The Improvement of Mathematical Creative Thinking Abilities Based on Self-Confidence Category in Senior High School Students

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https://doi.org/10.17977/um065.v6.i7.2026.6

Article history
Submitted: 1 May 2026
Revised: 14 May 2026
Accepted: 18 May 2026
Published: 23 May 2026

Keywords
GeoGebra
Mathematical creative thinking education
Self-confidence
Treffinger model

Abstract
The development of mathematical creative thinking abilities has become an essential focus in 21st-century education, yet students' performance in this area remains relatively low, particularly when influenced by affective factors such as self-confidence. This study aims to examine the effectiveness of the Treffinger learning model, assisted by GeoGebra, in improving students' mathematical creative thinking abilities, and to analyze differences in improvement across self-confidence categories (high, medium, and low). The research employed a quantitative quasi-experimental design with a pretest–posttest non-equivalent control group design. The study was conducted with senior high school students, where the experimental class received Treffinger learning assisted by GeoGebra, while the control class received conventional instruction. Data were collected through tests of mathematical creative thinking ability and a self-confidence questionnaire and analyzed using normalized gain and inferential statistical tests. The results revealed that the improvement in students' mathematical creative thinking abilities in the experimental class was significantly greater than in the control class across all self-confidence categories. These findings indicate that the Treffinger model, assisted by GeoGebra, is effective in enhancing both the cognitive and affective aspects of learning. Therefore, integrating innovative learning models and technology is recommended to foster students' creative thinking and support their self-confidence in learning mathematics.

1. Introduction

21st-century education demands that students can think creatively, solve problems, collaborate, and have technology literacy to adapt in a dynamic and complex world (Susanto & Azizah, 2025). In Indonesia, learning reformation has focused on creative ability as one of the competencies that students must be able to do (Permendikbud Nomor 12 Tahun 2024). Thinking creatively can be understood as an activity to generate or develop new ideas (Siswono, 2016). One of the key lessons that requires the ability to think creatively is mathematics. Mathematics is viewed not only as a collection of formulas and procedures but also as a universal means of honing the ability to think logically, analytically, systematically, critically, and creatively (Zahra & Roesdiana, 2023). The main purpose of learning mathematics in schools, particularly at the high school level, is to equip students with the ability to solve problems, reason, communicate, and connect mathematically, so that they can construct and reconstruct knowledge to solve real-life problems (Permendikbud Nomor 12 Tahun 2024; Darmayanti & Widodo, 2024). This is in line with the demands of the 21st century, which emphasize creative thinking skills.

The emphasize creative thinking in mathematics is important. The ability to think creatively in mathematics is known as the Mathematical Creative Thinking Ability (MCTA). MCTA is an essential ability to find diverse new ideas and solutions to solve problems (Maharani & Kusno, 2023). This ability not only determines academic success but also becomes a determinant of superiority and power in a competitive society in the world of work (Susanti & Juandi, 2021). This covers four components: fluency, flexibility, originality, and elaboration (Suherman & Vidákovich, 2025; Tamirrino et al., 2023). The MCTA component is used to assess students' creativity in mathematics to describe indicators think creative mathematical as following : (1) fluency, which refers to the ability for produce lots of ideas or solution ; (2) flexibility, which involves provision various solutions from various perspective ; (3) authenticity, which is capacity For produce unique answer use Language or expression personal; and (4) elaboration, which requires expansion of ideas or give explanation These components play a vital role in fostering creativity that enables students to face the challenges of modern education.

However, the achievement of education in Indonesia reveals a gap. The results of the 2015 Trends in International Mathematics and Science Study (TIMSS) placed Indonesia in the bottom 3, among 45 countries

ISSN: 2797-3174

(Hamzah & Dahlan, 2023). This underdevelopment indicates lower literacy and creativity among mathematics students in Indonesia than in other countries (Indrawati et al., 2025). It aligns with the research by Rajab et al. (2022) in high school students, found that the MCTA of students on the originality indicator is the lowest (12.5%). Research by Tamirrino et al. (2023) also confirmed a condition similar to that in West Bandung Regency. This indicates that the ability of creative mathematics students in Indonesia remains low and requires the use of appropriate learning models.

One of the learning models that can foster MCTA is Treffinger's model. The Treffinger model is a learning model that emphasizes the stages of creative thinking in a structured manner, with stages (1) basic tools, (2) practice with the process, and (3) working with real problems (Munandar, 2004; Ndiung et al., 2021). Basic tools include divergent thinking skills and creative techniques. Fluency, flexibility, and initiative in generating various ideas can be developed through these stages. Skills acquired in the basic tools stage are applied in practice with the process stage. Practice in these two initial stages continues with the working with real problems stage, where students use their abilities to solve problems and apply the information they have obtained in their lives. This model has been proven effective in improving students' MCTA (Hafriani et al., 2025; Wijayanti et al., 2021). The model's strength lies in integrating reflection and application processes, which encourage students to take creative risks (Lestari & Hadi, 2022; Ratnasari et al., 2020).

One technological support that can be integrated with the Treffinger Model is GeoGebra. GeoGebra is dynamic mathematical software that makes it easy for students to visualize abstract concepts, explore possible solutions, and receive immediate feedback (Mawardino & Fauzan, 2019). This integration not only increases student motivation and engagement but also encourages effective interaction and collaboration, which can ultimately improve students' self-confidence (Rosiyana et al, 2023). Thus, GeoGebra-assisted learning can provide a more comprehensive and meaningful learning experience that builds self-confidence.

Self-confidence is a psychological factor that plays an important role in learning mathematics. Self-confidence is an important quality students need to develop creative thinking skills in mathematics (Gunawan et al., 2022). Students with high self-confidence can optimize their MCTA (Dalilan & Sofyan, 2022). Trisnawati, et al. (2018) stated that there are 4 aspects of self-confidence, namely: (1) Believing in their own abilities, (2) making decisions independently, (3) Having a positive self-concept, and (4) Daring to express opinions. These four aspects are highly relevant in the context of learning mathematics, where students are required to convey ideas, take initiative, and be responsible for the problem-solving strategies they choose.

Previous research has shown that self-confidence is positively correlated with MCTA. Literature studies by Sari et al. (2023) showed that self-confidence has a significant positive correlation with MCTA. Students with high self-confidence tend to be more courageous in expressing ideas, actively engage in discussion, and are not afraid of failure when trying alternative solutions (Dalilan & Sofyan, 2022; Rusiyaningsih et al., 2025). Conversely, students with low self-confidence tend to be passive, reluctant to try new strategies, and only able to meet limited MCTA indicators (Rahmawati et al., 2024; Ratnasari et al., 2020). Therefore, strengthening self-confidence is a crucial part of designing learning that aims to develop students' mathematical creativity.

Although the effectiveness of the Treffinger Model and GeoGebra has been extensively studied separately, research gaps remain. One such gap is the limited number of studies that explicitly integrate these two components into a single unit in learning interventions. Furthermore, research that simultaneously examines the impact of this integration on MCTA (cognitive) and students' self-confidence (affective) remains limited. Most previous studies tend to separate the analysis of these two aspects, thus not providing a comprehensive picture of the interaction between models, media, cognitive abilities, and students' affective dispositions (Nufus et al., 2018; Ratnasari et al., 2020; Sari et al., 2023).

Based on the description of the gap, this research is important to conduct. This study aims to test the application of the Treffinger learning model, assisted by GeoGebra, to improve high school students' creative thinking skills in mathematics. More specifically, this study will also examine differences in MCTA improvement across student self-confidence categories (high, medium, and low) in trigonometry. The results of this study are expected to provide practical contributions as a reference for teachers in designing innovative mathematics learning, as well as theoretical contributions on the interaction among learning models, technology, and affective factors in fostering mathematical creativity aligned with the needs of 21st-century competencies.

2. Method

This research uses a quantitative approach. Quantitative research is research that involves the use of numbers throughout the research process, from data collection, interpretation, to results, and drawing conclusions (Syahroni, 2022). The method used in this study is quasi-experimental, namely, the selection of experimental and control groups is not completely random due to limitations in the field (Sugiyono, 2013). The design used in this study is a Pretest-Posttest non-equivalent group design with experimental and control

ISSN: 2797-3174

classes. The experimental class received the Treffinger learning model, while the control class used a conventional learning model, namely the Deep Learning approach.

This research was conducted at one of the Vocational High Schools in Bandung City in the even semester of the 2025/2026 academic year. The material given in this study was trigonometric ratios. The independent variable in this study was the Treffinger learning model assisted by GeoGebra, which was applied to the experimental class. The dependent variable in this study consisted of two components: mathematical creative thinking ability, measured through tests, and self-confidence, measured through questionnaires. Scoring guidelines for students' mathematical creative thinking ability were adopted from (Nufus et al., 2024). The self-confidence category was obtained from the student self-confidence questionnaire and grouped based on the average value. ($\bar{x}$)and standard deviation (s)into three categories according to Trisnawati, (2018), as follows.

If score $\geq \bar{x} + s$, then students are grouped into the high self-confidence category;

If $\bar{x} - s <$ score $< \bar{x} + s$, then students are grouped into the medium self-confidence category;

If score$\leq \bar{x} - s$, then students are grouped into the low self-confidence category.

The data used to test the increase in students' mathematical creative thinking abilities with high, medium, and low self-confidence categories is normalized gain (n_gain) data processed using SPSS 25 software, to determine the increase in students' mathematical creative thinking abilities using the normalized gain (n_gain) test. The n_gain formula 1 (Source : Lestari & Yudhanegara (2017)).

$$N_{gain} = \frac{Posttest\ Score - Pretest\ Score}{IMS - Pretest\ Score} \quad (1)$$

Information:
N_{gain} : Normalized gain
IMS : Ideal maximum score

The criteria for interpreting the n_gain score are Lestari and Yudhanegara (2017) as shown in Table 1.

Table 1. N_Gain Criteria

Mark N_{gain}	Criteria
$N_{gain} \geq 0.7$	High
$0.3 < N_{gain} < 0.7$	Medium
$N_{gain} \leq 0.3$	Low

After the n-gain values of students' mathematical creative thinking ability are grouped by self-confidence, a two-mean difference test is conducted. The two-mean difference test is conducted to determine whether students' mathematical creative thinking ability in the experimental class, across high, medium, and low self-confidence categories, is significantly higher than in the control class, across the same categories. If the n_gain score is normally distributed and has homogeneous variance, then the test is carried out using the t-test (independent-samples t-test with equal variance assumed). However, if the n_gain score is normally distributed and has non-homogeneous variance, the test is conducted using the independent-samples t-test (assuming unequal variances). The hypothesis in testing the difference between the two means is as follows.

$H_0 : \mu_1 \leq \mu_2$ (The increase in students' mathematical creative thinking abilities in the experimental class with a medium self-confidence category was not significantly higher than that of students in the control class with a high, medium, or low self-confidence category)

$H_1 : \mu_1 > \mu_2$ (The increase in students' mathematical creative thinking abilities in the experimental class with a medium self-confidence category was significantly higher compared to students in the control class with a high, medium, or low self-confidence category)

The significance level used is 5% ($\alpha = 0{,}05$) with the following testing criteria.

If the value is $Sig. \geq \alpha = 0{,}05$ then H_0 accepted.

If the value is $Sig. < \alpha = 0{,}05$ then H_0 rejected.

ISSN: 2797-3174

3. Results and Discussion

To determine the extent of improvement in students' mathematical creative thinking skills, an analysis was conducted of normalized gain (n-gain) data, categorized into three self-confidence levels: high, medium, and low. Before conducting a statistical test to assess the difference in average improvement between the experimental and control classes, the main prerequisite is a normality test of the data distribution. This normality test aims to determine whether the n-gain scores in each category are normally distributed. Considering that the number of samples in each category in this study was less than 50, the normality test was conducted using the Shapiro-Wilk statistical test with a significance level of α = 0.05. The following is a description of the results of the normality test for the distribution of n-gain data in each self-confidence category.

3.1. Results

Descriptive analysis was conducted to provide a general overview of improvements in students' mathematical creative thinking abilities, categorized by self-confidence levels, in both learning groups: the experimental group that received instruction using the Treffinger Model and the control group that received conventional learning. The data used for this analysis is the n_gain score, which compares improvements in students' mathematical creative thinking abilities between the two groups, categorized by self-confidence. Data on students' n_gain scores by self-confidence category are presented in Table 2.

Table 2. Student N_Gain Score Data Based on Self-confidence Category

Group	Treffinger Model Learning			Conventional Learning		
Category SC	High	Medium	Low	High	Medium	Low
N	5	28	5	5	23	7
Minimum	0.533	0.133	-0.067	-0.067	-0.067	0.133
Maximum	0.933	0.867	0.214	0.267	0.571	0.750
Mean	0.70293	0.47185	-0.01048	0.10667	0.24336	0.35998
Elementary School	0.186626	0.185320	0.125646	0.153478	0.132799	0.203730

Based on Table 2, in the experimental class of 38 students, students in the high self-confidence category (N = 5) obtained an average n-gain of 0.70293, with a minimum of 0.533 and a maximum of 0.933. Meanwhile, students in the medium category (N = 28) had an average of 0.47185, with a range of 0.133 to 0.867. As for the low category (N = 5), the average obtained was -0.01048, with a minimum value of -0.067 and a maximum of 0.214.

Based on the average values, it is clear that students with higher *self-confidence* tend to show higher increases in mathematical creative thinking skills. Students in the high category experienced the greatest increase, followed by those in the medium category. Conversely, in the low self-confidence category, the average *n-gain* was close to zero, even negative, indicating that students' ability increased relatively little in this group. This finding indicates that in the experimental class, self-confidence achievement is positively related to increases in students' mathematical creative thinking skills. Furthermore, the relatively comparable standard deviation values in the high and medium categories indicate that the variation in improvement in the two groups is not significantly different.

Furthermore, in the control class consisting of 35 students, students in the high self-confidence category (N = 5) obtained an average n-gain of 0.10667, with a minimum of -0.067 and a maximum of 0.267. In the medium category (N = 23), the average was 0.24336, with a minimum of -0.067 and a maximum of 0.571. Meanwhile, in the low category (N = 7), the average *n-gain* was 0.35998, with a minimum value of 0.133 and a maximum of 0.750.

Overall, when comparing the two groups, the experimental class showed a more directed pattern of improvement, in which increases in mathematical creative thinking skills tended to follow students' self-confidence levels. In contrast, in the control class, this pattern was not clearly visible. Thus, descriptively, it can be concluded that learning with the Treffinger Model tends to increase students' creative thinking skills in mathematics and is more aligned with students' self-confidence levels than conventional learning.

Inferential analysis was conducted to test whether the n-gain data for mathematical creative thinking ability, based on the self-confidence category, between the two classes differed significantly. To determine which statistical test to use, a prerequisite test was conducted first. If the scores were normally distributed and had homogeneous variance, the test was conducted using the independent-samples t-test (assuming equal variances). However, if the scores were normally distributed and had non-homogeneous variance, the test was conducted using the independent-samples t-test (assuming unequal variances, not assumed). If the normality test was not met, a non-parametric test would be conducted. The data used to test differences in students' self-confidence achievement between the experimental and control classes were achievement scores from the self-

ISSN: 2797-3174

confidence questionnaire. The test, namely the difference test of two means, was conducted to determine whether the n-gain in mathematical creative thinking ability, based on the self-confidence category, in the experimental class was significantly higher than that of the control class.

A normality test was conducted to determine whether the data used was normally distributed. The *Shapiro-Wilk test was used* because the sample size in this study was less than 50 people. The hypothesis for the N_Gain normality test for the high self-confidence category is as follows:

H_0: The n_gain data for the experimental class and control class with high, medium, or low self-confidence categories comes from a normally distributed population.

H_1: The n_gain data for the experimental class and control class with high, medium, or low self-confidence categories comes from a population that is not normally distributed.

The significance level used is 5% $(\alpha = 0{,}05)$with the following testing criteria.

If the value is $Sig. \geq \alpha = 0.05$ then H_0 accepted

If the value is $Sig. < \alpha = 0.05$then H_0 rejected

The test results with SPSS produced the following output in Table 3.

Table 3. Results of the N_Gain Normality Test for the Experimental and Control Classes Based on the High Self-Confidence Category

Class	Category Self-confidence	Shapiro Wilk		
		Statistics	df	Sig.
Experiment	High	0.115	5	0.200
Control		0.855	5	0.210
Experiment	Medium	0.972	28	0.629
Control		0.959	23	0.443
Experiment	Low	0.552	5	0.001
Control		0.921	7	0.473

Based on the description of the normality test results above, it can be concluded that the distribution of n-gain score data for the high and medium self-confidence categories in both research classes meets the assumption of normality (normal distribution). Therefore, the prerequisite steps for both categories will proceed to the homogeneity-of-variance test stage to determine the most appropriate parametric test (t-test or t'-test). Conversely, in the low self-confidence category, the experimental class data were not normally distributed. Because the prerequisites for parametric testing were not met in this category, the homogeneity of variance test was not necessary. Furthermore, the average difference in the increase in mathematical creative thinking ability for the low self-confidence category will be analyzed directly using a nonparametric statistical test, namely the Mann-Whitney test.

This homogeneity test was conducted using Levene's test to determine whether the variances of the n-gain data from the experimental and control classes in the high and medium self-confidence categories were homogeneous. The results of this test will determine which difference test for two means will be used in the next stage. The hypothesis for the N_Gain homogeneity test for the high self-confidence category is as follows.

H_0: The n_gain data of the experimental class and the control class with high or medium self-confidence categories have homogeneous variance.

H_1: The n_gain data for the experimental class and the control class with high or medium self-confidence categories have non-homogeneous variances.

The significance level used is 5% $(\alpha = 0{,}05)$with the following testing criteria.

If the value $Sig. \geq \alpha = 0{,}05$is then H_0 accepted

If the value is $Sig. < \alpha = 0{,}05$then H_0 rejected

The results of the homogeneity test with SPSS produced the following output in Table 4.

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Table 4. Results of the N_Gain Homogeneity Test for Students with High Self-Confidence Category

	Self-confidence Category	Levene Statistics	df_1	df_2	Sig.
Based on Mean	High	0.643	1	8	0.446
	Medium	4.220	1	49	0.045

Based on the results of the homogeneity prerequisite test above, further statistical testing steps can be determined to see the difference in the two average increases in students' mathematical creative thinking abilities. For the high self-confidence category, because the data are normally distributed and have homogeneous variance, the test will use the parametric t-test (independent-samples t-test with the assumption of equal variances). Meanwhile, for the medium self-confidence category, because the data is normally distributed but has non-homogeneous variance, the test will continue using the t-test (independent-samples t-test, with the assumption of equal variances not assumed).

Based on the prerequisite test results, the n-gain data in the high self-confidence category is proven to be normally distributed and has homogeneous variance, so the test uses a parametric test, namely the t-test (independent sample t-test with equal variances assumed). In the medium self-confidence category, the data are normally distributed but have non-homogeneous variance, so the test uses the independent-samples t-test (equal variances not assumed). Meanwhile, in the low self-confidence category, the data are shown to be non-normally distributed, so the test for differences in means is carried out using non-parametric statistics, namely the Mann-Whitney test. The result of difference of students' n-gain based on high self-confidence category produced the following output in Table 5.

Table 5. Results of the Difference of Students' N-Gain Based on the High Self-Confidence Category

	t	df	Sig. (1-sided p)
Independent Sample t-test (Equal variances assumed)	-5.518	8	0.001

Independent-samples t-test results table (Equal variances assumed) for n-gain data in the high self-confidence category; a significance value (1-sided p) of 0.001 was obtained. Because the significance value is smaller than the significance level of $\alpha = 0.05$, it is H_0rejected and H_1accepted. This shows that the increase in students' mathematical creative thinking abilities in the experimental class with high self-confidence is significantly greater than that of students in the control class in the same category. The result of difference of students' n-gain based on medium self-confidence category produced the following output in Table 6.

Table 1Results of the Difference of Students' N-Gain Based on the Medium Self-Confidence Category

	t	df	Sig. (1-sided p)
Independent Sample t-test (Equal variances not assumed)	-5.118	48.194	0.001

Independent-samples t-test results table (Equal variances not assumed) for n-gain data in the medium self-confidence category; a significance value (1-sided p) of 0.001 was obtained. Because the significance value is smaller than the significance level $\alpha = 0.05$, it is H_0rejected and H_1accepted. This indicates that the increase in students' mathematical creative thinking abilities in the experimental class with the medium self-confidence category is significantly higher than the control class in that category. The result of difference of students' n-gain based on low self-confidence category produced the following output in Table 7.

Table 7. Results of the Difference of Students' N-Gain Based on the Low Self-Confidence Category

N-Gain Value Data of Students' Mathematical Creative Thinking Ability with Low Self-Confidence Category		
Mann-Whitney University	Z	Sig. (2-sided test)
2.000	-2.562	0.010

Based on the overall results of the test of the difference between the two average n-gain scores across the three self-confidence categories, the application of the Treffinger learning model, assisted by GeoGebra, has been empirically shown to produce a significantly greater increase in mathematical creative thinking skills than the learning used in the control class, regardless of students' self-confidence levels. In other words, this learning model is effective at improving creative thinking skills in mathematics across groups of students with high, medium, and low levels of self-confidence.

ISSN: 2797-3174

3.2. Discussion

Based on the results of the N-Gain mean difference test, the findings were highly consistent: the null hypothesis was rejected across all self-confidence categories (high, medium, and low). This empirically demonstrates that the GeoGebra-assisted Treffinger learning model yields a significantly greater increase in MCTA than the conventional model, without being offset by students' initial self-confidence levels.

Precise statistical procedures support the robustness of these findings. In the high and medium self-confidence categories, the N-Gain data met the assumption of normality. They were therefore tested using the parametric Independent Samples t-test (each with a p-value < 0.001). Meanwhile, in the low category, where the data were not normally distributed, the non-parametric Mann-Whitney U test still yielded a statistically significant result ($p = 0.010$, or 0.005 for a one-tailed test). This reinforces the ideas of Callahan and Renzulli (2020) and Fadlurrohman (2025), which emphasizes that creativity is not a static talent but rather a competency that can be developed through simultaneous cognitive and affective engagement.

For students who already possess a high level of self-confidence, the Treffinger Model serves as an accelerator. The Working with Real Problems stage gives them full autonomy to explore complex trigonometry problems. Freed from the demands of memorizing procedural formulas, this group is able to project their divergent ideas fully into the GeoGebra tool. As a result, their N-Gain on the originality and elaboration indicators is very sharp. This achievement aligns with the findings of Rahmawati et al. (2024) and Ratnasari et al. (2020), which confirm that students with high self-confidence tend to demonstrate mastery of all components of Torrance's creative thinking because they are willing to take risks and offer unique answers.

Students with medium self-confidence generally possess adequate cognitive abilities but are often held back by doubt or fear of making mistakes when attempting unfamiliar problem-solving methods. In the experimental class, the Practice with Process phase acted as a catalyst. Focus group discussions provided them with social validation, reducing these doubts. Coupled with instant visual feedback from GeoGebra's dynamic features (such as Slider and Angle), students were able to immediately confirm the validity of their hypotheses without waiting for teacher correction (Sugiarni et al., 2025). This repeated mastery experience fostered their courage, resulting in a significant increase in their MCTA, particularly in the flexibility indicator, compared to students in the control class.

The most essential finding in this analysis is the success of the Treffinger Model in leveraging students' abilities in the lower category. Generally, students with low self-confidence experience stagnant improvement due to high levels of mathematical anxiety and a fixed mindset, the belief that their abilities cannot be changed (Yeager et al., 2019). However, the implementation of the Basic Tools phase in the experimental class fostered an inclusive learning climate in which every raw idea was valued without judgment (Munandar, 2004). This low-stakes learning environment successfully broke down their mental blockades. In accordance with the MCTA profile classification by Rahmawati et al. (2024), this consistent stimulation successfully boosted their fluency in identifying problems, recording statistically significant progress compared with control-class students at the same stratum.

Comprehensively, these findings underscore the intrinsic advantages of integrating the Treffinger Model and GeoGebra software. This learning facilitates subtle differentiation, enabling each student, regardless of self-confidence level, to find their own optimal trajectory. Unlike conventional Deep Learning approaches, which may not be flexible enough to accommodate the diversity of students' initial mentalities (Mutmainnah, et al., 2025). The use of GeoGebra in Treffinger's application has been shown to facilitate students' creative mathematical thinking. This validates the conclusions of Ratnasari et al. (2020) and Lestari and Hadi (2022) that a manipulative and supportive learning environment is key to constructing students' understanding and creativity.

3.3. Implications

In practical terms, the results of this study have the following implications. The Treffinger model, supported by GeoGebra, can serve as an effective alternative for improving students' creative thinking skills in mathematics. Learning that provides space for exploration and open problem-solving is better at developing students' potential than conventional learning. The finding that students with high *self-confidence* in conventional classes do not always achieve optimal results suggests that a less exploratory learning environment can limit students' potential, and that a learning model more adaptive to students' characteristics is needed.

3.4. Limitations

Despite the consistent findings across all self-confidence categories, several limitations should be acknowledged. First, the duration of the intervention was relatively short, which may not fully capture the sustained development of students' MCTA and self-confidence. Second, although this study demonstrates the

ISSN: 2797-3174

Treffinger Model assisted by GeoGebra can facilitate different MCTA based on self-confidence category, the sample size remains limited. It may limit the extension of identifying interaction between learning model, technology, and self-confidence can be generalized to other educational environments. Third, this study focused on trigonometry, which involves visualization and abstract reasoning supported by GeoGebra. As a result, the effectiveness of the Treffinger model in fostering mathematical creative thinking may differ when applied to other topics with different cognitive characteristics.

4. Conclusion

The findings of this study indicate that the improvement in students' mathematical creative thinking ability (MCTA) within the self-confidence category was significantly greater in the experimental class than in the control class. This result demonstrates that the implementation of Treffinger Model assisted by Geogebra is effective not only in enhancing students' MCTA or cognitive outcome, but also in accommodating the difference of their self-confidence or affective characteristics. These findings highlight the importance of integrating innovative instructional models with technological support to foster creative thinking and positive affective, which is self-confidence in mathematics learning.

Author Contributions

All authors have equal contributions to the paper. All the authors have read and approved the final manuscript.

Funding

No funding support was received.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/ or publication of this article.

Data Availability

The datasets generated during and/ or analyzed during the current study are available from the corresponding author on reasonable request.

Declaration on AI Use

The authors declare that no artificial intelligence (AI) or AI-assisted tools were used in the preparation of this manuscript.

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ISSN: 2797-3174