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INTEGRATING THE TRADITIONS OF KHIVA DECORATIVE ART INTO HIGHER EDUCATION THROUGH STEAM TECHNOLOGIES: METHODOLOGICAL PRINCIPLES AND DIDACTIC OPPORTUNITIES

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Abstract. This article examines the scientific and methodological foundations for integrating the traditions of Khiva decorative art into the higher education process based on the STEAM (Science, Technology, Engineering, Art, and Mathematics) approach. The historical formation of the Khiva ornamental style, the elements of its patterns, compositional structure, and coloristic characteristics are analyzed, and the didactic potential of teaching these within the STEAM methodology is substantiated. A three-stage methodological approach is proposed: studying pattern elements, analyzing compositional structure, and mastering coloristic features. It is demonstrated that STEAM principles — through harmonizing traditional art education with contemporary fields of knowledge — serve to develop students' professional and creative competencies.

Keywords: Khiva decorative art, STEAM education, higher education methodology, traditional decorative art, pattern composition, didactic integration, color theory, islimi ornament.

INTRODUCTION. Decorative and applied folk art, as a unique and inimitable realm of artistic creation, embodies centuries of accumulated experience in human civilization. This field occupies an integral place in human life — not only in the creation of material objects such as furniture, tableware, and clothing, but above all in shaping and enriching the spiritual world of individuals.

The concept of "folk decorative and applied art" encompasses a rich and multifaceted content, covering the unique folk creativity formed over centuries. Its contemporary successors — traditional artistic crafts and folk art — are united within the broader framework of cultural heritage. Transmitting this heritage to younger generations and preserving national identity represent urgent tasks for today's educational system.

The roots of Khiva decorative art extend to ancient crafts such as pottery and woodcarving. The earliest traces of this art are found in ceramic objects created during the Kushanian period. By the Kanguy era, wheel-thrown pottery had been fully mastered, and decorative techniques had developed into a sophisticated system. The use of red slip for finishing — rather than ornamental patterns — on ceramic vessels found at the ancient Toprak-Kala ruins is considered a stylistic hallmark of that period.

Following Uzbekistan's independence, the development of crafts and folk applied art became a priority of state policy. The 1997 Presidential Decree "On Measures for State Support of the Further Development of Folk Artistic Crafts and Applied Art" provided a strong impetus for the advancement of pottery and other crafts. [1] The Decree of November 17, 2017, "On Measures for the Further Development of Craftsmanship and Comprehensive Support of Craftsmen," [2] marked

another important milestone in elevating the field. The city of Khiva in the Khorezm region is internationally recognized for its unique applied art traditions and skilled masters.

Today, the teaching of traditional art forms in higher education often focuses exclusively on technical skills, failing to adequately develop students' complex thinking, scientific and analytical potential, and proficiency with modern digital tools. It is precisely this gap that establishes the urgency of applying the STEAM approach to applied art education.

This article is dedicated to analyzing the distinctive characteristics of the Khiva ornamental style and developing the scientific and methodological foundations for incorporating them into the higher education teaching process within the STEAM framework.

LITERATURE REVIEW. Numerous fundamental studies have been conducted on this topic. In his educational-methodological guide "Uzbek Folk Decorative and Applied Art," S. Bulatov provides a broad account of the historical development of Central Asian decorative art; the author conducts a comparative analysis of Uzbekistan's ornamental schools and systematically presents techniques for drawing and painting ornamental patterns. [3]

The 1958 work of G.A. Pugachenkova and L.I. Rempel examines the formation of artistic decorations in Uzbekistan's architecture, while their 1960 publication offers an in-depth study of the historical development of painting, sculpture, and ceramics in Central Asia. These studies also trace the patterns by which applied art styles evolved over time. [4, 5]

L.I. Rempel's work "Architectural Ornament of Uzbekistan" (1961) remains the primary source for the systematization and classification of Uzbek architectural decorations. [9] E.M. Pesherova conducted extensive research on Central Asian pottery, covering both ancient and medieval periods. [8]

Recent scholarly works by N.E. Ibadullayeva and S.E. Ibadullayev provide aesthetic analyses of traditional technologies in Khorezm pottery and tile-making; the distinctive features of the Khiva blue ceramic school have been discussed in international academic publications. Additionally, the collection "Atlas of Central Asian Artistic Crafts and Trades," edited by A.A. Hakimov, offers a broad overview of Central Asian craft traditions. [13]

International research on the STEAM educational approach demonstrates that integrating Art with STEM components significantly enhances students' creative and analytical thinking skills (Yakman, 2010; Land, 2013). However, dedicated studies on teaching regional traditional art — specifically Uzbek ornamental schools — within the STEAM framework have yet to be sufficiently developed. This article is aimed at filling precisely that scholarly gap.

RESEARCH METHODOLOGY. This study aims to systematically identify the distinctive characteristics of the Khiva ornamental style and to substantiate the possibilities of applying it to the teaching of visual and applied arts in higher education based on the STEAM methodology. The research employs comparative-analytical, historical-typological, and pedagogical-experimental methods.

Both historical and contemporary scholarly literature served as sources, as did direct observations of practicing master craftsmen. In particular, the recollections of Abdulla Boltayev, People's Artist of Uzbekistan, the reflections of skilled Khivan master Khayitvoy Bog'ibekov, and the insights of Tokhirjon Usmonov a representative of the Tashkent ornamental school on the formation and philosophical dimensions of Khiva decorative art constitute important source material.

Taking into account existing scholarly views that the Khiva ornamental school differs fundamentally from the styles of the Samarkand, Tashkent, Fergana, and Bukhara schools, this article analyzes the pattern elements, compositional structure, and coloristic characteristics of the

Khiva style step by step. This phased approach is intended to serve as a methodological foundation in the educational process, harmonized with the didactic principles of the STEAM methodology.

STEAM METHODOLOGY AND TRADITIONAL DECORATIVE ART: THEORETICAL FOUNDATIONS

STEAM - an educational concept formed from the initials of Science, Technology, Engineering, Art, and Mathematics is grounded in the interconnected teaching of diverse fields of knowledge. Khiva decorative art represents a unique cultural phenomenon that embodies all five of these components.

Science: The formation of pattern elements on the basis of natural forms -leaves, flowers, plant fibers - requires knowledge related to botany and the natural sciences. The influence of the Khorezm climate on pattern selection is grounded in scientific observation and analysis.

Technology: Analyzing and recreating ornamental samples through digital tools - graphic editors, 3D modeling software, virtual museums develops modern technological competencies.

Engineering: The constructive structure of ornamental compositions girih schemes, spiral islimi ornaments - demands engineering thinking: it is based on principles of symmetry, proportion, and geometric construction.

Art: The artistic-aesthetic system of Khiva decorative art - its color symbolism and stylistic distinctiveness -constitutes the central core of the educational process, lending meaning and vitality to the other components.

Mathematics: Geometric patterns, axes of symmetry, proportional relationships, and fractal structures are studied as practical expressions of mathematics. The process of calculating and drawing girih patterns directly develops mathematical thinking.

ANALYSIS AND RESULTS: A THREE-STAGE METHODOLOGICAL APPROACH BASED ON STEAM

Khiva decorative art possesses rich historical traditions, a distinctive system of form and content, and a uniquely original creative style. The following three-stage approach is recommended for teaching this art within the STEAM methodology in higher education.

STAGE I: Studying Pattern Elements (Science, Art)

In the first stage, students study the form, structure, and symbolic meaning of the pattern elements used in Khiva decorative art. Within the STEAM approach, this stage is not limited to artistic drawing students also explore the natural-scientific foundations of pattern elements.

It is particularly noteworthy that in the Khiva style, pattern elements are used in a comparatively restricted range compared to other schools. This is not coincidental: the selection of pattern elements is directly linked to the region's natural environment. The climates and flora of the Tashkent, Fergana, Namangan, Samarkand, and Bukhara regions differ fundamentally from those of the Khorezm region. The hot summers, cold winters, and scarcity of vegetation in Khorezm limited the opportunities available to Khiva ornamentalists to draw inspiration from nature.

As a result, simple and complex leaf forms, leafy flowers, madakhil, "qo'chqor shoxi" (ram's horn), tugma (locally called "dugma," meaning button), and mehrob (niche) elements occupy the primary place in Khiva patterns. Within the STEAM methodology, a comparative analysis of these elements against Tashkent school examples serves as a particularly effective didactic material for students (Figures 1–7).

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Figure 1. Leaves. Khiva pattern elements;



Figure 2. Leaves. Tashkent pattern elements; Figure

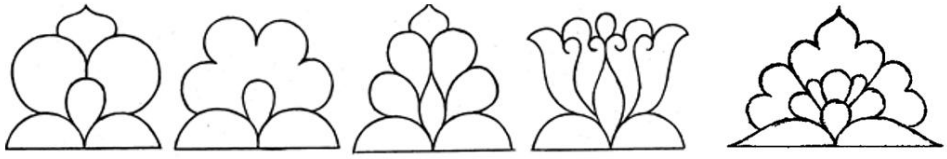


Figure 3. Leafy flowers. Khiva pattern elements;

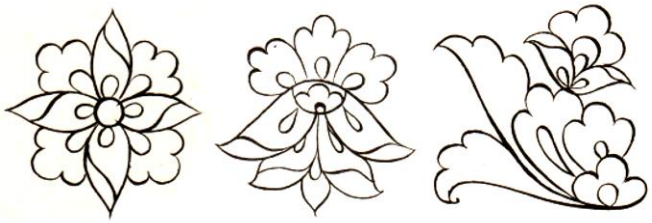


Figure 4. Leafy flowers. Tashkent pattern elements;

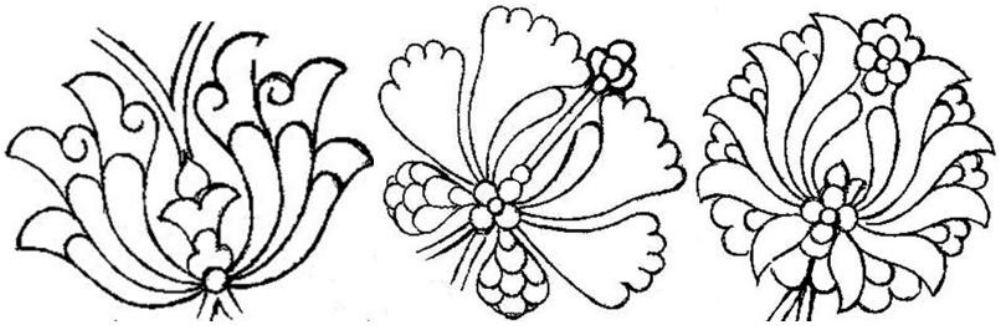


Figure 5. Multi-petaled flowers. Khiva pattern elements;

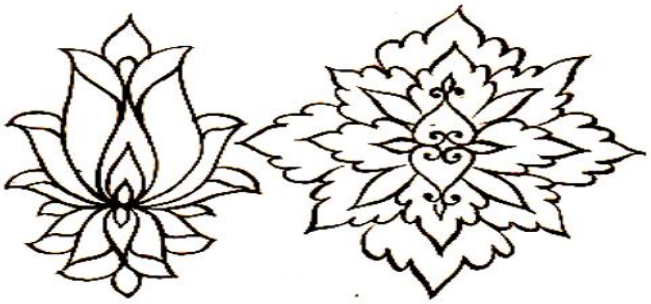


Figure 6. Multi-petaled flowers. Tashkent pattern elements;

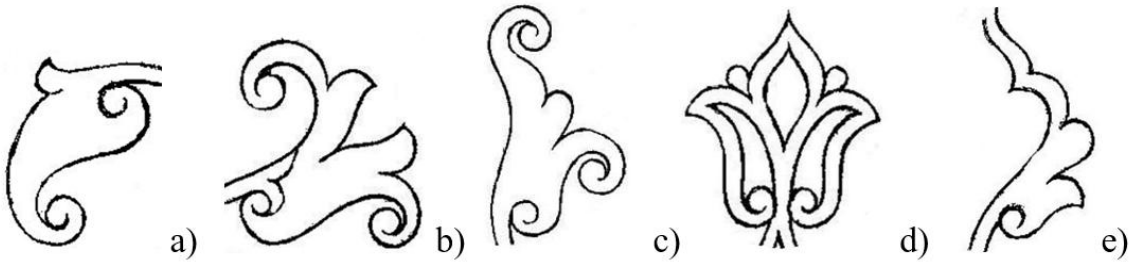


Figure 7. a), b), c) Ram's horn, d) madakhil, e) mehrob pattern elements.

During the learning process, based on the STEAM principle, students draw the leaf, leafy flower, and multi-petaled flower elements characteristic of the Khiva and Tashkent schools and independently analyze the differences in their forms and structures. Maintaining a scientific observation journal, writing botanical descriptions, and modeling elements in digital graphics are offered as supplementary assignments at this stage. This exercise is of significant importance for simultaneously developing comparative skills, visual literacy, and scientific thinking.

STAGE II: Studying the Structure of Ornamental Composition (Engineering, Mathematics, Art)

In the second stage, students study the structure of a complete ornamental composition in the Khiva style by sequentially arranging pattern elements. This stage fully encompasses the engineering and mathematics components of the STEAM methodology.

In the Khiva style, ornamental compositions are, as a rule, built on the basis of a spiraling branch movement. Such islimi ornaments are sharply distinguished from other schools' styles by their strongly dynamic character. In compositions made up of geometric shapes, girih star-patterns are drawn, with small spiral islimi ornaments placed between them; the result is a composition known as the "gulli girih" (floral girih). Khiva patterns are generally structured on the basis of madakhil, after which the islimi ornament is worked in a spiraling and delicate manner. In contrast, patterns belonging to the Bukhara and Samarkand schools are distinguished by their strong opulence and coloristic richness (Figures 8–9).

Figure 8. Bukhara. Ornamental composition on the wall of the Mohi-Xosa Palace;

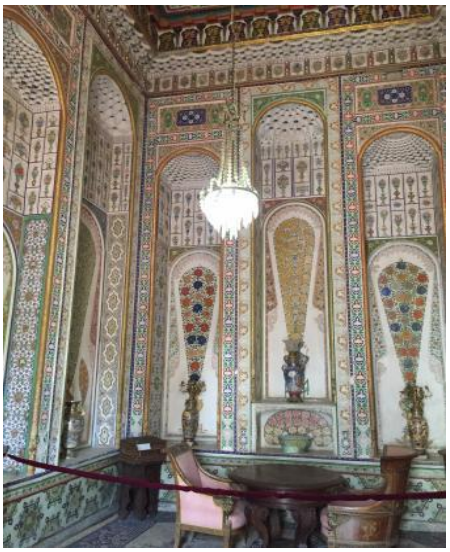




Figure 9. Khiva. Turunji ornamental composition on a tile.

Within the STEAM methodology, at this stage students first draw the girih scheme based on mathematical calculation (angles, axes of symmetry, proportions), then place the islimi ornament elements. Modeling ornamental schemes on a computer

using digital graphic editors (CorelDraw, Adobe Illustrator) directly engages the technology component. This exercise develops compositional thinking, the ability to sense the balance between geometric and organic forms, and an engineering-design approach.

STAGE III: Color Theory and Finishing Characteristics (Science, Technology, Art)

The third stage is dedicated to studying the colors and finishing style used in Khiva ornamental compositions within the STEAM framework. The general coloristic palette of Khiva patterns is often built on a blue-toned base: predominantly azure and green hues dominate. Colors are relatively few, yet they stand out for their distinctive elegance (Figures 10–11).

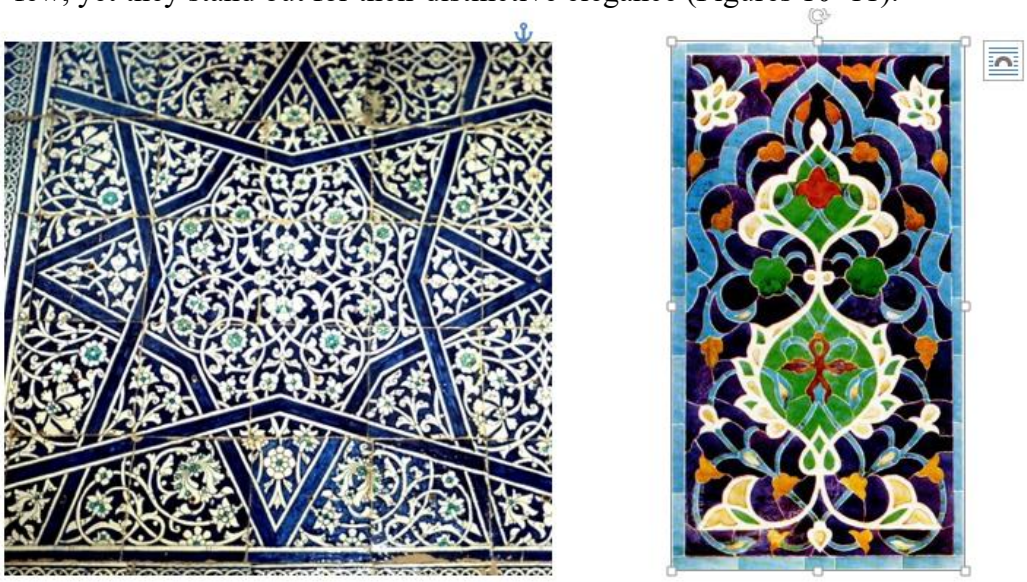


Figure 10. Khiva. Tash-hovli Palace (a) and Tashkent (b) style wall majolica cladding.

In finishing the ceilings of the colonnaded halls of Tash-hovli Palace — a rare jewel of Khiva architecture — red, yellow, and scarlet hues are used to great effect (Figure 11). This testifies to Khiva ornamentalists' aspiration to create works of unparalleled artistic achievement in terms of color as well, while preserving their own stylistic traditions.



Figure 11. Ceiling section of Khiva. Tash-hovli Palace.

In terms of finishing technique, Khiva patterns differ sharply from the Tashkent style: in the Khiva school, shading of leaves, stems, and

flowers is not employed — patterns are delineated with contour lines. In the Tashkent style, by contrast, shading of flowers, leaves, and stems is a widely used technique (Figure 12).

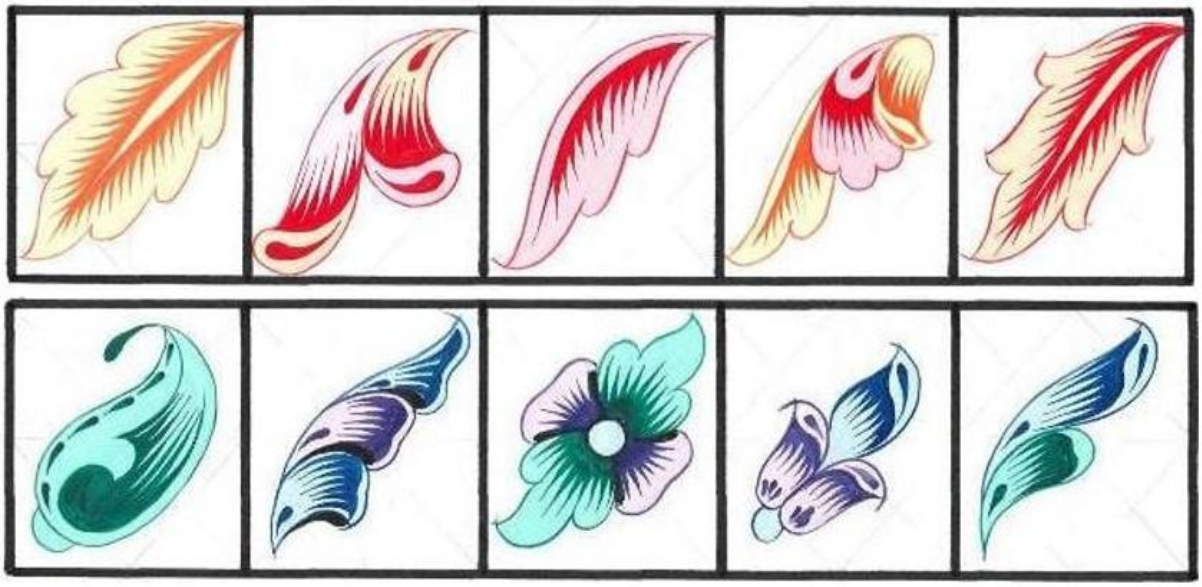


Figure 12. Finishing of patterns in the Tashkent ornamental school style (shading/targ'il berish).

Colors also carry deep symbolic meaning: white signifies purity, light, and good fortune; blue represents the sky and protection; azure is interpreted as a symbol of the highest faith. The majority of tile flowers are in white, blue, and azure — a choice that reflects an ancient worldview.

Within the STEAM approach, at this stage students study the physics of color (wavelengths, the mechanism of color perception), the chemical composition of pigments, and digital color models (RGB, CMYK). Linking traditional colors with modern technologies through spectral analysis and digital colorimetry instruments ensures the integration of students' knowledge.

CONCLUSION. Khiva decorative art represents a distinctive and integral artistic system that differs from other Uzbek ornamental schools in a number of important respects. The analysis conducted on the basis of the STEAM methodology permits the following principal conclusions.

First, the repertoire of pattern elements in Khiva decorative art was shaped in adaptation to the natural and climatic conditions of the Khorezm region: leaves, leafy flowers, madakhil, ram's horn, mehrob, and ties constitute the principal elements. This characteristic creates a solid foundation for organically incorporating the "Science" component of STEAM into the traditional art teaching process.

Second, Khiva ornamental compositions are built on the madakhil foundation, and the islimi ornament is worked in a spiraling, dynamic manner. This constructive solution is a practical expression of engineering and mathematical sciences, enabling a meaningful integration of the Engineering and Mathematics components of STEAM education.

Third, in terms of color, Khiva patterns rest on a blue-toned palette; the colors are few but carry deep symbolic meaning and possess strong aesthetic impact. Educational assignments related to the physics of color and digital technologies offer the possibility of successfully incorporating the Science and Technology components of STEAM into the learning process.

Fourth, shading techniques are not applied in finishing, which defines the principle of contour-based laconism characteristic of the Khiva style. This principle constitutes important didactic material for developing students' critical thinking in the areas of design and aesthetics.

The proposed three-stage STEAM-integrated methodological approach — that is, studying pattern elements on a scientific basis, conducting engineering-mathematical analysis of compositional structure, and mastering coloristic characteristics in harmony with technology can be applied as an effective didactic system in teaching Khiva decorative art within undergraduate programs in visual and applied arts. Such an approach enables not merely the preservation of the national artistic heritage, but also its deep comprehension within an academic environment and its continuation — in harmony with contemporary knowledge — in the creative work of a new generation of artists.

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