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Development of Students' Creative Thinking Based on Girih Patterns: Using the Samanid Mausoleum as an Example

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Abstract: This article provides an in-depth analysis of the artistic, geometric, and philosophical characteristics of girih patterns found in the Samanid Mausoleum, and explores their pedagogical potential in developing students' creative thinking. The research employs historical-analytical, visual-observational, pedagogical, and mathematical-geometric methods to examine the structure, symbolic meaning, and educational function of these patterns. Through these patterns, students are given the opportunity to deeply understand and integrate art, mathematics, design, and philosophy. In particular, the STEAM model allows the aesthetic, symmetrical, and fractal features of the patterns to enhance students' spatial thinking, creativity, and cultural identity. The article positions this unique architectural monument as a universal pedagogical resource in modern education.

Keywords: girih patterns, samanid mausoleum, creative thinking, geometric composition, fractal structure, STEAM approach, integration of art and mathematics, cultural heritage, educational innovation, symmetry and proportion.

INTRODUCTION

The historical and architectural monuments located in Uzbekistan constitute the rich cultural heritage of the Uzbek people. Among them, the Samanid Mausoleum (9th-10th centuries), built in Central Asia, stands out with its unique architectural solutions and perfect composition of geometric and plant-based patterns.

This ancient monument is not only of historical value but is also relevant today from a pedagogical and educational perspective. The geometric and plant-based patterns in the Samanid Mausoleum are interpreted as symbols of infinity, order, and Islamic philosophy, and they are used to develop students' creativity and mathematical thinking.

In modern education, particularly in the fields of fine and applied arts, design, engineering, and cultural studies, such monuments offer immense opportunities for the development of creative thinking within the STEAM (Science, Technology, Engineering, Arts, Mathematics) model. The patterns in the Samanid Mausoleum, with their mathematical-geometric foundations, philosophical symbols, and aesthetic harmony, can serve as a ready-made teaching tool for creative-based instruction.

This article provides an in-depth scientific analysis of girih patterns and their pedagogical potential.

METHODS

Historical-analytical method: The historical and architectural origins of the Samanid Mausoleum and its girih patterns, including their mathematical-geometric and philosophical-spiritual foundations, were studied based on academic sources by scholars such as I.L. Rempel, M. Bulatov, P. Zohidov, and Sh. Kamoliddin.

Visual-observational method: The external and internal decorations of the mausoleum, along with their geometric and compositional structures, were examined.

Pedagogical analysis: The changes in thinking that occurred in students as a result of using these patterns in fine and applied arts classes were analyzed.

Mathematical-geometric analysis: The structure of the patterns was analytically investigated, including the a, b, c modules, symmetry, proportion, and fractal structures of the designs.

RESULTS

1. Compositional and Symbolic System of the Patterns

The patterns used in the mausoleum—girih (geometric), plant-based, star-like, and octagonal shapes—symbolize a focus on the heavens.

Center and circle: The central circle is interpreted as "wahdaniyya" (the oneness of God), and the circle as a symbol of eternity.

Square: Represents the elements of the earth.A philosophical and religious symbol is embedded in each pattern (infinity and order: the repeating structure of girih patterns reflects the order of the cosmos—paradise, unity, divine order).

2. Geometric Structure and Proportions

The external dimensions of the Samanid Mausoleum are 10.8 × 10.8 m, and the internal dimensions are 7.2 × 7.2 m. It is a square-planned building with a dome in the shape of a hemisphere. (Figure 1, 2).

Figure 1. Front façade of the Ismail Samani Mausoleum

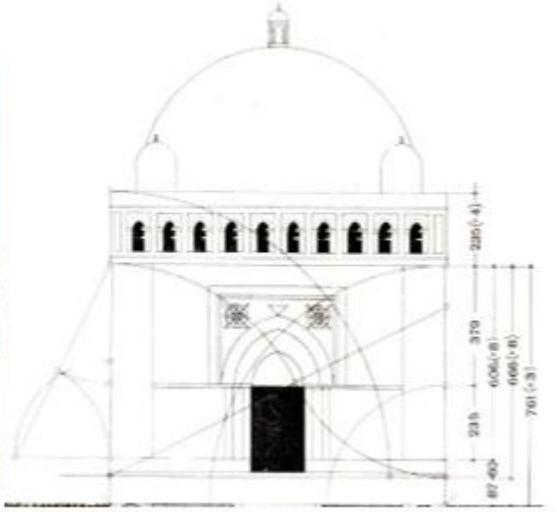

Figure 2. Graphic analysy of the architectural form construction.

- Dome: The dome was built using bricks with thicknesses of 90 cm, 76 cm, and 57 cm. This demonstrates the deep mathematical and geometric knowledge of the architects from that era.
- Brick Dimensions: The bricks used were of varying sizes: 31×31×5 cm, 27×27×4 cm, and 23×23×3 cm.

Girih Patterns and Proportions

- Girih Patterns: The girih patterns are composed of squares, octagons, and star-shaped polygons with 8, 10, or 12 points.
- Inner Panel Ornament: The ornamental pattern on the inner panel is placed within a rectangle measuring 112×199 cm, with a side ratio of 1:√3.
- Composition: The composition features a pair of "pearl" circles with a six-pointed star placed inside. The elements are interconnected proportionally.

Figure 3. Cast plaster panel of the Samanid Mausoleum.

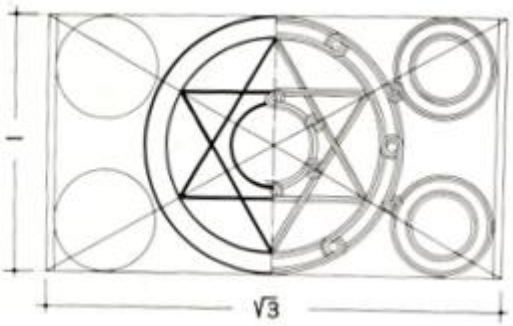

Figure 4. Analysis of the panel ornament structure

Use of Light: No color was used in the Samanid Mausoleum. The baked brick patterns create various shadow and light effects depending on the angle of the sun's rays.

Educational Effectiveness.

The patterns help students develop aesthetic taste, a sense of symmetry, rhythm, and spatial imagination.

The STEAM approach ensures the effective integration of art, geometry, and history.

Didactic-Pedagogical Outcomes.

Students' aesthetic perception, geometric imagination, and mathematical comprehension skills are enhanced.

Practical skills acquired during lessons include:

- Drawing shapes with 30°, 45°, and 60° angles.
- Constructing axes of symmetry and modular systems.
- Explaining fractal structures graphically.

DISCUSSION

The artistic and symbolic aspects of the Samanid Mausoleum's patterns are significant not only as historical heritage but also as a modern educational tool. Behind each girih pattern lie mathematical formulas, symmetry groups, and religious-philosophical symbols.

Through these patterns, we can achieve:

1.The integration of mathematics, art, and philosophy.

2. The explanation of fractal structures.

3. The application of light-and-shadow principles in lighting design.

4. The fostering of intercultural dialogue and multidisciplinary thinking.

The results of pedagogical experiments show that:

1. Students' engagement and ability to express their ideas have increased.

2. Creative thinking, as well as construction and design skills, have developed.
3. A sense of pride in cultural heritage has been strengthened.

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According to research by Lu and Steinhardt (2007), girih patterns contain mathematical principles of quasicrystals, similar to Penrose tiling. This can lead to a rediscovery of the history of mathematics in Uzbekistan. Through these patterns and the STEAM approach, students can gain a deeper understanding of practical exercises and learn to express their inventive ideas in a well-founded manner.

CONCLUSION

The application of the patterns from the Samanid Mausoleum in fine and applied arts classes demonstrates the following:

The patterns are structured based on a mathematical module, geometric symmetry, and fractal structure. Their philosophical content symbolizes infinity, order, vahdaniyya (oneness), and harmony.

By integrating the subjects of mathematics, art, culture, and philosophy, these patterns help students develop skills in:

- Creative-aesthetic thinking.
- Spatial-geometric comprehension.
- Cultural and national self-awareness.
- Analytical reasoning.

Research conducted on "Developing Students' Creative Thinking through the Beauty of the Samanid Mausoleum and Girih Patterns" shows that this unique architectural monument is not just a historical relic but a powerful didactic resource for modern education. The girih patterns in the mausoleum, with their:

- Geometric perfection,
- Aesthetic harmony,
- Depth of philosophical symbols, Awaken in students:
- Creative thinking.
- Strengthen mathematical-geometric concepts.
- Increase interest in art and culture.

Through the patterns' symmetry, fractal structure, and symbolic meaning, students' minds develop both aesthetic and analytical thinking simultaneously. This allows for the effective organization of interdisciplinary integration based on the STEAM approach. In summary, integrating the patterns from the Samanid Mausoleum into the educational process: Provides aesthetic pleasure, deepens scientific and cognitive skills, develops cultural and creative potential.

This monument and its system of patterns are proving their relevance as a universal pedagogical tool in contemporary education.

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