AGA KHAN MUSEUM CURRICULUM PROJECT

GEOMETRIC DESIGNS IN ISLAMIC ART
VISUAL ARTS UNIT PLAN GRADE 10

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Visual Arts Unit Plan Grade 10 AVI2O

Connections to the Aga Khan

Context
Students will learn to recognize, understand and create geometric patterns, mosaics, tiles and architectural decoration used throughout Islamic history with examples from the Aga Khan Museum. They will employ an enquiry-based model to create an artwork with a geometric pattern design (a variety of activities are suggested i.e. using recycled and found materials, creating stencils, or using modelling clay).

They will combine many of the expectations found in both the Grade 10 Visual Arts and Grade 10 Mathematics curricula, and, in particular, examine the similarities between the Creative Process and the Mathematical Process cycles.

The Ontario Curriculum Grades 9 and 10, *Revised*, 2010: Visual Arts Grade 10 AVI20
Curriculum Expectations

Overall and Specific Expectations

A. Creating and Presenting
A1. The Creative Process: apply the creative process to create a variety of art works, individually and/or collaboratively;

> A1.1 – use a variety of strategies to generate ideas and to develop plans for the creation of art works
> A1.2 – use experimentation, reflection, and revision when producing art works
> A1.3 – document their use of the creative process in a portfolio / sketchbook (as well as the mathematical process expectations)

A2. The Elements and Principles of Design: apply elements and principles of design to create art works for the purpose of self-expression and to communicate ideas, information, and/or messages;

> A2.1 – use various elements and principles of design to create art works that express personal feelings and communicate emotions to an audience
> A2.2 – apply elements and principles of design as well as art-making conventions to create art works that communicate ideas, information, or messages and/or that convey a point of view on an issue

A3. Production and Presentation: produce art works, using a variety of media/materials and traditional and/or emerging technologies, tools, and techniques, and demonstrate an understanding of a variety of ways of presenting their works and the works of others.

A3.1 – explore and experiment with a variety of materials and media and apply them to create art work (eg. use recycled, found or hand-made objects to make a mosaic)

A3.2 – demonstrate appropriate ways to prepare their art works for presentation

B. Reflecting, Responding and Analysing

B1. The Critical Analysis Process: demonstrate an understanding of the critical analysis process by examining, interpreting, evaluating, and reflecting on various art works;

B1.1 – identify and describe their initial reactions to a variety of art works and explain the reasons for their reactions (gallery walk and response)

B1.2 – identify and describe the elements and principals of design used in their own art works and the works of others, and describe their effects

B1.3 – explore and interpret a variety of art works, both historical and contemporary, to identify and describe their purpose and style, the materials used, and the meanings the works convey

B1.4 – use a variety of strategies to identify and reflect on the qualities of their own art works and the works of other and evaluate the effectiveness of these works

B2. Art, Society and Values: demonstrate an understanding of how art works reflect the society in which they were created, and of how they can affect personal values;

B2.1 – identify and describe the function of various types of art works in past and present societies

B2.2 – identify and describe ways in which various art works reflect the society in which they were created

B2.3 – identify and describe ways in which creating and/or analyzing art works has affected their personal identify and values

B3. Connections Beyond the Classroom: demonstrate an understanding of the types of knowledge and skills developed in visual arts, and identify various opportunities related to visual arts.

B3.1 – identify types of knowledge and skills acquired in visual arts and describe how they could be applied in a variety of areas of study ("In what ways have you used your visual arts skills in math? And your math skills in art?")

C. Foundations

C1. Terminology: demonstrate an understanding of, and use correct terminology when referring to, elements, principles, and other components related to visual arts;

C1.1 – use appropriate terminology related to elements and principals of design when creating and analyzing art works

C1.2 – use appropriate vocabulary to describe techniques, materials and tools when creating and presenting visual art works (eg. Mosaic, tile, symmetry, polygon)

C1.3 – identify and describe the stages of the creative process and the critical analysis process (and to see how these processes connect to a problem solving approach in math)

C2. Conventions and Techniques: demonstrate an understanding of conventions and techniques used in the creation of visual art works;

C2.1 – demonstrate an understanding of a variety of techniques that artists use to achieve specific effects, (eg. the use of layering to provide a sense of dimensionality)

C3. Responsible Practices: demonstrate an understanding of responsible practices related to visual arts

C3.2 – demonstrate an understanding of safe and conscientious practices associated with the use of materials, tools and technologies in visual arts and apply these practices when creating and/or presenting art works

C3.3 – demonstrate an understanding of how the production and presentation of art works can affect the environment and apply environmentally responsible practices when creating and presenting art works (eg. use recycled materials)

The Ontario Curriculum Grades 9 and 10 Mathematics *Revised,* 2005: Grade 10 Principles of Mathematics Applied MFM2P and Grade 10 Principles of Mathematics Academic MPM2D
Curriculum Expectations

Grade 10 Applied Mathematics (MFM2P)

Mathematical Processes
Demonstrate seven areas of mathematical processes (problem solving; reasoning and proving; reflecting; selecting tools and computational strategies; connecting; representing; and communicating)

Connecting: make connections among mathematical concepts and procedures, and relate mathematical ideas to situations or phenomena drawn from other contexts (e.g., other curriculum areas, daily life, current events, art and culture, sports);

Overall and Specific Expectations
• use their knowledge of ratio and proportion to investigate similar triangles and solve problems related to similarity;

– verify, through investigation (e.g., using dynamic geometry software, concrete materials), properties of similar triangles (e.g., given similar triangles, verify the equality of corresponding angles and the proportionality of corresponding sides);
– determine the lengths of sides of similar triangles, using proportional reasoning;

- Use the imperial system when solving measurement problems
- Solve problems involving the surface areas and volumes of figures

Grade 10 Academic Mathematics (MPM2D)

Processes
Demonstrate seven areas of mathematical processes (problem solving; reasoning and proving; reflecting; selecting tools and computational strategies; connecting; representing; and communicating)

Connecting: make connections among mathematical concepts and procedures, and relate mathematical ideas to situations or phenomena drawn from other contexts (e.g., other curriculum areas, daily life, current events, art and culture, sports);

Overall and Specific Expectations
• verify geometric properties of triangles and quadrilaterals, using analytic geometry.

   – determine, through investigation (e.g., using dynamic geometry software, by paper folding), some characteristics and properties of geometric figures (e.g., medians in a triangle, similar figures constructed on the sides of a right triangle);

   – verify, using algebraic techniques and analytic geometry, some characteristics of geometric figures (e.g., verify that two lines are perpendicular, given the coordinates of two points on each line; verify, by determining side length, that a triangle is equilateral, given the coordinates of the vertices);

- Use analytic geometry to verify geometric properties
- Solve problems involving the measures of sides and angles in acute triangles

Overall Learning Goals

By the end of this unit, students will be able to:
- recognize and understand the use of geometric patterns, mosaics, tiles and architectural decoration in Islamic art history;
- use the Creative and Mathematical Processes and an inquiry-based model to plan, create and share their own geometric artwork or contribute to a collaborative artwork;
- identify and describe ways in which their artwork describes their own identity and values, and the society in which they were created;
- co-create success criteria and understand what their successful learning looks like and what to look for during the learning and how to reflect and articulate what they have learned through this process.

Instructional Components and Context

Introduction to Islamic Art and Architecture   150 minutes

Readiness

Individual⇒Introduction and Assessment for Learning
Distribute **BLM #1 KWL Chart (**What I Know; What I Wonder; What I Learned);
students will complete the first two columns of the chart based on the following
headings, and will come back to complete the third column when the unit is complete:

   a. Islamic Art
   b. Geometry in Art
   c. Creative Process / Mathematical Process

Whole Class⇒Introduction to Islamic Art and Culture
Familiarize students with key background information:

-   Introduction to geometric patterns in Islamic art - built on combinations of
    circles and squares, which are repeated, overlapped, dissected with line
    segments, and combined to form intricate patterns; students will know the
    term tessellations which can repeat to infinity
-   These designs were used to embellish a wide range of works of art
    (architectural decoration, ceramics, calligraphy, metalwork, textiles and
    illuminated manuscripts)
-   Brief overview of Islamic principles and teachings – a way of life, religious
    code and legal system established by Muhammad (c 570-632); the teachings
    were revealed to him over a period of many years beginning in 610 and they
    became the text known as the Qur'an
-   Primary premise is monotheism (Allah) and the recognition of Muhammad as
    Allah's last prophet (others were Abraham, Moses and Jesus)
-   The Qur'an and the Traditions take a firm stance against idolatry and the
    worship of images
-   This form of decoration stressed the importance of unity, logic and order
-   Influenced by Islamic classical traditions and enhanced, during the 7th
    century, by Islamic mathematicians, astronomers and other scientists; these
    traditions continue to today (consider the combination of contemporary and
    historical elements in the architecture of the museum itself, by prize-winning
    architect Fumihiko Maki)
-   Western models of art adopted linear perspective of foreground, middle
    ground and background; Islamic art usually employs a different sense of
    space, a decorated foreground which is created by fitting polygonal shapes
    together like the pieces of a puzzle (tessellations)

Teachers:

-   Use reproductions of pieces from the Aga Khan Museum that are available for
    viewing on-line (Aga Khan Museum. 2016. *Aga Khan Collections.* Retrieved
    from https://www.agakhanmuseum.org/collection), and discuss how they

demonstrate some of the key teachings of Islamic art as outlined above; may use the questions found in the lesson or as attached in **BLM #2 Looking at Islamic Art**

- Examine both the Mathematical Processes and the Creative Process cycles (how are they similar? How do they differ?) see Ontario Ministry of Education curriculum documents:

Ontario Ministry of Education. (2010). *The Ontario curriculum, grades 9 and 10: The arts, revised.* Toronto, ON: Queen's Printer for Ontario.

Ontario Ministry of Education. (2010). *The Ontario curriculum grades 9 and 10: Mathematics, revised.* Toronto, ON: Queen's Printer for Ontario.

Terminology
Individual or Small Group⇒Terminology to engage with the Aga Khan Museum
- Prior to visiting the Aga Khan Museum, Familiarize students with names, processes and terms using **BLM #3 Aga Khan Museum Word Search**
- Students should look up any terms that they do not recognize

Materials
- Paper, pencils, rulers, compass
- Geometric grids (ie. hexagon, octagon or dodecagon grids) or tessellation grids
- Materials will change dependent upon the inquiry chosen below:
  o Found materials (natural: sticks, stones, snow; re-cycled materials, plastic bottle tops, coloured beads, plastic spoons, spools, electronics, toys – industrial and household cast-offs)
  o Plasticine, modelling clay, or, where there is a kiln available, clay and glaze; instruments to carve modelling clay (pen, pencil, paperclip, toothpicks)
  o Matte ceramic tiles, paint, brushes (and a top coat to seal the final artwork)
  o Mosaic glass, thin-set mortar; glasses, plates, recycled materials
  o Softoleum, Styrofoam; cutting and carving tools; printing ink; brayers
  o Cardboard or vinyl; sharp cutting tools; Fabric, textiles, pre-stretched canvasses; fabric ink

Minds On   The Aga Khan Museum   75-150 minutes

Whole Class⇒ Experiential Learning through Gallery Visit
1. Visit the Aga Khan Museum, Toronto. If you are unable to visit the gallery, go to their website for links to images from their collection and use other on-line resources to see images of Islamic tiles, mosaics, ceramics *and architectural details.* (Aga Khan Museum. 2016. *Aga* Khan Collections. Retrieved from https://www.agakhanmuseum.org/collection)

2. Watch the remarkable video along the wall when you first enter the Aga Khan Gallery. Notice the mathematical patterns that form the basis of the designs.

Guiding Questions:
- *What is the shape that is the basis for all of the designs?* Circle
- *How many different geometric shapes can you identify*? Hexagon, square, triangle, rhombus; hexagon, heptagon, octagon, decagon – other polygons
- *How might these complex geometric shapes be constructed?*
- *What is the benefit of using a mathematical pattern in creating these designs?* (repeat patterns over large areas; strength and rigidity in architecture; mass production; inexpensive; locally produced materials)
- *Where have you seen similar repeat patterns or shapes in the architecture or decoration of our homes, schools, local buildings? (*brick, interior tiles, landscaping, specific local examples)
- *How many different ways can you see a hexagon used?* (in various artworks, architecture, notecards, wooden decorations, etc)
- *Which of the elements and principles of design are most prominent in the design?*
- Consider that each tile was individually created by hand. *What techniques might the artisans had available to them at the time to help replicate the pattern?* (stencil)

Individual⇒Making Connections
3. Ask the students to select one of the items in the gallery and determine the geometric pattern hidden underneath the design; take photos for reference for future planning
4. Students will describe their initial reactions to a variety of art works and explain the reasons for their reactions; see **BLM #2 Looking at Islamic Art** or answer the following questions:
   a. Describe it *(What do you see? What words would you use to describe it? How would you describe the lines, the shapes, the colours? How would you describe it to someone who could not see it?)*
   b. Relate it *(What does this art remind you of? What things do you recognize / what things seem new to you? What interests you most about it?)*
   c. Analyse it *(Use the elements and principles of design to talk about this artwork)*
   d. Interpret it *(What title would you give this artwork? Who made this artwork? What is its purpose? How did you arrive at this idea? What do you think it would be like to live in this time? How might this artwork be created/used/decorated differently in current times?)*
   e. Evaluate it *(What is good about this artwork? What things would you change? Why should anyone else see this work of art? What would you do with it if you owned it? What is worth remembering about this artwork?)*

5. *What are the benefits of visiting a museum?* (see in real life a collection of the artistic, intellectual and scientific heritage of Muslim civilizations across the centuries; deeper understanding of the artworks; find similarities and differences among our cultures; recognize the creative and mathematical processes common to each other, and to artworks throughout different cultures and times; ability to think critically about art and culture)

Action! Geometric Pattern Design 75 – 225 minutes

Individual⇒Creating Patterns
1. Finding Geometric Shapes in Circles (PDF lessons from Metropolitan Museum of Art, New York)
   There are 11 activities to create various tile pattern grids. Students should complete "Activity 1 – Seven Overlapping Circles" and "Activity 2 – Finding Geometric Shapes Within Circles" to learn how to create designs through the use of two simple tools – a compass and a ruler. By creating patterns themselves, students will gain an understanding of geometric principles of the underlying grids and methods used by artists working with Islamic-style geometric art.
   See:
   The Metropolitan Museum of Art. 2004. *Islamic Art and Geometric Design: Activities for Learning.* Retrieved from
   http://britton.disted.camosun.bc.ca/Islamic_Art_and_Geometric_Design.pdf
   This link also includes a helpful section regarding resources and a glossary of terms.
2. Create your own tessellated pattern. Use pencil, compass, ruler and paper to create your design (or use Geometer's Sketchpad or a similar app if these technologies are available). You may wish to start from any number of grids available from many websites on-line to create your selected pattern (six- or ten-point geometric grid; tessellation grids; etc.)

Whole Group and Individual⇒ Making Connections through Mosaic Design
3. Art-making Inquiry Question: *How can you create a geometric design that reflects your understanding of the arts of Muslim Societies (Islamic art) and makes connections to your own personal identity and values, or a more contemporary society? How can you share your work in a more permanent presentation or a public forum? Consider these possibilities (and refer to the guiding questions below as you work through the creative process):*
   a. The class may decide to use the same pattern (i.e. hexagon or star-cross), and students may individualize their piece and then connect them together (choose the medium based on availability, e.g. paper tiles, or painting on white, matte ceramic tiles)
   b. Outside using sticks and found natural objects
   c. In snow similar to the artwork of Simon Beck
   d. Create your mosaics using a variety of recycled plastics

e. Use thin-set mortar to adhere glass, or found objects, to objects such as glasses (from the dollar store to make a vase or pencil holder) or plates or bowls
f. Carve your pattern into softoleum or Styrofoam and repeat your print on paper or a flat surface (paper, fabric, wall, floor, desk, etc.)
g. Create a stencil of your pattern and repeat it on a flat surface (as above)
h. Cut or pierce your pattern into fabric, textiles or even a pre-stretched canvas to employ the use of light in your design
i. Work with an existing patterned surface (ie. frost fence) and add found objects to the fence to create a repeating geometric patterns
j. Create a colouring book of your designs, and share with an elementary school class

Differentiated Instruction: Many of the activities outlined above can be differentiated to meet the varying needs of your students. Activities may be personalized to best fit a student's own interests and skill level.

Individual⇒Minds on Geometry
4. Math challenges:
   a. When designing the Aga Khan Museum, the architect and builders had a number of complex math problems to deal with. With your elbow partner, brainstorm a list of as many challenges you can come up with in 2 minutes.
   b. The building's footprint is 81 metres long and 54 metres wide. If we were to cover the entire floor in 16" x 16" ceramic tiles, how many tiles would we need to purchase? (Note – often architectural drawings use metric, while building suppliers still use an imperial measuring system. What do you have to do before you are able to answer this question?)
   c. The square courtyard of the building is 18 m x 18 m. How many cubic yards of concrete are required to pour a concrete pad that is 1 foot deep? If poured concrete costs $110 per cubic yard, how much did it cost to pour the pad in the courtyard?
   d. Find the math in your own art! Verify, using algebraic techniques and analytic geometry, some characteristics of your geometric drawing (e.g. verify that two lines are perpendicular, given the coordinates of two points on each line; verify, be determining side length, that a triangle is equilateral)
   e. Make a list of all of the math you had to use to complete the artwork you (and your class, in the case of a collaborative artwork) created. Refer to the Mathematical Processes (problem solving; reasoning and proving; reflecting; selecting tools and computational strategies; connecting; representing; and communicating).

Guiding Questions:
- *How does your planning and problem-solving combine both the Mathematical Processes and the Creative Process? How can you demonstrate your use of these processes?* (doodling; sketchbook; photo documentation; voice

recording; visual resources from museum visit or on-line; virtual bulletin boards [ie. Pinterest]; brainstorming)

- *Which of the elements and principles of design are most prominent in your design? How would your design change if you were to use different elements and principles?*
- *What changes to you notice when your design goes from one panel/tile to a number of repeated patterns? Does your eye move differently through your design when it is repeated? What are the new shapes that are created that you did not anticipate?*
- *As you work through the production of preliminary work in any of the activities above, how has your design changed or improved based on feedback from peers and teacher? What revisions or refinements have you made?*
- *In what ways have you used your visual arts skills in math? And your math skills in art?*

Assessment

A triangulated assessment strategy (observations, conversations and product) will be relied on throughout this unit, offering ample opportunities for assessing for, as, and of learning, while meeting the performance standards on the achievement charts.

Teachers will be looking for students to demonstrate:
- knowledge and understanding of content
- thinking skills through planning and processing and through critical and creative thinking
- communication by expressing and organizing ideas, and in creating a final product for a specific audience
- application of knowledge and skills to next context, and makes connections to themselves, their community or the world beyond them

A⊕L Assessment FOR learning
- Measured by reviewing the students' KWL chart (BLM #1), and through questions and responses through the background lesson.
- Teachers may wish to provide a more in-depth study based on the students' responses.

A⊕L Assessment AS learning
- Feedback from both teacher and peers, students monitoring their own progress and making adjustments, discussions, and teachers will pose questions to make students' learning explicit.
- Teachers can collect evidence of observations and conversations in a variety of ways from low-tech (paper notes, post-its, observation checklists, notes in staff handbooks) to using technology tools available (audio recording conversations and observations, Google docs, Evernote, blogs, etc).

A⊕L Assessment OF learning
- Students and teacher will co-construct a rubric outlining the success criteria to determine the essential learning for the final geometric design and the Choice Board activities (see below), and include in the overall response an opportunity for both student and teacher to share which aspects of the artwork or creative process were done well, which need improvement, and next steps.

🍎 Differentiated Instruction and Assessment

All of the inquiry-based activities and consolidation have ample opportunities for differentiated instruction and modifications during assessments, both by the student self-selecting the opportunities, or by the teacher encouraging individual students to choose appropriate activities for their own growth.

Consolidation   Choice Board   75 - 225 minutes

1. Go back to the KWL chart (BLM#1) that you filled out at the beginning of this unit. Complete the third column by adding all the things that you've Learned.

2. **Demonstrate your learning by completing one of the activities on the Choice Board attached as BLM #4**

Individual⇒Differentiated Assessment OF Learning
1. Respond to the guiding questions throughout this lesson in a blogpost
2. Create a travel brochure about the artwork and the areas from which it came
3. Create a Kahoot! (or similar app) quiz for your classmates on the essential learning for this lesson
4. Complete a Venn diagram (or similar graphic organizer on paper or with an app) about the similarities and differences between Islamic Art and Western Art during the same time period
5. Create a timeline showing key trends in Islamic Art and Western Art
6. Write a blogpost about your visit to the Museum and what you've learned about Islamic Art and how it has affected your identity and values
7. Film a news report about your trip to the Aga Khan. Interview some of your classmates. Include examples of art.
8. Film a news report about the collaborative artwork your class has created. Be sure to talk about what you learned through the process about math and art.
9. Your Choice (following a discussion with teacher)

Resources:
Henry, R. (n.d.). *Geometry – The language of symmetry in Islamic art.* Retrieved from
http://artofislamicpattern.com/resources/educational-posters/

Metropolitan Museum of Art. (2004). *Islamic art and geometric design activities for learning*. Retrieved from
http://britton.disted.camosun.bc.ca/Islamic_Art_and_Geometric_Design.pdf
(The Met also offers 91 videos on Islamic Art available on their website)

Ontario Ministry of Education. (2010). *The Ontario curriculum, grades 9 and 10: The arts, revised.* Toronto, ON: Queen's Printer for Ontario.

The Aga Khan Museum. (2016). *Aga Khan collections*. Retrieved from https://www.agakhanmuseum.org/collecction

The Aga Khan Museum. (2015) *Learning at the Aga Khan Museum.* Free pdf download at https://www.agakhanmuseum.org/learn/educators#teachers

Zhang, J. (2010). *Ornamente aus Osten und Westen - Patterns from East and West*. p. 2. Retrieved from http://jingzhang.de/portfolio/patterns-from-east-and-west/