

MAISA and the REMC Association of Michigan Best Practices in Technology Integration Plan

Title: Terrific Tessellations

Subject(s): MATH:transformational geometry tessellations, symmetry, patterns.

Intended Grade Level(s): 4 - 6

Description:

Tessellation: A tiling, made up of the repeated use of a shape that completely fills a plane without gaps or overlaps.

Terrific Tessellations is a geometry unit that allows students to experience the excitement and beauty of mathematics beyond numerical calculations. This unit integrates art and math followed by a technology component. Students explore tessellations that are found in nature and everyday objects. They look at art connections in designs of fabric, quilts, and mosaics. The life and artwork of M. C. Escher is highlighted through examples of his work and related web sites. Students continue to explore transformational geometry through the use of pattern blocks and geometric shapes, and then they begin to create their own tessellations with paper and pencil. The terms translation, rotation, and glide reflection are introduced, demonstrated and developed. Finally, the software program TesselMania! is introduced to the whole class. This software actually shows students how a design was made and through a slideshow they can watch it tessellate. Students then work in pairs to explore tessellations and to create new tessellations combining their previous hands-on knowledge of tessellations and the power of TesselMania! A final project allows students to create designs that could be used for wrapping paper, posters, or clothing designs.

Curriculum Benchmarks:

[MI.MAT.I.1.E.1](#) Recognize, describe, and extend numerical and geometric patterns.

[MI.MAT.I.1.E.4](#) Explore various types of numeric and geometric patterns (repeating, growing, shrinking).

[MI.MAT.II.1.E.2](#) Describe the attributes of familiar shapes.

[MI.MAT.II.1.E.4](#) Draw and build familiar shapes.

[MI.MAT.II.1.E.5](#) Explore ways to combine, dissect, and transform shapes.

[MI.MAT.II.1.E.6](#) Recognize parallel and perpendicular line segments and figures that have similarity and/or congruence.

[MI.MAT.II.2.E.2](#) Locate and describe objects in terms of their orientation, direction and relative position, including up, down, front, back, N- S- E- W, flipped, turned, translated; recognize symmetrical objects and identify their lines of symmetry.

[MI.MAT.II.2.E.3](#) Explore what happens to the size, shape and position of an object after sliding, flipping, turning, enlarging, or reducing it.

Materials/Hardware/Software:

Hands-on materials: Pattern blocks, geometric shapes, paper, pencils, blank transparencies, markers, crayons or colored pencils, scissors, tape

Required hardware: Overhead, Macintosh LC or later, System 7 or later, 32-bit Quick Draw, at least 2.0 megabytes of free RAM, printer

Required software: TesselMania!, Minnesota Educational Computing Corporation, 1994.

Optional: Internet connection to explore various geometry sites and research the work of M. C. Escher.

Activities/Procedures:

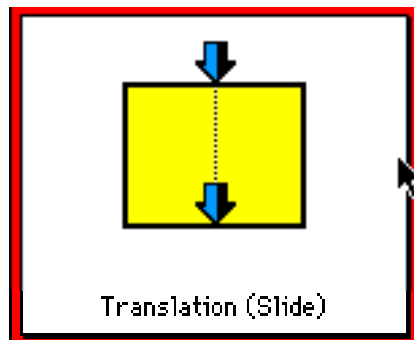
Preparatory Activities:

1. As a class, discuss the meaning of tessellation or tiling of the plane. Generate a list of tessellations that can be found in nature or everyday objects such as: kitchen or bathroom tiles,

honeycomb, patio bricks. Look at items (or pictures) of wallpaper, fabric, quilts, stained glass windows, mosaics.

2. Study the life and artwork of M.C. Escher. Check out books and websites that have collections of his work. Escher's work can be found on posters, T-shirts, giftwrap, ties, and mugs.
3. Use pattern blocks or geometric figures cut from paper or cardboard to clarify the concept of tessellations. Give each student one polygon and have them place it in the middle of a blank piece of paper (or a transparency) and trace around it. Then, lining the polygon up with any side of the traced image, have them trace the polygon again, repeating this process until they cover the entire page.
4. Working in pairs, have students investigate which polygonal shapes will tessellate and which ones won't. Discuss characteristics of tessellating figures.

Activity # 1: Introduction to Tessellations: Translations



Materials: Teacher: overhead projector, blank transparencies, copy of rectangle, markers, scissors, tape. Student: paper, pencil crayons or colored pencils, scissors, tape, and copy of rectangle.

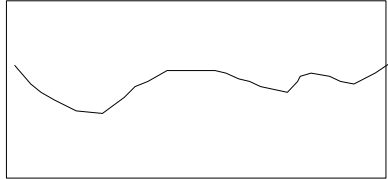
Rationale: Students who are unfamiliar with tessellations will benefit from a hands-on experience with translations before they begin to use the software.

Procedure:

1. Review the fact that certain polygons, such as triangles, quadrilaterals, and hexagons will tessellate the plane. Explain that

in this lesson they will learn a method of modifying a polygon so it will still tile the plane.

2. Distribute copies of a rectangle 2" by 3". Have students cut out the rectangle and use a light color to shade one side. Make a copy of the student rectangle on a colored transparency and cut it out. Recall with students that the rectangle will tessellate the plane.
3. Place your rectangle on the overhead projector and select any side. With a marker, draw a free-form line from one corner of the chosen side to the other. Students do the same. Keep the line fairly simple because they will be cutting on the drawn line. Suggest that the students flip the rectangle over so that they are drawing on the blank side.

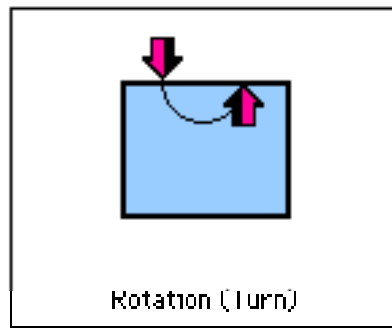


4. Cut along the line that has been drawn from one corner to the other. Remind students that they need to make a smooth cut so that they end up with only two pieces and no leftover scraps. Every piece of the rectangle must be retained.
5. On the overhead, demonstrate how to take the piece just cut and slide it across the rectangle to the opposite side. Make sure the edges are lined up and tape the two pieces together.
6. This type of move is called a "translation" or "slide." A translation is a type of geometric transformation; a transformation is used to change or transform the original figure.
7. Have students perform a translation with their piece and tape it in the appropriate position. Make sure that the blank sides of the two pieces are facing up.
8. Have students perform another translation on the remaining pair of sides. Do the same with your modified rectangle.
9. Once the two translations are complete, trace your modified shape in the middle of a transparency. Show that it tessellates by tracing

several more copies of your shape. Lead your students to identify the fact that translations are used both to transform the initial shape and to tessellate the plane.

10. Have students trace their shapes on paper to create a unique tessellation. Summarize the terms “tessellation,” “transformation,” and “translation.”
11. Have students color their tessellation creations and try translation with other polygons.

Activity # 2 Introduction to Tessellations: Midpoint and Vertex Rotations



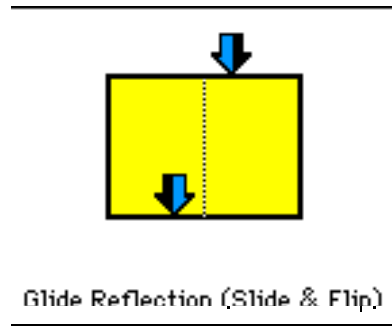
Materials and Rationale : Same as Activity #1, except instead of handout of a rectangle, prepare a handout of a right triangle.

Procedure: (Follow the same basic format of Activity # 1)

1. Demonstrate midpoint and vertex rotations using the overhead and handouts of a right triangle. Review the terms triangle, right triangle, hypotenuse and vertex.
2. Have students perform a midpoint rotation with their piece and tape it in the appropriate position.
3. Have students perform a vertex rotation with their piece and tape it appropriately.
4. After the two rotations are complete, allow students to add details to their transformed triangle.

5. Have students trace their shapes on paper to create a unique tessellation.

Activity #3 Introduction to Tessellations: Glide Reflections



Materials and Rationale : Same as Activity #1, except instead of handout of a rectangle, prepare a handout of a square.

Procedure: (Follow the same basic format of Activity # 1)

1. Demonstrate glide reflections using the overhead and handouts of a square. Review the terms quadrilateral and square.
2. Students perform the glide with the piece that they just cut.
3. Demonstrate how to take the piece that was just translated (glide) and reflect (flip) it. The combination of the glide and the reflection becomes the glide reflection.
4. In a similar manner, have students perform another glide reflection on the remaining pair of sides.
5. Trace the modified shape and continue to trace more copies of the shape on the transparency to demonstrate the tessellation to the students.
6. Have students trace their shapes to create a unique tessellation.

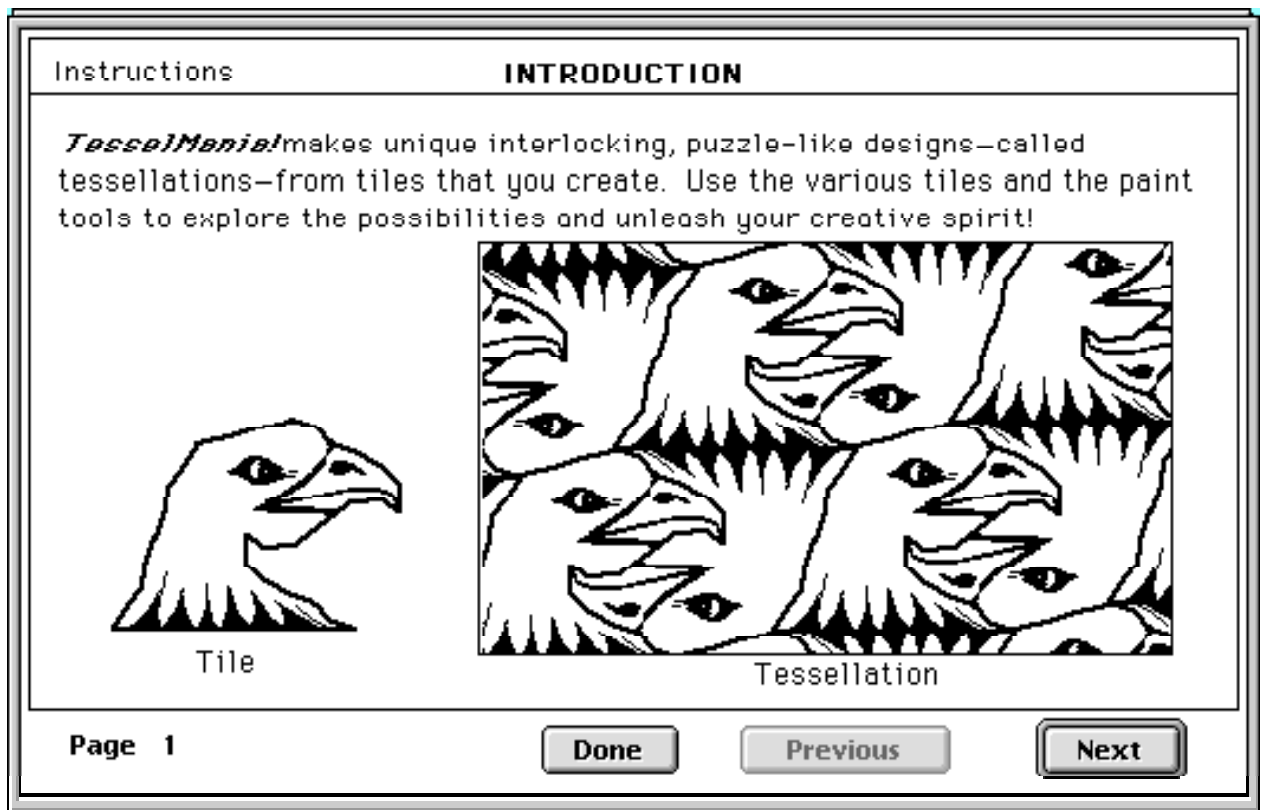
Activity # 4 : Introduction to *TesselMania!*

Teacher materials: One computer and large monitor or LCD display

Rationale: Seeing a demonstration of the software will help the students to get started with the program, to connect how it ties to their hands-on experiences with tessellations (Activities # 1 - 3), and see what options are available with the program.

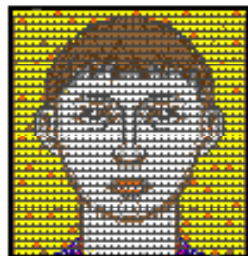
Procedure:

1. Open up the *TesselMania!* program. Following the logo screens, the start-up options will appear. Choose **New** to create a new document. Explain that the **Open** button is for opening a saved tessellation and **Instructions** provides a set of instruction for using the program. Go through the instructions on the screen. See below for samples of the introduction.

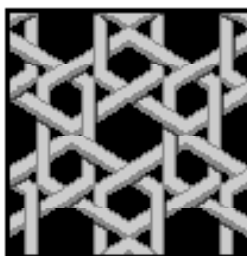


A tessellation is a tiling made up of copies of a shape that fit together with no gaps or overlaps. The word "tessellation" comes from the Latin word *tessella*—the small square tiles used in ancient Roman mosaics. For many centuries, people around the world have used tessellations to create decorative patterns.

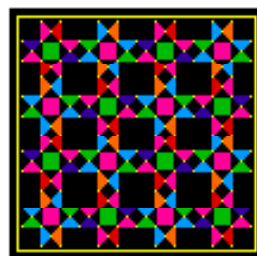
Today, you can find tessellations all around you—in a brick wall, a tiled floor, a quilt pattern, a lace tablecloth, or a fabric or wallpaper pattern.

Roman wall *tessella*

Celtic stone carving

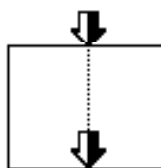


Star patterned quilt

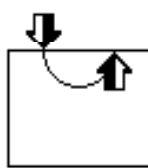
Islamic *celestia* screen

To create a tessellation, you must start with a tile. In *TesselMania!* you must choose the geometry of the tile. The geometry determines how you can change the tile outline and also how the tile fits together when it tessellates.

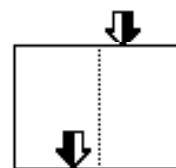
There are three kinds of geometric moves (transformations) that you can choose from: translation (a slide), rotation (a turn), and glide reflection (a slide and a flip). When choosing a tile, click on the "Show Me" button to see an animated example of the transformation.



Translation



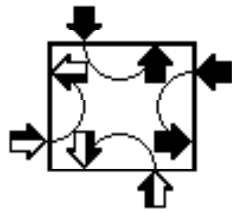
Rotation



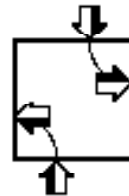
Glide Reflection

There are several ways a tile can be put together using translation, rotation, and glide reflection. You will need to select the particular tile you want to work with. For example, both of these tiles use rotation.

This tile uses rotations around the midpoint of each side.



cccc

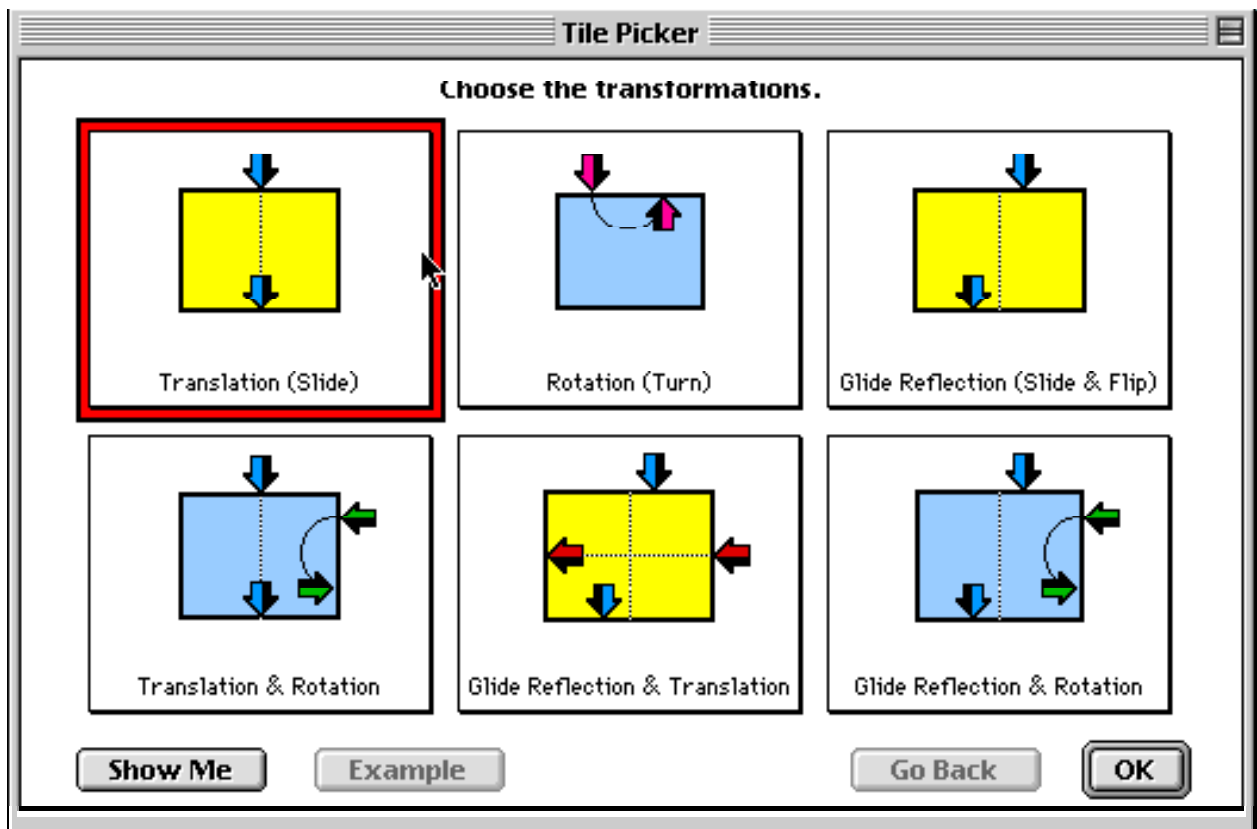


C4C4C4C4

This tile uses two rotations around vertices.

When selecting a particular tile, click on the "Show Me" button to see an animated example of the transformations.


2. After the introduction, select **New** and then "Translations". Demonstrate how to "see" a translation by clicking on the **Show Me** button. Click on the other transformational types, discuss what they are and the meaning of the arrows, and show students the examples.
3. Select "Translations" and the **OK** button. Demonstrate the options and use the **Show Me** button to see an animated example and **Example** button to see a sample tessellation. Point out that the **Go Back** button returns to the previous screen.





4. To transform the shape, select the **Arrow** and demonstrate how it can be used to move or reshape the original polygon. Select the **Tack** to demonstrate how to add points to the polygon.

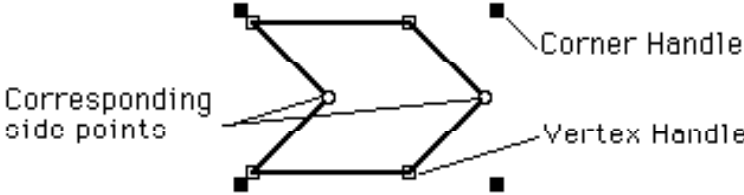
Instructions **CREATING A TESSELLATION**

TesselMania! provides three tools for changing the tile outline.

 Use the **ARROW** to move a tile, change its size by dragging a corner handle, or change its shape by dragging a vertex handle.

 Use the **TACK** to add points to the tile outline. These points can be dragged to change the shape of the tile. For each point you add, a second point will be added according to the geometry of the tile. When you drag a point, its corresponding point also moves.

 Use the **SCISSORS** to delete points you've added to the tile.



Corner Handle

Vertex Handle

Corresponding side points

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5. After the transformation is complete, illustrate the process of making an automatic transformation by clicking on **Tile Magic** to view an animated sequence showing how each transformation is carried out.
6. Demonstrate how to add details to the transformation with the paint tools.
7. Click on the **Tessellate** button to see the plane automatically tessellated with the new shape.

Additional:

8. Click on the **Tessellation Magic** button to watch the shape tile the plane step-by-step. Click on the **Metamorphic Magic** button to display the animation of the final tessellation as it is developed from the original polygon.
9. Use the **Edit Tile** button to return to the single tile and explain how to alter the tile with more colors or details.

Activity # 5 Using TesselMania!

Student Materials: One computer per student or pairs of students.

Rationale: This lesson allows student to begin exploring and become creative with tessellations by using transformation to gain familiarity with the computer program, translations, rotations, and glide reflections.

Procedure:

1. Students work individually or in pairs to create one tessellation to share with the class. Explain to the students that they will need to explain the type of transformation used to make the shape and how the shape was moved to fill the plane.
2. Ask students to create a title for their finished design.
3. If a projection system is available, have students display their tessellation to the class. The class can guess the shape of the original tile, and the type of transformation used to modify the tile, and

the transformation used to tessellate the plane. The students can then use the **Tile Magic** button to demonstrate how the tile was created and the **Tessellation Magic** button to show how the plane was filled.

Activity # 6: Design with TesselMania!

Teacher Materials: Sample of items such as wallpaper, wrapping paper, fabric or web sites with tessellation patterns.

Student Materials: Samples of tessellation patterns, one computer per student or pairs of students.

Rationale: Students combine their creative talents to create designs that could be used for wallpaper, wrapping paper, fabric, posters, or clothing designs.

Procedure:

1. Display teacher and student examples of tessellation patterns. Brainstorm uses to tessellation patterns.
2. Explain to students their goal of experimenting with TesselMania! to produce a design they could use on a product of their choice.
3. Give students opportunity to share their designs.
4. Have students compile a slide show of the various designs.

Assessment/Evaluation:

Evaluation is ongoing throughout this unit. Students should work together cooperatively to create, design and share tessellations. An continuing slide show can be developed with TesselMania! to share the creative talents of the students. As students discover new ways to tessellate, they can demonstrate and explain their discoveries to the class with the computer/TV connection. Journal entries, using geometric language, would facilitate in helping the students make sense of how objects tessellate. A culminating activity could be a final project which is designed, developed and produced by pairs of students and then is presented to the other members of the class. This project could be a creation of a tessellation design that can be

Score	Criteria	Examples
	<i>The student -</i>	
4 Exemplary	demonstrates clear understanding of key concepts	applied the concepts of polygons and tessellations orally or in writing
	designs accurate transformations	tessellations had no design errors
	exceeds requirements	tessellations showed a great deal of creativity in the final design product; participated actively in class discussions
3 Competent	demonstrates basic understanding of key concepts	comprehended the concepts of polygons and tessellations orally or in writing
	designs transformations with few errors	tessellations had some transformation design errors
	meets requirements	tessellations were completed satisfactorily; participated somewhat in classroom discussions
2 Needs some development	demonstrates partial understanding of key concepts	recognizes common polygons and tessellations
	designs transformations with many errors	tessellations had many transformation design errors
	meets some requirements	tessellations were completed inadequately; participated little in class discussions
1 Needs extensive development	demonstrates unclear understanding of key concepts	did not recognize common polygons and tessellations
	designs transformations with substantial errors	did not complete tessellation project

Follow-up Activities:

- Have students create a classroom slide show of various tessellation designs.
- Save slideshow on a videotape to share with other classes and parents.
- Explore the life and works of M.C. Escher.
- Make an annotated list of tessellation-related web sites.
- Develop a HyperStudio presentation about tessellations.
- Bind printouts of student tessellations together in book form.
- Analyze various tessellations to determine the beginning shape and method of design.
- Create class wrapping paper.

Resources:

Books:

Britton, Jill, and Dale Seymour, Introduction to Tessellations.
Palo Alto: Dale Seymour Publications, 1989.

Britton, Jill and Walter, Teaching Tessellating Art. Palo Alto: Dale Seymour Publications, 1992.

Web Sites: There are many tessellation-related websites. Here are a few to start with:

Download the TesselMania Demo

<ftp://forum.swarthmore.edu/software/demos/tesselmania.sea.hqx>

World of Escher

<http://lonestar.texas.net/~escher/>

HyperStudio & Tessellations in Color

<http://forum.swarthmore.edu/sum95/suzanne/colortess.html>

What is a Tessellation?

<http://forum.swarthmore.edu/sum95/suzanne/whattess.html>

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