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INSECTA**Integrative Science Education and Teaching Activity Journal**Journal homepage : <https://jurnal.iainponorogo.ac.id/index.php/insecta>

Article

Implementation of The Treffinger Model Based STEM Approach to Students' Creative Thinking SkillEni Lestari^{1*}, Sofwan Hadi²^{1,2} Institut Agama Islam Negeri (IAIN) Ponorogo, Indonesia**Corresponding Address: enilestari1608@gmail.com***Article Info**

Article history:

Received: May 21, 2022

Accepted: May 23, 2022

Published: May 30, 2022

Keywords:Treffinger Model;
STEM Approach;
Creative Thinking;**ABSTRACT**

Creative thinking can encourage students to solve problem. Learning Treffinger model provides opportunities for students to understand the concept through the process of solving problems creatively. The approach used to support this model is STEM approach. The STEM learning that encourages increased thinking skills creative. This research aims to determine the implementation learning with the Treffinger model based STEM, the application of the Treffinger model based STEM on creative thinking skills, and factors that affect learning. This research uses an approach quantitative and using Quasi Experiment with the Posttest-only Design with Nonequivalent Group. Population that used are students of class VIII at SMP Ma'arif 1 Ponorogo total of 84 students. The research sample from control class was 28 students and from the experimental class a total of 29 students. Data analysis techniques that used are independent test sample t test. Based on the data analysis, it was found that (1) implementation of the Treffinger model learning based on STEM is carried out very well, (2) the ability to think creatively in the class that applies the model Treffinger based STEM is better than non-implemented the model, (3) the teacher's ability to deliver the subject matter and students who play an active role have an important role in the implementation conducive learning.

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INTRODUCTION

The preparation of a good learning process by the teacher is important to support the achievement of the development of creative thinking skills in students. At the age of teenagers is an important stage in the development of creative thinking skills somebody. Brain development in adolescents aged 15-16 years has a big possibility support student learning flexibility and creativity (Antink-Meyer & Lederman, 2015). There are various creative thoughts from someone so that it can be easier in finding solutions to the problems at hand. In line with Hartini and Kusdiwelirawan stated that creative thinking can help students to solve various problems in the learning process (Hartini dan Kusdiwelirawan, 2014). According to Alencar et al., a person's creative power is not only solve problems, but can help him in responding to opportunities existing and become more productive in facing

challenges and able to contribute in increasing the progress of the country (Alt & Raichel, 2020).

The teaching model is one of the things that must be mastered by a teacher educators in teaching and learning activities (Farihatun & Rusdarti, 2019). In the world of education there are various learning models that can be used to convey subject matter to students. According to Trianto, the learning model is a pattern which is used as a guide for making lesson plans and determine the tools needed, such as material books, computers, curriculum and others (Risnaini et al., 2016). The recommended learning model is in accordance with the 2013 curriculum found to be oriented towards student activity.

The learning model can be interpreted as a conceptual framework that describes a systematic procedure in organizing learning activities to achieve learning objectives. This means that the learning model is a the design of learning activities so that in its implementation it can run smoothly good, interesting, easy to reach in a clear order (Octavia A., 2020). Based on the description It can be said that the learning model is a conceptual framework which describes a systematic procedure used as a guide in make lesson plans and determine the tools needed to achieve learning goals.

The learning model has special characteristics that are not found in the strategy, methods and procedures. The special characteristics of the learning model are as follows. 1) The learning model has a rational or reasonable thinking theory. This matter means in the creation or development of learning models, they considering theory and reality on the ground not just fictitious mere. 2) The learning model has a clear goal of what must be achieved, including good student learning activities and how to solve problems in teaching and learning activities. 3) The learning model has the necessary teaching behavior so that able to achieve learning goals. 4) The learning model has a conducive and comfortable learning environment so as to be able to achieve the goals that have been designed (Darmadi, 2017).

Learning Treffinger is a model that prioritizes activity students in the learning process. The Treffinger model was introduced by Donald J. Treffinger, a president at the Center of Creative Learning in 1980 as efforts to generate creative learning. According to Huda, model This learning is also known as CPS (Creative Problem Solving). Treffinger (Sari & Putra, 2015). According to Treffinger et al., this model is a learning model that does not only involves cognitive abilities but also in collaboration with affective abilities at each stage, namely in the form of understanding the challenges faced exist, generate ideas and preparing for action (Nugraheni et. al., 2019). Meanwhile Ekawati explained that the Treffinger model is a creative learning that implement divergent thinking (thinking processes in many directions and generate many ideas) and convergent thinking (thinking to discover one of the most appropriate solutions) (Darminto et al., n.d.). Based on this opinion, it can be seen that Treffinger's model is a learning model that emphasizes the creative process by combines cognitive and affective abilities to find ideas as solutions problem.

The ability to think creatively can be known through several indicators, namely: fluency, flexibility, elaboration, and originality. In fluency of thinking, students are required to be able to give ideas or relevant ideas correctly. The flexibility of students' thinking is marked by the ability to provide multiple solutions to current problems faced. Elaboration is characterized by a precise and detailed solution of the problem is being faced. While on the originality indicator, students are able to provide a different solution with his friend but right according to the problem (Jankowska et al., 2019).

The Treffinger learning model is one model that invites students to in solving problems by looking at the facts that exist in the environment around, helping students to master concepts which then generate ideas and choose the right solution to implement. Treffinger models can help students to think creatively in solving problems and providing opportunities

for students to show their abilities, including creativity and abilities solution to problem. Learning with the Treffinger model consists of several levels that encourage students to be able to develop their abilities and thinking power. According to Treffinger et al., application of the Treffinger model in learning by involving the ability cognitive and affective at each level, namely: 1) understanding the challenges or problems; 2) generate ideas as solutions; 3) prepare appropriate actions with problems being faced (Nugraheni et. al., 2019). As is several levels used in learning make it easier for students in determining solutions according to the problems they face creatively.

According to Treffinger this learning model has several advantages, namely: 1) this model assumes that creative thinking is a learning process and result; 2) learning is carried out regardless of background and level of knowledge; 3) the existence of a combination of cognitive and affective dimensions at the same time in learning; 4) existence integrating divergent and convergent thinking skills for problem solving; 5) there are systematic stages with various dynamic methods and techniques (Wirahayu & Purwito, 2018). Learning with the Treffinger model emphasizes the concept of development and process aspects of students. By involving cognitive abilities and affective at each level in the Treffinger model can encourage students to learn independently creative (Isnaini dan M. Duskri, 2016). Application of the right model in activities learning is expected to be able to achieve quality education.

The STEM (Science, Technology, Engineering, and Mathematics) approach is one of the learning approaches that provide a variety of knowledge and skills from multiple disciplines at once. According to Breiner et al., STEM learning is a curriculum that integrate science, technology, engineering, and mathematics with additional practical activities in the process (Dare et al., 2019). This STEM-based learning oriented to the integration of multidisciplinary science in the process of its activities so that students are expected to have a variety of experiences that can used to solve various problems at hand. STEM-based learning that emphasizes the activeness of students in the teaching and learning process then they get real experience that affect their knowledge, skills, and attitudes. That matter This is in accordance with Papert's theory of constructionism which states that the process of learning is carried out with coaching and experience (Bahrum & Samsudin, 2021). The STEM involves students with various components including application of science or science with various technologies to shape their understanding. As stated by Bryan et al; Sanders, STEM integrated in the curriculum are activities that involve students in technology or design engineering that actualizes science learning and/or mathematical content (Dare et al., 2019). This is in accordance with the theory of connectivity quoted from Shriram & Warner; Smidt et al., who stated that this theory emphasizes interaction between users in social networks through digital technology (Bahrum & Samsudin, 2021).

Learning using a STEM approach that emphasizes active students are also in accordance with the theory of cognition. According to the theory of cognition as quoted from Brown et all., learning carried out with activities, contexts, and situations from the culture through the hands and psychomotor activities of the learners (Awalin & Ismono, 2021). Dari From this statement, we can know that the STEM approach has support from various theories, both in terms of components and in their practical application emphasizes active student-based activities that are able to build their knowledge alone.

According to Jamal, the ability to think is defined as an attempt to add knowledge and experience which can then build the power to change behavior and control action. He added that thinking activity formed is influenced by time, which consists of: period of thinking, situations and conditions, as well as themes that become the center of the activity of thinking itself (Ibriza, 2019). A person's ability to think can influence the actions of his behavior, so there needs to be good habituation to direct it in a positive direction. According to Rhodes,

creativity is the context of a person's personality, product that one produces, one's environment that produces creative products, and the way someone thinks when creating a product or an original response.⁴⁸ Meanwhile, Kounios & Beman; Perkins, creative thinking is a phenomenon that uncontrollable or subconscious which can sometimes result in new insight (Jankowska et al., 2019).

According to Bybee R.W., STEM can make students learn to be able to apply and practice the components of STEM into the various situations they face in their lives so that they trained to communicate, cooperate, think critically, and develop the level of their creative thinking in accordance with the demands of the 21st century (Hermansyah, 2020). in line With this, according to Vikram & Magued, the STEM approach can encourage students to to design, develop, and utilize affective manipulatives so that they can improve mathematical creative thinking skills (Octaviyani et al., 2020). Approach STEM is used to prepare students to solve problems by integrating various disciplines creatively. There is a learning integrating various disciplines, students do not just understand the concept but can use the knowledge that has been gained to create solutions in solving problems. In previous research, the Treffinger model combined with STEM was able to significantly reduce students' misconceptions (Zaqiyatunnisak, 2019).

The existence of various creative thoughts from someone makes it easier find solutions to the problems at hand. According to Alt & Raichel explains that creativity involves an original approach to being able to used in solving problems combined with the discovery solution or produce a new one (Alt & Raichel, 2020). Creative thinking is not enough only in the form of content management but requires the ability to be able to apply the knowledge possessed flexibly according to the needs and demands. According to Zabelina & Robinson, creative individuals tend to show more flexible cognitive abilities (Gregory et al., 2013). Existence creative thinking skills in students are needed to develop a sense of their curiosity so that they will continue to explore and look for relevant information regarding the problems faced in the learning process (Hartini dan Kusdiwelirawan, 2014).

The ability to think creatively is also defined as a thought from someone or the result of a new discovery to produce a new product, either in the form of real ideas or works, and which are relatively real with what been there before. The discovery in question can be in the form of ideas or ideas, actions, behavior, works of art, and so on which are various things These are obtained from life experiences both from learning at school and from school from family and society (Utami et al., 2018). According to Ridong & Xiaohui (2017) the process creative thinking is able to generate many ideas or ideas based on intuition in solving problems (Wasiran & Andinasari, 2019). Based on these various opinions, we can know that creative thinking is an ability in a person to generate new ideas, behaviors, works of art, and ways of thinking or a new, original perspective gained from good life experiences of the learning process that can be used to solve problems.

Creative thinking is basically closely related to various components such as science, mathematics, and technology. According to Ernochova & Selcuk, creative thinking has integration with technology when creativity and literacy are combined into powerful tools in teaching and learning process (Alt & Raichel, 2020). As we know that STEM learning is an integration of science, technology, engineering, and mathematics. According to Vikram & Magued, the STEM approach can encourage students to designing, developing and utilizing something that is manipulative and affective so that it can be used to increase creativity in the mathematical field (Octaviyani et al., 2020). Based on the description above, it can be found the relationship between STEM, Treffinger model and creative thinking skills. Aspects in creative thinking consist of 4 (four) components, namely fluency in thinking, flexibility or flexibility, originality, and elaboration (Jankowska et al., 2019). The following is a conceptual framework of the model Treffinger, STEM and creative thinking skills.

Each stage of the Treffinger model encourages students to be able to play an active role in learning so that it can bring up the power of creative thinking. Thinking ability smooth flow can be encouraged by presenting open problems in Stage I and Stage II which can allow for many ideas to be generated. Use Open problems can allow students to generate many alternatives solutions that can show flexibility in thinking. In addition, there is a discussion process as a group can develop their thought processes (elaboration) in the process solution to problem. In Stage III, students can analyze and find ideas in problem solving (originality) which can then be emphasized in the form of action details. In line with this, the STEM approach encourages students to be able to manipulate and develop the knowledge that has been obtained so that able to increase their creativity. Thus the Treffinger model combined with a STEM approach to develop thinking skills creative students. Statement Based on the above, the research carried out research with the title "Implementation of The Treffinger Model Based STEM Approach to Students' Creative Thinking Skill"

METHODS

The approach used in this research is quantitative. The type of research that carried out using a Quasi Experiment Design (quasi-experimental design). Quasi Experiment Design, namely the existence of an experimental group and a control group, but the control group cannot function to control external variables that have an effect on experiment (Sugiyono, 2019). This type of research looks at the pattern of cause-and-effect relationships by comparing the results of the experimental group and the control group (Annuuru et al., 2017). This study uses a Posttest-only Design with Nonequivalent research design Groups. The research design is described as follows.

Table 1. Design Research of Posttest-only Design with Nonequivalent Group

Class	Treatment	Posttest
Experiment	X	O ₁
Control		O ₂

(Hastjarto, 2019)

Information:

- X = Treffinger Model based STEM
- O₁ = Posttest results of experimental class students
- O₂ = Posttest results of control class students

The research was carried out in the even semester of the 2021/2022 academic year. Researcher carry out learning activities in the control class and experimental class on 24 February 2022 to March 11, 2022. The population is all subjects who will be measured in the form of units to be studied (Sugiyono, 2019). The population in this study is all eighth grade students of SMP Ma'arif 1 Ponorogo for the academic year 2021/2022 totaling 83 students. The sample used in this study consisted of 2 classes, namely class VIII A as the experimental class and class VIII B as the control class. Class VIII A totaled 29 students consisting of 10 male students and 19 female students. While class VIII B totaled 28 students consisting of 16 male students and 12 female students.

RESULTS AND DISCUSSION

Application of the STEM-based Treffinger learning model at SMP Ma'arif 1 Ponorogo it can be said that it is still rarely used by teachers at the school. There are additional STEM elements in learning support the successful application of the model Treffinger to achieve learning goals. This research is to find out the difference creative thinking skills in classes that apply the Treffinger model based STEM with classes that do not use the model. The learning activities conducted in this study were four meetings, namely three times providing learning materials and one posttest.

Research on creative thinking skills is carried out by giving questions to students student. The test questions used consist of 3 essay questions with an open ended type. The matter refers to indicators in creative thinking skills, namely fluency in thinking, flexibility, elaboration, and originality. Based on the research that has been done, the researcher obtain posttest data from the control class and the experimental class. Giving questions to taking the value is done after finishing studying the material pressure of substances and its application in everyday life. The data that has been obtained is then used to identify descriptive data with Minitab.

The results of the post-test data analysis carried out a prerequisite test to ensure that the data obtained normal and homogeneous. The normality test used is the Kolmogorov-Smirnov using Minitab 16 software with a significance level of 0.05. The P Value of the two sample classes is greater than 0.150, then the two classes can be stated to be normally distributed. Data that has been declared normal, then the next step homogeneity test was carried out. The purpose of the homogeneity test is to find out whether the two samples used in this study have the same variance (homogeneous) or not. Homogeneity test using software-assisted Levene test Minitab 16 with a significance level of 0.05. Homogeneity level based on test results Levene's Test in the control class and experimental class has a P-Value value of 0.505 which is greater than the level of significance. Thus it can be concluded that the data in the two classes have the same or homogeneous variance.

The data that has been obtained is known to be normally distributed and has a variance the same or homogeneous. The data is then carried out parametric test using t test. The t-test is used to determine whether there is a difference in the mean between the two groups that unpaired or two groups of data from different subjects. Data analysis used to find out the difference in the average value of students' creative thinking abilities in the class control and experimental class using the Independent Sample t-test. Test results on The difference between the creative thinking ability of the control class and the experimental class is as follows.

Tabel 2. Result *Independent Sample t-test* Class of Control and Experiment

	N	Mean	StDev	SE Mean
Class Control	29	88,90	6,61	1,2
Class Experiment	28	80,69	6,31	1,2

Difference = mu (Class Control) - mu (Class Experiment)
Estimate for difference: -8,21

T-Test of difference = 0 (vs not =) P-Value = 0,000

Based on the results of research that has been done, students' creative thinking skills obtained by conducting posttests in classes that apply the learning model A Treffinger based STEM with classes that do not implement the model has P-Value value of 0.000. So it can be said that the class that applies the model A Treffinger based STEM with classes that do not implement the model has significant difference. The results of the t-test on students' creative thinking skills obtained a value of the average in the class that applies the Treffinger based STEM learning model of 88.90. Meanwhile, in classes that do not apply the Treffinger model based STEM has an average value of 80.69. The value of the estimate for difference, namely the average value of the class that does not apply the STEM-based Treffinger model is reduced with the average value of the class that applies the STEM-based Treffinger model of (-8.21). This proves that the class that implements the .-based Treffinger model STEM has better creative thinking skills than the classroom who do not apply the Treffinger model based STEM.

The results of this study are in accordance with previous findings which showed that creative thinking skills of students who apply the Treffinger model based STEM are more better than classes that apply conventional learning models (Puspita, 2018). The application

of the Treffinger model based STEM can help students understand the material lessons better. Students who have understood the concept of the subject matter well characterized by the existence of low misconceptions in these students. This corresponds to previous research which shows that after the application of the Treffinger model with the STEM approach, students experienced a decrease in misconceptions by 47.96% (Za'qiyatunnisak, 2019). With the high level of student understanding and low misconceptions make it easier for students to accept the subject matter. So that it can support the development of thinking skills.

The results of the average score on several indicators of creative thinking in students are as follows.

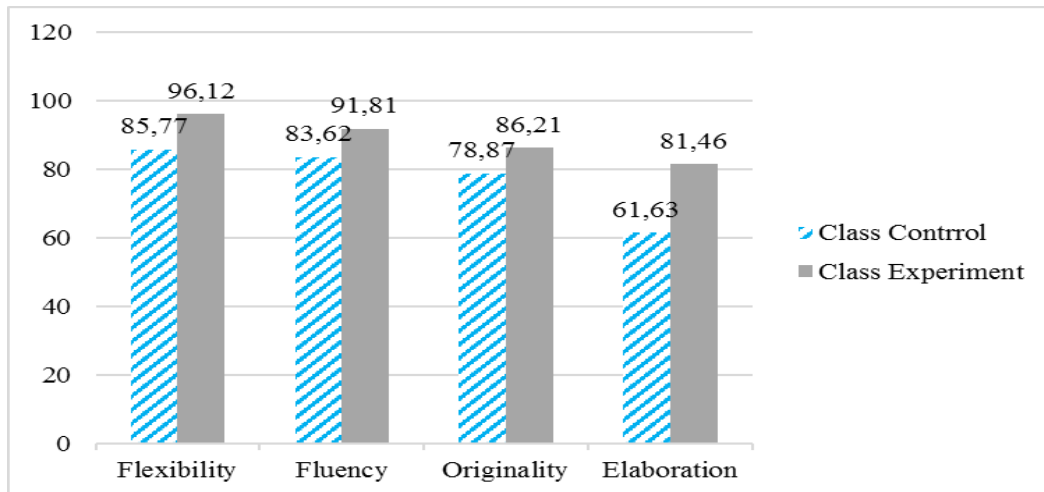


Figure 1. Average value of Creative Thinking Indicators for Control Class and Experiment Class

Based on the results of the data analysis obtained the value of students' creative thinking skills at classes that implement the Treffinger model based STEM with classes that do not applying the model in Figure 1, shows the differences in each indicators of creative thinking, namely flexibility of thinking, fluency of thinking, originality, and elaboration. Data analysis based on each of these indicators is as follows.

Flexibility of Thinking

Indicators of flexibility of thinking allow students to produce a lot alternative solutions to solve problems. Classes that implement the Treffinger model most of the STEM based systems have been able to generate alternative solutions by linking the theories that have been studied, but there are still some students who has not been able to. Whereas in classes that do not apply the Treffinger model based STEM students are most of the students who have not been able to provide the right solution and have not able to relate it to theories. This can be seen from the average value of on the indicators of flexibility of thinking obtained by the class that applies the Treffinger model based STEM approach is 96.12 while the class that does not apply the model it is only 85.77.

The average score on the flexibility of thinking indicator is the highest value, from both classes that implement the Treffinger model based STEM and those that do not apply the model. This is because in the Treffinger model, students encouraged to play an active role in learning, especially at the stage of awakening ideas supported by various demonstrations and asked to submit a response. Meanwhile, for classes that do not apply the Treffinger model based STEM learning is only given an explanation of the material and practice questions so that students do not play an active role in learning to build their knowledge. This matter in accordance with previous research which explained that learning with using interactive demonstrations has a positive effect on ability students' thinking (Rasagama et al., 2013).

Fluency of Thinking

In the indicator showing students can give a lot of ideas and provide an accurate description. Classes that implement the Treffinger model based STEM is mostly able to generate many ideas accurately and describe it, but there are still students who have not been able to. While in class who did not apply the Treffinger model based STEM were mostly able to give a lot of ideas but have not been able to describe them precisely. This can be seen from the average value of the class that applies the Treffinger model based STEM is 91.81 while the class that does not apply the .-based Treffinger model based STEM only got a score of 83.62. Obtaining an average score on the indicators of fluency in class thinking that applies Treffinger model based STEM is higher than the non-implementing class the model. There is a significant difference in the average value due to the class applying the Treffinger model based STEM, students were asked to express knowledge precisely by directing it to various phenomena that relevant in everyday life.

Originality

In the originality indicator, students can analyze and find ideas that different in problem solving. Classes that implement the Treffinger model based STEM is mostly able to analyze and find different ideas in complete the given problem. This is due to the involvement of students actively in learning activities. However, there are still students who have not been able to analyze the problem properly. Whereas in classes that do not apply most of the Treffinger model based STEM have not been able to analyze and find different ideas to solve the given problem. That matter can be seen from the acquisition of the average value on the originality indicator in the class that applying the Treffinger model based STEM of 86.21 while in the lower class did not apply the model only 78.87. This is in accordance with research previously found that students who are motivated and play an active role in learning activities shows a better learning achievement (Fairuzabadi et al., 2017). The average value of the originality indicator in the class that applies the Treffinger model based STEM is better than not applying the model. Question given to the originality indicator is included in the easy category that leads to to students' knowledge and experience. The questions on the originality indicator are made with emphasizes the proper application of concepts.

Elaboration

The elaboration indicator is marked by the student's ability to develop ideas in more detail. Classes that implement the Treffinger model based STEM systems are mostly able to develop ideas in more detail for solve the problem, but there are still some students who have not been able to develop ideas well. While classes that do not apply the model Most of the Treffingers based STEM have not been able to develop their ideas in more detail. This can be seen from the acquisition of the average score in the class that apply the Treffinger model based STEM, which is 81.46 while the lower class did not apply the model only 61.63. The elaboration indicator has the lowest average value than the indicator other. However, in classes that apply the Treffinger model based STEM has a higher average value than the class that does not apply the model. This is because the class that applies the Treffinger model based STEM has a group discussion process that allows development of thinking skills more easily. There are group discussions too allows students to express ideas, listen to the opinions of friends, and together in improving their thinking skills later used to solve problems (Ristiasari et al., 2012). So that students can fully understand the concept and when faced with a problem, students can develop solutions in more detail.

Based on the analysis of the results of the average value of creative thinking ability on each indicator, it can be seen that the flexibility of thinking indicator has a value of the highest, both of the classes that apply the Treffinger model based STEM as well as classes

that do not apply it. While the elaboration indicator has the lowest average value compared to other indicators for the two classes. Thing This is different from previous research which stated that the highest value of found in the fluency indicator of thinking, while the lowest value was found in indicators of flexibility of thinking (Puspita, 2018). Despite having models and approaches the same, but there are other factors that affect learning so that lead to differences in research results.

One of the factors that influence students' creative thinking skills in class experiment compared to the control class is the implementation of the learning Treffinger model based STEM. The teacher in this case has a big role to create conducive atmosphere so that students feel comfortable and easy to understand learning materials. Teachers in delivering material can do various things, Among them are: providing illustrations of real problems related to life everyday, using language that is easily understood by students, using various symbols, pictures or real objects (Sinambela, n.d.). As is the interactive nature of the teacher can attract the attention of students to play an active role in learning learning process so that it has an impact on their thinking ability.

In addition to the implementation factor of learning with the Treffinger model based STEM, Another factor that influences the level of creative thinking ability is students who active during the learning process. Activity is one of the important components in teaching and learning activities. When students are actively involved in learning, they can find their own concepts during teaching and learning activities. Therefore students can be actively involved in problem solving. There is an active role of students in learning activities have a big role in the success of the learning process teach. Students' creative thinking skills in classes that apply the model better Treffinger than based STEM non-model implemented classes this cannot be separated from the factors of teachers, learning support media, and students who play an active role during the teaching and learning process.

CONCLUSION

The application of the Treffinger model based STEM is carried out using demonstrations and practicals. The existence of a demonstration and practicum process is intended to encourage the development of creative thinking skills in students. The creative thinking ability of the class that applied the STEM-based Treffinger model was better than the class that did not apply the model. This can be seen based on the results of the average posttest value of the class that applies the STEM-based Treffinger model of 88.90 while the class that does not apply the model is only 80.69. The value of the estimate for difference between the experimental class and the control class is 8.21. Based on the four indicators of creative thinking, namely fluency in thinking, flexibility, originality, and elaboration, classes that apply the Treffinger model based STEM have higher scores than the class that did not apply the model. Difference the ability to think creatively is due to the class that applies the Treffinger model based STEM is a process for understanding problems through stimuli from the teacher generates ideas supported by various demonstrations and practicums, and apply skills based on understanding concepts that they already have. Success in the application of the Treffinger model based STEM in learning cannot be separated from teacher and student factors. This research is only limited to the theme of substance pressure and its application in everyday life, hope to other researchers to be able to apply it with other materials.

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