Creating Islamic Patterns from Folded Shapes

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Abstract

In this practical workshop participants will learn how to fold shapes including squares, equilateral triangles and hexagons from colored paper circles and A-size paper. The participants will then have the opportunity to make Islamic patterns for themselves using the folded shapes. This work can be extended to include participants designing and making their own patterns. There will also be opportunities to discuss implications for classroom practice, and ways in which the ideas can be used for students of varying interests and abilities.

Introduction

Geometry is at the heart of Islamic art. The designs and patterns use a finite number of geometric shapes that combine in many different ways. Traditionally, Islamic patterns are created through compass and ruler constructions but this method is often time consuming and can be complicated to oversee in the classroom. Students frequently do not exercise the precision required to achieve accurate results. An alternative method of creating Islamic patterns in the classroom is through manipulation of folded paper shapes cut from circles or A-size paper. Metric (A-sized) paper is mathematical paper system based on root 2 rectangles and is commonly used throughout the Europe, see [1, 2]. Squares, equilateral triangles, hexagons and rhombi can be quickly and easily folded from colored circles or A-size paper. Fixing these folded shapes onto large sheets of backing paper or card enables the quick assembly of eye-catching and colorful patterns. A photograph of pupils exploring how to create a tiling pattern from folded paper kites is shown in Figure 1.

Figure 1: Pupils exploring Islamic patterns using folded paper kites

The aim of this workshop is to ensure that participants become familiar with the methods for making a variety of folded shapes and using these to create Islamic patterns. This will act as a creative stimulus for designing other patterns, exploring the properties of the folded shapes and investigating how to fold other shapes. Participants will be encouraged to reflect on their own teaching which, in turn, will allow them to introduce new teaching strategies that help to:

- make cross-curricular connections between art and mathematics
- develop two-dimensional spatial awareness
- broaden students' creative outlook and develop practical skills
- increase students' motivation and enjoyment of mathematics

These activities assist in increasing pupils' understanding of two-dimensional shapes, symmetry and pattern. The material in this workshop can also be combined into the teaching of a larger cross-curricular project across the art, religious education and mathematics departments, which could include topics such as symmetry, two-dimensional shapes, tessellations, paper folding and a study of Islam and Islamic geometric patterns. Further examples of patterns that can be created using folded paper shapes are available from [3].

A series of successful workshops have been delivered by Meenan and Thomas to school groups alongside an exhibition of tilings and polyhedra, presented at the University of Leeds [4]. Photographs from one such workshop are shown in Figure 2. A report on a workshop by the accompanying teacher and her class is available from [5].

Figure 2: *Students in a practical paper-folding workshop*

Geometry and Symbolism in Islamic Design

Patterns are symbolic in Islamic culture [6]. It is within the circle, the symbol of unity, that polygons, the building blocks of tiling patterns, are constructed. The circle has also been regarded as a symbol of eternity, without a beginning and without an end. The compass and ruler constructions of the three

fundamental shapes used in Islamic art – the equilateral triangle, the square and the hexagon – are shown in Figure 3.

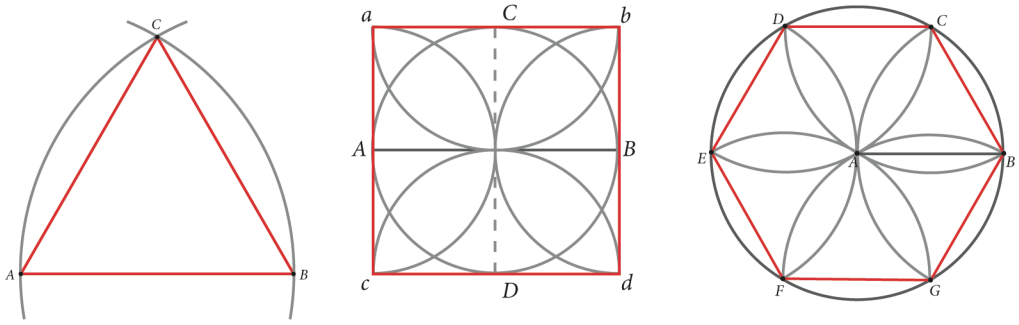


Figure 3: *Constructions of a) a triangle, b) a square and c) a hexagon*

The equilateral triangle, the simplest regular polygon, consists of only three equal lines connected at three vertices. Two lines cannot enclose a plane – three are needed – and so three is the beginning. By tradition the triangle is a symbol of harmony and human consciousness. The square is often taken as the symbol to represent the earth and its four corners symbolically represent the four directions – north, south, east and west or the four states of matter – water/liquid, earth/solid, air/gas and fire/ether. The hexagon represents heaven [6]. Another symbol commonly found in Islamic decoration is the star. The star symbolizes equal distance in all directions from a central point. All stars, whether they have 6, 8, 10 or more points, can be created through division of a circle into equal parts. The center of the star is the center of the circle from which it was created, and its points touch the circumference of the circle. The rays of the star spread out in all directions making the star an appropriate symbol for the spread of Islam.

Repetition and variation are important aspects of Islamic design. A series of tiles may consist of only one or two shapes, although the patterns on the tiles themselves may be different. In other designs, a number of different shapes are combined to create a complex interlocking pattern, as shown in Figure 4.

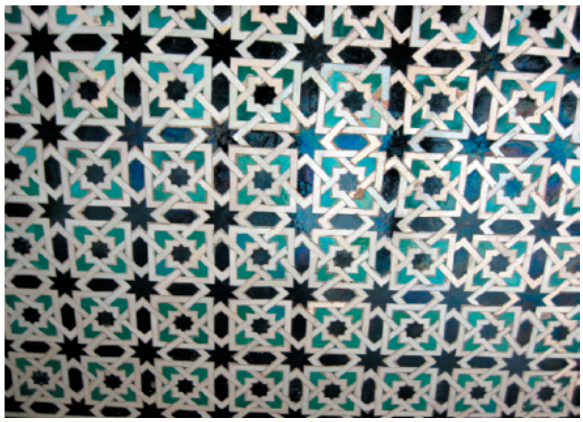


Figure 4: *A tiling pattern found at the Alcazar, Seville, Spain*

In many Islamic patterns, different elements seem to dominate, depending on how the pattern is viewed. A simple example is shown in Figure 5. It can be considered to be a six-pointed star surrounded by six rhombi or as three rhombi surrounded by three six-pointed stars. For further examples and discussion of Islamic geometrical patterns and their constructions see [6, 7, 8].

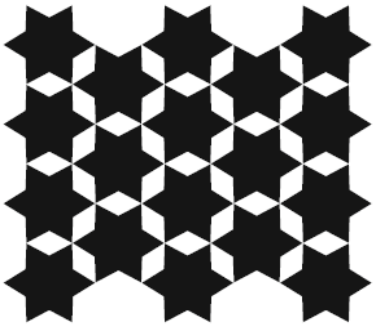


Figure 5: *Six-pointed star tiling*

Creating Shapes and Tiling Patterns

Workshop participants will have the opportunity to fold two-dimensional shapes from colored paper circles or A-size paper. All the shapes are straightforward to accurately fold following the instructions and diagrams shown in Figures 6 – 9. Short video clips demonstrating the folding are available online at [9]. No previous experience is required and pleasing results can be achieved in a relatively short time.

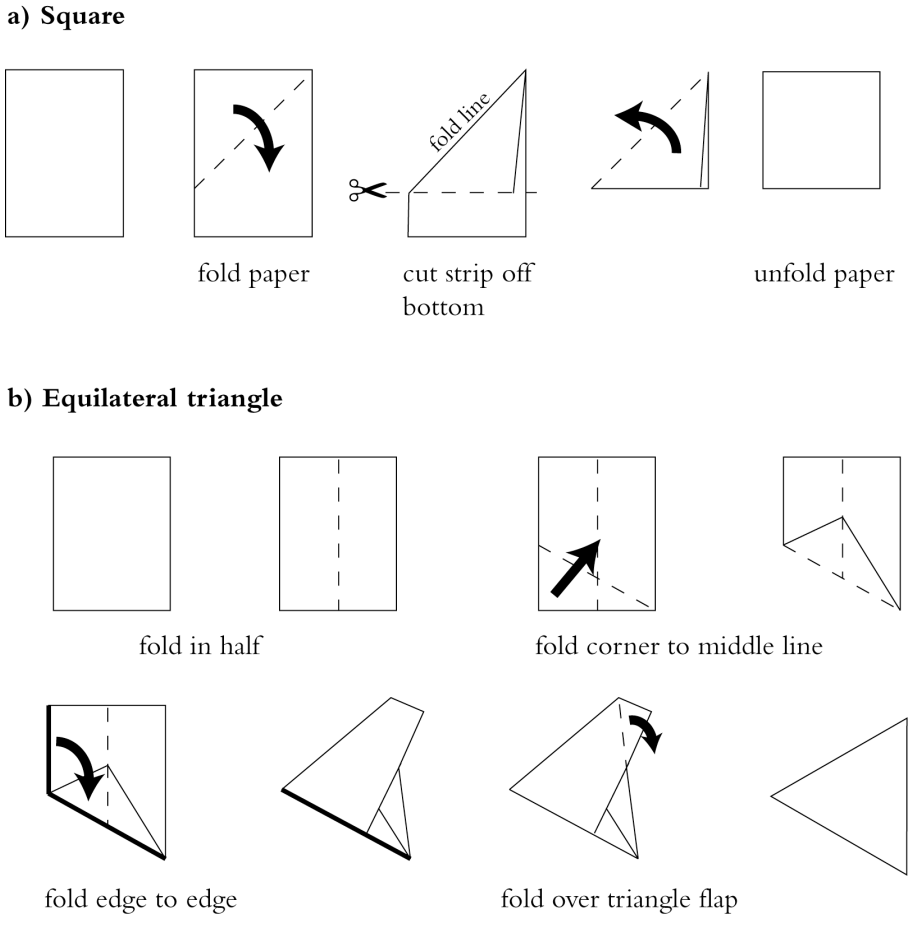


Figure 6: *Folding instructions for a) a square an b) an equilateral triangle from 'A' size paper*

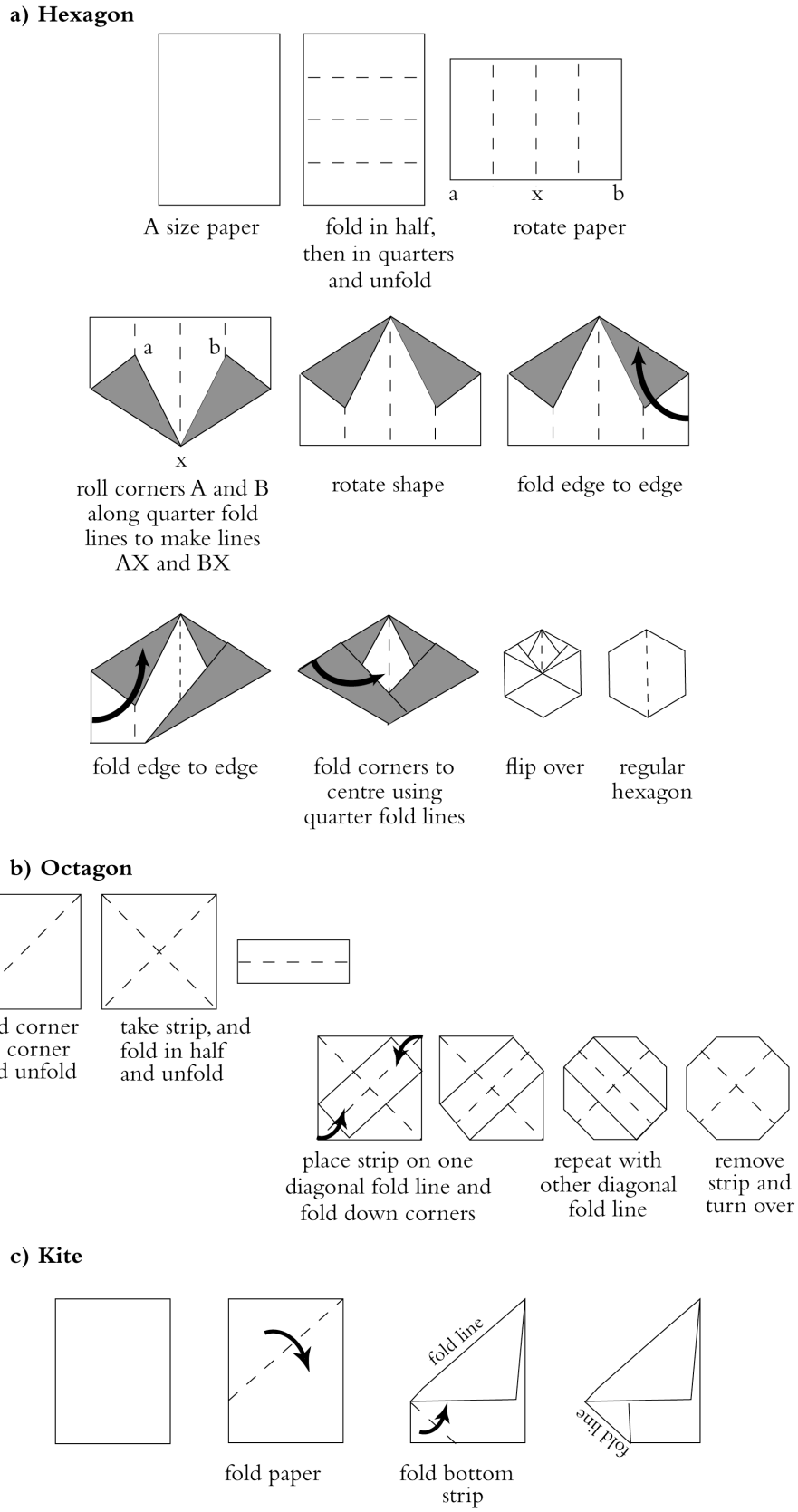
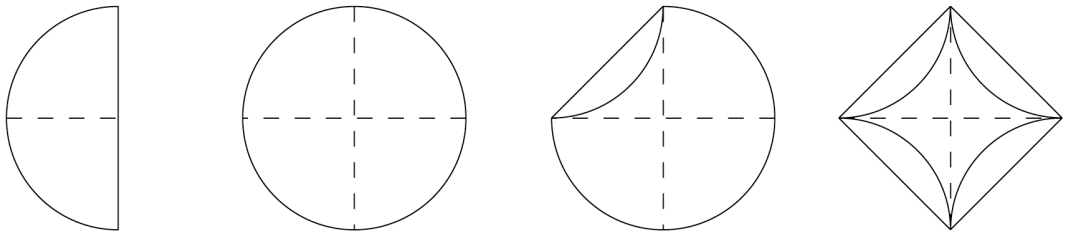


Figure 7: *Folding instructions for a) a hexagon and b) an octagon and c) a kite from 'A' size paper*

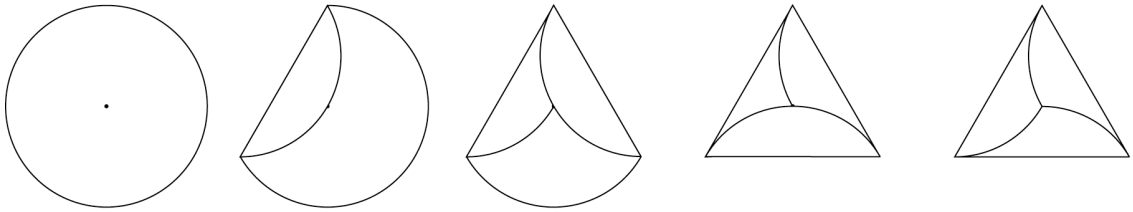
a) Square



Fold the circle in half. Open and fold the diameter back on itself to create two diameters at right angles.

Then fold in the four flaps as shown to a square.

b) Equilateral triangle



Mark the centre. (The centre can be found by folding the circle in half, then in half again.)

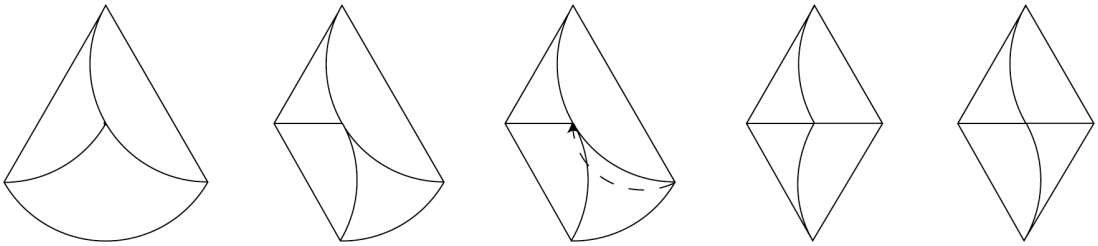
Fold in the edge to the centre.

Fold in the edge the centre again so that the new fold joins previous fold.

Fold in once again to the centre to create an equilateral triangle.

The flaps can be interleaved to give a triangle like this.

c) Rhombus



First fold two arcs to the centre.

Then fold up the end of the chord to the centre of the circle.

Do the same with the end of the other chord.

Tuck in the flaps. You now have a neat rhombus.

Figure 8: *Folding instructions for a) a square, b) an equilateral triangle and c) a rhombus from circles*

Regular hexagon

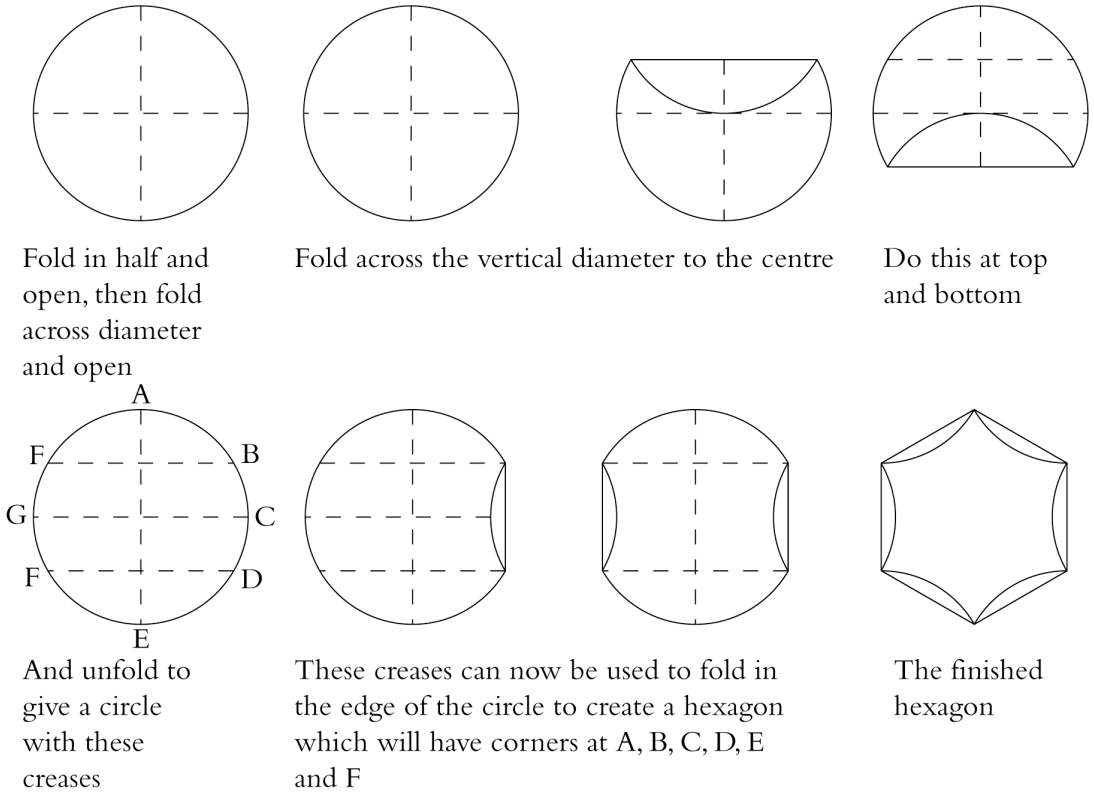


Figure 9: *Folding instructions for a hexagon from a circle*

A selection of Islamic tiling patterns that can be made using folded shapes is illustrated in Figure 10. Decorative designs can be drawn onto the plain tiling patterns once constructed.

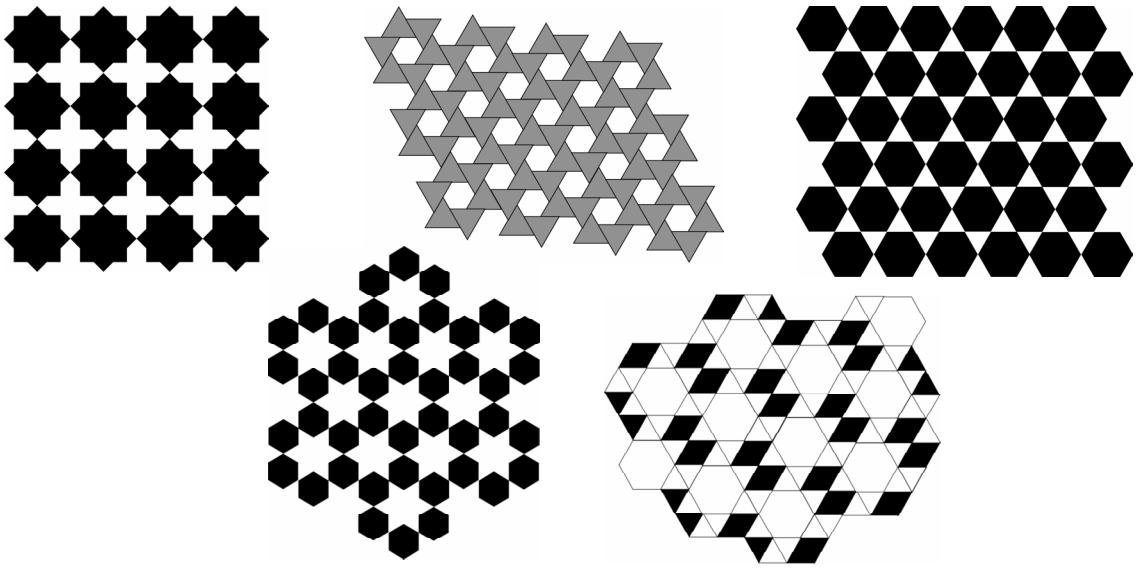


Figure 10: *Islamic tiling patterns*

Summary

This paper presents a novel approach to the teaching of two-dimensional shape and pattern. Setting these subjects in the cross-curricular context of Islamic art makes the topics more relevant to students. It has been observed by the authors that the students involved in the paper folding workshops have shown a deeper engagement with the subject. The material presented in this paper forms a component of a larger seminar, which was designed to promote the teaching of two and three-dimensional geometry in both a visual and practical way. This workshop was successfully targeted at 10 – 16 year old students of a wide range of abilities and was associated with the exhibition *'Form, Shape and Space'* [1]. A freely available teacher's booklet was developed to support this larger seminar and contains activity sheets on making polygons and polyhedra using compass and ruler constructions, as well as paper folding and pull-up net methods [10].

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