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Identification of Process Skills and Learning Results Through the Treffinger Model

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Abstrak

Model Treffinger merupakan pendekatan pembelajaran yang menekankan pada pengembangan keterampilan siswa dalam mendorong proses belajar. Tujuan dari penelitian ini adalah untuk menganalisis pengaruh penggunaan model pembelajaran Treffinger terhadap keterampilan proses dan hasil belajar geografi. Penelitian ini dilakukan dengan membagi siswa menjadi dua kelompok yaitu kelompok eksperimen dan kontrol. Penelitian dilakukan di MAN 2 Ambon dan melibatkan siswa kelas VIII yang dipilih secara acak dari bulan September hingga November. Teknik analisis data yang digunakan adalah multivariat (MANOVA) dengan bantuan SPSS 26.0 for windows. Berdasarkan hasil penelitian, uji normalitas, uji homogenitas, dan multikolinearitas menunjukkan bahwa data terdistribusi normal, homogen, dan kolinear. Selanjutnya, berdasarkan pengujian hipotesis, terdapat perbedaan keterampilan proses dan hasil belajar yang signifikan antara siswa yang belajar dengan model pembelajaran Treffinger dan siswa yang belajar dengan model pembelajaran konvensional. Model pembelajaran Treffinger menunjukkan pengaruh yang lebih baik dengan nilai F hitung = 12,85 dan taraf signifikansi untuk Pillai's Trace, Wilks' Lambda, Hotelling's, dan Roy's Largest Root lebih kecil dari 0,05. Sedangkan untuk test of between subjects, diperoleh nilai F= 0,116 dengan signifikansi kurang dari 0,05. Dengan demikian, dapat disimpulkan bahwa Model Treffinger adalah model pembelajaran yang efektif dalam mengembangkan keterampilan berpikir kreatif dan inovatif siswa dalam meningkatkan hasil belajar geografi.

Kata Kunci: Model Pembelajaran Treffinger, Ketrampilan Proses, Hasil Belajar

Abstract

The Treffinger model is a learning approach that emphasizes developing students' skills and encouraging learning. This study aimed to analyze the effect of using the Treffinger learning model on process skills and learning outcomes of geography. This research was conducted by dividing students into two groups, namely the experimental and control groups. The research was conducted at MAN 2 Ambon and involved randomly selected class VIII students from September to November. The data analysis technique used was multivariate (MANOVA) with the help of SPSS 26.0 for Windows. Based on the research results, the normality test, homogeneity test, and multicollinearity show that the data is normally distributed, homogeneous, and collinear. Furthermore, based on hypothesis testing, there are significant differences in process skills and learning outcomes between students who study with the Treffinger learning model and students who learn with conventional learning models. The Treffinger learning model shows a better effect with a calculated F value = 12.85, and the significance level for Pillai's Trace, Wilks' Lambda, Hotelling's, and Roy's Largest Root is less than 0.05. Whereas for the test between subjects, the value of F = 0.116 was obtained with a significance of less than 0.05. Thus, the Treffinger Model is an effective learning model for developing students' creative and innovative thinking skills in improving geography learning outcomes.

Keywords: *Treffinger Learning Model, Process Skills, Learning Outcomes*

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INTRODUCTION

Education is the main key to any progress and improvement of valuable human resources. These human resources will be able to compete in the global era (Hasanah dan Deiniatur, 2019). More and more cutting-edge inventions are emerging alongside globalization's quick progress, especially in the modern era of 4.0. As a result, educational program plans in schools must provide for the possibility of responding to changes in the economic, training, social, and cultural worlds as well as to advancements in technological innovation (Tirtoni, 2020). All nations are racing to improve their human resources in order to work and compete in the 21st century's global competition environment. Because of this, it is essential to acquire the competencies necessary to meet the demands of the twenty-first century (Sudirtha et al., 2021). Public authorities have proposed efforts to improve the quality and quantity that are carried out in the name of education. One of the efforts made by public authorities is usually institutions to obtain outputs from an educational institution that is ready to compete around the world (Pujilestari. 2020).

Education in schools cannot be separated from learning and teaching activities which include all activities related to the implementation of learning and the provision of lesson topics so that students can gain skills n scientifically valuable forever (Nasution, 2015). Every learning activity consistently expected satisfactory learning outcomes, and this implies that the educational cycle includes how a developing learning experience should occur (Nurjannah et al., 2020). The ability of educators to complete learning activities is the primary factor in determining how well a teaching and learning process is going, although other factors, such as the degree to which students can interpret the material and the dominance of the material provided by educators, are also important.

The process of learning is a crucial activity in the field of education. to improve the teaching and learning process as shown by the best possible learning results. The best learning outcomes depend on a variety of factors, such as motivation and curiosity (Nahar, 2016). Learning is a complicated cycle because it not only absorbs information but also includes various exercises and actions that must be taken to achieve the goal. Educators are the spearhead in developing further training, where the individual concerned is responsible for organizing, coordinating, and creating an environment that encourages students to carry out their activities in the study room (Wirahayu et al., 2018).

In the process of implementing learning as it is today, learning should take place effectively, efficiently, innovatively and be directed at the learning process carried out on students. However, reality says otherwise, offering material in ongoing learning is often embedded in teaching teaching materials and tends to be less clear and has the potential to reduce student understanding (Sukmana & Suartama, 2019). In addition, there are still many teachers who apply conventional learning with the lecture learning model which is still quite dominantly applied in learning, so that it will have an impact on low learning outcomes (Wulandari et al., 2020). The student learning process is strongly influenced by the quality of the teacher. The teacher is the main component that has a central role in the success of education (Geni et al., 2020).

Learning Geography in the structure of learning programs at the secondary school level is very important to be taught. The basic explanation is that geography provides information and the composition of values and mentalities and abilities to students who are directly related to the environment. This environment is a suitable medium for teaching geography (Wara, 2016; Susilawati & Sochiba, 2022). To enhance their understanding of geography, students should engage in educational experiences both inside and outside the classroom to broaden their perspectives. This will help them to better utilize this important field of study. This approach is known as a "naturalistic" approach to teaching and learning (Hermayuni et al., 2021). This is based on the scientific approach to geography which is based on the environment.

The scientific approach in learning activities would be better if using the Treffinger. Treffinger is learning by involving skills in encouraging the creative learning process (Kusuma et al., 2020). Treffinger is a model that straightforwardly manages inventive problems, including mental and emotional abilities at each level of the model. This level is divided into three levels of reasoning, to be more specific: level I is essential equipment (improvement of anomalous functions, level II is practice with processes (complex reasoning and compound feelings), and level III is working with actual problems (participation in existing challenges) (Ngalimun & Pd, 2014; Herianto, A., & Sahrup, 2019).

Based on the description above, it is the attention of researchers to examine the treffinger learning model that will be used in learning activities in geography subjects. An explanation for choosing *treffinger* this are first, this model is feasible to be applied to high school students because this model expects students to think imaginatively and then basically in dealing with problems. Second, this learning model has a more concise punctuation mark, which when applied, will help students in dealing with a problem, especially the problem of geography three, this learning model has benefits that can affect critical reasoning abilities because these considerations it can handle confusing problems to develop student learning outcomes.

Various researchers have extensively examined the Treffinger model, focusing on different aspects and approaches. For instance, Ndiung et al., (2021) applied RME principles to teach mathematics, emphasizing critical thinking skills. Kusuma et al., (2020) investigated how creative reasoning skills and mathematical problem-solving abilities can be improved, along with students' interest in learning. Rahmadhani & Ahmad, (2022) explored the relationship between anxiety and mathematical analogy ability, while Rifa'i et al., (2020) analyzed students' mathematical creative thinking abilities. Nizham & P, (2017) studied the enhancement of mathematical literacy, self-efficacy, and the reduction of mathematical anxiety. Dwijanto et al., (2019) investigated the ability of students to think creatively about mathematics, based on their interest in learning and using question cards. On the other hand, some researchers have focused on the learning outcomes of the Treffinger model. For example, Munandar et al., (2021) integrated audio-visual media to enhance basic chemistry learning outcomes. Sugiartini, (2023) and Malini et al., (2022) utilized image media to teach natural science concepts. Haryanto & Pujiastuti, (2020) analyzed student errors in solving open-ended problems based on Newman's procedure. Lastly, Yulinsa et al., (2021) studied the understanding of mathematical concepts using Alqurun teaching materials.

The novelty of this research with previous research is the integration of process skills and learning outcomes that previous researchers have yet to carry out. This study seeks to integrate the Treffinger model on process skills with learning outcomes. In addition, in previous research, learning geography using the Treffinger model in various letters has not been done to the author's knowledge. Therefore, this study seeks to see the effect of this model in improving process skills and learning outcomes.

METHOD

The study is quasi-experimental research, which utilized the Pre-test, Post-test, Nonequivalent Control Group Design to investigate the similarity level between two groups. The research was conducted in MAN 2 Ambon and involved two randomly selected classes of 30 students each, from a population of VIII-grade students. The study included two groups, namely the experimental and control groups. The treatment involved the use of Treffinger-type learning models and conventional learning, which were assigned randomly to the selected classes.

This research took three months, from September -November. In general, the treatment is divided into several stages.

1. In the first stage, limited observations were made to obtain information about the conditions in learning, the number of students (subjects) involved in the research, implementation schedules, and learning outcomes, to further determine the research subjects.
2. The second stage is giving treatment to the class that has been selected. Namely, the experimental class is treated using the Treffinger learning model.

3. The third stage gives a post-test. The results of this post-test are used to determine students' abilities after learning is carried out. Based on this value, an analysis and description of the influence of the Treffinger learning model are carried out on process skills and learning outcomes. The research treatment with the application of the Treffinger model has been carried out in 4 (four) meetings, each lasting 2 x 50 minutes. The post-test is carried out outside of learning hours with an allotted time of 70 minutes for five essay questions. The instrument in the form of a test consists of items representing the learning objectives and the measured indicators.

The data collected in this research is quantitative, obtained from process skills tests and science learning outcome tests in the form of examinations. To ensure the validity and reliability of the instruments used for measurement purposes, validity and reliability tests were performed. The validity test involved expert judgment and empirical validity, which was evaluated using the Pearson Product Moment formula. The correlation coefficient of the two test group values was calculated, resulting in a high validity criterion of rxy = 0.621. The reliability test used the Cronbach Alpha reliability measurement coefficient to assess the test's degree of reliability from the test group's value. The test of the 12 given questions yielded a high criterion of α = 0.81, indicating high reliability.

The next stage is to analyze the data. The data analysis was carried out with the help of Statistical Products and Solution Services (SPSS). The data analysis that will be carried out is the normality test with the Kolmogorov-Smirnov and Shapiro-Wilk normality tests. The homogeneity test uses Levene's Test of Equality of Error Variances; the variance/covariance matrix homogeneity test is carried out with the Box test; the multicollinearity test is based on the variance inflation factor (VIF) or tolerance, and finally testing, the hypothesis using SPSS 26.0 for windows. The first hypothesis test regarding differences in process skills and learning outcomes of students who are taught geography with Treffinger learning models with conventional learning based on multivariate analysis of variance (MANOVA) with a significance level for Pillai's Trace, Wilks' Lambda, Hotelling's and Roy's Largest Root is smaller than 0, 05. The second hypothesis concerns the differences in geographic process skills between students who take part in learning using the Treffinger-type cooperative learning model and those who take part in conventional learning using the Least Significant Difference (LSD) method. For a significance level of α = 0.05. The third hypothesis regarding differences in geography learning outcomes between students who study with the cooperative learning model Treffinger model and students who learn with conventional learning models based on the results of the test of between-subjects effects.

RESULTS AND DISCUSSION

In the research results section, general descriptions of process skills, learning outcomes, prerequisite tests, and hypothesis testing will be presented. The general description of the research results describes the comparison of the average value and standard deviation of process skills and student geography learning outcomes. The average score, standard deviation, variance, minimum, maximum, and total score are all described in the descriptive analysis of the process skills data. Table 1 below shows the findings of the descriptive analysis of the students' geography process skills data.

Table 1. Results of Data Process Skills Descriptive Analysis

Statistics						
		Observation	Communication	Grouping	Measurements	Conclusion
N	Valid	30	30	30	30	30
	Missing	0	0	0	0	0
Mean		67.01	68.18	75.18	66.01	67.01
Median		71.01	71.01	76.01	66.01	71.01
Std. Deviation		8.220	6.527	7.806	7.958	8.458

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Variance	61.790	37.554	45.857	49.490	55.88
Range	20	20	20	20	20

Table 1, it can be seen the comparison of process skills between students who received treatment and those who did not, seen from the results of process skills based on the level of mastery of 6 aspects, namely: observation, communication, grouping, measurement, concluding, and predicting. Data on student learning outcomes were obtained from the results of the learning outcomes test which consisted of 20 questions. Descriptive analysis of learning outcomes data describes the average score, standard deviation, variance, minimum, maximum, and total score. The results of the descriptive analysis of student learning outcomes data can be seen in Table 2.

Table 2. Descriptive analysis of study results outcomes

		Statistics			
		Pre-Test Control	Post-Test Control	Pre-Test Experiment	Post-Test Experiment
N	Valid	29	29	29	29
	Missing	0	0	0	0
Mean		73.68	81.13	75.30	83.44
Median		73.0	82.01	81.01	91.01
Std. Deviation		6,934	7,142	6,937	8,317
Variance		42,223	48,696	43,223	62,971
Range		20	25	20	30
Minimum		54	61	61	61
Maximum		76	86	81	91

The comparison of learning results between the experimental class and the control class can be observed in Table 2. The information in Table 2 above describes the learning outcomes of the experimental and control classes based on the post-test data. Test for Prerequisite Preliminary tests are conducted, such as, before the theory is put to the test.

Classic Assumption Test

Normality

Test The normality test is carried out with *Kolmogorov-Smirnov and Shapiro-Wilk* As stated in Table 3 below,

Table 3. Normality Test

Tests of Normality							
	Kelas	Kolmogorov-Smirnova			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
HB	Pre-test Control	.263	30	.024	.921	30	.023
	Post-test Control	.277	30	.011	.924	30	.033
	Pre tes Eksperimen	.327	30	.004	.933	30	.036
	Post-test Experiment	.313	30	.005	.924	30	.035
KP	Pre-test Control	.321	30	.006	.914	30	.023
	Post-test Control	.317	30	.005	.915	30	.026
	Pre-test Experiment	.323	30	.004	.932	30	.041
	Post-test Experiment	.214	30	.006	.936	30	.037

a. Lilliefors Significance Correction

The data on process skills and student learning outcomes in Table 3 above achieved a significance level above 0.05, indicating that they came from a normal distribution.

Variance homogeneity

Levene's Test of Equality of Error Variances Table 4 was used to conduct the homogeneity test of variance for process skills and learning outcomes.

Table 4. Table of Variance Results of the Homogeneity Test for Process Skills and Learning Objectives

Test of Homogeneity of Variances				
Levene Statistic		df1	df2	Sig.
HB	.361	3	116	.781
	.312	3	116	.816
	.312	3	104.817	.816
	.301	3	117	.826
KP	.113	3	117	.954
	.148	3	117	.933
	.147	3	114.054	.933
	.111	3	117	.955

The learning outcomes and process skills have a bigger significance than 0.05, as shown in Table 4 above. In particular, learning outcomes have a significance of 0.933, and proc, ess skills have a value of 0.816. Thus, it can be said that learning outcomes and process skills have a homogenous distribution.

Variant/Covariance

Table 5 was used to conduct the Levene's Equality of Error Test, which is a test of homogeneity of variance for both process skills and learning outcomes data using variances in the matrix.

Table 5. Summary of Variant Matrix/Kovar Homogeneity Test Results

Box's Test of Equality of Covariance Matrices	
Box's M	8,978
F	.967
df1	9
df2	154203,165
Sig.	.467

From Table 5, it is known that *Box's M* has a value of 8978 with a significance of 0.467. Thus, because the significance of *Box's M* is greater than 0.05, the variance/covariance matrix of the dependent variable is the same.

Multicollinearity

The multicollinearity test was conducted to find out whether there was a high enough relationship or not between the variable process skills and student learning outcomes. If no relationship is high enough, it means that there are no similar aspects measured on that variable, thus the analysis can be continued. The technique used to determine multicollinearity is the guideline used is *variance inflation factor (VIF*) or tolerance. The test is considered to have failed if the independent variable's VIF value is greater than 10.0, which indicates that the independent variable is multicollinear. Table 6 displays the findings of the analysis.

Table 6 Matrix of Intercorrelation Between

Coefficients								
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIEW
1	(Constant)	-3.443	1.145		-3.009	.004		
	HB	.086	.011	.604	8151	.000	.997	1.005
	KP	-.004	.013	-.017	-.212	.834	.997	1.005

From Table 6 above, it can be seen that the tolerance value between process skills and learning outcomes is more than 0.1 and VIF is less than 10.0, so the multicollinearity of the variable is collinear so that *MANOVA* can be continued.

Hypothesis Testing

Hypothesis 1

The first claim, that there are differences between pupils who learn using Treffinger and conventional methods, was put to the test. Multivariate analysis of variance (MANOVA) was employed to investigate this claim. Table 7 below provides the Manova test summary.

Table 7. An overview of MANOVA

Multivariate Tests										
Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared	Content. Parameter	Observed Powerd
Intercept	Pillai's Trace	.987	14585.575b	3.000	126.000	.001	.975	28161.150	2.000
	Wilks' Lambda	.012	14585.575b	3.000	126.000	.003	.975	28161.150	2.000
	Hotelling's Trace	246.057	14585.575b	3.000	126.000	.001	.975	28161.150	2.000
	Roy's Largest Root	246.067	14578.575b	3.000	126.000	.004	.975	28161.150	2.000
Class	Pillai's Trace	.383	8.476	5.000	241.000	.009	.194	52.473	2.000
	Wilks' Lambda	.642	9.813b	5.000	241.000	.004	.217	59.693	2.000
	Hotelling's Trace	.574	11.177	5.000	32.000	.003	.239	66.517	2.000
	Roy's Largest Root	.922	22.664c	4.000	116.000	.002	.370	67.418	2.000

Based on Table 7 above, the analysis's findings indicate that the calculated value is = 12.85, with a significance level of less than 0.05 for Pillai's Trace, Wilks' Lambda, Ho- telling's, and Roy's Largest Root. Thus, it may be inferred that there are differences between scientific students who are taught using the Cooperative learning model of the Treffinger model and students who are taught conventionally in terms of process skills and learning outcomes. Based on the results of the test for Between-subjects Effects, Manova analysis was employed to assess the second and third hypotheses. Table 7 below provides a summary of the test results for between-subjects effects.

Table 8. Test Results

Tests of Between-Subjects Effects									
Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Content. Parameter	Observed Power
Corrected Model	KP	22.355a	4	4.694	.278	.867	.004	.415	.081
	HB	34455.437b	4	839.248	31.398	.012	.425	72.155	2.000
Intercept	KP	739917.793	2	713811.71327353.792		.012	.879	26732.832	2.000
	HB	733417..671	2	728158.76523279.788		.012	.679	24374.776	2.000
Class	KP	28.387	4	6.893	.134	.967	.004	.358	.084
	HB	3146.655	4	916.228	22.544	.005	.376	67.398	2.000
Error	KP	6723.709124		51.917					
	HB	5987.934124		52.973					
Total	KP	654389.0820132							
	HB	758143.031	13						

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Corrected	KP	3476.133125
Total	HB	6882.467125

Hypothesis 2

According to Table 8 above, the student's geography process skills have an F value of 0.116 with a considerably lower than 0.05 at the source. Treffinger's cooperative learning model and traditional learning students. Treffinger's style of cooperative learning approach and classes of pupils who adhere to traditional learning.

Furthermore, the study utilized the Least Significant Difference (LSD) method to examine the significance of the difference in average scores of process skills between the Treffinger cooperative learning model and the traditional learning model. The study had 30 participants in each of the two model groups, with a total of 60 samples, and a statistical value of t (0.025; 58) = 2.00 was used. The rejection limit was determined to be LSD = 0.032 using the t-table statistical value for the dependent variable of process skills.

Table 8 presents a summary of the results from the significance test that compared the average pair process score between the experimental group using the Treffinger model and the control group using the traditional learning model. The table indicates that the difference in the average process skill score between the experimental and control groups is less than 0.05, with a standard deviation of 1.1817. Hence, at a significance level of 0.05, the experimental group's average process skills score was significantly different. The experimental group's average score for process skills was statistically higher than that of the control group.

These findings suggest that there is a significant difference in the average score of process skills between student groups who participate in experiment-based learning using Treffinger's cooperative learning model and those who adhere to traditional learning methods.

Hypothesis 3

Cooperative learning framework Treffinger and learners who use traditional teaching methods. The value of F = 0.116 is reached with a significance level less than 0.05 based on the test of between-subjects effects as displayed in Table 8 above. Thus, it may be said that kids who study using the treffinger and students who study conventionally have quite different learning outcomes.

Additionally, a comparison of the Treffinger model learning model and the traditional learning model is offered, along with an examination of the importance of the difference in the average score of learning outcomes. The Treffinger model and the traditional learning model's predicted mean score and standard deviation (SD) for student group learning outcomes are shown in Table 9 as follows:

Table 9. Estimated Learning Outcomes Average Score

Multiple Comparisons

Dependent Variable: HB

LSD

(I) Kelas	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
				Lower Bound	Upper Bound
Pre tes Kontrol	-3.334*	1.652	.047	-6.61	-.07
	-7.368*	1.652	.000	-10.65	-4.11
	-12.834*	1.652	.000	-16.11	-9.57
Post tes Kontrol	3.334*	1.652	.047	.07	6.61
	-4.034*	1.652	.017	-7.31	-.77
	-9.501*	1.652	.000	-12.78	-6.24
Pre tes Eksperimen	7.36*	1.652	.000	4.11	10.65
	4.034*	1.652	.017	.77	7.31
	-5.468*	1.652	.002	-8.75	-2.21
Post tes Eksperimen	12.834*	1.652	.000	9.57	16.11
	9.501*	1.652	.000	6.24	12.78

	5.468*	1.652	.002	2.21	8.75

The difference in the average learning outcome score has a standard deviation of 1.652 and a significance value of less than 0.05, as can be seen from Table 9 above. With typical learning models, the Treffinger average score differs significantly at a significance level of 0.05. The average Treffinger score is statistically higher than the average group learning outcomes score from the traditional learning model. Students who study using the Treffinger model produce superior learning results than those who follow the traditional learning model.

According to the examination of the data, Treffinger is very successful at enhancing process skills and student learning outcomes. It is evident from the six core elements of the developed process skills that the types of process skills held by students who received experimental instruction and those who received conventional instruction differ significantly. Students can practice this part of their process skills by using the syntax that is present in the cooperative learning model of the Treffinger type.

If we look at the influence of Treffinger's learning model, it has shown changes in every aspect of process skill, such as communicating, concluding, and predicting, when compared to process skills with direct treatment, even though the understanding of aspects of students' process skills is still in the moderate category. conventional.

It takes a process to teach students the process skills of communicating, concluding, and forecasting since the treffinger's syntax makes it highly possible to improve students' process abilities. This indicates that students build scientific attitudes through the development of process skills. Strong process skills are correlated with high learning outcomes.

Discussion

The study used multivariate analysis (MANOVA) to analyze the results of skills tests and geography learning achievement tests of students taught with the Treffinger-type learning model. The findings show a significant difference in the average score of process skills between the experimental and control groups. The statistical analysis yielded an F count value of 12.85 and a significance level of less than 0.05 for Pillai's Trace, Wilks' Lambda, Hotelling's, and Roy's Largest Root. In addition, the intersubject test showed a value of F = 0.116 with a significance level of less than 0.05.

A similar study by Ndiung et al., (2021) also used MANOVA to determine the effect of the Treffinger creative learning model with the RME principle on creative thinking skills in mathematics, while controlling for numerical ability. The findings show that students who learned mathematics using the Treffinger model had higher creative thinking skills compared to those who learned through conventional models. Moreover, students who learned through the Treffinger model with higher RME principles also had higher creative thinking skills. The study found that numerical abilities contribute 33.2% to students' creative thinking skills. These results suggest that the Treffinger creative learning model with the RME principle can significantly influence students' creative thinking skills and should be used by mathematics teachers to develop these skills.

A study conducted by Akhmad et al., (2021) utilized a quasi-experimental research design with a pretest and posttest to investigate the effectiveness of the Treffinger model as an alternative to conventional learning methods. The results indicated that the use of the Treffinger model had a positive impact on improving critical thinking skills in the experimental group, resulting in a significant increase in comparison to the control group. The Mann-Whitney U Test was used to analyze the data since the normality and homogeneity tests revealed non-normal distribution and non-homogeneous variants. The decision-making process resulted in the rejection of H0 if sig (2-tailed) ≥ 0.05, with a gain score of 17.91 in the experimental group and 3.83 in the control group. The researchers suggested that the Treffinger model could be useful in improving students' thinking skills, particularly in dealing with complex problems. They also emphasized the importance of teachers mastering the model's steps for optimal implementation and recommended geography teachers to use the model to achieve their learning objectives.

Widiari et al., (2014) used a quasi-experimental with a posttest control group design only to evaluate the learning outcomes of students who were taught using the mind-mapping learning method. The results of this study indicate that first, the results of learning mathematics in the experimental group of students who were taught using the mind-mapping learning method were classified as very high, with an average (M) of 42.10. Second, the results of learning mathematics in the control group of students taught using the expository learning method were classified as moderate, with an average (M) of 32.64. Third, based on the results of the t-test calculation, a tcount of 3.89 is obtained. At the same time, the t-table with a significance level of 5% is 1.68. Thus, it can be interpreted that there are significant differences between groups of students who are taught using the mind mapping learning method (piker map) and groups of students who are taught using the expository learning method in class III elementary school students in Cluster IX Buleleng District in the 2013/2014 academic year. So, it was concluded that by applying the mind-mapping learning method.

Widiari et al., (2014) conducted a quasi-experimental study using a posttest control group design to examine the learning outcomes of students who were taught using the mind-mapping learning method. The findings indicate that students in the experimental group who were taught using the mind-mapping learning method had significantly higher learning outcomes in mathematics, with an average score of 42.10, compared to the control group who were taught using the expository learning method and had moderate learning outcomes, with an average score of 32.64. The t-test results show that there is a significant difference between the two groups of students, with a tcount of 3.89 and a significance level of 5%. Therefore, it was concluded that the mind-mapping learning method is effective in improving learning outcomes in mathematics for third-grade elementary school students in Cluster IX Buleleng District during the 2013/2014 academic year.

Ramadhan et al., (2021) conducted a development research project aimed at creating learning tools for flat-sided geometric spaces using the Treffinger model and the Geogebra application. The study followed the Research and Development (R&D) approach and was designed to align with the 2013 curriculum. The learning device consisted of a lesson plan (RPP) and student worksheets (LKPD) and was validated by experts and teacher practitioners. Both RPP and LKPD were deemed sufficiently valid, and minor revisions were made based on the validator's suggestions to ensure their feasibility for use in the learning process. The study results showed that the tools were valid and feasible for use in the learning process. The study's theoretical implications relate to the use of learning models that align with social reconstruction theory.

Sugiartini (2023) and Malini et al. (2022) conducted a Quasi-Experimental research with a quantitative approach to evaluate the use of image media in natural science material. The study used observation sheets to measure cognitive, affective, and psychomotor aspects of student learning activities. The t-test analysis with a 5% significance level was used to compare the experimental class that used the Treffinger learning model with the control class. The results showed that the experimental class using the Treffinger model performed significantly better in cognitive and biological learning outcomes compared to the control class. The experimental class also had a higher proportion of students with very good and good scores in the affective category, while the control class had a higher proportion of students with very good and good scores in the affective category compared to those in the quite good and poor categories. In terms of psychomotor aspects, 50% of the students in the experimental class achieved a very good category, while in the control class, only 39% of the students achieved a very good category, and some indicators did not improve.

Kusuma et al., (2020) examined the improvement in the creative thinking skills and mathematical problem-solving of students who received the Treffinger learning model, which was better than students who received regular learning. Furthermore, it is known that the learning interest of students who receive the Treffinger learning model is better than those who receive regular learning. Overall, it is known that there is a relationship between students' mathematical creative thinking skills and students' mathematical problem-solving skills, as well as between learning interest and creative thinking skills and students' mathematical problem-solving skills. By association, each variable is classified as moderate. Therefore. Teachers should develop the

Treffinger learning model better in preparing teaching materials according to student's needs so that students' mathematical abilities are developed better. They need to understand that it is important to increase students' interest in learning to improve student mathematical abilities.

Kusuma et al., (2020) conducted research to investigate whether the Treffinger learning model was effective in improving students' creative thinking and mathematical problem-solving abilities. The results revealed that the students who were taught with the Treffinger learning model demonstrated greater improvement in both creative thinking and problem-solving abilities compared to those who received traditional instruction. The study also showed that the students who received the Treffinger learning model were more interested in learning than those who received traditional instruction. The research also found a moderate correlation between students' mathematical creative thinking abilities and problem-solving abilities, as well as between their interest in learning and creative thinking and problem-solving abilities. The authors suggest that teachers should develop teaching materials that cater to the needs of individual students using the Treffinger learning model to improve their mathematical abilities. Additionally, teachers should recognize the importance of increasing students' interest in learning to enhance their mathematical abilities.

The study conducted by Nizham & Avip, (2017) aimed to investigate the effectiveness of the Treffinger learning model in enhancing students' self-efficacy and literacy skills while reducing their math anxiety. Furthermore, the study aimed to explore the relationship between early math skills and the improvement in students' mathematical literacy skills. The study utilized various instruments such as literacy skills tests, self-efficacy scales, math anxiety scales, observation sheets, and interviews with students. The collected data was analyzed using t-tests, one-way ANOVA, and two-way analyses. The findings of the study indicate that students who received the Treffinger learning model had similar improvements in literacy skills compared to those who received conventional teaching. However, the Treffinger learning model was found to be more effective in improving students' self-efficacy and reducing math anxiety. Additionally, the study found that the effectiveness of the Treffinger model varied based on the initial math abilities of students. Overall, the study highlights the effectiveness of the Treffinger learning model in improving students' math literacy skills and reducing math anxiety, making it a viable alternative to conventional teaching methods.

Triwibowo et al., (2017) conducted a study to evaluate the effectiveness of the Treffinger learning model with an open-ended approach in promoting learning mastery and enhancing creative thinking skills of seventh-grade students with different learning styles, namely visual, auditory, and kinesthetic. The research findings indicated that (1) the Treffinger learning model with an open-ended approach was effective in achieving learning mastery, (2) it significantly improved the mathematical creative thinking skills of the participants, with a moderate gain index of 0.47, (3) students with visual learning styles demonstrated highly creative mathematical thinking skills at level 4, while students with auditory and kinesthetic learning styles displayed creative mathematical thinking skills at level 3.

Munandar et al. (2021) used the Treffinger learning model in combination with Audio Visual media to improve the fundamental chemistry learning outcomes of students. The results revealed that the average student learning outcomes increased from 63.33 in the first cycle to 72.67 in the second cycle, with a significant increase in the completeness of learning outcomes, from 22.5% in the first cycle to 87.5% in the second cycle. On the other hand, Dwijanto et al., (2019) investigated whether the Treffinger learning model, supported by problem cards, can help students attain classical graduation or Minimum Mastery Criteria for mathematical creative thinking, whether it is more effective than the PBL learning model, and whether students' mathematical creative thinking abilities are related to their learning interest. The study employed tests, questionnaires, observations, and interviews to collect data. The findings showed that students who used the Treffinger learning model supported by problem cards attained classical graduation and the Minimum Mastery Criteria for mathematical creative thinking and performed better than those who used the PBL learning model. Moreover, students with high learning interest demonstrated better mathematical creative thinking abilities than those with low learning interest.

Munandar et al. (2021) utilized the Treffinger learning model in conjunction with Audio Visual media to enhance the fundamental chemistry learning outcomes of students. The findings indicated that the average student learning outcomes increased from 63.33 in cycle I to 72.67 in cycle II. Furthermore, there was a significant rise in the completeness of learning outcomes, with nine individuals or 22.5% in the first cycle and 35 individuals or 87.5% in the second cycle. Dwijanto et al. (2019) examined the following aspects: (1) the ability of students' mathematical creative thinking with the Treffinger learning model supported by problem cards to attain classical graduation or Minimum Mastery Criteria, (2) whether students' mathematical ability is better with the Treffinger learning model or PBL learning model, and (3) whether students' mathematical creative thinking abilities correlate with students' learning interest. The data collection methods included tests, questionnaires, observations, and interviews. The outcomes indicated that students' mathematical creative thinking skills with the Treffinger learning model supported by problem cards attained classical graduation and the Minimum Mastery Criteria, and were better than students with the PBL learning model. Additionally, high learning interest was connected with better mathematical creative thinking abilities compared to low learning interest.

Wirahayu et al., (2018) conducted a study using a posttest control group design to investigate the effect of the Treffinger learning model on the divergent thinking abilities of students. The study focused on the relationship between the independent variable of the Treffinger learning model and the dependent variable of divergent thinking. To measure students' divergent thinking skills, an essay test was administered. The collected data was analyzed using SPSS 21.0 for Windows and t-test. The results indicated that the experimental group, who received the Treffinger learning model, scored an average of 80.72 on the divergent thinking test, whereas the control group scored 75.73. An independent sample t-test analysis revealed a p-value of 0.002, which is less than the significance level of 0.05 ($p<0.05$). This suggests that the Treffinger learning model significantly influenced the divergent thinking skills of FIS Geography students at the State University of Malang.

Haryanto & Pujiastuti (2020) conducted a study to investigate the types of errors and their causes made by students when solving open-ended geometry questions using the Newman procedure. They also evaluated the quality of learning using the context-based Treffinger model and assessed whether it led to classical completeness. The research design utilized a mixed method, including a pre-experimental design with a one-shot case study design. The findings showed that one subject in the medium group and all subjects in the low group made errors in problem understanding, while transformation errors were committed by one subject in each group. All subjects in the upper group and one subject in the medium group made errors in processing ability, and all subjects in the upper group and one subject in the medium group made errors in writing. The causes of these errors were attributed to a lack of problem understanding, the need to learn strategies, difficulties in determining calculations, and a lack of attention to writing. The Treffinger model was found to be helpful in achieving classical completeness in the students' ability to solve open-ended geometry questions.

Yulinsa et al., (2021) conducted a study to evaluate the effectiveness of the Treffinger learning model in improving students' understanding of mathematical concepts with the help of Al-Qur'an teaching materials. The research used a quantitative quasi-experimental design with three stages: pretest, treatment, and posttest. Data analysis indicated that there was a difference in the increase of understanding of mathematical concepts between the experimental and control groups. The difference was statistically significant, as tested using a one-way Anova test with a significance level of 0.05. The N-Gain test showed that the average increase in understanding of mathematical concepts was the highest in the class that applied the Treffinger learning model assisted by Al-Qur'an teaching materials (0.84), followed by the class that applied the Treffinger learning model (0.66), the class that applied conventional learning models assisted by Al-Qur'an teaching materials (0.43), and the class that applied conventional learning models (0.14). Hence, it can be concluded that the Treffinger learning model assisted by Al-Qur'an teaching materials is more effective than the Treffinger learning model, conventional learning models assisted by Al-Qur'an teaching materials, and conventional learning models in enhancing students' understanding of mathematical concepts.

Rifa'i et al., (2020) conducted a study to examine the enhancement of students' mathematical creative thinking skills using quasi-experimental design with the nonequivalent pretest-posttest control group. The participants were selected through purposive sampling based on specific criteria. Data collection involved the use of observation and test methods, with an essay test used to measure the students' mathematical creative thinking skills. The obtained data was quantitative in nature and was analyzed using normality, homogeneity, and mean difference tests. The statistical technique used in data processing was parametric statistics with t-test. The findings of the study indicated that the mathematical creative thinking skills of class XI Madrasah Aliyah Mathla'ul Anwar Pusat Menes students who received the Treffinger learning model were superior to those who underwent conventional learning.

CONCLUSION

The Treffinger learning model teaches process skills and student learning outcomes. The analysis's findings for Pillai's Trace, Wilks' Lambda, Hotelling's, and Roy's Largest Root were calculated with an F indicating that groups of students participate in experiment-based learning and those who follow conventional learning have significantly different average scores for process skills. With the Least Significant Difference (LSD) approach, the difference between the average score for the pairing process abilities of the Treffinger model and the traditional learning model based on a standard deviation is consistently greater than the conventional learning model's average score for group learning outcomes. Students who use the Treffinger model produce superior learning results than those who use the traditional learning model.

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