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Research Article

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The Effect of Treffinger Learning Model on Student's Creative Thinking Skills

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Abstract: The Treffinger Learning Model (TLM) is a structured approach to fostering creative thinking and problem-solving skills through three phases: basic tools, practice with the process, and working with real problems. It emphasizes student-centered learning, encouraging learners to explore multiple solutions and apply creative strategies in academic and real-life contexts. This study investigated the impact of the TLM on students' creative thinking skills of Grade 8 students of Banisilan National High School for academic year 2025-2026. The study utilized quasi-experimental research design involving two intact sections: TLM (n=40) and non-TSI (n=35). The data were collected using teacher-made creative-thinking open-ended tests. Although the study revealed that the level of students' creative thinking skills in their pretest and post-test result both for TLM and non-TLM groups were very low, Quade's Nonparametric ANCOVA confirmed a significant difference between the two groups. To strengthen students' creative thinking skills, integrating the Treffinger Learning Model into mathematics instruction is recommended, alongside ongoing teacher training to ensure its sustained impact.

Keywords: Creative Thinking, Treffinger Learning Model.

INTRODUCTION

Background of the Study

Creative thinking requires imagination, intelligence, insight, and ideas in accordance with certain objects, problems, and conditions that are being faced (Birgili, 2015). Creative thinking in mathematics does not have to always produce truly new solutions, but these solutions are new to certain individuals (Lince, 2016). For example, when students can solve mathematical problems using different ways than those taught by the teacher, they can be said to have good mathematical creative thinking skills. There are three indicators of mathematical creative thinking ability, namely fluency, flexibility, and authenticity (Runisa, 2017). Fluency is the ability to provide more than one mathematical answer. Flexibility is the ability to provide more than one mathematical way by using different concepts. Authenticity is the ability to provide unusual mathematical solutions.

However for many years, the results of the Trends in Mathematics and Science Study (TIMSS 2019) and the Program for International Student Assessment (PISA) revealed a challenge for the Philippines. In the 2019, Trends in International Mathematics and Science Study (TIMSS), an international examination of mathematics and science for grade 4, Filipino children performed worse than students in other nations.

Meanwhile, in the 2022 Creative Thinking Assessment of the Program for International Student Assessment (PISA) created by the Organization for Economic Cooperation and Development (OECD), the Philippines had the second to the lowest mean score in the Creative Thinking Assessment with a mean score of 14, which is tied with Uzbekistan but higher than the lowest among all countries who participated in the assessment which is Albania. The Philippines also ranked lower than the PISA average regarding the creative thinking performance of girls and boys, with girls receiving a mean score of 16 and boys having a mean score of 12.

In order to address these educational obstacles, students should be asked to answer problems more frequently during the learning process in order to improve their problem solving and creative thinking skills. It is essential to have an engaging, varied, and always interesting learning model that encourages students to participate and improve their mathematical abilities, particularly their capacity for mathematical problem solving and creative thinking (Özsoy, *et al.*, 2015). A paradigm that encourages active involvement and allows students to explore different strategies for solving problems is the Treffinger learning model.

The Treffinger learning model is a learning process that provides opportunities for students to brainstorm ideas and find the most correct answers (Octavia,2020). This model is designed by Donald Henry S. Treffinger is president of the Center for Creative Learning Inc. in Sarasota, Florida. According Erlande, R., & Chotimah, U. (2023), this model was developed as an attempt to generate creative learning.

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Trefingger model is a model that combines two domains of learning namely cognitive and affective domain. There are 3 levels of Treffinger Model namely basic tools, practice with process, and working with real problems. Level 1 (basic tool) consist of divergent thinking skills and creative technique. Level 2 (practice with process) is a chance given for students to practice the skills that have been learnt in level I. Level 3 (working with real problem) is applying skills learnt in two level toward a challenge in real world (Nisa, 2011).

Numerous study such as of Rohaeti (2016) and (Duski, 2020) showed that students' mathematical creative thinking ability taught by using Treffinger model is better than students' mathematical creative thinking ability taught by conventional model. Rohaeti further added that there is a positive response of students toward applying Treffinger model in mathematics learning.

Unfortunately, in the Philippine context, there are only few studies about Treffinger Model and its effect on learning and teaching mathematics in general. Hence, the researcher conducted this study to examine whether employing Treffinger learning model significantly affect students' creative thinking and problem- solving skills in Math.

Statement of the Problem

This investigated the effect of Treffinger Learning Model in the mathematical creative thinking and problem-solving skills of Grade 8 students of Banisilan National High School. Specifically, this study sought to answer the following questions:

- What is the level of creative thinking skills when exposed to Treffinger Learning Model and those exposed to non-Treffinger Learning model in terms of:
- Pre-test: and Post-test?
- Is there a significant difference in the creative thinking skills of students exposed to TLM and non-TLM using pre-test as a covariate?

Significance of the Study

The significance of this study is rooted in its potential to contribute to the educational field by providing insights into the effectiveness of the Treffinger Model in enhancing students' creative thinking in mathematics. The findings of the study will benefit the following stakeholders:

Students. Through exposure to the Treffinger Model, the study's result will help students to approach mathematical problems from many perspectives that would foster a deeper understanding and greater resilience as they tackle complex challenges. By engaging in activities that require innovation, students can develop skills that are crucial for academic success and future careers.

Teachers. This study will provide valuable insights for teachers in understanding how the Treffinger Model can be integrated into their teaching practices for them to develop and implement creative teaching methods that can enhance student learning outcomes. By adopting the Treffinger Model, teachers can create a more dynamic and interactive learning environment, which can lead to improved student-teacher relationships and a more positive classroom atmosphere

Parents. As your students becomes more adept at creative thinking and problem-solving, their confidence will naturally grow. They will be more willing to take risks and explore new ideas, leading to a more enriched learning experience. Th skills developed through the Treffinger Model are not just academic but are essential for future success. Whether your child pursues higher education or enters the workforce, these skills will provide a solid foundation for navigating complex challenges.

School Administrators. School administrators can leverage the findings of this study to support the adoption of teaching models that have been shown to enhance students' creative thinking skills. By implementing innovative educational strategies, schools can enhance their competence and excellence.

Future researcher. The findings of this study can contribute to the existing body of knowledge on educational models that enhance creative thinking skills. It provides a foundation for future research exploring similar or related educational interventions. The study's results can contribute to the development and refinement of theories related to creative thinking and educational practices, offering new perspectives and directions for scholarly inquiry.

Scope and Delimitation of the Study

This delimits to one teaching strategy, the effect of Treffinger Learning Model in the mathematical creative thinking skills of Grade 8 students.

The conduct of the study was among the Grade 8 students of Banisilan National High School. The respondents of this study were divided into control

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and experimental group. One group was exposed Treffinger Learning Model while the control group was exposed to traditional learning method. This study was implemented from September 2025 to October 2025, specifically in the second quarter of the school year 2025-2026. The coverage of the study are volume of three-dimensional objects, Pythagorean Theorem, and Triangle Inequality.

Furthermore, a quasi-experimental research design was employed to measure effect of Treffinger Learning Model in the mathematical problem solving and creative thinking skills. The research instruments used in this study was the open-ended solving questionnaires that was checked using the adopted problem solving and creative thinking skills rubric

Definition of Terms

The following terms were used in the study are defined operationally:

Creative Thinking Skills in math is the ability to approach mathematical problems with originality, flexibility, and critical reasoning, employing diverse strategies to generate innovative solutions beyond conventional methods. It was measured through an open-ended solving questionnaire and was evaluated through a 5-level adopted rubric

Treffinger Model is a framework designed to foster creative problem-solving and critical thinking. It combines two domains of learning namely cognitive and affective domain. Moreover, the model describes level of learning start from basic level to complex level

Non-Treffinger Learning Model pertains to the 5E (Engage, Explore, Explain, Elaborate, Elaborate) teaching strategy given to the control group in accordance to the Daily Lesson Log as mandated by Department of Education Department Order No. 42 series of 2016.

THEORETICAL FRAMEWORK

This chapter contains the review of related literature and related studies, the conceptual framework, the theoretical framework, the research paradigm and the study's hypothesis. It further elaborates the relationship of problem solving and creative thinking skills.

REVIEW OF RELATED LITERATURE AND STUDIES

Creative Thinking Skills

Creativity is one of the 21st-century abilities. Capacity to learn new things from diverse ideas is a key component of creative thinking skills. It is a specific component that is crucial for producing new information and covers the various facets of development (Fatmawati *et al.,* 2019). It has more facets, is more intricate, and goes well beyond simple thought. According to Birgili (2015), creative thinking refers to the entire spectrum of cognitive processes that humans employ based on a specific object, problem, environment, or behavior toward an event and the issue within their capabilities. Creativity is part of the higher order thinking skills which is considered important for students to improve the quality of education (Yen & Halili, 2015). Creative thinking skills train students to develop ideas and arguments, pose questions, acknowledge correct arguments, and influence students to think openly and to be more responsive towards differing perspectives (Tahir, 2017; Forrester, 2008; Tendrita *et al.,* 2016).

This skill aids in the development of a specific quality that would enhance insights regarding the various discoveries made, newly learned information, and newly developed principles wherein they attempt to use their imaginations to think more deeply, the intelligence to think beyond a specific theory, and the various insights and ideas about a problem. A person must cultivate creative thinking in order to succeed in the current world (Borodina *et al.,* 2019).

Originally, the three core components of creativity according to Torrance are: fluency, flexibility, and originality (Silver, 1997). Fluency refers to the number of ideas generated in response to a prompt; flexibility is the apparent shifts in approaches taken when generating responses to a prompt; and originality refers to the originality of ideas generated in response to a prompt. However in more recent studies there exist one additional factor which is elaboration according to the works of Bakar *et al.,* 2015. According to Surya and Syahputra (2017), the capability to express oneself is known as fluency. Flexibility is the capability of an individual to create various ideas from a different view. Originality is the capability of an individual to suggest a unique idea that differs from what we see in the books or from any suggestions of different individuals. Elaboration is the capability of an individual to present the different factors influencing them and to suggest any ideas.

In Asia, the working paper for the Southeast Asia Basic Education Standards (SEA-BES) in mathematics incorporates creativity in the common

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core regional learning standards (SEAMEO, 2016). In the Philippines, the conceptual framework of mathematics education in the new K to 12 basic education curriculum aims to hone creativity (DepEd, 2016). An investigation of research studies from 1965 to 1980 revealed that mathematics achievement is positively correlated to mathematical creativity (Bicer, *et al.*, 2020).

At the classroom level, mathematical creativity is the process that results in novel and/or insightful solutions and the formulation of new questions and/or possibilities that allow an old problem to be regarded from a new point of view. For Bicer (2021), this definition of mathematical creativity implies that mathematical ideas or processes that students produce may be new to them. Creative thinking is an artificial process by finding methods until the most appropriate way to think is obtained (Majaya, 2013). Activities will bring up various alternative solutions to solve a problem using creative thinking (Anwar *et al.*, 2021). The results of creative thinking will bring up creativity which is called the creative thinking product.

Research indicates a strong relationship between learning achievement, creative thinking abilities, and the consequences for education as a whole (Saragih & Napitupulu, 2015). Higher order thinking refers to the ability to apply and alter prior information and experiences to think critically and creatively while making decisions and coming up with solutions for everyday issues (Sari, & Yunarti, 2015; Supardi, 2015). Since the development of students' creative thinking abilities is one of the qualities of higher order thinking skills, mathematics instruction in schools needs to place a strong emphasis on this area. It is said that having creative thinking abilities, sometimes known as creativity, ensures the growth of one's mathematical talents overall (Nugraha & Mahmudi, 2015; Nuryanti, 2016).

In a study done by Turla *et al.*, (2023), it was found that the Grade 6 pupils describe their creative thinking skills in terms of fluency, flexibility, originality, and elaboration as high. In their study, it was concluded that the creative thinking skills of the respondents have no significant relationship to their problem-solving skills. This is on the contrary in the study of Anggy *et al.*, which shows a significant effect of problem-solving methods on students' mathematical creative thinking skills with a classical absorption rate of 87.10% (Prawiyogi *et al.*, 2020). Thinking creatively is crucial for finding solutions to problems (Amin *et al.*, 2019). It will give every individual the idea to solve mathematical problems using this skill to build an abstract idea representing the given problem. Creative thinking skills include problem-solving that develops, implements, and leads to new ideas, encourages curiosity, improves flexibility, and increases one's ability to identify connections between the different concepts and ideas in solving the problem (Yayuk, 2020). Many researchers have learned the importance of creative thinking skills in problem-solving. Problem-solving enhances thinking abilities. Hidayat *et al.*, (2018) demonstrate that teaching students to improve their creative thinking and problem-solving skills can address the lack of abilities of students.

Generally, Mathematics instruction has not provided sufficient opportunity for students to seek answers in different ways from what has been taught. The classroom instruction tends to focus on the development of analytical thinking with routine problems. Many primary school teachers reported lack of updates related to the ways to create mathematical problems that require higher order thinking skills. The demand to achieve the minimum passing grade also pressures teachers to create easier types of questions (Siswono, 2018). The purpose of studying mathematics is so that students are able to understand the concept of mathematics, using reasoning ability, solving problems, using ideas with the help of symbols, tables, diagrams or other medias to make situation clearer or problem. Also, to have an attitude to value the use of mathematics in life (Hidayat, 2017). Creative thinking skills are needed to be able to reach that goal.

Creative thinking skills in mathematics learning is the ability that enables students to find various solutions or idea to solve problems not only mathematical problems but the creativity that is needed in work. Career Centre Maine Department of Labour USA stated that creative thinking skills is one of the skills that is needed in work (Mardhiyyah *et al.*, 2014). It is because in work, not only do they need smart people but they also need intelligent people that are full of ideas and innovation to support the progress of related agencies. Creative thinking skills serves as a fundamental tool for preservice teachers to solve challenging and complex problems, formulate solutions to a problem, and utilize different tools in solving problems especially involving statistics (Mariano-Dolesh *et al.*, 2022). In a study conducted by Leen *et al.*, (2014)., which stated

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that critical and creative thinking skills could be improved through teacher preparation and professional development programs, changing the form of assessment, incorporating technology in teaching and learning.

In order to prepare students for life in a digital age where one needs to be able to offer something that machines cannot, mathematics education goes beyond teaching students how to use formulas and perform calculations to teaching them how to approach problems from various angles (Rocena, 2021). and offer several solutions to the problem. These are referred to as creative thinking talents in literature. The United Nations Educational, Scientific, and Cultural Organization (UNESCO), for example, emphasizes that teaching pupils to think critically and creatively in mathematics classes helps them become future contributors to global sustainability and socioeconomic development (UNESCO, 2012).

Treffinger Learning Model

First presented by Donald J. Treffinger in 1980, the Treffinger's learning model applies creative learning processes through the use of convergent (thinking processes by seeking the most appropriate solution) and divergent (thinking processes that go in various directions and can obtain many alternative solutions) thinking processes (Darminto, 2013). The Treffinger learning model can provide flexibility for students to find alternative solutions to a problem independently and students are given the freedom to express their ideas, and students are given the freedom to formulate and design ways to solve a problem This will therefore enable students to express their creative thinking and, via creativity, discover their own creative potential for idea generation and issue resolution (Akbar *et al.*, 2015).

The Treffinger learning model consists of three levels, namely level I Basic tool, level II practice with process and level III working with real problems. Basic tools include divergent thinking skills (think creatively). In the introduction, divergent functions include the development of fluency, flexibility, originality, and elaboration in thinking. Practice with the process is giving students the opportunity to apply the skills learned at stage I in practical situations. The introduction in phase II includes application, analysis, synthesis, and assessment (evaluation). Working with real problems, that is, applying the skills learned in the first two stages to real-world challenges. Here students use their abilities in ways that are meaningful to their lives.

The learning model with Treffinger's development is for the growth of the primary concern's learning process. Students can think freely in the first Treffinger model stage without worrying about being rejected. Treffinger illustrates the relationship between cognitive and affective skills at each level of the model, emphasizing the importance of both in helping students think critically and overcome their fear of being rejected. Besides the meaningful process is also used divergent thinking process, and the process of thinking convergent. (Pomalato, 2019)

The use of Treffinger model in teaching has been supported by a number of studies (Dwijanto *et al.*, 2019; Nizham, *et al.*, 2017). Various conclusions from the studies on the use of Treffinger creative learning model showed that it can enhance the students' thinking ability. Advantages of the Treffinger's learning model include: (1) Its foundational assumption that creativity is both a process and an outcome of learning; (2) Its application to students with different backgrounds and knowledge levels; (3) Its focus on cognitive and affective dimensions during the model's development process; (4) Gradual involvement in the capacity to think both divergently and convergently when solving a problem; and (5) Its systematic development stages with different approaches and methods that can be carried out in flexible stages (Sari & Putra, 2015).

Treffinger's learning model is one approach that can be used to maximize the mathematics learning process for gifted students is the (Maharani, 2018). Numerous earlier researches have demonstrated how students may apply Treffinger's learning approach to mathematics classes. study by Wiladah *et al.*, assessed Treffinger's learning model for students in class XI of high school, whereas study by Isnaini *et al.*, assessed Treffinger's learning model for junior high school students in the seventh grade.

Ndjung *et al.*, 2021, published that the creative thinking skill and mathematics learning outcome of the students who learn mathematics through the Treffinger learning model with realistic mathematics education approaches are better than those of their counterparts who learn mathematics through the conventional teaching model both separately and simultaneously. It can be said that the integration of Treffinger's creative learning

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model combined with the six principles of Realistic Math Education as one of the learning models that can be used by elementary school teachers in mathematics learning to shape creative thinking skills while enhancing mathematics learning outcomes.

Treffinger's learning model provides higher student creativity results than students with conventional learning models because this model facilitates students to practice divergent thinking and allows students to think more actively and share their solutions. This will also help expand students' cognitive abilities because each student will be more motivated to think creatively and be different from other students in solving problems (Lince, 2016; Khuziakhmetov & Gorev, 2017). In a study of Hidayati et. al (2021), they found that students who are given learning using the Treffinger learning model show an increase both in terms of learning achievement abilities and the level of creativity assessed from the aspect of creative thinking and problem solving (Isnaini *et al.,* 2016). This Treffinger model is expected to develop students' creativity in solving problems, direct students to think logically about the relationship between concepts and situations in problems and appreciate the diversity of thinking that arises during the problem-solving process (Hidayati *et al.,*2021).

Treffinger's learning model not only increases creativity but also student achievement. This is possible because Treffinger's learning model can stimulate 3 domains of mathematical ability, namely knowing, applying, and solving novel problems. Knowing is facilitated by the opportunity for students to know the basic principles, procedures, and concepts of solving mathematical problems. Then at the applying stage, students are allowed to apply previously known conceptual knowledge and understanding to solve common problems. Then at the novel problem-solving stage, students are required to transfer knowledge and abilities into new problem situations that require reasoning and planning skills. This will help students to solve problems correctly and completely (Sheromova *et al.,* 2020).

Moreover, the application of the Treffinger model is effective for improving math learning outcomes. There is a difference between the average pretest-posttest scores before and after the application of the Treffinger learning model in class (Utama & Sudarsana, 2023). There is a difference in the improvement of students' mathematical literacy skills learning by learning the Treffinger model and students learning with conventional learning based on early mathematical abilities. Student response to Treffinger model learning is better than students learning with conventional learning. Therefore, learning model Treffinger can be an alternative model of learning to improve students' mathematical literacy skills, and self-efficacy students, and able to reduce mathematical anxiety. (Nizham, & Suhendra, 2017)

Conceptual Framework

This study adheres to four learning theories: divergent thinking theory (Guilford,1967), constructivism learning theory (Bruner, 1966), inquiry-based learning theory (Bruner, 1966), and metacognitive learning theory (Flavel,2004). The study anchors on the notion that creative thinking is a process and an outcome in learning. When students are facilitated to practice divergent thinking and allows students to think more actively and share their solutions. This will also help expand students' cognitive abilities because each student will be more motivated to think creatively and be different from other students in solving problems (Lince, 2016)

Divergent Thinking Theory is the ability to develop several alternative solutions to a given circumstance or problem, which indicates the ability to think creatively and solve problems (Runco, 2011). The first evaluation that is referred as divergent thinking abilities that consisted of fluency, flexibility, originality, and elaboration. Furthermore, Wallas (1926; cited in Dickman, 2014) presented a four-stage model of problem solving, that is composed of: preparation, incubation, illumination, and verification. The preparation involves background content-knowledge, which suggests learning specificity, as well as conscious work on the problem at hand. Incubation refers to an interstitial lull during which the solver spends time away from consciously working on the problem. Illumination, sometimes known as insight, refers to the solution's emergence into an individual's conscious thinking. Additionally, verification denotes the solver's checking, assessment, and implementation of a solution. That four-stage model is frequently incorporated or adapted in works on the creative thought process.

Based on the theory of constructivism, learning mathematics is a process of personal creation that is aware of social influences. For example, a student's knowledge base and structural

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organization are just two examples of the cognitive processes that are influenced by cultural influences when thinking and solving problems. Stated differently, cultural differences among learners may drive individuals to pose challenges in distinct ways, specifically by generating problems in distinct ways based on their background, culture, and community. As a social constructivist, Vygotsky (1978) proposed that social and cultural interaction centered on shared experiences, utilizing cognitive tools of a linguistic and physical type, leads to growth. Conversely, he described a metric known as the "Zone of Proximal Development" (ZDP) as the distinction between pupils' performance on problem solving with assistance or group work and their ability to solve problems on their own. This indicates that it refers to the range of tasks that an individual can complete with help but is nonetheless unable to complete on their own. In the interim, learners must be guided by suitable tools and help, such as scaffolding, to perform new tasks or skills. Eventually, the scaffolding can be removed, allowing learners to finish the work on their own. Thus, mathematical exercises, In this respect, problem solving and creative thinking activities and strategies can be considered as scaffoldings that should be structured around projects that engage students in the solution of a particular community based problem, school based problem or regional problem relevance to their worlds.

The "Inquiry-Based-Learning" theory by Dewey (1938) offers a more successful approach to teaching that is based on cooperative learning scenarios. Essentially, the teacher poses a question, and then the students are left to conduct independent research and learn under the teacher's supervision. The main learning activities that students participate in during inquiry-learning include formulating original questions, gathering evidence to support those questions, elucidating the evidence, relating the explanation to the knowledge gained from the investigative process, and formulating an argument and justification for the explanation. Consequently, the problem-solving tasks can be deemed advantageous educational endeavors if they are connected to the "Inquiry-Based- Learning" environment. Bruner (1966) highlighted that pedagogy and curriculum should require students to work together during addressing issues, as a type of active learning.

Since students' perception of the subject is profoundly altered when they begin to pose their own original mathematical questions and see these questions become the focus of discussion, "Inquiry-Based-Learning" reminds education to trend towards a novel attitude that students' role is beyond problem solvers as well as they can become skilled in discovering and correctly posing problems. Meanwhile, these activities could embed them in metacognitive strategies during face-to-face (FTF) interactions in classroom settings and lead them to independent learners. As a result, teachers'

Flavell (2004) defined that metacognition knowledge is one's knowledge concerning one's own cognitive processes, executive and control that can be divided as declarative, procedural and conditional. Metacognition in problem solving refers to the knowledge and processes used to guide thinking directed toward the successful resolution of a problem (McCormick, 2003). In the other word, metacognitive skills support problem solvers in understanding the problem, selecting suitable solution strategies, monitoring solution strategies effectively, and identifying and overcoming obstacles to solving the problems. Ultimately, metacognition is an important component for incorporating appropriate information and strategies during the problem solving.

Accordingly, metacognitive strategies are a type of scaffolding that can help the student to improve his/her problem solving and posing skills. Scaffolding can take many forms, for example, cueing or the posing of metacognitive questions (e.g., "What is your goal?" and "What strategy do you use. Md Nor and Ilfi (2012) reported that the phases of metacognition involved in problem posing tasks among secondary school students are reading, planning, interpreting, and checking which adopted from Phang's (2009) categories. The metacognitive skills involved in mathematical problem posing tasks are yet to be determined among undergraduates as there are several sets of metacognitive skills engaged in problem solving suggested by pervious researchers (Thomas, 2012).

METHODOLOGY

This chapter presents the methodology of the study. It includes the research design, the study's settings, participants, sampling procedure, research instrumentation, data gathering procedure, ethical consideration and data analysis used in the investigation

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Research Design

This study utilized a quasi-experimental research design to evaluate the effect of the Treffinger Learning Model on their skills for creative thinking while examining students' learning experiences and perspectives.

Research Setting

This study will be conducted at Banisilan National High School, Poblacion 1, Banisilan, Cotabato during school year 2024-2025.The Municipality of Banisilan, third congressional district of North Cotabato. Banisilan National High School has Junior High School Regular Sections, Special Program for the Arts (SPA) Section, Senior High Academic Strand, and Senior High School Technical and Vocational Track.

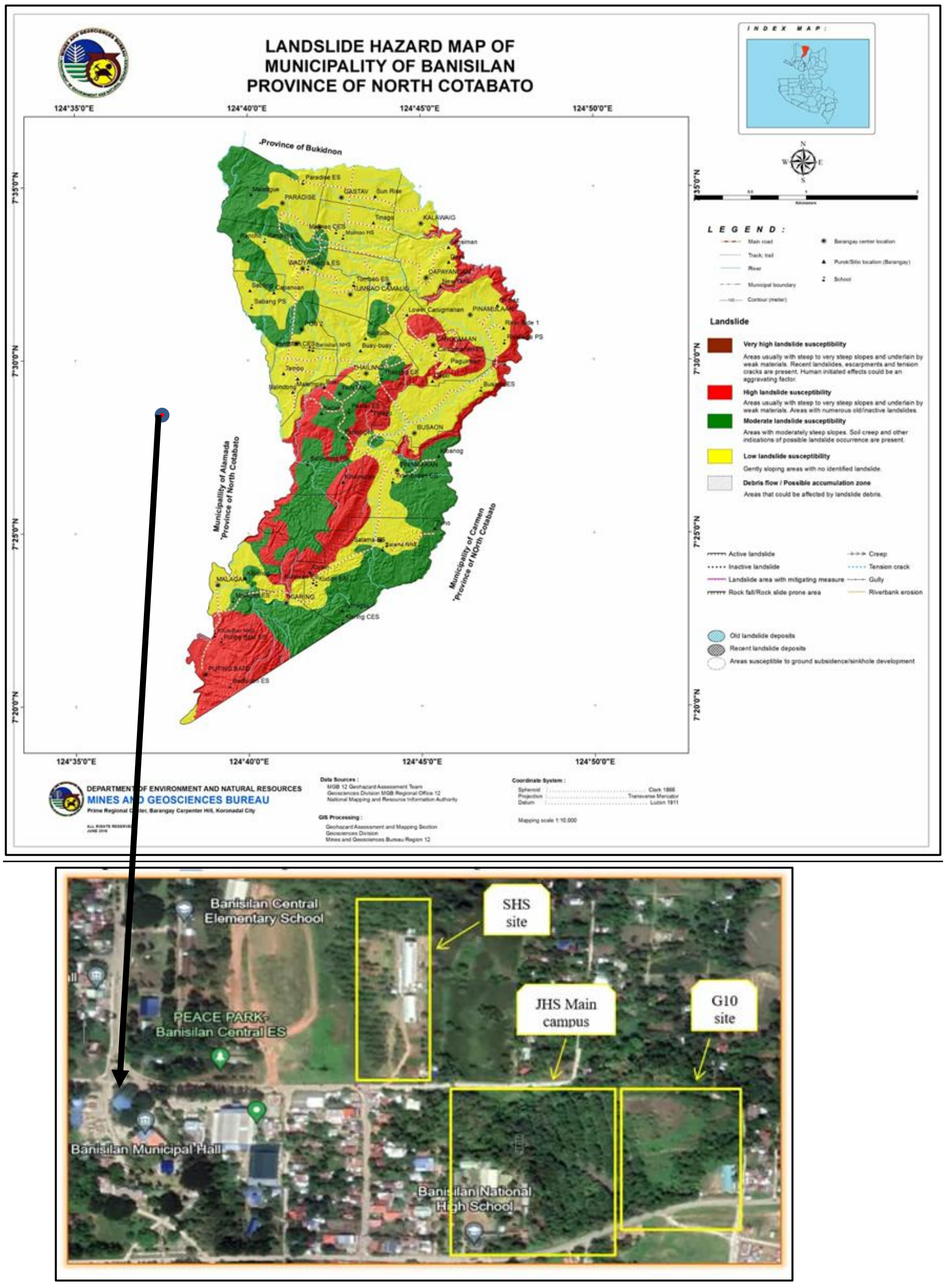

Figure 1: Map of Banisilan, Cotabato Showing Banisilan National High School

Sampling Procedure

A simple random sampling method was used to select the number of respondents from each section. This ensured fairness in the selection of the respondents. A total of 2 heterogenous sections are within grade 8. Through a toss coin, the researcher chose one section class as the control group that was taught using while the control group was given non-TLM direct instruction. Also through a toss coin, the researcher chose another

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section class as the experimental group that was taught using Treffinger Learning Model.

Participants of the Study

The participants of this study were two (2) intact sections of grade 8 students of Banisilan National High School for S.Y 2025-2026 during the second grading period. One section constituted the control group, while the other was the experimental group. There is a total of seventy-five (75) participants in this study, for which there were forty (40) participants for the TLM group and thirty-five participants (35) for the non-TLM group.

Research Instrumentation

The data on creative thinking skill of the students was collected with open-ended tests which consists of 5 items. The rubric of creative thinking skills was be adopted from the work of Sonjaya and Yuliyanto (2022). The content of the test instrument for measuring mathematical creative thinking skills was validated by 3 public school master teachers. The result was interpreted using the scale below adapted from the standards set criteria after the scores were transmuted:

Table 1: Level of proficiency

Level of Proficiency	Range Scale	Interpretation
Exemplary	90%-100%	Very High Performance
Above Average	86%-89%	High Performance
Average	80%-85%	Moderate Performance
Below Average	75%-79%	Low Performance
Deficient	65%-74%	Very Low Performance

Validation of the Instruments

Researcher-made questionnaire as well as the interview protocol have undergone content validation by experts. The researcher begins with the selection of three (3) qualified mathematics experts and providing them with the draft instrument, clear guidelines, and validation criteria, such as clarity, relevance, and comprehensiveness. Experts evaluated the instrument. The feedback is analyzed, often using the Content Validity Index (CVI) to measure agreement among experts. The process ensures that the final instrument is reliable, relevant, and aligned with its objectives.

Data Gathering Procedure

The researcher and the thesis adviser signed a letter of request that was sent to the following authorities: The Schools' Division Superintendent of Cotabato who will authorize the study's conduct; the principal of the school; and consent forms signed by the participants and their parents. They were made aware that all information gathered will be kept private.

Although the Division office approves the conduct of the study to take place only beyond class hours, it also advised the researcher to coordinate with the school principal and mathematics department head for proper arrangement. Given the grounds that the researcher is a DepEd teacher duly authorized to deliver instruction and facilitate learning; the subject matter and coverage lessons strictly follow the topics assigned by the DepEd's Most Essential Learning Competencies (MELCS) and Learning Exemplars for the second quarter of the said grade level ; content delivery is anchored on DepEd's Daily Lesson Log ;and research activities such as pre-test, posttest, and interviews was done after class hours – the researcher was permitted to implement this research.

Before to the conduct of the intervention, a pretest was administered for both classes, Class A and Class B, that determined the students' level of problem-solving and creative thinking skills before employing TLM. Meanwhile, during the conduct of the study the researcher will use the Treffinger Learning Model (TLM) embedded in the learning material for Grade 8 students. The experimental class (Class A) was exposed to TLM, while the control group (Class B) was exposed to non-TLM which will use daily lesson logs anchored to 5E learning model. After indulging the approach, a post test for both groups was administered.

Implementation

The implementation of the Treffinger Learning Model began by engaging students in independent exploration of a problem using their prior knowledge and initial understanding of the concept. Students were given time to think and generate possible solutions individually which they later presented in front of the class. After sharing their initial solutions, the teacher discussed the relevant concepts and principles to strengthen students' foundational understanding.

Following this, students were grouped to foster collaboration and cooperative learning. In their

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groups, students worked together to solve successive word problem, applying what they had learned while exchanging ideas and strategies with their peers. Each group presented their collective solutions for them to compare, evaluate, and reflect on the variety of approaches demonstrated by their classmates.

The teacher then guided the students to revisit their previous solutions and reinvent or refine their answers based on new insights gained through discussion and observation. Finally, students were given a real-world problem to solve individually, enabling them to apply the learned concepts and strategies independently.

Non-TLM Teaching Approach (5E)
The control group, another intact Grade 8 section, was taught using the standard DepEd lesson plans based on the 5E learning model (Engage, Explore, Explain, Elaborate, and Evaluate). During the engage phase, students' prior knowledge was activated to link with the new concepts that will spark curiosity and setting a purpose for learning. For the explore phase, the researcher guided students as they actively investigated concepts through creative questioning and/or problem-solving tasks. For the explain phase, students' ideas and findings were facilitated. Then, introduction of formal terms, concepts, and explanations take place to deepen their understanding. For elaborate phase, students were guided in applying what they had learned to new situations. This encourages them to extend their learning and connect concepts to real-life contexts. For the evaluate phase, students' understanding through formative as well as summative assessments were analyzed.

Statistical Technique Used
The researcher utilized descriptive statistics such as frequency, mean, and standard deviation to determine the level of the students' problem-solving and creative thinking skills Quade's Analysis of Covariance (ANCOVA) was used to determine the significant difference in students' problem-solving and creative thinking skills. The pre-test will serve as the covariate.

Quade's ANCOVA is a nonparametric alternative to the traditional analysis of covariance (ANCOVA). It is beneficial when key parametric assumptions required to parametric ANCOVA, such as normality and homogeneity of variances, are not met (Graphpad Ir & Abolfazl Ghoodjani, 2023). Ghasemi and Zahediasl (2012) supported nonparametric tests when the data deviates from a normal distribution and the sample size is small. In this study, normality tests were revealed for problem-solving skills (p = 0.000) and creative thinking skills (p = 0.012). Consequently, the researcher followed the procedure for Quade's nonparametric ANCOVA, as outlined by Bizz Pedia (2020).

PRESENTATION, ANALYSIS AND INTERPRETATION OF DATA

This chapter discusses the analysis and interpretation of data collected from respondents related to the study's hypothesis. In this chapter, tables and other figures were used to give a convenient analysis of the data. The order of presentation follows the sequence identified in the study.

Creative Thinking Skills of TLM and Non-TLM Group
Table 1 presents the level of creative-thinking skills of students exposed to TLM and Non-TLM in their pre-test and posttest. It shows the mean, mean percentage score, frequency and the qualitative interpretation of the collected data.

Table 2. Level of Creative Thinking Skills

	TLM (n=40)				non-TLM (n=35)				
Grade Scale	Pretest		Posttest		Pretest		Posttest		Q.I.
	f	%	F	%	f	%	F	%	
90% - 100%	0	0%	0	0	0	0%	0	0	VHCTS
86% -89%	0	0%	0	0	0	0%	0	0	HCTS
80% - 85%	0	0%	2	5	0	0%	0	0	MCTS
75% - 79%	0	0%	8	20	0	0%	2	5.71	LCTS
74% and below	40	100%	30	75%	35	100%	33	94.28	VLCTS
Mean	6.82		12.46		6.01		9.23		
MPS	66.73		72.40		65.91		68.97		
QI	VLCTS		VLCTS		VLCTS		VLCTS		

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Legend:		
	Percentage Equivalent	Qualitative Interpretation
	90-100	Very High Creative Thinking Skills
	86-89	High Creative Thinking Skills
	80-85	Moderate Creative Thinking Skills
	75-79	Low Creative Thinking Skills
	74 and below	Very Low Creative Thinking Skills

As illustrated in table, 40 or 100% of the students exposed to TLM had a very low creative thinking skill in pretest. On the same way, 35 or 100% of students exposed to non-TLM have low creative thinking skills in their pretest.

The group which was exposed to TLM had a mean of score of 6.82 equivalent MPS to 66.73 which indicate a very low creative-thinking skills. The non-TLM group had a mean of 6.01 or MPS of 65.91 which indicates a very low creative thinking skill as well.

This score turnout was very much reasonable because the lessons haven't been formally introduced to them and the concept of having multiple correct answers are relatively new to them. This is similar to the finding of Casing and Roble (2021) where before their experiment, the mathematical creative thinking ability of the two groups of students has not been manifested and was functioning poorly as evidenced by the low pretest scores.

Similarly, Karunarathne, (2024) found that undergraduate students initially exhibited low levels of creative thinking skills, which significantly improved after receiving formative feedback and engaging in collaborative learning. In the same vein, Ekayana, *et al.*, (2024) revealed students begin with limited skills prior to the intervention. Consistent with these findings, Yayuk, *et al.,* (2020) highlighted that creative thinking skills are often underdeveloped at the outset and must be intentionally nurtured through well-designed instructional approaches.

For their posttest, there are 30 or 75% of the students exposed to TLM who have very low creative thinking skills, 8 or 20% have low creative thinking skills, and 2 or 5% have moderate creative thinking skills. On the other hand for the posttest exposed to non-TLM ,33 or 94.28% have a very low creative thinking skills for their posttest and 2 or 5.71 have low creative thinking skills.

In addition, the TLM group obtained a mean score of 12.46 and a mean percentage score of 72.40. This indicates a very low creative thinking skill result. While the non-TLM group had mean of 9.23 equivalent and a mean percentage score of 68.97 indicating a very low creative thinking skills result as well.

Before the implementation, all students in TLM and Non-TLM did not meet expectations indicating a similar level of "very low creative thinking skills" in Mathematics as indicated in Table 2. This upward shift in the TLM group aligns with findings from Coxbill *et al.*, (2023), who concluded that students exposed to structured interventions showed significant gains in performance from pretest to posttest. Their study emphasized that targeted instructional models can enhance both cognitive and creative capacities when implemented consistently. Similarly Susanti, and Sukarelawan, (2024) analyzed pre-post performance and found that students' creative reasoning improved notably when exposed to inquiry-based and reflective learning strategies. These findings reinforce the idea that creative thinking can be cultivated through intentional pedagogical design.

Moreover, Ocila, (2022) demonstrated that virtual simulation tools significantly improved students' academic performance in science, suggesting that engaging, exploratory environments like those fostered by TLM can enhance creative engagement. Gregorio (2024) also reported that the use of Strategic Intervention Materials (SIM) in biology instruction led to a marked increase in students' creative output and conceptual understanding, especially when paired with hands-on activities. These studies collectively affirm that exposure to diverse and student-centered methodologies can lead to meaningful improvements in creative thinking, even among initially low-performing learners.

Non-Parametric ANCOVA (Quade's) of Posttest Results in Creative Thinking Skills between Treatments

Table 2 shows the Non-Parametric ANCOVA (Quade's of posttest results between treatments. The pretest was used as a covariate to statistically

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equate dissimilar prognostic variables which may have an effect on the analysis.

Table 3. Non-Parametric ANCOVA (Quade's) Results in the Students' Creative Thinking Skills

Source	SS	Df	MS	f-value	p-value
Group	9559.834	1	9559.834	28.319	.000**
Intercept	42.488	1	42.488	.126	.724
Error	24642.831	73	337.573		
Total	34202.666	75			
Note: ** Significant at 0.05 level					

Table 4 reveals a significant difference in creative thinking skills between the control and experimental groups. The f-value of 28.319 and a p-value of 0.000 indicate a statistically significant difference at the 0.05 level. These results suggest that the intervention used in the experimental group was effective in improving creative thinking skills. The large gap in mean scores highlights the impact of the experimental approach, which may have provided more structured strategies or opportunities for students to develop and apply creative skills effectively. Additionally, the R-squared value of 0.280 suggests that a substantial portion of the variance in creative thinking scores can be explained by the intervention.

Students who learn mathematics through the Treffinger Learning Model are better than their counterparts who learn through conventional teaching models, both separately and simultaneously. Treffinger's model provides higher creativity outcomes because it facilitates divergent thinking and encourages students to think actively and share their solutions (Lince, 2016). As reported by Sari and Putra (2015), the model's strength lies in its adaptability to students with varied backgrounds and its emphasis on both cognitive and affective development. Moreover, open-ended mathematical problems allow multiple correct answers, fostering creativity and higher-order thinking (Kartikasari, 2022). Such problems help students generate multiple solutions and develop flexibility, fluency, and originality—skills critical to creative thinking in mathematics (Adeoye, & Jimoh, 2023).

Adding to this, Ndiung, *et al.*, (2019) found that students exposed to the Treffinger model integrated with Realistic Mathematics Education principles demonstrated significantly higher creative thinking skills. Their study emphasized that the model's structured phases, particularly "Practice with the Process", enabled students to explore ideas more freely, reflect on their reasoning, and develop innovative approaches to problem-solving.

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

This chapter presents the summary of findings, conclusions based on the effect of Treffinger Learning Model on students' creative thinking skills, and recommendations for improvement of further studies.

Summary

The study examined the problem-solving and creative thinking skills of grade 8 students of Banisilan National High School. Specifically, it determined the students' creative thinking skills before and after the intervention of Treffinger Learning Model. The primary data sources were scores obtained by the students in the written open-ended solving test. This study used descriptive statistics and Quade's Analysis of Covariance

The following significant findings were drawn from the study:

The overall mean percentage score of students' creative thinking skills prior to the exposure in the TLM group is 66.73 while for the non-TLM group is 65.91 indicating that students under both groups have a very low creative thinking skill. In the posttest, the students exposed the TLM had a mean percentage score of 72.24 and which indicates a very low creative thinking skill and those exposed to non-TLM had a mean percentage score of 68.97 which indicate a very low creative thinking skill.

Difference with F-value equal to 28.319 and a probability value of 0.000 ($p<0.05$) between groups indicating high significant difference in creative thinking skills.

Conclusions

Based on the findings of the study, the following conclusion are drawn.

Both students exposed to TLM and non-TLM started with a very low creative thinking skills as

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revealed by their pretest. Although the scores increased, it was still in the in the range of very low creative thinking

The students exposed to TLM have a creative thinking skill that are statistically significant from those exposed to non-TLM in the posttest. It means that the problem-solving skill of the students exposed to TLM and non-TLM significantly differed.

Recommendations

Based on the findings and conclusion of the study, the following recommendations are given:

The educators in the field of Mathematics may try to utilize interventions in their instruction such as Treffinger Learning Model (TLM)

To improve students' creative thinking skills, the researcher recommends to integrate Treffinger Learning Model since it trains students to self-check their learning as they constantly revisit solutions while they learn from others as they practice with the process. This will help them improve their openness to new ideas and strategies.

The researcher encourages policy makers to provide more avenues where teacher can be better equipped to handle different learning styles that is embedded in students solving strategies. Inclusivity and proper handling are of great help in improving creative thinking skills.

Lastly, further research is recommended to include other variables which are not included in the study. The longer duration of implementation and more number of respondents is highly suggested to verify effectivity of the method used.

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