results using the two-way ANOVA test in Table 6 shows that in the fifth row, namely Learning Model * Early Mathematical Ability indicates that the significant value of $0.820 > 0.05$. We concluded no interaction between the learning models and early mathematical ability (high, medium, and low) on students' mathematical critical thinking skill. There is no effect given by the learning model and early mathematical ability simultaneously on students' mathematical critical thinking skill. In line with the finding of Simbolon (2017: 99), there was no interaction between learning strategies and early mathematical ability on students' mathematical critical thinking skill.

CONCLUSION

Based on the analysis results, findings, and discussion in the previous discussion, we get the conclusions, namely: (1) There is a positive effect of the discovery learning model on mathematical critical thinking skill of students, (2) There is positive effect of early mathematical ability on mathematical critical thinking skill of students, (3) There is no interaction between the learning model and early mathematical ability on mathematical critical thinking skill of students.

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REFERENCES

Abdurrahman, M. 2012. *Children with Learning Difficulties (Theory, Diagnosis, and Remediation).* Jakarta: PT RinekaCipta

Antika, M.S., Andriani, L., Revita, R. 2019. The Effect of the Application of the Think-Pair-Square Type of Cooperative Learning Model on the Ability of Understanding Mathematical Concepts in terms of the Early Mathematics Ability of Junior High School Students. *Juring (Journal for Research in Mathematics Learning). Vol. 2, No.2: 118-129*

Daulay, A.P. 2017. Development of Problem Based Learning Learning Tools to Improve Mathematical Reasoning Ability and Self-Efficacy of Class X Students of SMAN 1 Medan. *Thesis,* Postgraduate Program. Medan: State University of Medan

Dewi, D. P., Mediyani, D., Hidayat, W., Rohaeti, E. E., & Wijaya, T. T. (2019). Analisis Kemampuan Berpikir Kritis Matematis Siswa Smp Pada Materi Lingkaran Dan Bangun Ruang Sisi Datar. *JPMI (Jurnal Pembelajaran Matematika Inovatif), 2*(6), 371. https://doi.org/10.22460/jpmi.v2i6.p371-378

Dewi, S. N., Wijaya, T. T., Budianti, A., & Rohaeti, E. E. (2018). Pengaruh Model Teams Games Tournament Terhadap Kemampuan Pemahaman Matematik Siswa Kelas XI SMK di Kota Cimahi Pada Materi Fungsi Eksponen. *WACANA AKADEMIKA: Majalah Ilmiah Kependidikan, 2*(1), 99. https://doi.org/10.30738/wa.v2i1.2570

Haeruman, L.D., Rahayu, W., Ambarwati, L. 2017. The Influence of the Discovery Learning Model on the Improvement of Mathematical Critical Thinking Ability and Self-Confidence in terms of the Early Mathematical Ability of High School Students in East Bogor. *Jurnal JPPM. Vol. 10, No. 2: 157-168*

Hanun, F. 2010. The Effect of Learning Methods and Early Ability on Mathematics Learning Outcomes. *Widyariset Journal. Vol. 13, No.1: 123-133*

Haryani, D. 2012. Profile of High School Students' Critical Thinking Process with Fielde Independent Cognitive Style and Female Gender in Solving Mathematics Problems.

National Seminar on Mathematics and Mathematics Education FMIPA UNY. 10 Novemver 2012: 175 - 182.

Herdiman, I., Nurismadanti, I.F., Rengganis, P., and Maryani, N. 2018. Students' Mathematical Critical Thinking Ability on Circle Material. Prism's Journal. Vol. 7, No. 1: 1-10

Kulsum, S. I., Hidayat, W., Wijaya, T. T., & Kumala, J. (2019). Analysis on high school students' mathematical creative thinking skills on the topic of sets. *Jurnal Cendekia : Jurnal Pendidikan Matematika*, *03*(02), 431–436. https://doi.org/https://doi.org/10.31004/cendekia.v3i2

Mahmuzah, R. 2015. Increasing Mathematical Thinking Ability of Junior High School Students Through Problem Posing Approach. Banda Aceh: Journal of opportunities. Vol 4, No. 1: 64-72

Manullang, M., &Rajagukguk, W. 2016. Some Factors that Affect The Performance of Mathematics Teachers in Junior High School in Medan. Journal of International EdicationStudies.Vol. 9 No. 4.ISSN 1913-9020

Minarni. A., Sri, D.L., and Annajmi. 2018. Students' Mathematical Thinking Ability and Affective Aspects. Medan: Smart Hope

Ministry of National Education. 2003. Law of the Republic of Indonesia Number 20 of 2003 concerning the National Education System. Jakarta: Ministry of Education

Ministry of National Education. (2006). Regulation of the minister of national education Number 22 of 2006 concerning Standard Content for Primary and Secondary Education Units. Jakarta: BNSP

Russeffendi, E. T. 2006. Teaching Mathematics: To Improve CBSA. Bandung: Tarsito

Russeffendi. 2005. Basics of Educational Research and Other Non-exact Fields. Bandung: Tarsito.

Simbolon, M. 2017. The Effect of Macromedia Flash Assisted Problem Solving Learning Strategies on Critical Thinking Ability and Self-Confidence of Class VII Students at SMP Negeri 5 Padang Bolak. Thesis, Postgraduate Program. Medan: State University of Medan.

Sinaga, A.M., and Hadiati, S. 2001. Empowerment of Human Resources. Jakarta: RI State Administration Institute.

Sugiyono. 2012. Qualitative and Quantitative Research Methods R & D. Bandung: Alfabeta

Suherman, E. et al., 2001. Contemporary Mathematics Learning Strategies. Bandung: JICA-UPI.

Surya, Y. F., Zulfah, Astuti, Marta, R., & Wijaya, T. T. (2020). The Development of Open-Ended Math Questions on Grade v Students of Elementary School. *Journal of Physics: Conference Series*, *1613*(1). https://doi.org/10.1088/1742-6596/1613/1/012081

Syahputra, E. 2016. *Applied Statistics*. Meda: Unimed Press

Widarto., Pardjono., And Widodo, N. 2012. Development of Soft Skill and Hard Skill Learning Models for Vocational School Students. CakrawalaPendidikan, Th. XXXI, No. 3: 409-423

Yi, L., Ying, Z., & Wijaya, T. T. (2019). The Trend of Mathematics Teaching Method Has Change From Fragments To Systematics. *Journal Cendekia: Jurnal Pendidikan Matematika*, *3*(2), 471–480. https://doi.org/10.31004/cendekia.v3i2.137

Yusmanto, and Herman, T. 2015. The Effect of the Application of Discovery Learning Learning Model on the Improvement of Mathematical Critical Thinking Ability and Self-Confidence of Class V Elementary School Students. *EduHumaniora Journal, Vol, 7, No.2: 140-151*