МАТЕМАТИКА И МАТЕМАТИЧЕСКО ОБРАЗОВАНИЕ, 2011
MATHEMATICS AND EDUCATION IN MATHEMATICS, 2011
Proceedings of the Fortieth Jubilee Spring Conference
of the Union of Bulgarian Mathematicians
Borovetz, April 5–9, 2011

GIRIH PATTERNS IN INFORMATION TECHNOLOGIES TEACHING*

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This article presents the possibility to create girih patterns with the program THE GEOMETER'S SKETCHPAD as an optional activity in Information Technologies.

A pattern is a composition of rhythmically repetitive elements. Symmetry is the basis of the construction of the ornament. Ever since antiquity people have decorated with ornaments all their craft objects – from pottery and textile to architectural structures.

The ornaments, decorated the ceramic tiles covering the Central Asia and Middle East buildings from XII-XIV centuries have been the focus of great interest in the recent years. These ornaments have their own characteristic features of composition, technology of execution and a name – girih (Fig. 1). The word girih is of Persian origin and means a knot.

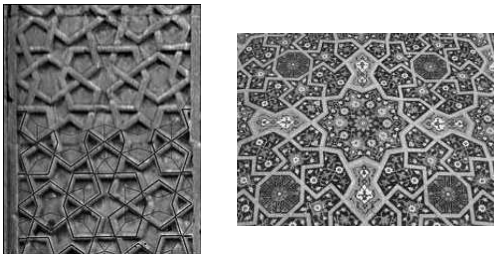


Fig. 1

A girih pattern is composed of embossed interwoven lines, which decorate ceramic tiles covered with coloured glaze. Only part of the ornament is laid on a separate tile so in order to obtain the whole pattern it is necessary to arrange and fit precisely several tiles. In fact only the lines which form the girih pattern are evident not the tiles themselves.

But a few years ago, it was discovered that many of these patterns were actually made using a set of five repeating tiles, called girih tiles [1].

Drawings of five polygon shapes used to construct girih patterns for ceramic tiles were discovered in medieval documents from Middle Asia. The rolls with the models for decoration of tiles for girih patterns were copied and handed from craftsman to craftsman. Each girih tile is decorated with lines and is sufficiently simple to be drawn using only

*2000 **Mathematics Subject Classification:** 51F20 (GM).
Key words: tessellation, girih tiles, polygon, rotation, translation, reflection.

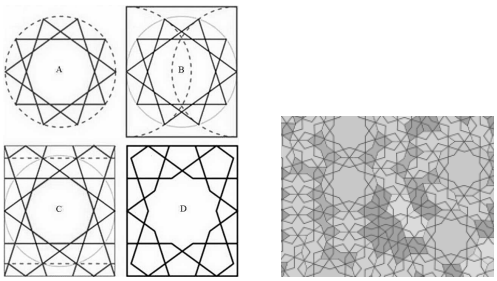


Fig. 2

mathematical tools documented in medieval Islamic sources. By laying the tiles edge-to-edge, the decorating lines connect to form a continuous network across the inside of tiling (Fig. 2).

The five girih tiles actually are two regular polygons – decagon and pentagon and three irregular polygons. All sides of these figures have the same length and all their angles are multiples of 36° ($\pi/5$). Most uses of girih tiles in Islamic architecture are periodic. They had unit basic pattern which were repeated in the same orientation within tilling the plane.

To tessellate a plane with girih tiles is a challenge for the students and it is a suitable task for an optional activity in Information Technologies. The integration in the IT training of tasks in spheres such as decorative art and history helps for the enlargement of the general knowledge of the students and shows the application of IT skills in different areas. This task makes it possible new knowledge to be gained through active, purposeful activities, ideas to be formulated and realized. The use of specialized software for geometric construction such as the program THE GEOMETER'S SKETCHPAD develops skills applicable to Mathematics teaching.

To solve the problem skills to construct the five basic girih tiles – two regular and three irregular polygons are necessary [2]. Furthermore, skills to realize translation, reflection, rotation are needed.

The construction of the polygons is followed by the construction of the decoration of each of them with girih lines. The girih lines intersect the sides of the polygons in their midpoint at an angle of 54°. Rotation or reflection can be used in order to construct girih lines. Moreover, a tool can be created which can construct two lines crossing the midpoint of the side of the polygon at an angle of 54° (Table 1).

When the five girih tiles are built it is convenient tools to be created for each of them (Table 2). In this way the tools for the five tiles can be used many times.

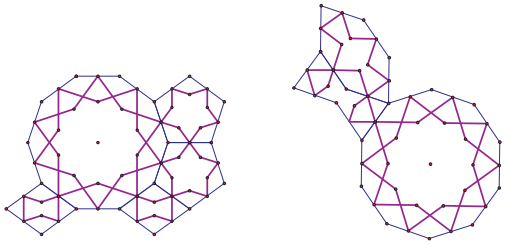
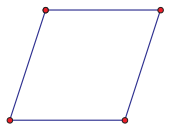
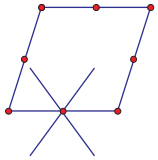
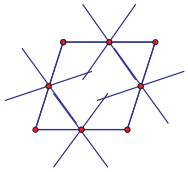
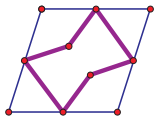


Fig. 3

Table 1. Algorithm for construction of a girih tile with THE GEOMETER'S SKETCHPAD program

	Steps of the algorithm	Construction
1	Construct the polygon: Construct a side of the polygon. Rotate the side by interior angle of the polygon using • Construct menu/Segment • Transform menu/Rotate	
2	Construct the girih lines: Construct the midpoints of the sides. Select a side. Rotate the side by 54° around the midpoint of the side • Construct menu/Midpoints • Transform menu/Rotate	
3	Repeat this process until construct all girih lines.	
4	Make the girih ornament and create a tool for this tile using • Custom tool/Create new tool	

The students are given the opportunity to experiment with the combination and the arrangement of the tiles. In order to construct a girih pattern they have to check if each combination creates a tessellation of the plane. When the students have accumulated enough experience with the arrangement of the girih tiles, they come to the idea of creating a basic pattern which is repeated by means of rotation, translation or reflection until tessellate the plane (Fig. 3).

Some girih patterns can be constructed with the use to translation (Fig. 4).

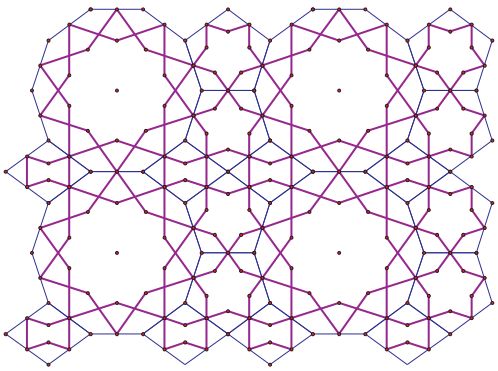
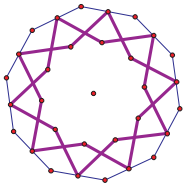
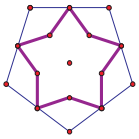
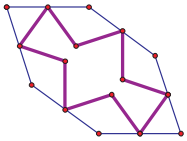
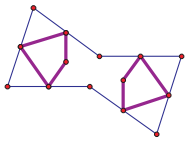
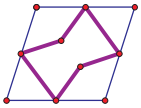


Fig. 4

Table 2. Five figures, that make girih patterns

	figure	construction
1	a regular decagon;	
2	a regular pentagon;	
3	an irregular hexagon with interior angles of 72° and 144°;	
4	a bow-tie (irregular hexagon) with interior angles of 72° and 216°;	
5	a rhombus with interior angles of 72° and 108°.	

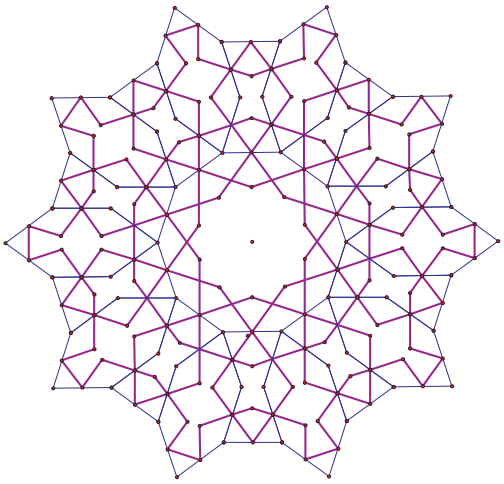


Fig. 5

Other girih patterns can be constructed with rotation (Fig. 5).

It can be verified that there are patterns which are extended to the plane only in an

aperiodic way.

There are many ways to combine the five basic girih tiles. The students on their own find out that new combination results in new tessellations. By filling the polygons interior with different colours impressive girih patterns are obtained.

The ancient craftsmen built the five girih tiles only by means of mathematical tools, but modern students can reproduce their skills and suggest new girih patterns with the help of a specialized software.

The successful fulfillment of the individual projects develops resourcefulness and intelligence, brings pleasure and satisfaction with the activity, new concepts, terms, knowledge useful for Mathematics teaching are learnt.

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ГИРИХ ОРНАМЕНТИ В ОБУЧЕНИЕТО ПО ИНФОРМАЦИОННИ ТЕХНОЛОГИИ

Клавдия Борисова

В статията се разглежда възможността за създаване на гирих орнаменти с програмата THE GEOMETER'S SKETCHPAD в извънкласна работа по Информационни технологии.