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RESEARCH TITLE

The Effect of an Enrichment Program in Geometry on Developing Creative Thinking Skills among Middle School Students

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Abstract

This study explored the impact of an activity-based enrichment program on eighth-grade students' creative thinking in geometry, focusing on "triangle similarity" and "Pythagoras' theorem." The program aimed to enhance fluency, flexibility, originality, and problem sensitivity.

A sample of 47 students from Mas'adeh Middle School in the Golan Heights was randomly divided into an experimental group (24 students) and a control group (23 students). Using a quasi-experimental design, the experimental group received the enrichment program, while the control group followed traditional instruction. Creative thinking was assessed through personal portfolios evaluated with an analytical rubric based on the Torrance Tests of Creative Thinking.

Findings revealed a positive effect of the program, with significant improvement in originality and problem sensitivity. Although gains in fluency and flexibility were observed, they were not statistically significant, suggesting that further time and practice may be needed. Additionally, the program supported the development of students' cognitive structures, fostering critical thinking, problem-solving, and the ability to connect theoretical concepts with practical applications.

The study concluded that integrating enrichment activities into geometry instruction can effectively promote creative thinking. It recommends that educators adopt teaching strategies that nurture creativity and provide a supportive environment for individual differences, experimentation, and non-traditional thinking.

Key Words: Enrichment program, originality, problem sensitivity, mathematics.

عنوان البحث

تأثير برنامج إثرائي في مادة الهندسة على تنمية مهارات التفكير الإبداعي لدى طلاب المرحلة المتوسطة

المستخلص

استكشفت هذه الدراسة أثر برنامج إثرائي قائم على الأنشطة في تنمية التفكير الإبداعي لدى طلاب الصف الثامن في مادة الهندسة، مع التركيز على موضوعي **تشابه المثلثات** و**نظرية فيثاغورس** .هدف البرنامج إلى تعزيز الطلاقة والمرونة والأصالة والحساسية للمشكلات.

تكونت عينة الدراسة من (47) طالبًا من مدرسة مسعدة الإعدادية في هضبة الجولان، وجرى تقسيمهم عشوائيًا إلى مجموعة تجريبية (24 طالبًا) ومجموعة ضابطة (23 طالبًا). وباستخدام التصميم شبه التجريبي، تلقت المجموعة التجريبية البرنامج الإثرائي، بينما درست المجموعة الضابطة بالطريقة التقليدية. تم تقييم التفكير الإبداعي من خلال ملفات إنجاز شخصية باستخدام قائمة تقدير تحليلية مبنية على اختبارات تورانس للتفكير الإبداعي.

أظهرت النتائج وجود أثر إيجابي للبرنامج، حيث تحقق تحسن ملحوظ في **الأصالة** و**الحساسية للمشكلات** .أما في **الطلاقة** و**المرونة**، فقد لوحظت مكاسب لكنها لم تكن دالة إحصائيًا، مما يشير إلى الحاجة لمزيد من الوقت والممارسة. كما ساعد البرنامج في تطوير البنى المعرفية للطلاب، مما عزز مهارات **التفكير الناقد** و**حل المشكلات**، وربط المفاهيم النظرية بالتطبيقات العملية.

خلصت الدراسة إلى أن دمج الأنشطة الإثرائية في تعليم الهندسة يمكن أن يسهم بفاعلية في تنمية التفكير الإبداعي. وأوصت باعتماد استراتيجيات تدريسية تشجع على الإبداع، وتوفير بيئة تعليمية داعمة للفروق الفردية، والتجريب، والتفكير غير التقليدي.

الكلمات المفتاحية: برنامج إثرائي، الأصالة، الحساسية للمشكلات، الرياضيات.

1. Background of the Study

1.1 Introduction

The study entitled *"The Effect of an Enrichment Program in Geometry on Developing Creative Thinking Skills among Middle School Students"* addresses a pressing challenge in mathematics education: the limited development of creative thinking within traditional geometry instruction. Despite the growing emphasis on fostering creativity in educational contexts, geometry lessons often rely on procedural teaching methods that constrain students' ability to think divergently, solve problems flexibly, and engage with abstract concepts in meaningful ways. This issue is particularly evident among middle school students, who frequently struggle to connect geometric principles with real-life applications and innovative problem-solving strategies.

To respond to this pedagogical gap, the study investigates the impact of an activity-based enrichment program designed to enhance students' creative thinking skills—specifically fluency, flexibility, originality, and problem sensitivity—within the geometry unit. The program centers on two core topics: "Pythagoras' Theorem" and "Triangle Similarity," chosen for their conceptual richness and potential to stimulate higher-order thinking.

The research was conducted during the second semester of the 2024/2025 academic year at Mas'adeh Preparatory School, located in the northern region of the Golan Heights. The study targeted eighth-grade students, forming a purposive sample that reflects the human, spatial, temporal, and subject boundaries of the investigation.

Accordingly, the study aims to (1) examine the effect of the enrichment program on students' creative thinking development in geometry, (2) assess its influence on specific dimensions of creativity, and (3) offer pedagogical recommendations for integrating enrichment strategies into mathematics instruction to foster deeper conceptual understanding and innovative thinking.

1.2 Research Problem

Despite the increasing attention modern educational systems give to developing creative thinking skills, mathematics instruction in many educational settings still relies on traditional methods that focus on memorization and the mechanical application of procedures. This approach limits students' ability to generate new ideas or provide unconventional solutions to mathematical problems.

In the field of geometry in particular, students often struggle with non-routine problems that require flexible and original thinking, highlighting the need for alternative teaching methods capable of fostering their creative thinking.

Enrichment programs based on educational activities represent an effective educational approach in this context, providing an interactive learning environment that motivates students to explore and solve problems through diverse strategies. Such programs contribute to the development of various dimensions of creative thinking, including fluency, flexibility, originality, and problem sensitivity.

Accordingly, the research problem arises in determining the effect of an activity-based enrichment program on developing creative thinking skills among eighth-grade students in the geometry unit, providing them with a learning environment that encourages innovative thinking and autonomy in solving geometric problems.

1.3 Research Question

What is the effect of an activity-based enrichment program on the development of creative thinking skills (fluency, flexibility, originality, and problem sensitivity) among eighth-grade students in the geometry unit?

1.4 Research Hypotheses

Main Hypothesis: There are no statistically significant differences at the 0.05 significance level ($\alpha = 0.05$) between the mean scores of the experimental and control groups in the post-test of creative thinking skills attributable to the teaching method (activity-based enrichment program versus traditional instruction).

1.5 Research Objectives

This study aims to:

1. Examine the effect of an activity-based enrichment program on the development of creative thinking skills among eighth-grade students in the geometry unit.
2. Measure the program's impact on students' fluency, flexibility, originality, and problem sensitivity.
3. Provide educational recommendations on designing effective enrichment programs to enhance creative thinking in geometry instruction.

1.6 Significance of the Study

Scientific Significance: The study contributes to expanding theoretical and educational knowledge regarding the impact of activity-based enrichment programs on the development of creative thinking skills among eighth-grade students in the geometry unit. It also provides recent empirical evidence on how to enhance students' creative abilities in mathematics and addresses a research gap concerning the effectiveness of such programs in the middle school educational context.

Practical Significance: The study offers teachers and educators practical tools and strategies that can be implemented in the classroom to foster students' creative thinking. Additionally, it aids in designing effective enrichment activities in geometry instruction, supporting the development of innovative teaching practices based on discovery and problem-solving, and encouraging students' active participation and independent thinking.

1.7 Scope of the Study

This study was limited to the following:

- **Human Scope:** A sample of eighth-grade students at Mas'adeh Preparatory School.
- **Spatial Scope:** Mas'adeh Preparatory School, located in the northern part of the Golan Heights.
- **Temporal Scope:** The study was conducted during the second semester of the 2024/2025 academic year.
- **Subject Scope:** This study is limited to examining the effect of an enrichment program based on educational activities in the subject of Geometry, specifically focusing on the units: *Pythagoras' Theorem* and *Similarity of Triangles*, on the creative thinking skills of eighth-grade students.

1.8 Study Terms:

Effect: Effect refers to the change produced by the enrichment program in the dependent variables of the study. This effect is measured by comparing the results of the experimental and control groups before and after implementing the program. It is expressed through statistical significance and quantitative differences, reflecting the effectiveness of the educational intervention in producing meaningful educational and pedagogical change (Al-Khalifa, 2010; Cohen, 1988).

Operationally, the researcher defines effect as the measurable outcome of changes in academic achievement, the development of creative thinking skills, and attitudes toward mathematics among eighth-grade students through the application of an activity-based enrichment program. This effect is assessed using appropriate instruments, such as achievement tests, creative thinking questionnaires, and mathematics attitude surveys.

Enrichment Program: An enrichment program is an educational program designed to broaden and deepen students' learning in specific areas, typically targeting gifted or high-ability learners. Such programs aim to provide rich and engaging learning experiences that encourage independent exploration, critical thinking, and creativity. The enrichment program relies on offering additional content beyond the standard curriculum, enhancing higher-order thinking skills such as analysis, application, and innovation. It also includes various activities, such as projects, research tasks, and hands-on exercises, designed to stimulate learning through non-traditional methods (Gubbels, 2023).

Operationally, the researcher defines the enrichment program as a set of carefully developed educational activities aligned with the prescribed curriculum. The program is implemented within a defined timeframe, providing supplementary and supportive content for the geometry unit, aiming to improve academic achievement, develop creative thinking skills, and enhance positive attitudes toward mathematics.

Educational Activities: Educational activities are a set of processes and events designed to achieve specific learning objectives. These activities encompass a variety of approaches, including hands-on exercises, educational games, presentations, and interactive discussions, which help enhance understanding and student engagement. Educational activities aim to deliver knowledge innovatively, encouraging critical thinking and motivating active participation. They can also integrate educational materials with real-life contexts, making learning more relevant and effective (Skillshub, 2024).

Operationally, the researcher defines educational activities as interactive tasks and experiences designed in alignment with the prescribed curriculum and incorporated into the enrichment program. These activities aim to achieve clear and specific learning objectives, including solving geometric problems, and are implemented in a manner that encourages student interaction and motivates them to think creatively in problem-solving.

Creative Thinking: "Creative thinking is an iterative process in which an individual generates, processes, experiments with, refines, critically evaluates, and communicates ideas in order to solve a problem, improve an existing solution, or enrich knowledge in novel ways" (Brandt, 2023, p. 3).

In this study, the researcher operationally defines creative thinking as the cognitive process by which eighth-grade students generate unconventional and innovative solutions to geometric problems within the enrichment program. This involves the students' ability to think originally and creatively in solving geometric problems and generating new ideas. It is manifested through a set of skills including:

- **Fluency:** producing numerous ideas;
- **Flexibility:** approaching problems from diverse perspectives (variety of ideas);
- **Originality:** presenting unconventional and novel solutions to geometric problems (novelty of ideas).

These capacities are measured using specially designed tests and tasks to assess creative thinking in educational contexts related to geometry and are reflected in students' performance in the enrichment program activities.

Eighth Grade: This refers to the educational level encompassing students aged between 13 and 14 years.

2.Literature Review

2.1 Theoretical Framework

Modern education aims to prepare students with higher-order thinking skills capable of addressing contemporary challenges in innovative ways. Among these skills, creative thinking has become a central focus of the educational process. In mathematics, particularly in geometry, there is a pressing need to develop students' creative thinking due to the subject's abstract nature, which requires multiple and flexible solutions to problems.

Enrichment programs are considered one of the most effective educational strategies for fostering creativity, as they provide an interactive learning environment rich in activities that stimulate discovery, inquiry, and problem-solving through unconventional approaches.

2.1.1 Creative Thinking

In light of the rapid developments characterizing the modern era, creative thinking has become one of the fundamental components upon which effective education is built. The goal of education is no longer merely the transmission of knowledge; rather, it aims to develop cognitive abilities and enhance thinking skills, foremost among them the capacity to generate new ideas and seek innovative, non-traditional solutions to problems. Creative thinking encompasses several core components, including fluency, flexibility, originality, and elaboration, all of which can be cultivated within an appropriate learning environment.

Mathematics provides a fertile ground for developing creative thinking, given the subject's problems that require diverse strategies in analysis, interpretation, and inference. Research indicates that integrating open-ended activities and problems with multiple solutions into enrichment programs helps create a stimulating environment that fosters creativity in the classroom. In this regard, Joklitschke et al. (2022) emphasized that fostering creative thinking in mathematics involves not only encouraging the generation of new ideas but also developing specific components such as fluency in idea generation, flexibility in shifting between multiple strategies, originality in providing unconventional solutions, and elaboration to expand and refine proposed ideas. The study further highlighted that providing rich, open-ended mathematical tasks creates a dynamic learning environment that supports free expression and breaks the rigidity associated with traditional computational thinking, positively impacting students' creativity and self-confidence in class.

Enrichment programs designed with a clear educational vision contribute to developing students' creative thinking by stimulating intellectual curiosity, challenging their abilities, and encouraging them to make learning decisions based on exploration, experimentation, and reflection. Numerous studies have highlighted the effect of enrichment programs in this regard, emphasizing that diversity in activities and opportunities for students to interact with content in multiple ways, according to their choices, are key factors supporting the growth of creative abilities. Almarashdi and Barbar (2023) found that designing mathematics enrichment programs based on open-ended problems and applied tasks significantly increased students' creative thinking, particularly in the dimensions of fluency, flexibility, and originality. Similarly, Jou (2020) reported that the systematic integration of inquiry-based activities within design-oriented learning environments fosters creative cognitive readiness and encourages positive student engagement with educational challenges.

Guilford (1950) defined creative thinking as the production of many and varied ideas, while Torrance (1974) emphasized problem sensitivity, hypothesis formulation, and the generation of original solutions. Sternberg and Kaufman (2010) considered it the ability to reorganize knowledge in innovative ways with functional value. These definitions indicate that creative

thinking is a complex cognitive process based on originality, fluency, flexibility, and elaboration, influenced by cognitive, personal, and environmental factors.

Researchers agree that creative thinking is a skill that can be developed in open educational environments that encourage free expression and value diversity (Beghetto & Kaufman, 2014). Applied studies (Paz Baruch et al., 2025) highlight the integration of its four core skills—fluency, flexibility, originality, and elaboration—alongside additional components such as problem sensitivity, productive imagination, and perseverance (OECD, 2023).

Research also supports the interconnectedness of these dimensions, which operate within a cognitive sequence beginning with problem recognition and culminating in the production of original and refined solutions (Sosna et al., 2025; Delphi, 2022). Recent models (Beghetto, 2020; Paaßen et al., 2022) have proposed frameworks combining originality, value, and functionality, emphasizing the importance of integrating creative activities into educational content to enhance deep and sustainable learning.

Accordingly, creative thinking is considered a fundamental cognitive skill that should be nurtured from early stages through a stimulating educational environment that provides learners with the confidence and motivation for creativity and active participation in building a renewed future.

2.1.2 Creative Thinking and Its Relationship with Learning Mathematics

Creative thinking has become a central focus in modern educational approaches due to its role in enabling learners to handle complex situations with flexibility and innovation. Its importance is particularly evident in mathematics, given the subject's abstract and complex nature, which necessitates higher-order skills such as problem-solving and reasoning. Accordingly, creative thinking is considered an educational necessity in mathematics instruction, providing students with tools to explore concepts, reconstruct understanding, and generate innovative solutions (Amer, 2020).

Al-Atoum, Al-Jarrah, and Bishara (2009) and Al-Ajlouni and Al-Hmarani (2009) highlighted that creative thinking skills in mathematics include the following:

- **Fluency:** The ability of a student to generate the largest possible number of appropriate responses to a mathematical question or problem within their capability. Fluency is measured by the number of correct responses directly or indirectly related to the problem, reflecting the smoothness and flow of ideas within a given time.
- **Flexibility:** The capacity to produce a wide variety of unconventional ideas in response to a mathematical situation or problem, measured by the diversity of categories of ideas generated.
- **Originality:** The ability to produce uncommon responses to a given question, assessed statistically within the group to which the student belongs. The less frequent an idea, the more original it is considered.
- **Problem Sensitivity:** The ability to identify multiple problems in a given situation that others may not perceive. This skill enables innovators to recognize challenges and motivates them to generate diverse solutions.

Educational research has demonstrated a positive relationship between the development of creative thinking and achievement in mathematics. Kim (2018) found that students who learned through creativity-based methods were better able to provide unconventional solutions and performed better on logical thinking tests compared to traditional instructional methods. Similarly, Abu Hani et al. (2024) concluded that integrating creative thinking

strategies enhances students' ability to handle complex problems and improves their motivation and positive attitudes toward mathematics.

Al-Zouei et al. (2025) confirmed that teachers' use of fluency, flexibility, and originality skills enhances students' understanding of mathematical concepts and classroom engagement. Additionally, Abdel-Haq (2023) demonstrated that designing an interactive learning environment based on creative thinking significantly improved originality, flexibility, and fluency, while linking concepts to real-life mathematics, thereby increasing students' motivation and self-confidence.

Therefore, creative thinking represents a pivotal element in learning mathematics, not only for improving achievement but also for fostering positive attitudes, increasing motivation, and enhancing the ability to apply knowledge in practical contexts.

2.1.3 Creative Thinking and Its Relationship with Learning Geometry

Creative thinking constitutes a fundamental pillar in learning mathematics in general and geometry in particular, as it requires cognitive abilities including spatial visualization, mental flexibility, and the generation of non-routine solutions. Leikin and Sriraman (2022) emphasized that mathematical creativity serves as an indicator of advanced understanding, enabling learners to transition from procedural to conceptual thinking and to employ diverse strategies when faced with unconventional tasks.

Engineering activities involving modeling, drawing, and imagination contribute to enhancing three dimensions of creative thinking: fluency, flexibility, and originality (Kozlowski et al., 2019). Additionally, Gridos et al. (2022), demonstrated that visual representations of shapes and solids develop the ability to generate multiple solutions compared to verbal problems, linking this effect to the concept of "geometric shape perception," which enhances visual and spatial reasoning.

2.1.4 The Relationship between Enrichment Programs and Creative Thinking

Recent literature indicates a positive relationship between enrichment programs and the development of creative thinking, as such programs provide a stimulating environment that allows students to explore new ideas beyond rote learning, thereby enhancing fluency, cognitive flexibility, and the ability to generate innovative solutions.

Qabbad (2011) found that students participating in enrichment programs outperformed their peers in fluency and flexibility skills. Similarly, Al-Juhaiman and Ayoub (2012) confirmed the effectiveness of enrichment programs in developing creative abilities, a finding supported by Al-Zahrani et al. (2020), who reported that a future problem-solving model improved prediction skills and alternative generation.

Internationally, Bulut Ates and Aktamis (2024) demonstrated that integrating cognitive thinking techniques with problem-based learning within an enrichment framework enhances scientific creativity skills, while Elballah et al. (2024) indicated that programs based on open-ended future-oriented problems promote divergent thinking and sustainable creative abilities.

The effectiveness of enrichment programs is determined by their integrative design, which considers learners' characteristics, applies advanced cognitive strategies, and provides a supportive environment that allows experimentation without fear of negative evaluation (Beghetto, 2010). Consequently, these programs serve as a comprehensive framework for cultivating an open mind capable of navigating complexity and generating original solutions.

2.1.5 The Role of Enrichment Programs in Enhancing Students' Creative Thinking Skills

The development of creative thinking has become an essential educational objective in light of contemporary cognitive and technological transformations. Education is no longer focused solely on content delivery but also on cultivating higher-order thinking skills. Enrichment programs have emerged as an effective tool for reshaping the learning experience, providing stimulating environments that allow students to explore their ideas and expand their thinking patterns through interactive activities that encourage experimentation and unconventional approaches, thereby enhancing fluency, flexibility, originality, and elaboration. Al-Bishr and Al-Arfaj (2023) demonstrated the effectiveness of an enrichment program based on active learning in promoting these skills and increasing students' readiness for scientific competitions.

The literature also emphasizes that enrichment programs create safe environments that foster initiative and experimentation, enhancing self-confidence and independent thinking. Almutairi (2023) reported that a STEM-based enrichment program contributed to the development of twenty-first-century skills, including creativity and problem-solving, through inquiry-based practical activities. These findings align with Lee, Chang, and Wu (2021), who noted that problem-based learning enhances creative thinking through tasks requiring multiple and flexible solutions, as well as with Gilligan and Kaufman (2022), who highlighted the role of enrichment programs in developing originality and free exploration in mathematics.

The value of these programs lies in their qualitative content and constructive interaction, particularly when designed according to modern educational models and interactive teaching strategies that consider students' diverse needs. Integrating modern educational media further supports active and experimental learning, cultivating cognitive abilities capable of innovation. Abdel Karim (2016) emphasized that creativity is a central goal of the educational process and requires stimulating, diverse environments that foster flexibility and transcend conventional solutions.

Consequently, it is evident that creative thinking is a fundamental element in shaping the learner's personality, and enrichment programs serve as a pivotal tool in its development, unleashing students' latent potential and enhancing their capacity for innovation and renewal, which in turn facilitates the development of other aspects, such as positive attitudes toward mathematics.

2.2 Previous Studies

The study by Manlangit et al. (2025), aimed to develop high school students' creative thinking skills through an enrichment program based on digital worksheets that integrated mathematical concepts with local cultural content, within the framework of "Ethnomathematics." These worksheets were designed as non-traditional educational activities intended to connect school knowledge with learners' real-life contexts, reflecting a clear enrichment dimension in both content and methodology. The study employed a quasi-experimental design with a sample of 90 students, who completed pre- and post-tests using standardized measures to assess three dimensions of creative thinking: fluency, flexibility, and originality. The results revealed significant improvements among the experimental group compared to the control group, indicating that context-based enrichment activities are effective in broadening students' perspectives and developing their creative skills in mathematics.

In a recent study, Khalil et al. (2023), investigated the effect of a STEM-based curriculum on developing creative thinking among 94 students in grades 10 and 12. The researchers applied

a quasi-experimental design and used the Torrance Tests to measure creativity skills, focusing on four dimensions: fluency, flexibility, originality, and elaboration. The results showed statistically significant differences in favor of the experimental group in fluency, flexibility, and originality, supporting the effectiveness of integrating science, technology, engineering, and mathematics in fostering creativity.

Al-Zahrani and Al-Obaidi (2024), supported the rationale for enrichment programs, showing that simulation-based education transforms classroom components into open-ended real-life experiences that enhance creativity (fluency, flexibility, originality). Using a descriptive-survey method, a questionnaire on creativity dimensions was administered to 52 teachers. The results indicated very high effectiveness of simulations in fluency and originality and high effectiveness in other dimensions, with no differences according to school type. The study recommended continuing and developing simulations, providing teachers with tools and training, and employing simulations as a structural element in early childhood enrichment programs, as teachers expressed strong conviction in their importance for fostering creative capacities from an early age.

Kareem et al. (2022), conducted an experimental study to measure the effectiveness of a Learning Extended Model (LEM) in developing creative thinking skills among middle school students in mathematics. The sample consisted of first-year middle school students, who engaged in interactive activities designed to enhance fluency, flexibility, and originality, measured with precise assessment tools and analyzed statistically using the Torrance Test. The results showed significant superiority of the experimental group over the control group, confirming the effectiveness of enrichment activities in stimulating creative thinking and highlighting the role of interactive educational models as a practical approach to developing students' abilities in mathematics.

Al-Ghamdi (2019), conducted a quasi-experimental study with a one-group design to examine the effectiveness of a STEM-based enrichment program in developing creative thinking skills among gifted middle school girls. The study used the Torrance Tests of Creative Thinking (Verbal Form A), with a sample of 17 gifted first-year middle school students. Results showed statistically significant differences in favor of the post-implementation scores on the total score and the dimensions of originality, flexibility, fluency, and elaboration, confirming the impact of targeted enrichment programs in stimulating students' creative abilities. The study recommended adopting and generalizing STEM-based enrichment programs in gifted classrooms and educational administrations, as well as building teachers' capacities and providing practical guides for designing integrated enrichment units focused on twenty-first-century skills (projects, problem-solving, critical and creative thinking).

Kim (2016), conducted a meta-analysis of 26 studies examining the impact of enrichment programs on creative thinking among gifted students. Using a random-effects model and including over 5,000 students across various educational stages, the results showed that enrichment programs significantly enhanced creativity with a large effect size ($g = 0.96$), particularly for long-term programs that included open-ended activities.

2.2.1 Commentary on Previous Studies

Previous studies demonstrate a clear consensus on the pivotal role of enrichment programs, in various forms and approaches, in developing students' creative thinking skills across educational stages. The impact is especially evident in the dimensions of fluency, flexibility, and originality, which most studies have used as central indicators for assessing creative thinking, employing standardized tools such as the Torrance Tests or equivalent assessments.

Manlangit et al. (2025) illustrated the effectiveness of integrating local cultural contexts with

academic content in developing creative thinking skills through digital worksheets linking mathematical knowledge with students' daily lives, showing significant improvement in fluency, flexibility, and originality. Similarly, Khalil et al. (2023) demonstrated that a STEM-based curriculum led to clear development in these skills through applied activities integrating science, engineering, and technology.

Kareem et al. (2022) and Al-Ghamdi (2019) confirmed the importance of interactive programs aimed at creativity. The former focused on the LEM model with stimulating mathematical activities, while the latter implemented a STEM-based enrichment program, both showing significant improvements in fluency, flexibility, and originality, reflecting the effectiveness of flexible, multi-solution activities.

Kim (2016), further confirmed, through a meta-analysis of 26 studies, that the effect size of enrichment programs on creative thinking is high (g = 0.96), especially in long-term programs with open-ended activities.

Based on the overall evidence, the researcher concludes that developing creative thinking is not a spontaneous result of providing different content but requires the integration of several elements: a well-designed program, realistic and flexible activities, a supportive classroom environment, and an instructor capable of effective guidance. These studies collectively indicate that enrichment programs constitute a successful approach to cultivating learners able to tackle challenges non-traditionally and contribute to a learning system that meets the demands of the twenty-first century.

3.Research Methodology

3.1 Study Design:

The researcher adopted the experimental approach using a quasi-experimental design for this study, due to its suitability for the study objectives and field implementation conditions. This design allows for a comparison of the effect of the enrichment program between an experimental group, which received the intervention, and a control group, which did not. This facilitates identifying differences in the impact of the enrichment program on creative thinking.

The study instrument was applied to both groups, allowing for the comparison of pre- and post-test results and enabling conclusions regarding the effectiveness of the implemented enrichment program.

3.2 Study Participants

Study Population: The study population consisted of all eighth-grade students in public schools located in the villages of the Golan Heights during the second semester of the 2024/2025 academic year. The total number of students in this population was 466, distributed across five schools in the main villages of the Golan Heights.

Study Sample: Mas'adeh Preparatory School, located in the village of Mas'adeh in the Golan Heights, was selected using a convenience sampling method, as the researcher is a teacher at the school. This facilitated communication, field follow-up, and the provision of suitable conditions for accurate and organized implementation of the study, noting that the overall population is relatively homogeneous.

The school has three eighth-grade sections. Two of these sections were randomly selected for the study: one served as the experimental group (n = 24), and the other as the control group (n = 23), resulting in a total sample of 47 students.

Although the sections were randomly assigned, the researcher ensured group equivalence by

reviewing official school records and comparing students' mathematics grades. To verify that the grades followed a normal distribution, the Shapiro-Wilk test was applied, along with the Kolmogorov-Smirnov test. Table (1) presents the distribution test results for the students' mathematics grades prior to implementing the program.

Table (1): Statistical results of the Shapiro-Wilk and Kolmogorov-Smirnov tests to verify the normality of mathematics achievement scores in the pre-test for the experimental and control groups

Group	N	Shapiro-Wilk	Significance (p)	Kolmogorov-Smirnov	Significance (p)
Experimental	24	0.950	0.200	0.127	0.288
Control	23	0.949	0.200	0.096	0.261

It is evident from Table 1 that all p-values in both the Shapiro-Wilk and Kolmogorov-Smirnov tests for the experimental and control groups exceeded the significance level (0.05), with values of 0.288 and 0.261 for the Shapiro-Wilk test, and 0.200 for the Kolmogorov-Smirnov test in both groups. This indicates that the mathematics achievement scores of the students in the pre-test followed a normal distribution in both groups. Therefore, applying the **Independent Samples t-test** to compare the mean achievement scores between the two groups is statistically appropriate. Table 2 presents the results of this test.

Table 2: Results of the Independent Samples t-test to examine the significance of differences in pre-test achievement scores between the experimental and control groups

Significance (p)	t-value	Experimental (N = 24)		Control (N = 23)		Domain
		Mean	SD	Mean	SD	
0.668	**0.432**	**16.64**	**66.91**	**20.37**	**64.56**	Total Score

The results presented in Table (2) show that the *p*-value reached 0.668, which exceeds the significance level of 0.05. This indicates that there were no statistically significant differences between the control and experimental groups, suggesting that the two groups were equivalent in their prior achievement in mathematics.

3.3 Study Instrument

The study employed a personal portfolio as an assessment tool to measure students' creative thinking skills. The researcher developed an individual portfolio for each eighth-grade student as a means of evaluating the development of creative thinking in the geometry units. The portfolio included a series of tasks and projects completed over a specific period, aligned with the implementation of the enrichment program. It reflected the extent to which students were able to apply mathematical knowledge through the four creative thinking skills outlined in Torrance's model (1974): fluency, flexibility, originality, and problem sensitivity. Each task and question was carefully designed to correspond to a particular skill, thereby supporting the objectives of the enrichment program while aligning with the official curriculum and 21st-century skills.

The tasks and projects were reviewed by a panel of experts in mathematics curricula, instructional methods, and educational assessment to verify their face validity, appropriateness for the targeted age group, and clarity of content. Based on the reviewers' feedback, necessary modifications were made before adopting the final version of the instrument.

For evaluation purposes, the researcher employed an analytic rubric, a systematic assessment tool built on a set of criteria and indicators directly linked to the four creative thinking skills. This rubric allowed for the independent evaluation of each skill, providing clear performance indicators along with progressive performance levels (Excellent, Good, Needs Improvement). Such an approach enabled a precise identification of students' strengths and weaknesses in demonstrating creative thinking skills.

The rubric and its indicators were also presented to the panel of experts for validation and to ensure their suitability for the study's context.

3.3.1 Reliability of the Portfolio Instrument

To examine the reliability of the portfolio assessment, the internal consistency coefficient (Cronbach's Alpha) was calculated. The overall Alpha value reached 0.897, indicating a high level of reliability in the scoring process using the analytic rubric.

In addition, the researcher computed internal consistency coefficients for the creative thinking skills included in the portfolio by calculating the correlation between the total portfolio score and the individual scores of each sub-skill.

Table (3): Correlation Coefficients Between the Total Portfolio Score and Each Creative Thinking Skill (Internal Consistency)

No.	Sub-Skill	Correlation Coefficient	Significance Level
1	Fluency	0.872	*0.000
2	Flexibility	0.797	*0.000
3	Originality	0.920	*0.000
4	Sensitivity to Problems	0.886	*0.000

*Significant at $\alpha = 0.05$

The results presented in Table (3) indicate that the internal consistency coefficients between the total portfolio score and each creative thinking sub-skill were high, ranging from 0.797 to 0.920. All correlations were statistically significant at the 0.000 level, demonstrating a strong internal consistency between the sub-skills and the overall portfolio score. This finding reflects the high internal coherence of the portfolio components and suggests that the four creative thinking skills function in an integrated manner within the overall structure of the instrument. Consequently, these skills make a significant contribution to assessing students' creative thinking through the tasks and projects included in the portfolio.

3.4 Statistical Procedures

The data were analyzed using the (SPSS) statistical software package to address the study questions and test the hypotheses, as follows:

1. Using statistical methods to verify the validity and reliability of the instruments.
2. Calculating means and standard deviations.
3. Conducting an Independent *t*-test for two groups.
4. Using the Shapiro-Wilk test to assess normality of distribution.
5. Performing Analysis of Covariance (ANCOVA).

3.5 Study Procedures

1. Selecting an appropriate school for conducting the study—Mas‘adeh Preparatory School—to ensure the availability of necessary resources and facilitate implementation.
2. Identifying the geometry unit from the eighth-grade mathematics textbook as the focus of the applied enrichment program.
3. Designing the enrichment program according to the ADDIE model, incorporating modern strategies such as discovery-based learning and problem-solving, while taking into account students’ individual differences, and presenting the program to experts for necessary adjustments.
4. Developing an instrument to measure creative thinking skills and verifying its validity and reliability.
5. Dividing the sample into an experimental group, which applied the enrichment program, and a control group, which received traditional instruction, and ensuring equivalence between the two groups.
6. Implementing the creative thinking skills assessment during the enrichment program and documenting the results for each student in a personal portfolio.
7. Collecting and statistically analyzing the data to determine the effect of the enrichment program on students’ creative thinking skills.

3.6 Study Variables:

Independent Variable: The enrichment program.

Dependent Variable: Creative thinking skills.

4. Study Results

This chapter presents the findings of the study, which aimed to investigate the effect of an enrichment program based on educational activities within the geometry unit on the development of creative thinking skills among eighth-grade students.

4.1 Results for the Research Question

What is the effect of the enrichment program based on educational activities on the development of creative thinking skills among eighth-grade students?

To address the second research question, the second hypothesis was tested:

There are no statistically significant differences at the 0.05 significance level ($\alpha = 0.05$) between the mean post-test scores of the experimental and control groups in creative thinking skills, attributable to the teaching method (enrichment program based on educational activities vs. traditional instruction).

To ensure that the data followed a normal distribution, the Shapiro-Wilk test was applied. Table (4) presents the results of the Shapiro-Wilk test for the post-test scores of creative thinking skills for both the experimental and control groups.

Table (4): Statistical Results of the Shapiro-Wilk Test for Verifying the Normal Distribution of Post-Test Scores in Creative Thinking Skills for the Experimental and Control Groups

Creative Thinking Skill	Group	N	Shapiro-Wilk	Significance Level
Fluency	Control	23	0.910	0.151
	Experimental	24	0.841	0.201
Flexibility	Control	23	0.897	0.122
	Experimental	24	0.916	0.059
Originality	Control	23	0.739	0.062
	Experimental	24	0.883	0.319
Sensitivity to Problems	Control	23	0.748	0.542
	Experimental	24	0.916	0.349
Total Creative Thinking Score	Control	23	0.917	0.147
	Experimental	24	0.888	0.112

*significance level (α = 0.05).

This confirms that the normality assumption was satisfied, meaning that the data are normally distributed. Accordingly, parametric tests were used to examine the hypothesis related to the second research question.

To test the second hypothesis, the researcher calculated the means and standard deviations of students' scores on the creative thinking skills scale (fluency, flexibility, originality, sensitivity to problem-solving, and the total creative thinking score) for both the control group, which received traditional instruction, and the experimental group, which was taught using the enrichment program. This was done in the post-test of creative thinking skills to identify any initial differences between the two groups prior to conducting detailed statistical analyses. The results are presented in Table (5).

Table (5): Means and Standard Deviations of Students' Post-Test Scores in Creative Thinking Skills by Study Group (for Each Skill and Total Score)

Creative Thinking Skill	Group	N	Pre-Test Mathematics Scores (School Grade)		Post-Test Creative Thinking Scores	
			Mean	SD	Mean	SD
Fluency	Control	23	64.57	20.38	3.96	1.33
	Experimental	24	66.92	16.65	4.42	1.50
Flexibility	Control	23	64.57	20.38	3.57	1.71
	Experimental	24	66.92	16.65	4.21	1.04
Originality	Control	23	64.57	20.38	2.91	1.36
	Experimental	24	66.92	16.65	4.25	1.54
Sensitivity to Problems	Control	23	64.57	20.38	2.32	0.96
	Experimental	24	66.92	16.65	3.96	1.43
Total Creative Thinking Score	Control	23	64.56	20.38	13.13	3.86
	Experimental	24	66.92	16.65	16.92	4.89

*significance level (α = 0.05).

The means presented in Table (5) indicate a slight advantage for the experimental group in post-test creative thinking skills. The experimental group scored higher in fluency (4.42 vs. 3.96), flexibility (4.21 vs. 3.57), originality (4.25 vs. 2.91), and sensitivity to problems (3.96 vs. 2.32), as well as in the total creative thinking score (16.92 vs. 13.13). However, these observed differences are not sufficient to determine statistical significance. Therefore, an Analysis of Covariance (ANCOVA) was conducted, as presented in Table (6), to examine whether these differences were attributable to the teaching method after controlling for the effect of the pre-test scores.

Table (6): ANCOVA Results for the Effect of Enrichment Program-Based Instruction on Eighth-Grade Students' Creative Thinking Scores in the Experimental and Control Groups

Creative Thinking Skill	Source	Sum of Squares	df	Mean Square	F	Sig.	Effect Size (Eta²)
Fluency	Pre-test	3.075	1	3.075	1.543	.221	
	Teaching Method	2.133	1	2.133	1.070	.307	
	Error	87.714	44	1.994			
	Total	919.000	46				
Flexibility	Pre-test	6.564	1	6.564	5.247	.027	
	Teaching Method	4.137	1	4.137	3.307	.076	
	Error	55.046	44	1.251			
	Total	779.000	46				
Originality	Pre-test	7.394	1	7.394	4.020	.051	
	Teaching Method	19.331	1	19.331	10.509	.002	.193
	Error	80.933	44	1.839			
	Total	717.000	46				
Sensitivity to Problems	Pre-test	4.746	1	4.746	3.333	.075	
	Teaching Method	16.232	1	16.232	11.400	.002	.206
	Error	62.647	44	1.424			
	Total	616.000	46				
Total Score	Pre-test	64.623	1	64.623	3.494	.068	
	Teaching Method	154.491	1	154.491	8.353	.006	.160
	Error	813.819	44	18.496			
	Total	11712.000	46				

*significance level ($\alpha = 0.05$).

The results of the ANCOVA analysis presented in Table (6) indicate the following:

1. **Fluency**

Table (6) shows the ANCOVA results for the effect of enrichment program-based instruction on fluency in creative thinking. The F-value associated with the teaching method was 1.070 at

a significance level of 0.307, which is greater than the established α level of 0.05. This indicates that there are no statistically significant differences between the mean scores of the experimental and control groups attributable to the teaching method. Furthermore, the effect size (Eta^2) for the teaching method was very low, suggesting that the teaching method did not substantially contribute to explaining the variance in students' fluency scores.

2. Flexibility

Table (6) presents the ANCOVA results for the effect of the enrichment program on flexibility in creative thinking. The F-value for the teaching method was 3.307 with a significance level of 0.076, exceeding the 0.05 threshold, indicating no statistically significant difference between the two groups due to the teaching method. In contrast, the F-value for the pre-test variable was 5.247 at a significance level of 0.027, demonstrating a statistically significant effect of prior achievement on flexibility scores. The effect size (Eta^2) for the teaching method remained low, indicating that the enrichment program did not contribute substantially to the variance in flexibility scores between the groups.

3. Originality

Table (6) shows the ANCOVA results for the effect of enrichment program-based instruction on originality in creative thinking. The F-value for the teaching method was 10.509 with a significance level of 0.002, which is below the 0.05 threshold, indicating a statistically significant difference between the groups in favor of the experimental group. The effect size (Eta^2) for the teaching method was 0.193, considered large according to Cohen's criteria, meaning that the enrichment-based teaching method accounted for 19.3% of the variance in originality scores. Regarding the pre-test variable, the F-value was 4.020 with a significance level of 0.051, close to the significance cutoff, indicating a limited effect of prior achievement. To show the true differences between the groups after controlling for pre-test scores, the researcher calculated the adjusted means, as presented in Table (7).

Table (7): Adjusted Means of Originality Scores After Controlling for Pre-Test Effect

Group	Adjusted	Standard
Experimental	4.255	0.277
Control	2.939	0.283

Table (7) presents the adjusted means after controlling for pre-test scores. The adjusted mean for the experimental group was 4.255 with a standard error of approximately 0.277, while the control group had an adjusted mean of 2.939 with a standard error of approximately 0.283. These results indicate that the experimental group maintained its advantage over the control group even after controlling for pre-test differences, reinforcing the statistical significance of the findings and confirming the positive effect of the enrichment program based on educational activities on students' originality.

4. Sensitivity to Problems

Table (6) presents the ANCOVA results for the effect of enrichment program-based instruction on sensitivity to problems in creative thinking. The F-value for the teaching method was 11.400 with a significance level of 0.002, which is well below the 0.05 threshold, indicating a statistically significant difference between the groups in favor of the experimental group. The effect size (Eta^2) for the teaching method was 0.206, considered large according to Cohen's criteria, meaning that the enrichment-based teaching method accounted for 20.6% of the variance in this skill. Regarding the pre-test variable, the F-value was 3.333 with a significance level of 0.075, which is not statistically significant at the 0.05 level, suggesting that the effect of prior differences was limited.

To show the true differences between the groups after controlling for pre-test scores, the researcher calculated the adjusted means, as presented in Table (8).

Table (8): Adjusted Means of Total Creative Thinking Scores After Controlling for Pre-Test Effect

Group	Adjusted Mean	Standard Error
Experimental	3.938	0.244
Control	2.760	0.249

Table (8) presents the adjusted means after controlling for pre-test scores. The adjusted mean for the experimental group was 3.938 with a standard error of approximately 0.244, while the control group had an adjusted mean of 2.760 with a standard error of approximately 0.249. These results indicate that the experimental group maintained its advantage over the control group even after accounting for pre-test differences, reinforcing the statistical significance of the findings and confirming the positive effect of the enrichment program based on educational activities on students' sensitivity to problems.

5. Total Score

Table (6) presents the ANCOVA results for the effect of enrichment program-based instruction on the total score of the creative thinking test. The F-value associated with the teaching method was 8.353 with a significance level of 0.006, which is below the 0.05 threshold, indicating a statistically significant difference between the groups in favor of the experimental group. The effect size (Eta^2) for the teaching method was 0.160, considered large according to Cohen's criteria, meaning that the enrichment-based teaching method accounted for 16% of the variance in the total creative thinking score. Regarding the pre-test variable, the F-value was 3.494 with a significance level of 0.068, which is not statistically significant at the 0.05 level, suggesting that the effect of pre-test differences was minimal.

To demonstrate the true differences between the groups after controlling for pre-test scores, the researcher calculated the adjusted means, as shown in Table (9).

Table (9): Adjusted Means of Total Creative Thinking Scores After Controlling for Pre-Test Effect

Group	Adjusted Mean	Standard Error
Experimental	13.208	.898
Control	16.842	.879

Table (9) presents the adjusted means after controlling for pre-test scores. The adjusted mean for the experimental group was 16.842 with a standard error of approximately 0.879, while the control group had an adjusted mean of 13.208 with a standard error of approximately 0.898. These results indicate that the experimental group maintained its advantage over the control group even after accounting for pre-test differences, reinforcing the statistical significance of the findings and confirming the positive effect of the enrichment program based on educational activities on students' overall creative thinking skills.

5.Study Question Results:

What is the effect of the enrichment program based on educational activities on developing creative thinking skills among eighth-grade students?

To discuss this question, the researcher examined the results of the hypothesis associated with it: *There are no statistically significant differences at the 0.05 level between the mean scores of the experimental and control groups on the post-test of creative thinking skills attributable to the teaching method (enrichment program-based versus conventional).*

The study results reveal a clear positive impact of the enrichment program based on educational activities on the development of creative thinking skills among eighth-grade students, particularly in the domains of originality and sensitivity to problems, along with a notable improvement in the overall creative thinking score. Although the skills of fluency and flexibility did not show statistically significant differences, the means indicate noticeable progress in favor of the experimental group, suggesting a positive effect that may require a longer duration and additional training opportunities to achieve statistically measurable changes.

Originality showed remarkable improvement, reflecting the capacity of carefully designed activities to stimulate unique and unconventional thinking in an educational environment that encourages freedom of expression and continuous experimentation, moving beyond rote learning and traditional patterns. Sensitivity to problems was also clearly enhanced, as students demonstrated greater awareness and analytical ability regarding problem aspects, reflecting the effectiveness of training in careful observation and linking theory with practice.

At the overall creative thinking level, the results indicate an integrated effect of the program, contributing to the development of students' cognitive framework rather than a single skill. These findings align with Manlangit et al. (2025), who highlighted the effectiveness of integrating mathematical knowledge with local culture, and Khalil et al. (2023), who demonstrated the strength of STEM curricula in enhancing fluency, flexibility, and originality. Similarly, Karim et al. (2022), and Al-Ghamdi (2019), confirmed the impact of interactive, multi-solution activities on developing unconventional thinking, while Al-Zahrani and Al-Obaidi (2024), showed the role of simulation-based learning in promoting originality and fluency. Furthermore, Aitache and Kola (2022) ,emphasized the importance of student-centered active learning approaches in fostering creative thinking across cognitive, social, and emotional domains.

The absence of statistically significant differences in fluency and flexibility may be attributed to the program's focus on developing originality and sensitivity to problems, as well as the application duration, sample characteristics, and the importance of teacher guidance tailored to students' needs. These results underscore the importance of creating a learning environment that encourages inquiry, experimentation, and moving beyond ready-made solutions, enhancing students' confidence in their creative and initiative-taking abilities—skills essential for meeting twenty-first-century challenges.

Additionally, the study provides an applied model for integrating creative thinking skills within an authentic mathematics learning context, particularly in abstract topics such as geometry, through open-ended tasks and real-world projects, alongside authentic assessment tools such as portfolios. This approach fosters flexible and original thinking and suggests that structured in-class enrichment programs and activities contribute to preparing independent learners capable of creative problem-solving, consistent with the goals of modern education.

The researcher believes that this program, developed and tested within the context of this

study, represents a flexible and expandable framework for enhancing students' creative thinking skills. It provides a stimulating learning environment that supports discovery and problem-solving through innovative approaches, enabling students to think with flexibility and originality and to apply acquired knowledge in new situations. These findings emphasize the importance of adopting structured in-class enrichment programs and activities to foster creative thinking and develop students' capacities to face educational challenges effectively and confidently, in line with the goals of modern education aimed at preparing independent and creative learners.

6. Study Recommendations:

1. **Integrating Enrichment Programs into the Curriculum:** Incorporate enrichment-based educational activities int mathematics topics, particularly geometry units, to enhance students' creative thinking skills.
2. **Teacher and Supervisor Development:** Provide training for teachers on designing and implementing innovative enrichment activities, with ongoing support and supervision from educational coordinators to ensure effective application.
3. **Promoting the Development of Creative Thinking Skills:** Focus on developing the dimensions of creative thinking (fluency, flexibility, originality, and problem-solving) and use systematic assessment tools, such as portfolios, to document individual progress.
4. **Supporting Educational Policies and Research:** Encourage policymakers to adopt enrichment programs in curriculum development and support research to expand their application and study their impact on creative thinking and related skills.

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