NTTI Media-Rich Lesson

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NAME

"Tessellate Your Tessellations"
LESSON TITLE

Fifth Grade – Sixth Grade
GRADE LEVELS

Two (2) 60 minutes class periods
TIME ALLOTMENT

OVERVIEW

What does tessellation mean? Webster's definition is, "a covering of an infinite geometric plane without gaps or overlaps by congruent plane figures of one type or a few types." A tessellation is a repetitive pattern using one or more geometric shapes. These geometric shapes are called regular polygons. The shapes fit together with no holes or gaps. The word tessellate comes from the Latin word for tile. Tessellations are sometimes called tiling patterns. The simplest tessellation would be a checkerboard. Think of other examples. (Honeycomb, egg cartons, soccer balls, linoleum patterns). A polygon is a closed plane figure made by joining line segments (see figure I). A Regular polygon is a polygon whose sides are all the same lengths, and whose angles are all the same (see figure II).

Through the activities presented in this lesson, students will explore the geometric concept of tessellations, where tessellations are found in nature, what are tessellations, and determine which regular polygons will tessellate. Tessellation once meant tiling by using equal squares. It now means using any shapes that can be repeated in a way that leaves no gaps. Students will examine websites and video clips that will enhance their understanding of how tessellations are created.

SUBJECT MATTER
Geometry (Spatial Sense), Problem Solving & Reasoning & Art

LEARNING OBJECTIVES

Students will be able to:

- Identify regular polygons that will tessellate.
- Create a tessellation using a variety of regular polygons alone or in concert.
- Create sketches demonstrating all the possible tessellations through spatial reasoning and problem solving.
- Determine which figures will tile a plane.
- Work cooperatively and collaboratively on a project.
- Identify tessellations found in nature.

STANDARDS

National Standards for Teachers of Mathematics

Subject: Mathematics
Standard: 5 number 18
Level III: Middle School/Jr. High (Grades 6-8)
Description: Understands the concept of tessellation (i.e., a repetitive pattern of polygons that fit together with no gaps or holes).

Georgia's Standards

www.glc.k12.ga.us
Mathematics (5th Grade)

Standards matching this resource:

M.6.16 identifies congruent and similar geometric figures.

M.7.20 Compares and contrasts geometric figures with respect to congruency and similarity (scaling, dilations).

M.9-12.42 Constructs congruent geometric figures using reflections, translations, and rotations.

- Geometry: perimeter and area; volume, surface area, lateral area; angle and triangle classifications and relationships; symmetry, similarity, congruence; transformations; collinear points, distance between points, midpoint of segment; Pythagorean theorem.

M.9-12.19 Identifies and differentiates between similar and congruent figures and identifies figures that have been transformed by rotation, reflection, and translation.

M.9-12.32 Identifies congruent figures (images and preimages) formed by translating or reflecting geometric figures.

Art Standards (5th & 6th Grades)

11 Topics: Critical Analysis and Aesthetic Understanding

Standard: Illustrates how elements of art and principles of design are used in combination to create contrast in artwork.

MEDIA COMPONENTS

Websites

Interactive Games under this site:
The Tessellation Tool
This tool allows you to build tessellations and other designs by attaching the corners of various shapes to one another. To make a tessellation, you need to create an arrangement of repeating shapes, which leaves no spaces or overlaps between its pieces.
http://www.boxermath.com/plp/modules/online/workshop/toolbox/mosaictool.html

http://www.geocities.com/williamwchow/escher/escher.htm - this Web site talks about many of Escher's drawings and how they contain mathematical ideas never seen elsewhere.

http://www.worldofescher.com/
The world of Escher – gives a brief summary of his life.

Video(s)

1. Math Vantage #104: Tessellations/Transformations – Tessellations are explained and are shown in quilt patterns, architecture, and nature. The written material instructs students in making tessellations and increases skill in the transformations of rotating, reflecting, and translating shapes.

2. The Kay Toliver Files: Polygons – This video reviews polygons while introducing and guiding students in an investigation of the third dimension, as they transform polygons into polyhedral.

MATERIALS

- Pictures of mosaics (3 different pictures per cooperative group of 4 students)
- Transparency of mosaics for teacher use
- Cutouts of each polygon shape (classroom set -30 for each individual class) – make sure you have enough replacement worksheets.
- Baggies
- Internet Access
- Videos (Math Vantage, Kay Toliver Files) – 1 copy of each
- Television, VCR or DVD needed to view videos.
- Teacher should prepare dies shapes of the square, equilaterals triangle, hexagons, pentagons, trapezoids to be place in baggies. Use card stock paper when cutting out these shapes.
- White card stock (2 reams)
- Color pencils (class set of 30)
- 1 ream of copier paper
- Large posted chart paper – (1-2 pads should be enough)

- Pictures of different types of tessellations (overhead copies or a classroom set of teachers)

PREP FOR TEACHERS

1. Prerequisite: Students must be familiar with:
   - *Congruent* - having the same size and same shape.
   - *Symmetry* - a regular, balanced arrangement on opposite sides of a line or plane.
   - *Polygon* - a closed plane figure with three or more sides and angles.
   - *Translation* - when a figure slides in any direction.
   - *Rotation* - when a figure is turned around a point or vertex.
   - *Reflection* - when a figure is flipped across a line.
   - *Pattern - repeating shape*

2. Please, bookmark Web sites, load plug-ins, cue videotapes, and prepare student materials and View each video before showing to students and Web-based resources. Also, consider inviting a high school mathematics/art teacher, a local artist who is familiar with tessellations and the work of M. C. Escher, and your local hardware store expert on tiling floors.

3. Gather pictures of tessellation patterns in nature. See Attachments.

4. Do research on M.C. Escher (the mathematician/artist) and his work on tessellations.

5. Look at examples of paving, tiling, and tessellation encountered in everyday life.

6. Overhead transparencies of examples of tessellation patterns

Media Components

Overhead projector (optional)

Computer Resources:

- Modem: 56.6 Kbps or faster.
- Browser: Netscape Navigator 4.0 or above or Internet Explorer 4.0 or above. Macintosh computer: System 8.1 or above and at least 32 MB of RAM.
- Personal computer (Pentium II 350 MHz or Celeron 600 MHz) running Windows® 95 or higher and at least 32 MB of RAM
- Software: Excel (optional)

Bookmark these Sites:

TIP**:** Preview all sites before presenting them to the class.
Interactive Games under this site:
The Tessellation Tool

This tool allows you to build tessellations and other designs by attaching the corners of various shapes to one another. To make a tessellation, you need to create an arrangement of repeating shapes, which leaves no spaces or overlaps between its pieces.
http://www.boxermath.com/plp/modules/online/workshop/toolbox/mosaictool.html

http://www.geocities.com/williamwchow/escher/escher.htm - this Web site talks about many of Escher's drawings and how they contain mathematical ideas never seen elsewhere.

http://www.worldofescher.com/
The world of Escher – gives a brief summary of his life.

INTRODUCTORY ACTIVITY: SETTING THE STAGE (Engage)
Step 1
Open lesson on tessellations by pointing out the patterns of ceiling tiles, pictures of mosaics (figure V) and floor tiles in the classroom. Ask students to write a description of what shapes they can identify and identify the similarities and differences between the shapes (if any). Sample answers could be square, trapezoid, rectangle, i.e. Ask the students what they notice about these items. Start a list of student's observations on the board or use chart paper. Ask the students what they think these items have to do with math. Sample of an answer – these shapes are used when we study geometry. List those answers on the board. If students have not mentioned patterns, point out the patterns to them. Explain that these types of repeating patterns are called tessellations.

At this point, explain to the students that they will view a video on polygons. Teacher will provide a **FOCUS FOR MEDIA INTERACTION,** asking students to watch and listen to the video clip (The Kay Toliver Files on Polygons). **PLAY** the clip when, Mrs. Toliver says, "Ok pencils down". (Track 2:27). **PAUSE** clip track 3:49 – Mrs. Toliver's says, "We had someone say they saw hexagon, rhombus, and square." **CHECK** to see if your students can give the geometric group name of the shapes that Mrs. Toliver's students described. Teacher will then ask students "What do we call these shapes?" The answer: should be "polygons". **CHECK** for understanding asks the question: "Could someone give me the definition of a polygon?" Possible answer: A polygon is a closed figure with three or more sides. Teacher will display on the overhead the transparency of Figure I (Polygons). This display will give students a visual look at shapes that are polygons and those that are not. Start a discussion of the properties of polygons. Start a list of student's observations on the chalkboard or chart paper. After the group discussion provide a **FOCUS FOR MEDIA INTERACTION, start** the video clip on track 3:58. **PLAY** clip until it reaches track 4:27 and then **STOP.** This part of the video will affirm student's observation.

Arrange students in groups of four (4) for learning activity 1. Tell students that they will be using certain polygons to construct tessellations.

LEARNING ACTIVITIES

Learning Activity 1 -
Step 1
Insert Math Vantage #104: Tessellations/Transformations into your VCR.
Pass out worksheet #1
Turn on computer and LCD panel for Focus for Media Interaction
Bookmark the following Web site:
http://www.boxermath.com/plp/modules/online/workshop/toolbox/mosaictool.html

State your objectives for today's lesson:

- Identify regular polygons that will tessellate.
- Create a tessellation using a variety of regular polygons alone or in concert.
- Work cooperatively and collaboratively on a project.
- Identify tessellations found in nature.

Step 2
Open this part of the lesson by providing your students with a **FOCUS FOR MEDIA INTERACTION,** asking students to watch and listen for the definition of tessellation, what type of polygons are common to tessellation, and where tessellations are found in our everyday life on the video clip (Math Vantage #104: Tessellations/Transformations). **PLAY** clip until it reaches but pentagons cannot form tessellations **STOP** the video**. CHECKING FOR UNDERSTANDING,** teacher will have students recalls the properties of a regular polygon (Answer: sides are equal in length (congruent), angles are equal) and what is meant when something tessellates, and where tessellations are found through questioning.

1. What regular polygons are the only ones that work were making a tessellation? Answer: square, hexagon, & an equilateral triangle
2. What is the definition of a tessellation? Answer: a tessellation is a pattern of repeating, congruent shapes with no overlaps, or gaps.
3. What does the word congruent mean? Answer: same size or shape which can be
4. What is the fundamental region of a tessellation? Answer: the geometric shape that repeat in a tessellation.

Provide a **FOCUS FOR MEDIA INTERACTION: REWINDING** video to back to the beginning to allow your students to check their answers. **STOP** the video when it reaches but pentagons cannot form tessellations. Teacher should restate questions 1-4 and post student responses on chart paper or chalkboard.

Provide a **FOCUS FOR MEDIA INTERACTION,** asking your students to watch and listen for answers to questions 5-10.
START video when she says "so what about my tie...

5. Why do bees use a hexagon to build their habitat? (Answer: hexagon)

6. Why do they use hexagons to build the habitat? Answer: hexagons are the most efficient use of space in building their habitat.
7. How long did it take honeybees to figure this out? Answer: over million of years of evolutionary time.
8. How do we change the shape of the fundamental regions? (slide the shape-translation, turned – rotation; flip-reflection)
9. Name three professions that use tessellation? Answer: Architect quilt makers, & bee keeper
10. Why is the rectangular shape used for bricks in constructing building? (Answer: rectangles are the most efficient use of space for materials. They interlock. They are pleasing to the eye.

…

Reinforcing information on how to tessellate a regular polygon: Provide a **FOCUS FOR MEDIA INTERACTION,** by going to the Bookmark Web site on your computer (BoxerMath.com)
http://www.boxermath.com/plp/modules/online/workshop/toolbox/mosaictool.html -- The Tessellation Tool --This tool allows you to build tessellations and other designs by attaching the corners of various shapes to one another. To make a tessellation, you need to create an arrangement of repeating shapes, which leaves no spaces or overlaps between its pieces.

Teacher will demonstrate through animation how to tessellate an equilateral triangle. Have several students come up and demonstrate their understanding of tessellation allowing them to design a tessellation on this web site.

CULMINATING ACTIVITY

Bring closure to the lesson with an activity tied to lesson objectives. A hands-on component is often included here. Hands-on activities are investigative, exploratory lesson components where students reinforce concepts and processes through their own manipulation of data, documents, or materials.
Step 1:

Explain to your students that they will now create their own tessellation work of art. Begin by handing out to each student a baggie of geometric shapes, 1 pack of color pencils, one (1) sheet of plain white paper (practice sheet) and one (1) of card stock (final product).
Step 2

On the overhead projector, the teacher will place transparencies of figure III for student to get a **VISUAL VIEW** of different tessellation designs. Have a student give the definition of a tessellation. Teacher should point out on each design that none of the designs shows any gaps or overlaps of the geometric shape used.
Step 3

At this point teacher can demonstrate on the overhead how to use a shape to design a tessellation. Explain to your students that now they will begin to design their own tessellation work of art by either translating, rotating, or reflecting the regular polygon they have chosen.

Step 4
Explain to students that they will have 10 minutes to investigate the different shapes in their baggie using their plain white paper to experiment on. Tell them that they will **only be allowed** to use one (1) shape in their design. Once the 10 minutes are up have students show what they have created.

Step 5
Teacher will need to monitor student progression by walking, discussing each student's design, and assisting students who are having difficulties.

Step 6
Allow students to share their designs with the class (show & tell). Teacher should place student work on display around the classroom.

Evaluation
Explain to your students that they will be evaluated using a Rubric System. (Please see Figure IV for an example of a grading rubric that you can use with this lesson to grade your students' efforts on their tessellation design).

CROSS-CURRICULAR EXTENSIONS
List cross-curricular activities and interdisciplinary projects that may be generated from the lesson.

LANGUAGE ARTS (RESEARCH PAPER)/ART

Have your student read about M.C. Escher, the artist, the mathematician, the man, and his use of tessellation in his art. Have them visit the following web sites to read about M.C. Escher
http://www.geocities.com/williamwchow/escher/escher.htm - this Web site talks about many of Escher's drawings and how they contain mathematical ideas never seen elsewhere.
http://www.worldofescher.com/
The world of Escher – gives a brief summary of his life.
Have you student visit the Internet to locate additional Web sites that will assist them in their research.

Student should develop a power-point presentation and share their findings with other classes in their school or at a PTA meeting.

COMMUNITY CONNECTIONS

Include real-world actions students can take to follow through on lesson concepts. These include activities such as interviews, community-based art projects, performances, portfolios, and letter or email writing to relevant government, academic) or business personnel. For additional insight into community-based projects, go to the *Making Family and Community Connections* site at www.thirteen.org/edonline/conceDt2class/month9.

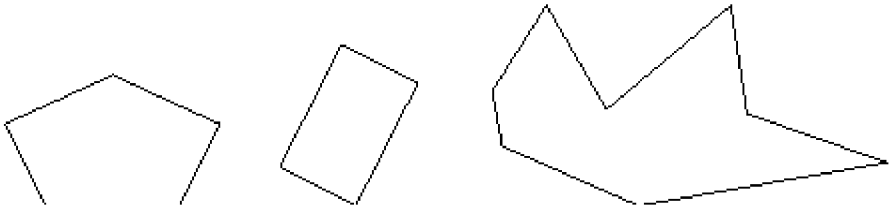
- If possible, find out if your local museum has any of M.C. Escher artwork on display and take a field trip to the museum.
- Invite an art teacher from a local high school, university or college to speak to your students about tessellations and to work with students on their tessellation designs.
- Take a field trip, if possible, to an area in your city that have lots of building and look at the tessellating designs of those buildings.

Figure I: Polygon

A polygon is a closed figure made by joining line segments, where each line segment intersects exactly two others.

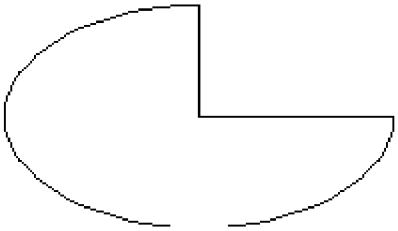
Examples:

The following are examples of polygons:



The figure below is not a polygon, since it is not a closed figure:

The figure below is not a polygon, since it is not made of line segments:



The figure below is not a polygon, since its sides do not intersect in exactly two places each:

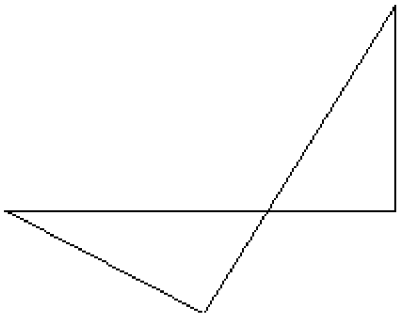
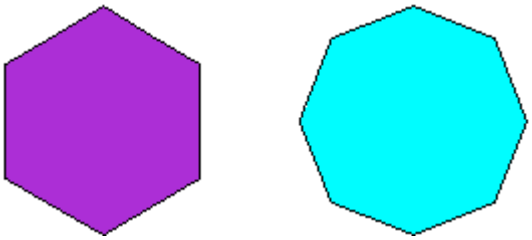


Figure II: Regular Polygon

A regular polygon is a polygon whose sides are all the same lengths, and whose angles are all the same.

Examples:

The following are examples of regular polygons:



Examples:

The following are not examples of regular polygons:

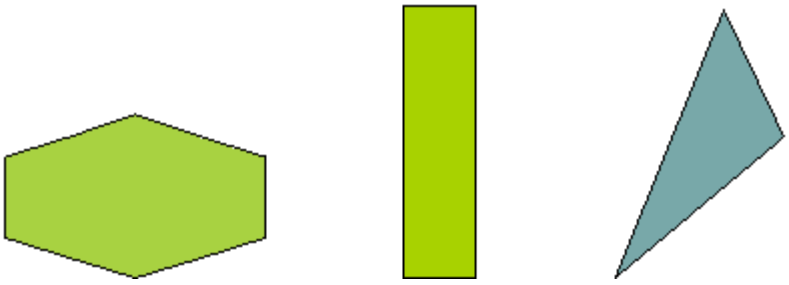
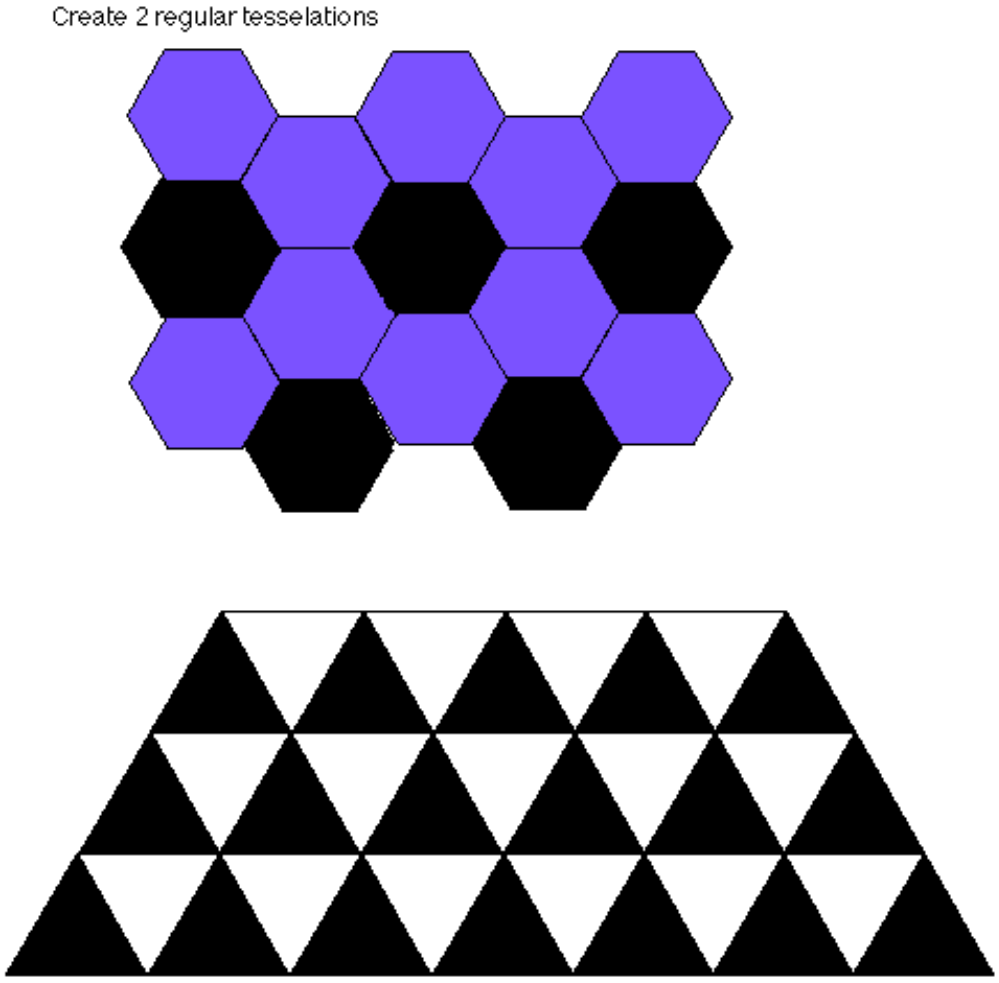
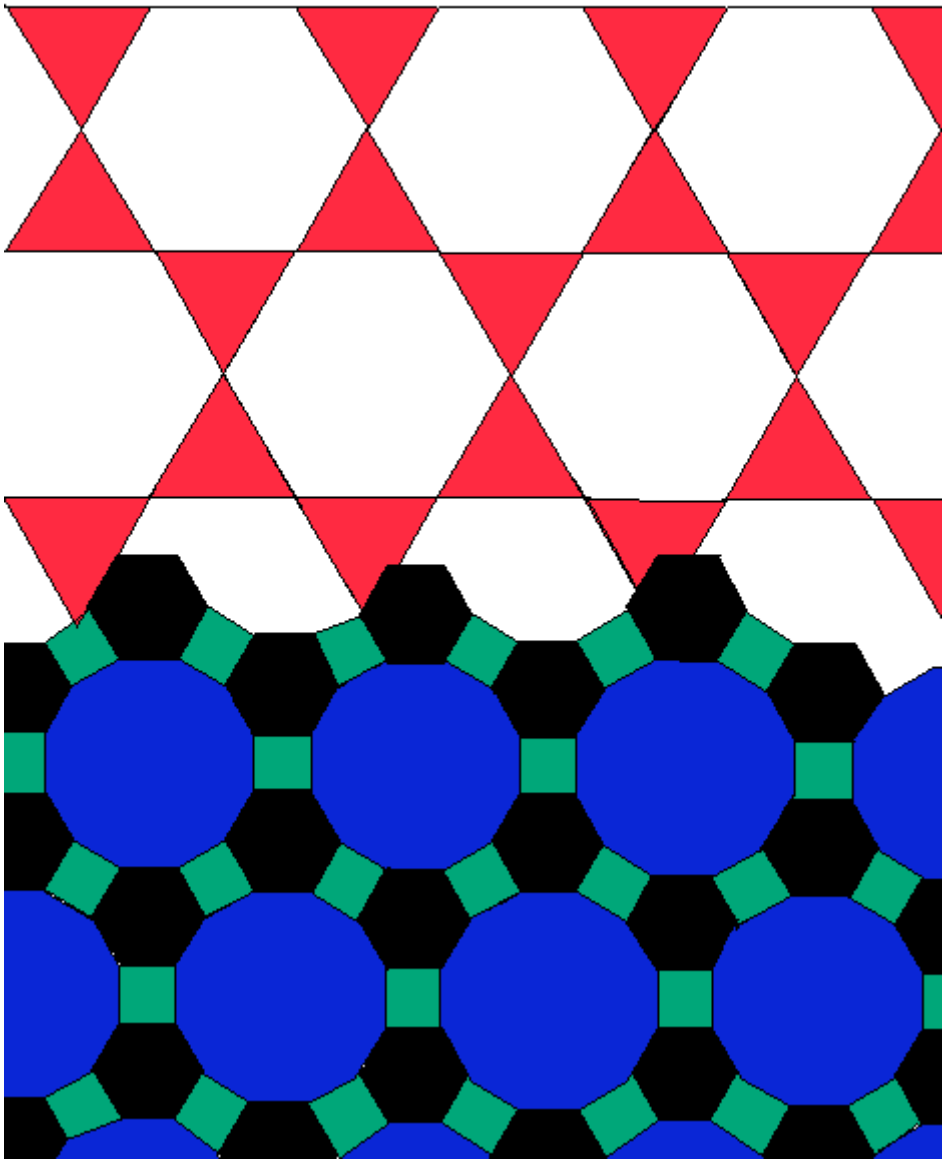
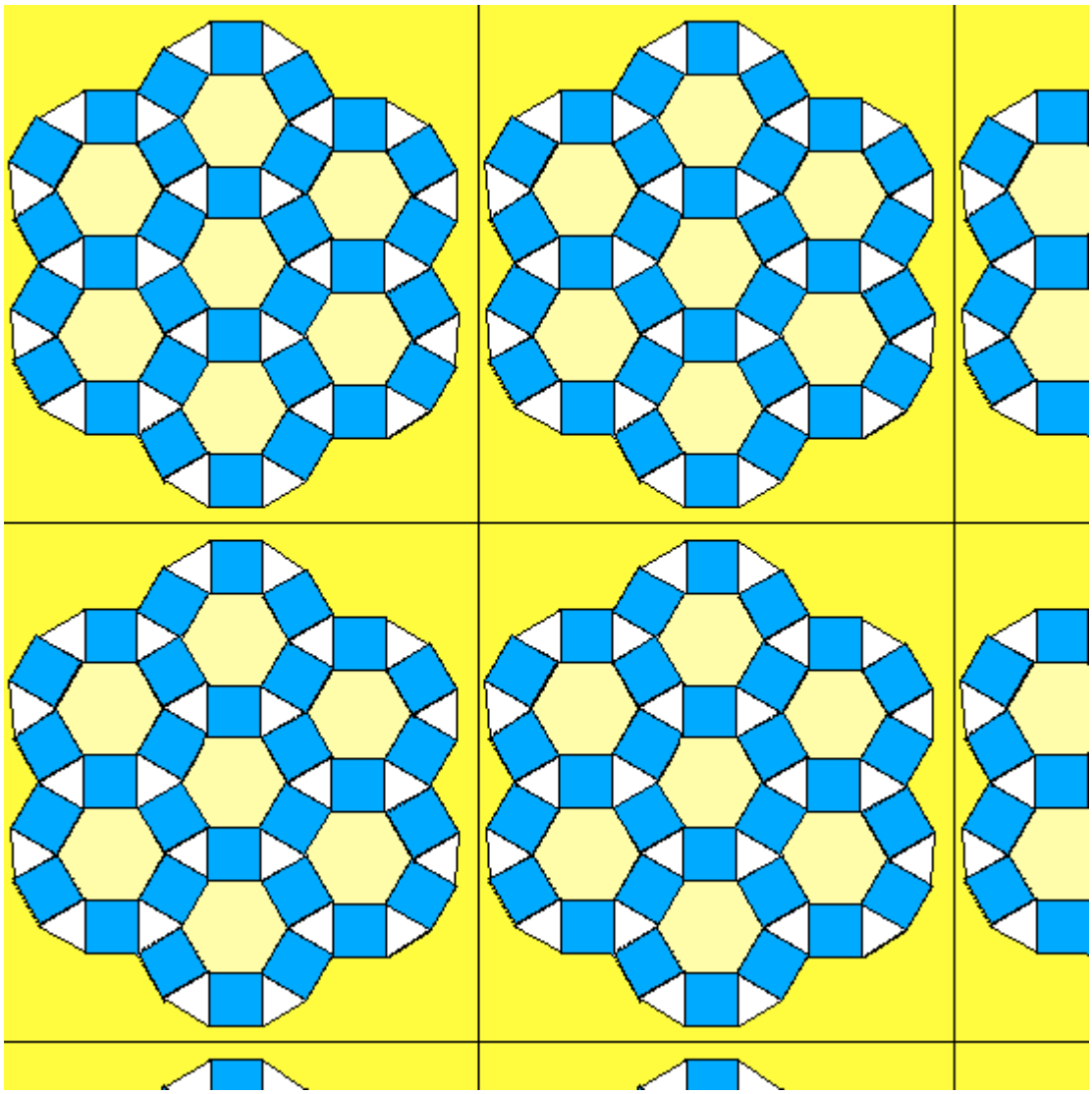


Figure III
Examples of tessellations



Create 2 Semiregular tesselations





Handout 4

Worksheet I

Name _____
Date_____

Video Questions on Tessellations

Math Vantage Video Questions
First Part of Video

1. What regular polygons are the only ones that work were making a tessellation?
2. What is the definition of a tessellation?
3. What does the word congruent mean?
4. What is the fundamental region of a tessellation?

Second Part of the Video

5. Why do bees use a hexagon to build their habitat?
6. Why do they use hexagons to build the habitat?
7. How long did it take honeybees to figure this out?
8. How do we change the shape of the fundamental regions?
9. Name three professions that use tessellation?
10. Why is the rectangular shape used for bricks in constructing building?

Figure IV

Possible Rubric

Dimensions of Performance	**4 points Excellence Score**	**2-3 points Satisfactory Score**	**1 point Below standard**
Creativity of tessellation design	Design is pleasing to the eye, very colorful, symmetrically correct (picture is balanced). Student did not have any gaps or overlaps in their design.	Design is pleasing to the eye, symmetrical, and colorful. Gaps or overlaps in their design were observed.	Design is colorful, but no symmetry is observed. Two or more geometric shapes were used in design. Gaps and overlaps of shapes are in picture, no symmetry.
Presentation of Tessellation design. Individual work	Student selected the correct geometric shape to tessellate. Student gave a clear description of why he/she chose that shape to tessellate. Picture was clean. Student finished project within the allotted time period.	Student selected the correct geometric shape to tessellate. Student gave a clear description of why he/she chose that shape to tessellate. Picture was clean. Student did not finish project in the allotted time.	Student did not select the correct geometric shape to tessellate. Picture was clean. Student could not give a clear description of why he/she chose that shape to tessellate. Student did not finish project in the allotted time.

Maximum number of points a student can receive is 8 for a grade of an A.
7 points - - B
6 points - - C
5 points - - D
4 or below – not passing

Handout 6

Mosaics