

Annotated Lesson



A 5th grade Every Day Math Lesson

Tessellations

EDU 312, Fall 2004

Table of Contents

Click on the sections below to access each item

Section	Page Numbers
<u>Theoretical Foundation</u>	3-5
<u>Works Cited</u>	6
<u>Modification Key</u>	7
<u>Lesson</u>	8-17
<u>Every Day Math Information</u>	18-21
<u>Prior Knowledge Checklist</u>	22
<u>Exemplary Student Computer Tessellation</u>	23
<u>Average Student Computer Tessellation</u>	24
<u>Struggling Student Computer Tessellation</u>	25
<u>Exemplary Student Journal Activity</u>	26/27
<u>Average Student Journal Activity</u>	28-29
<u>Struggling Student Journal Activity</u>	30-31
<u>Exemplary Student “Create Your Own Tessellation” worksheet</u>	32
<u>Average Student “Create Your Own Tessellation” worksheet</u>	33
<u>Struggling Student “Create Your Own Tessellation” worksheet</u>	34
<u>Discussion of Student Learning</u>	35-39
<u>Lesson Reflections</u>	40-43

Theoretical Foundation

Creating lessons based on a theoretical framework is essential. Positive pedagogical theories must support lesson plans and instruction so as to facilitate students' thinking. This lesson plan, based on the fifth grade Every Day Math series concerning lesson 3.8 tessellations, is based on the theories of Piaget, Vygotsky, Van de Walle, Bloom, and Henry, Henry, and Riddoch. Theoretical foundations such as constructivism, social interaction and discussions, the use of whiteboards, manipulation of materials, cooperative learning groups, and higher order thinking are just a few of the theories that support my teaching philosophy and this lesson.

Piaget focuses on constructivism, prior knowledge, assimilation and accommodation, and stages of cognitive development. In this lesson, students are able to construct their own knowledge. After being shown numerous models of tessellations and having the opportunity to use technology to create similar patterns, students work to identify what a tessellation is, therefore creating their own knowledge of a tessellation. The definition of tessellation will not be introduced until students have acquired the concept of what a tessellation is, supporting constructivism as well. They will work in groups and individually to use one another to begin constructing their own knowledge.

Students at this age level (10-11 years) are in Piaget's concrete operational stage in which "they solve problems by manipulating concrete objects" (Sherman and Sherman 76). To determine the properties of tessellations, students will be able to use common objects such as tile, ties, checkerboards, and pillowcases as well as pattern blocks and a pattern block web site. Simply stating what a tessellation is would not be sufficient. Students in this stage need to use a variety of manipulatives to support their ideas. By using common objects that students are familiar with, they will be more likely to connect tessellations to their prior knowledge and use processes of assimilation and accommodation to include these ideas into their repertoires. Piaget's model "tells us that students come to use not with blank minds but with previous learning" (Sherman and Sherman 72). Prior knowledge will be assessed through questioning, initial building of patterns, and a checklist to determine students' misconceptions and base future instruction according to students' current ideas.

Vygotsky's theories are also supported by this lesson. Vygotsky supports constructivism as well as social interaction and working in the zone of proximal development. In this lesson, students first work in partners to create tessellations. "Vygotsky believed that through social

interaction, children gain knowledge from peers, older children, and adults who know more and have more experience” (Sherman and Sherman 78). By working in pairs, students will be able to build off of one another’s ideas and create a more advanced understanding through social interaction and the internalization of discussions. By assessing prior knowledge, the teacher will be able to see where the students are cognitively and push to have them work in their zone of proximal development through scaffolding. By including guiding questions in this lesson, a basis for scaffolding is created.

Van de Walle’s theories are incorporated into this lesson in numerous ways. First, Van de Walle believes that students can impose their concepts on a model. “The more ways that children are given to think about and test out an emerging idea, the better chance it has of being formed correctly” (Van de Walle 30). By using models such as common objects and pattern blocks, students are given a variety of models to impose ideas upon. Van de Walle also supports cooperative learning groups as he states, “In groups or pairs, children are much more willing and able to speak out, explore ideas... and take risks” (Van de Walle 33). By working in pairs to discover what tessellations are, students will be more willing to test out their ideas and take risks. This lesson also uses cooperative learning strategies such as think-pair-share to encourage collaborative thinking throughout the lesson. Van de Walle also mentions a variety of assessment procedures including checklists for individuals or groups.

More specifically, Van de Walle addresses the teaching of tessellations. Van de Walle suggests using only one and no more than two colors to build tessellations (Van de Walle 357). In this lesson, all the examples use only one or two colors. Furthermore, when students build their own tessellations they only use one or two shapes of pattern blocks, therefore limiting them to one or two colors. Van de Walle also suggests telling students to “work from the center out,” which is stressed as students create their own tessellations on the web site (Van de Walle 358).

Bloom’s Taxonomy is another pedagogical theory supported by this lesson. This taxonomy “provides a basis for planning activities that require complex, critical thinking” (Zarrillo 84). This lesson incorporates a variety of levels. First, students use the knowledge level as they recall previous ideas to create an initial idea of what a tessellation is. The comprehension level “is the ability to state or restate the main idea of something” (Zarrillo 84). Students work in groups in this lesson to discover the main idea of what tessellations are, and then are required to state this main idea in numerous instances. Students focus on the application

level as they apply their ideas to more specific ideas of regular tessellations to discover which regular polygons form regular tessellations. In the synthesis level, “the learner creates something new as the parts of something are rearranged into an original configuration” (Zarrillo 84).

Students will use the synthesis level as they create their own regular tessellations based on the knowledge they have acquired about tessellations and regular tessellations.

The ideas of Henry, Henry, and Riddoch address the use of whiteboards in instruction as shown in the article *Whiteboarding Your Way to Great Student Discussions*. Using whiteboards in think-pair-share activities as well as group work, students will be “more likely to develop a critical opinion...students can easily see what is being written and drawn, and also know that it is easily modified” (Henry, Henry, and Riddoch 2). Students have the opportunity to use whiteboards in numerous instances throughout this lesson, allowing both the students and the teacher to gain a greater understanding of how others are thinking. Henry, Henry, and Riddoch also support presentations of whiteboards. Through this lesson, students will have the opportunity to present their ideas in groups to the rest of the class.

Using a theoretical framework as the basis of instruction is imperative. This lesson about tessellations supports the ideas of Piaget, Vygotsky, Van de Walle, Bloom, and Henry, Henry, and Riddoch. The facilitation of student learning is a process that involves pedagogical theories as well as personal theories, all of which are supported by this lesson.

Works Cited

- Henry, David, Julie Henry, and Stephanie Riddoch. "Whiteboarding Your Way to Great Student Discussions." 2003.
- Sherman, Sharon and Robert Sherman. Science and Science Teaching: Methods for Integrating Technology in Elementary and Middle Schools. New York: Houghton Mifflin Co., 2004.
- Van de Walle, John A. Elementary and Middle School Mathematics: Teaching Developmentally. 5th ed. New York: Person Education, Inc., 2004.
- Zarrillo, James J. Teaching Elementary Social Studies: Principles and Applications. 2nd ed. New Jersey: Pearson Education Inc., 2004.

Modifications of the Lesson



Modifications made during the lesson



Modifications suggested by CT



Modifications based on lesson reflections

Name: Pamela Szeffler

Subject: Math (Every Day Math)

Grade: Grade 5 (25 students)

Date: November 1, 2004

Time: 60 minutes (8:25-9:25)

3.8 Regular Tessellations

Background and Big Ideas:

This lesson is the eighth lesson (3.8) in *Unit 3 Geometry Explorations and the American Tour*. Before this lesson, students will already have participated in lessons in which they explore angles, use a protractor, use a compass, explore congruent triangles, and determine the properties of polygons. After this lesson, students will investigate angles of polygons and solve problems using the geometry template. Students should be thinking about and discovering the following Big Ideas:

1. An acute angle has a measure that is greater than zero degrees and less than ninety degrees; obtuse angle has a measure greater than ninety degrees and less than one-hundred-eighty degrees; and a right angle has a measure of exactly ninety degrees.
2. There are 360 degrees in a circle and 180 degrees in a straight line.
3. A protractor is used to measure angles and a compass is used to draw a circle and copy a line segment.
4. Triangles can be defined as either equilateral (three sides same length), isosceles (at least two sides same length), or scalene (no sides same length) based on the measure of their sides.
5. Shapes are congruent if they have the same size and shape.
6. Polygons can be classified based on whether or not they are regular, convex or non-convex, have parallel sides, and angle measures.
7. Tessellations are arrangements of repeated, closed shapes that cover a surface so that no shapes overlap, and there are not gaps between shapes. Regular tessellations are formed when one regular polygon can tile a plane.

Since this lesson comes late in the unit, many of the Big Ideas will already have been discussed in previous lessons. Therefore, students should have already acquired Big Ideas 1-6. This lesson will mainly focus on Big Idea 7. Students will use a pattern block website and common objects such as checkerboards and the floor to determine the qualities of tessellations, and more specifically regular tessellations. They will create their own tessellations using these qualities as well.

Assessment of Understanding/ Application to Bloom's Taxonomy:

Assessment of this lesson will first be based on group work, then individual assessment the day of the lesson, and then individual assessment in the future.

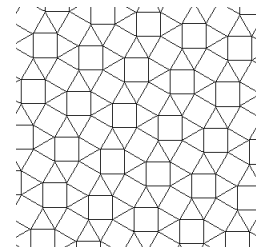
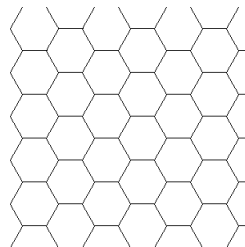
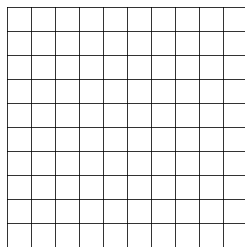
1. During the lesson, students will have the opportunity to work in groups of two using a think-pair-share strategy to determine qualities of tessellations. Groups will share their ideas orally with the teacher, and the teacher will use a checklist to evaluate students' prior knowledge. This uses the Knowledge level since students are simply recalling information they may have learned in previous instances.
2. Student will then work in pairs to design their own tessellations and to locate tessellations around the classroom. As a way to assess prior knowledge, the teacher will observe each

group while they create tessellations on the computer and work to discover the characteristics of a tessellation. The teacher will collect the printed copies of their tessellations to determine if the pairs can create a tessellation without any gaps or overlapping. This formative assessment is based on the Knowledge level since it is just assessing what students may already know before new knowledge is introduced.

3. Another form of formative assessment will evaluate students independently as they complete EDM journal pages 86 and 87. Students will work to complete the page which requires them to identify regular polygons and whether or not they tessellate. This uses the Analysis level because students will be analyzing shapes to see if they fit the characteristics of a regular tessellation.
4. As a form of summative assessment after the lesson (Wednesday morning), students will complete a worksheet in which they will be required to draw a regular tessellation and identify three characteristics of why it is a regular tessellation (pattern, no gaps, no overlapping). This uses the Synthesis level because students will actually be creating their own regular tessellations using their knowledge about tessellations.

****If I would do this lesson again, I would have students use only one shape to create their tessellations. Once I am sure they can create a tessellation with one shape, only then would I allow them to make a tessellation with more than one shape.****

5. As a form of summative assessment in the future, students will have to answer questions on the unit test that deal with tessellations. Students will be shown three pictures and will be required to determine which are regular tessellations and why. For example, students may be shown the following figures and may be asked to write three reasons why each is or is not a regular tessellation.



Room Set-up:

- Students will sit in their normal seats, which are already grouped into sets of four (one group of 5)
- During presentations, students will stand around their desk groups facing the class.
- An overhead will be located at the front of the room.

Sources:

Everyday Mathematics. Fifth Grade Teacher's Lesson Guide. Volume 1. Chicago: Everyday Learning, 2002 181-184.

Van De Walle, John A. Elementary and Middle School Mathematics. New York: Pearson, 2004 357-358, 374.

http://ejad.best.vwh.net/java/patterns/patterns_j.shtml

NYS Standards:

MST Standard 1: Students will use mathematical analysis, scientific inquiry, and engineering design, as appropriate, to pose questions, seek answers, and develop solutions.

MST Standard 3: Students will understand mathematics and become mathematically confident by communicating and reasoning mathematically, by applying mathematics in real-world settings, and by solving problems through the integrated study of number systems, geometry, algebra, data analysis, probability, and trigonometry.

Key Idea of Concept Key Idea 1: Mathematical Reasoning: Students use mathematical reasoning to analyze mathematical situations, make conjectures, gather evidence, and construct an argument.

Performance Indicator or Area 1A: Apply a variety of reasoning strategies.

Major Understanding 1A4: Use a variety of problem solving strategies

Major Understanding 1A5: State problem in own words

Performance Indicator or Area 1B: Make and evaluate conjectures and arguments, using appropriate language.

Major Understanding 1A4: Clarify problems with peers

Using inquiry, students will identify the characteristics that make a tessellation and regular tessellations. They will have to state these ideas in their own words. They will then use mathematical reasoning to determine if other figures are tessellations or not. Working in groups and individually, students will decide whether or not certain figures are regular tessellations using problem-solving strategies.

Key Idea of Concept Key Idea 4: Modeling/Multiple Representation Students use mathematical modeling/multiple representation to provide a means of presenting, interpreting, communicating, and connecting mathematical information and relationships.

Performance Indicator or Area 4A: Visualize, represent, and transform two and three-dimensional shapes.

Major Understanding 4A1: Analyze the effects of combining, subdividing, and changing basic shapes.

Major Understanding 4A2: Use geometric ideas to solve problems.

The students will have the opportunity to use a pattern block website and other geometric figures to determine whether they tile a plane. Students will then have to use this knowledge to solve problems concerning regular tessellations.

Key Idea of Concept Key Idea 7: Patterns and Functions Students use patterns and functions to develop mathematical power, appreciate the true beauty of mathematics, and construct generalizations that describe patterns simply and efficiently.

Performance Indicator or Area 7E: Apply the concept of similarity in relevant situations

Major Understanding 7E1: Use concrete and artistic experiences to explain similarity and congruence in plane geometric figures.

Performance Indicator or Area 7F: Use properties of polygons to classify them

Major Understanding 7F1: Classify polygons by properties and develop definitions.

Performance Indicator 7G: Explore relationships involving points, lines, angles, and planes.

Major Understanding 7G1: Understand the basic characteristics of angles.

Using inquiry activities, students will identify the patterns found in tessellations. They will then find how pictures of tessellations are similar to one another. They will then draw their own patterns of regular tessellations.

ELA Standard 1: Students will read, write, listen, and speak for information and understanding.

ELA Standard 4: Students will read, write, listen, and speak for social interaction.

Students will work in groups to record ideas concerning tessellations. Groups will then state their ideas orally to the class.

Objectives:

1. Given pictures of tessellations, students will work in pairs to determine the characteristics associated with tessellations (i.e. repeating patterns, no overlapping, no gaps), stating their answers orally.
2. Given a pattern block website, students will work in pairs to create their own regular tessellations, printing their tessellations.
3. Given pages 86 and 87 of their EDM journals, students will work in pairs to determine shapes that are regular polygons and whether or not these shapes form regular tessellations, recording their answers in their journals.
4. Given a regular tessellation worksheet, students will draw their own regular tessellations and state in writing three characteristics that make it a regular tessellation (i.e. made of regular polygon, only one shape used, tiles entire surface).

If I would do this lesson again, I would have students use only one shape to create their tessellations. Once I am sure they can create a tessellation with one shape, only then would I allow them to make a tessellation with more than one shape.

5. Given cooperative learning groups, students will work in groups appropriately by asking questions, observing appropriate volume, and taking turns.

Materials:

- Everyday Mathematics Fifth Grade Teacher's Lesson Guide pgs. 181-184
- Math Journal p. 86 & 87
- Create Your Own Regular Tessellation worksheet (30)
- Small whiteboards and markers (25)
- Large whiteboards and markers (6)
- Pattern blocks (5 for each group- total 30)
- 50 pre-cut pentagon and octagon shapes
- Group work checklist

- Checkerboard
- Tie
- Pictures of tessellations (7)
- Overhead of tessellation
- Pillow case
- Tile piece

Activities and Procedures:

Anticipatory Set/Assessment of Prior Knowledge (estimated time 5 minutes)

1. “Boys and girls, we are going to start math, so you may take out your math journals and a pencil, and clear your desks of everything else.”
2. Once the students’ desks are cleared, I will ask, “By a show of hands, who here has ever made a puzzle?” Explain that they are going to make puzzles in math today.
3. Hold up the checkerboard and say, “This is an example of the math puzzle” and then hold up the tile, pillow case, tie, and put up an overhead and repeat the same statement.



Items used to show what a tessellation is during the anticipatory set

4. Conduct a think-pair-share activity in which students describe what is similar between the puzzles and what makes them special.
 5. I will tell the students that I am going to give everyone a minute to think to themselves what is similar between these items. When I call pair, share your ideas with the person next to you. When I call out share, share your ideas with the people at your table, and then I am going to call on people to share ideas.
 6. “I will do a clapping rhythm like this (demonstrate rhythm). That is your cue to stop what you are doing, put down your supplies, stop talking, and look up here. You should join me in clapping. Let’s try it.” Perform clapping rhythm, have students do the same.
 7. Tell students to start thinking to themselves what makes these figures similar to one another. During this time, the teacher will walk around the room and record students’ comments on a checklist.
 8. Students should say that the same shape is repeated, covers the whole surface, etc. If they don’t, ask questions then guide them such as “What can you tell me about the shapes, etc.”
- ** To improve instruction, students should identify patterns they see in the classroom, school, or at home, and should also draw some patterns of their own.****
9. Once students identify that they form patterns, don’t have gaps, and don’t have overlaps, have them repeat these three qualities out loud.

10. Tell the students, now that we know three characteristics of these special puzzles (pattern, no gaps, no overlaps) we can name this special puzzle. "It is called a tessellation."
 11. Write the word on the board.
 12. Have students repeat the word three times with the teacher, and then state the three characteristics out loud again and have students repeat.
 13. Explain to students, "When I have to remember or say a big word, I often make a song for that word, so I made a song for tessellation."
 14. Pass out the song lyrics.
 15. Explain that I will sing it first and then students should join in.
 16. Sing the song "Tessellation Tessellation, forms patterns all around/ Tessellation Tessellation, no gaps or overlaps found"
 17. Have students sing along a second time.
- ** If I were to do this lesson again, I would make sure to have students identify examples and non-examples so that I am sure they understand the concept and are not just repeating the song.**



Here is a picture of one student singing the Tessellation Song!

Main Activity #1 (estimated time 20 minutes):

1. Explain to students that they are going to have a chance to use a website to create their own puzzles to look similar to those they saw with the checkerboard, tie, etc.
 2. Hold up the demonstration pieces, and explain they are going to use a web-site to create their own tessellations; one with only 1 shape and one with 2 shapes.
- ** Have students tile the entire surface to identify any errors in patterns.**
3. Have everyone look at the television screen, and explain and demonstrate how to get to the website and how to move the pieces around. Demonstrate for students and remind them to "work from the center out" (VDW 358).



A television/computer connection aids in the explanation of directions.

4. Explain to students that they are going to work in pairs with the person sitting next from to them. Remind students of good group work. Each pair will have ten minutes to make two of these puzzles. One will be with only one shape (point to yellow octagon puzzle) and one with two shapes (point to red and green pattern). As Van DeWalle suggests on pg. 357, only one color will be used for each shape “so that the focus is on the spatial relationships.”
 5. Explain that once they have their puzzles, they must let Mr. Heer or I know by raising their hands, and then they will be able to print them in black and white which Mr. Heer and I will show them how to do.
 6. Have students restate the directions.
 7. Remind students that they need to be quiet in the hallways and Media Center because classes are still going on.
 8. Call tables to line up quietly at the door.
 9. Take students to the Media Center or classroom computers/commons and assign them to computers.
- ** Mr. Heer took 12 students to the Media Center because there was a conference going on in the next room****
10. Once students are seated, walk them through getting to the website.
 11. Once at the website, tell the students they may begin.
 12. While students are working, the teacher will walk around and observe groups.



Students work on a web-site to create their own tessellations



13. At the end of ten minutes, the teacher will make sure students have printed and will have them line up and walk quietly back to the classroom.

****I had only a few students print their tessellations due to time constraints.****

14. The teacher will have students write their names on their figures and will call on groups to hold up their figures for the class to see, and ask if they ran into any problems. “Did any shapes overlap or have any gaps?”

**** This would be a great point to identify any errors in pattern formations.****

Main Activity #2 (estimated time 5 minutes)

1. Tell students that tessellations, especially regular tessellations, are all around. Remind them of the checkerboard and pillow case
2. Explain to students that everyone should think of a tessellation they see in the classroom, have seen around school, or have seen at home. Tell them that I will call on someone in a minute so everyone should be thinking.
3. Tell the students they may begin.
4. After a minute, the teacher will call on students to share a few ideas.

**** I included this activity at the end of the lesson. I told students to find an item around school or home that is a regular tessellation and report it back to me on Wednesday morning.****

****If I were to do this lesson again, I would have students record their ideas on a piece of paper as an extra form of assessment to see if students can recognize tessellations in the real world.****

Assessment/ Independent Practice (estimated time 10 minutes):

1. Have students open math journals to page 86.
2. Instruct students to underline the word tessellation on the top of their paper and then write the three characteristics of tessellations from the board onto their paper.
3. Call on a student to read the first directions of the sheet. Have students circle the three polygons that are regular polygons and underline the same measure of sides and same angles measures.
4. The teacher will be walking around the room making sure all students are writing the correct answers.
5. Explain to students that regular tessellations are formed from regular polygons that tile an entire surface.

**** I had students restate the degree measures of equilateral triangles and squares from a lesson the previous week.****

6. Tell students, using pattern block pieces (pass them out) they should complete p. 86 and p.87 to see which regular polygons form regular tessellations. Explain that they will have to share their pieces with others at their table.

**** Students also used their templates to make figures as well.****

****For students who have difficulty manipulating objects, they can use the website to create accurate tessellations.****

**** One suggestion my CT made was to demonstrate what I wanted the students to do. Some students didn't understand how to draw their figures, which led to me and the classroom teacher having to assist individuals in the drawing.****

7. While students are working, the teacher will walk around and observe students' answers.

8. When students are finished, perform clapping rhythm to cue students to stop what they are doing and look up front.
- ** A few students were confused on what they actually had to do with the shapes, so I stopped the lesson and did a demonstration on the board.**
9. Call on students to share their answers, and record them on the board.
10. Walk around and make sure students copy the right answers.
11. Ask students, based on their journals, what three regular polygons make regular tessellations?
12. Call on two students to share.
15. Explain to students that there are only three regular tessellations: triangles, squares, and hexagons and have students repeat the three regular tessellations out loud and circle them in their journals.



Here, a student uses pattern blocks to answer the questions on p. 86 and p. 87

Main Activity #3 (estimated time 15 minutes):

1. Pose the question, “Why do only triangles, squares, and hexagons form regular tessellations? Why don’t octagons or pentagons work?”
2. Explain to students that they are going to work in their desk groups to answer these questions.
3. Explain that each desk group will get a white board. They must write down why they think triangles, squares, and hexagons are the only regular polygons that can form regular tessellations. They will have ten minutes.
4. Remind students of good group work (listen to others, ask questions, try to understand each other’s ideas) and explain they must chose a person to write or take turns writing ideas.
5. Give each group a white board and tell them they may begin.
6. During this time, the teacher will be walking around the room observing student ideas.
7. After ten minutes, perform the clapping rhythm.
8. Have each desk group stand around their desks and share their ideas. Try to have everyone talk by calling on students to share pieces of the ideas.
9. Use student ideas to guide students to the understanding that the angle measures of a regular polygon must have a multiple of 360 degrees for it to tessellate.
10. Show students an example using squares on the overhead. Ask how many degrees an angle of a square measures. Circle the inner angles to show that they form a circle, which equals 360 degrees (90 degrees times 4). Perform the same exercise with an equilateral triangle.

** I had to alter this activity due to time constraints. Since the classes switch, I did not have enough time to go into the white boarding activity. Instead, I put four squares on the overhead, and asked the students “Why do only triangles, squares, and hexagons form regular tessellations?” I had students think to themselves and then I called on students to share. A few students mentioned size, so I guided them to think about the measure of the angles, having them restate that an equilateral triangle has 60 degree angels. I then performed step 10.**

**If I had the opportunity to do this lesson again, I would actually make this activity an entire lesson to make sure students understand question four. **

Closure (estimated time 5 minutes):

1. The teacher will tell the class, “You did an excellent job of discovering tessellations and regular tessellations today. I want everyone to think of three characteristics of all tessellations, and three types of regular tessellations.”
2. After a minute of thinking, I will call out pair, and I want you to share your ideas with the person next to you. When I call out share, I want you to share with your group, and then I will call on each group to share an idea. You may begin thinking about three characteristics of all tessellations and three types of regular tessellations.
3. While students are pairing and sharing, the teacher will walk around and listen to different ideas.
4. Once the think-pair-share sequence has been completed, the teacher will call each group to share their ideas.
5. The teacher will then explain that on Wednesday morning, students will fill out a regular tessellation identification sheet and tomorrow they will get to learn more about the angles of polygons.
6. Tell students to keep their eyes out for tessellations around the school and neighborhood and let them know they can play with more tessellations on the website if they get free time during the day.

Independent Practice:

Students will complete math journal page 86 and 87 for independent practice. Students will first complete this task individually and then share ideas with the class. Students will also complete the Create Your Own Regular Tessellation worksheet on Wednesday morning in which they will be required to draw their own regular tessellation and state why it is a regular tessellation.

Differentiated Instruction:

Above Average Learners:

- Students can be given more complex pictures of tessellations using multiple shapes (ex. Escher’s lizards) to use throughout instruction.
- After the lesson, students can research Escher and draw Escher type tessellations instead of regular tessellations on the independent practice sheet.

Students with Disabilities:

- Students can be given their own set of pattern blocks for easier manipulation as well as a way to express ideas.

[Table of Contents](#)

3.8

Regular Tessellations

OBJECTIVES To introduce tessellations; and to discover which regular polygons tessellate and which do not.

summaries

materials

1 Teaching the Lesson

Students are introduced to the history and concept of tessellations; they explore regular tessellations and decide which regular polygons tessellate and which do not. [Geometry]

Math Journal 1, pp. 86 and 87
Student Reference Book, pp. 150 and 151
 Study Link 3.7
 Teaching Master (*Math Masters*, p. 31)
 Geometry Template scissors

2 Ongoing Learning & Practice

Students play *Angle Tangle* to practice estimating and measuring angles. [Geometry, Measurement and Reference Frames]
 Students practice and maintain skills through Math Boxes and Study Link activities.

Math Journal 1, p. 85
Student Reference Book, p. 258
 Study Link Master (*Math Masters*, p. 248)
 Geometry Template (or protractor and straightedge)
See Advance Preparation

3 Options for Individualizing

Extra Practice Students make tessellations with pattern blocks and record them on paper. [Geometry]
Enrichment Students read and discuss a story about polygons that tessellate. [Geometry]

pattern blocks
 Geometry Template (optional)
A Cloak for the Dreamer
See Advance Preparation

Additional Information

Advance Preparation For the Study Link in Part 2, students are asked to collect examples for a Tessellation Museum. You may want to prepare a space in your classroom for this museum.

For the optional Enrichment activity in Part 3, you will need to obtain a copy of the book *A Cloak for the Dreamer* by Aileen Friedman (A Marilyn Burns Brainy Day Book, Scholastic, 1994).

Vocabulary • regular polygon • tessellation • regular tessellation • tessellate

Getting Started

Math Message

Follow the directions on Math Masters, page 31.



Study Link 3.7 Follow-Up

Have students share their answers to the "Odd Shape Out" problems. If time permits, have several students pose the problems that they created.

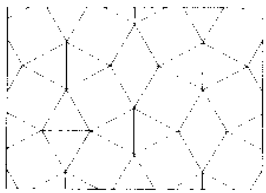


Mental Math and Reflexes

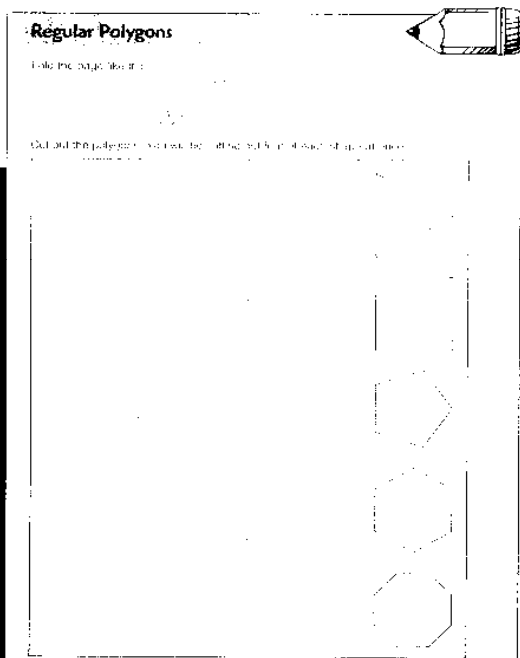
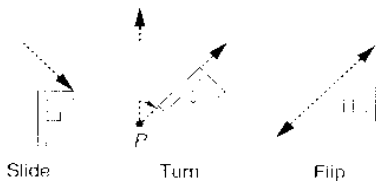
Students use estimation to answer questions like the following:

- Frieda has \$12.00. Does she have enough money to buy 7 pounds of apples at \$1.49 per pound? yes
- Jimmy reads about 47 pages an hour and reads 1 hour each day. Will he be able to finish a 283 page book in a week? yes
- Mark wants to take his two best friends to lunch. He has \$20.00. Does he have enough to buy three hamburgers at \$2.49 each, three large drinks at \$1.59 each, and three orders of fries at \$2.18 each? yes

Have volunteers share their strategies for solving the problems.




A tessellation



Math Masters, p. 31

1 Teaching the Lesson


◆ Math Message Follow-Up (Math Masters, p. 31)

WHOLE CLASS DISCUSSION 

Allow time for students to finish cutting out the **regular polygons** on *Math Masters*, page 31. Review the names of the polygons. Students may wish to verify that the polygons are regular by checking to see that the sides are the same length and the angle measures are equal.

These polygons may be discarded at the end of the lesson.

◆ Exploring Tessellations (Student Reference Book, pp. 150 and 151)


WHOLE CLASS DISCUSSION 

Have students read pages 150 and 151 of the *Student Reference Book*. Discuss the pages. Include the following points:

- A **tessellation** is an arrangement of repeated, closed shapes that cover a surface so that no shapes overlap, and there are no gaps between shapes. (See the margin.)
- Some tessellations repeat only one basic shape. Others combine two or more basic shapes.
- In a tessellation, the basic shapes are translated (slid), rotated (turned), or reflected (flipped) to fill the surface. (See the margin.)
- In a regular polygon, all of the sides are the same length, and all of the angles have the same measure.
- A tessellation consisting of regular polygons is called a **regular tessellation**.

Have students identify tessellations that they see around them—in ceiling or floor tiles, carpet designs, designs on clothing, and so on. Ask which of these tessellations use only one shape, and whether any are made with regular polygons. (For example, the floor or ceiling may be tiled with squares.)

◆ **Exploring the Basic Shapes in Regular Tessellations** (*Math Journal 1*, pp. 86 and 87; *Math Masters*, p. 31)

PARTNER ACTIVITY 

Students use the regular polygons that they cut out from *Math Masters*, page 31 to help them complete the tables on journal pages 86 and 87 and answer the questions on journal page 87.


For each of the given regular polygons, partners must decide whether the polygon can be used to create a regular tessellation. Have students use their Geometry Templates to draw an example of each tessellation. For polygons that do not tessellate, the drawing should show either an overlap or a gap in the design.

Students share their results from the journal page with the class. Verify that all students have discovered that only the triangle, square, and hexagon can be used to create regular tessellations. The other two regular polygons will not **tessellate**.

Have volunteers explain why they think there are only three regular tessellations. Each angle in a regular pentagon is 108° . No multiple of 108° equals 360° , so there will be overlaps or gaps if pentagons are arranged around a point. The angles in polygons with seven or more sides are too big. If three such polygons are arranged around a point, they will overlap. If only two are used, there will be a gap.

2 Ongoing Learning & Practice

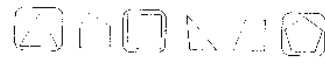
◆ **Playing Angle Tangle**
(*Student Reference Book*, p. 258)

PARTNER ACTIVITY 

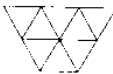

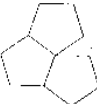
Students play *Angle Tangle* to practice estimating and measuring angles. For detailed instructions, see page 258 of the *Student Reference Book*.

Regular Tessellations


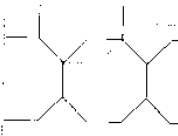
1. A regular polygon is a polygon in which all sides and all angles have the same measure. Circle the regular polygons below.



2. In the table below, write the name of each regular polygon under its picture. Then, using the polygons that you cut out from Activity 26 on 4, decide whether it can tessellate. Can you create a regular tessellation? Drawing your answers in the table columns. In the last column, show your drawing. Try to draw multiple examples of how the regular polygons tessellate or do not tessellate. Show any gaps or overlaps.

Polygon	Tessellates? (yes or no)	Draw an Example
triangle	yes	
square	yes	
pentagon	no	

Regular Tessellations (cont.)

Polygon	Tessellates? (yes or no)	Draw an Example
hexagon	yes	
octagon	no	

3. Which of the polygons can be used to create regular tessellations?
Triangles, squares, and hexagons

4. Explain how you know that these are the only ones. Three pentagons leave a gap, and 4 pentagons create an overlap. For regular polygons that have 7 or more sides, 2 shapes leave a gap and 3 shapes create an overlap.

Math Journal 1, p. 87

Math Boxes 3.8

1. Make the following numbers from the number 9317.

Change the digit

- a. 9 to 4
- b. 3 to 6
- c. 1 to 2
- d. 7 to 9

Write the number in the box.

6 7 2 9 4

2. Three Lines, One Total

• 1000	• 3,200
• 100	• 600
• 10	• 600
• 1	• 8
• 100,000	• 40,000,000

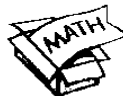
3. Write a number in each box. Use the number lines to show 40 minutes on a clock face.

STUDENT PAGE

Math Journal 1, p. 85

◆ **Math Boxes 3.8** (*Math Journal 1, p. 85*)

INDEPENDENT ACTIVITY



Mixed Review Math Boxes in this lesson are paired with Math Boxes in Lessons 3.6 and 3.10. The skill in Problem 1 is a prerequisite for Unit 4.

◆ **Study Link 3.8** (*Math Masters, p. 248*)



Home Connection Students collect tessellations. You may want to allow students more than one night to complete this assignment. Display their work in a Tessellation Museum.

NOTE: Several math-supply catalogs offer paper pattern blocks. These are already cut to the correct shapes and colors. They only need to be separated and glued down. Tessellmania™ is an excellent computer program for exploring tessellations.

Tessellation Museum

1. Tessellations are made by joining shapes together so that they fit together without any gaps or overlaps. The shapes used are called tessellating shapes. Some tessellating shapes are shown below.

2. Ask students to make a tessellation using the shapes shown. A key word is "repeat." They should use the same shape over and over.

3. Ask students to make a tessellation using the shapes shown. A key word is "mix." They should use different shapes together.

STUDY LINK MASTER

Math Masters, p. 248

3 Options for Individualizing

◆ **EXTRA PRACTICE Making Tessellations with Pattern Blocks**

INDEPENDENT ACTIVITY

15-30 min

Art Link! Students use pattern blocks to create tessellating patterns. They trace their patterns onto a piece of paper, either by tracing around the blocks or by using the Geometry Template. They might color their patterns in a way that emphasizes repeating elements.

◆ **ENRICHMENT Reading about Polygons That Tessellate**

SMALL-GROUP ACTIVITY

5-15 min

Literature Link Read the following book with students

A Cloak for the Dreamer

Summary: Tailors design patchwork cloaks made of rectangles, squares, triangles, and circles. The cloak made of circles is unacceptable because it has open spaces. The tailors think of a unique way to fix the cloak. Discuss why the patchwork cloaks made of rectangles, squares, triangles, and hexagons did not have any open spaces. Ask, *Why was this not possible with the cloak made of circles?*

Prior Knowledge Assessment
Tessellation Checklist

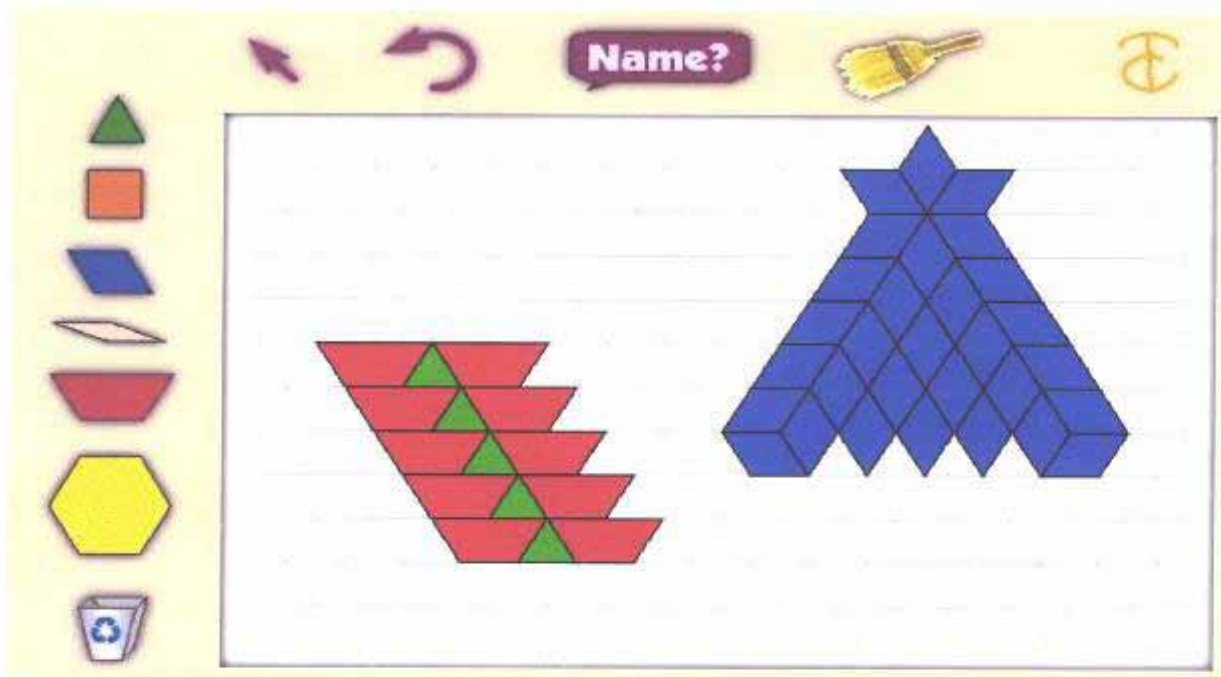
Student Partners	Create a pattern	Don't overlap	Don't have gaps
Table 1			
A	✓	○	○
B	✓	○	○
C	✓	○	○
D	Absent		
Table 2			
E	✓	○	○
F	✓	○	○
G	✓	●	○
H	✓	●	○
I	Absent		
Table 3			
J	✓	○	●
K	✓	○	●
L	✓	✓	✓
M	✓	✓	✓
Table 4			
N	✓	○	✓
O	✓	○	✓
P	✓	✓	✓
Q	✓	✓	✓
Table 5			
R	✓	○	○
S	✓	○	○
T	✓	○	○
U	✓	○	○
Table 6			
V	✓	●	●
W	✓	●	●
X	✓	○	○
Y	✓	○	○

✓ Successfully identifies idea

● had a general idea, but not fully able to explain it

○ did not mention the idea

Many students also mentioned
the use of 1 or 2 shapes



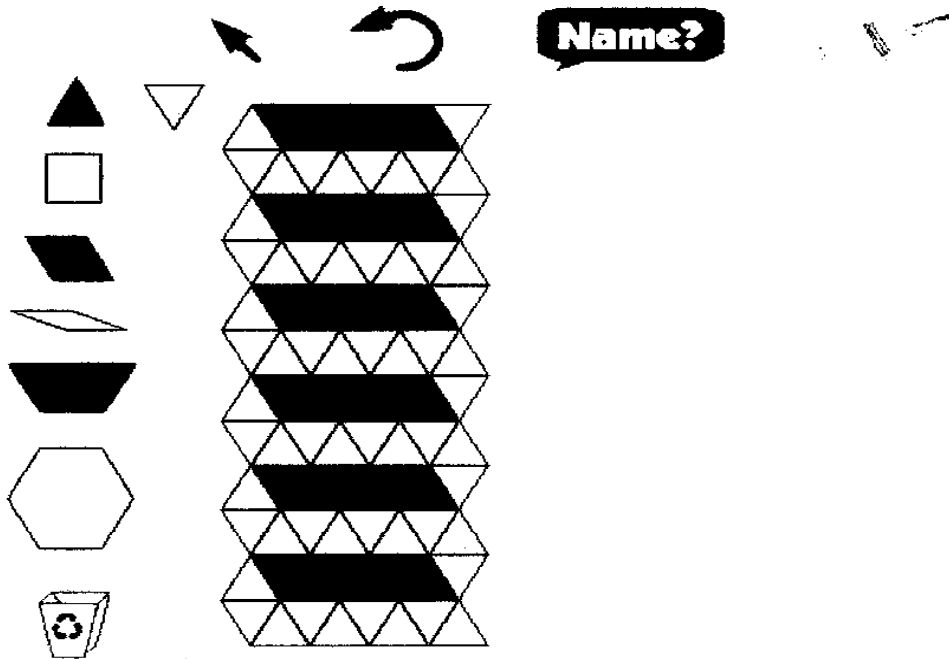
[instructions](#) | [description](#) | [instructions to print out](#)

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Student M's tessellation

Student M is an advanced student, especially in math and science.

Notice how he creates designs with the shapes. This student commented, "I made stairs and a tree." He creates a pattern in both instances. In the blue figure, this student creates a pattern that must carry on over a large expanse to show a true pattern, showing possible abstract thought.



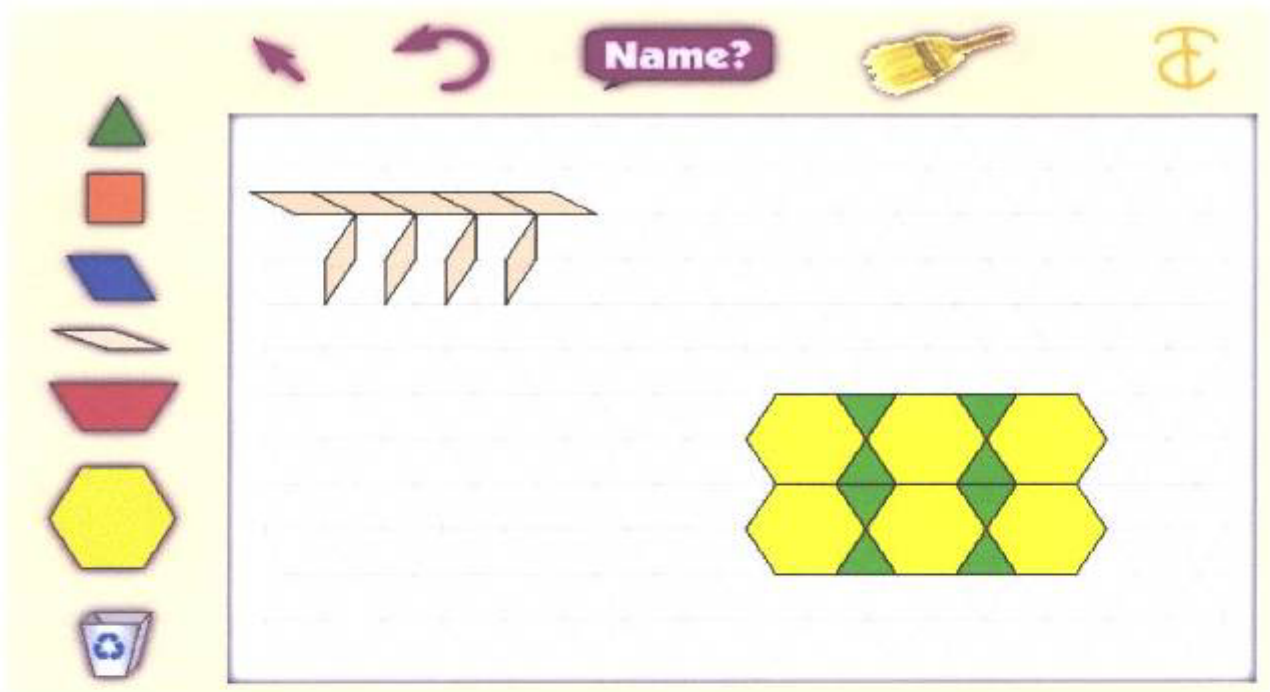
[instructions](#) | [description](#) | [instructions to print out](#)

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Student B's tessellation

Student B is an average student. She often participates in discussions on math but she is not one of the top students when it comes to math.

Student B creates a pattern; however, she only makes one row of this pattern. If she went on further, she would have found that she should have made rows of trapezoids and rows of triangles to form the tessellation rather than placing triangles next to the trapezoids. She had the right idea, but needed to take it further. She also did not create a tessellation using only one shape.



[instructions](#) | [description](#) | [instructions to print out](#)

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Student J's tessellation

Student J is a struggling student. He receives resource room services and often needs extra explanation on math concepts.

Student B creates an excellent tessellation in the bottom right hand corner. His tessellation forms a pattern, has no gaps, and no overlaps. However, the tessellation in the upper left hand corner poses a problem. Student J tried to use one shape to form a tessellation; however, by slanting the shapes he formed numerous gaps, therefore not making it a tessellation. While the student could have simply made regular rows of this shape, he chose to slant the shape, which actually caused a problem.

Date

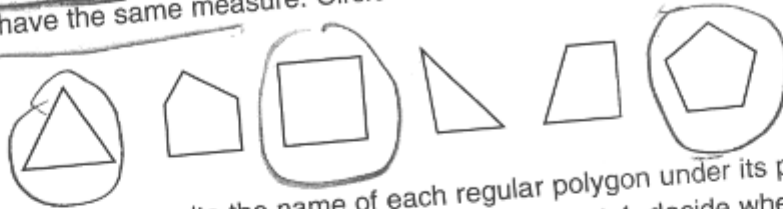
Exemplary Student Work

Time






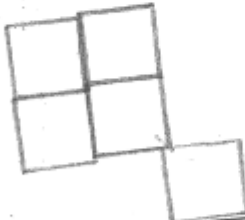


Regular Tessellations

1. A **regular polygon** is a polygon in which all sides are the same length and all angles have the same measure. Circle the regular polygons below.

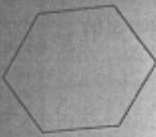
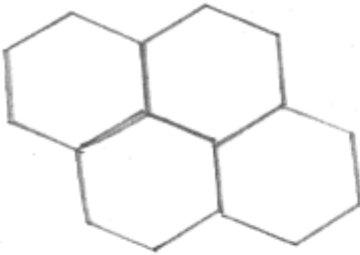




Regi
Polygons

2. In the table below, write the name of each regular polygon under its picture. Then, using the polygons that you cut out from Activity Sheet 4, decide whether each polygon can be used to create a regular tessellation. Record your answers in the middle column. In the last column, use your Geometry Template to draw examples showing how the polygons tessellate or don't tessellate. Record any gaps or overlaps.

Polygon	Tessellates? (yes or no)	Draw an Example
 <u>triangle</u>	 yes	
 <u>square</u>	yes	
 <u>pentagon</u>	NO	

ular Tessellations (cont.)

Polygon	Tessellates? (yes or no)	Draw an Example
 hexagon	yes	
 octagons	No	

3. Which of the polygons can be used to create regular tessellations?

hexagon, square, triangle

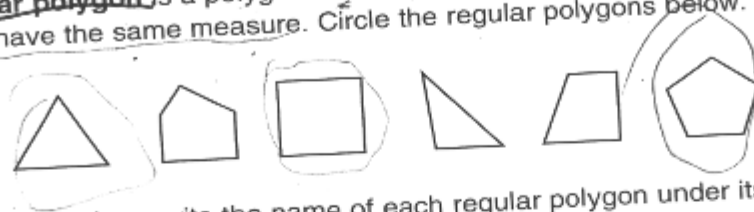
4. Explain how you know that these are the only ones. the rest have

all-gaps


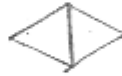


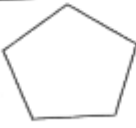
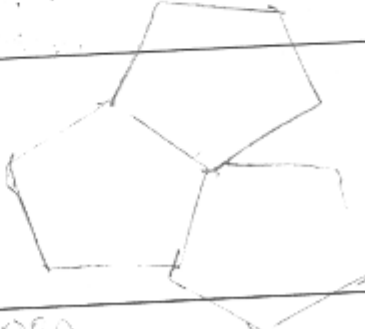


Regular Tessellations

1. A **regular polygon** is a polygon in which all sides are the same length and all angles have the same measure. Circle the regular polygons below.

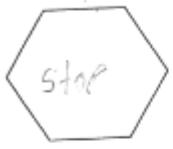
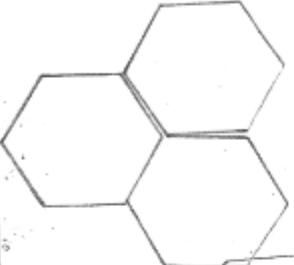

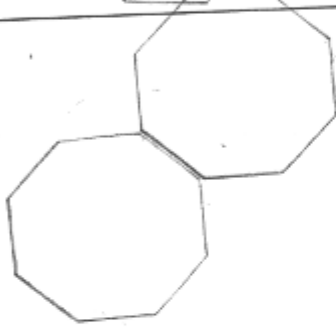


2. In the table below, write the name of each regular polygon under its picture. Then, using the polygons that you cut out from Activity Sheet 4, decide whether each polygon can be used to create a regular tessellation. Record your answers in the middle column. In the last column, use your Geometry Template to draw examples showing how the polygons tessellate or don't tessellate. Record any gaps or overlaps.

Polygon	Tessellates? (yes or no)	Draw an Example
 _____	yes	
 _____	yes	
 _____	no	

Regular Polygon

Tessellations (cont.)

Polygon	Tessellates? (yes or no)	Draw an Example
 <hr/>	yes	
 <hr/>	no	

3. Which of the polygons can be used to create regular tessellations?

triangle, square, hexagon

4. Explain how you know that these are the only ones.



Date

Struggling Student Work

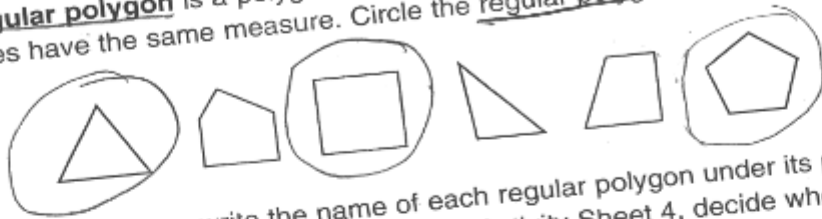
Time



Regular Tessellations

1. A **regular polygon** is a polygon in which all sides are the same length and all angles have the same measure. Circle the regular polygons below.


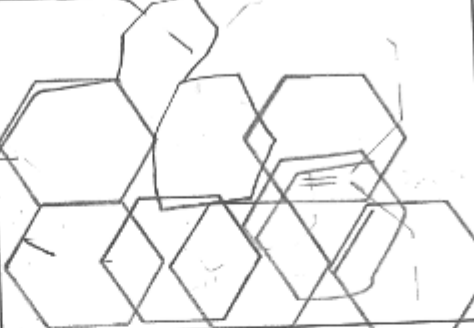


regular
polygon



2. In the table below, write the name of each regular polygon under its picture. Then, using the polygons that you cut out from Activity Sheet 4, decide whether each polygon can be used to create a regular tessellation. Record your answers in the middle column. In the last column, use your Geometry Template to draw examples showing how the polygons tessellate or don't tessellate. Record any gaps or overlaps.

Polygon	Tessellates? (yes or no)	Draw an Example
 _____	yes	
 _____	yes	
 _____	no	

Regular Tessellations (cont.)

Polygon	Tessellates? (yes or no)	Draw an Example
	no	
	no	

3. Which of the polygons can be used to create regular tessellations?

Triangles, squares, and hexagons

4. Explain how you know that these are the only ones.

Exemplary Student Work
Name: _____
Every Day Math

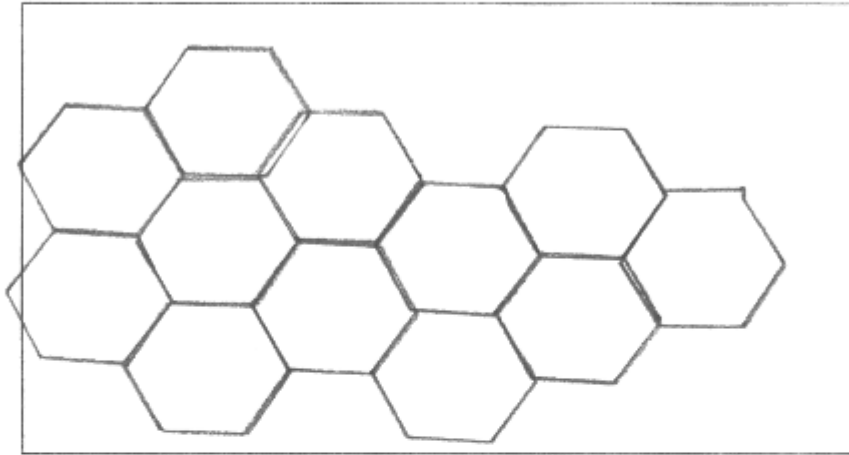
Date: 11/3/04
Mr. Heer



Create Your Own Regular Tessellation



Directions: In the box below, draw a regular tessellation. You may use pattern blocks to help in drawing the shapes. Answer the question that follows as well.



Write three reasons why the tessellation you drew is a regular tessellation.

1. All the shapes create a pattern.
2. It has no overlaps in the pattern.
3. It also has no gaps in it.

Average Student Work

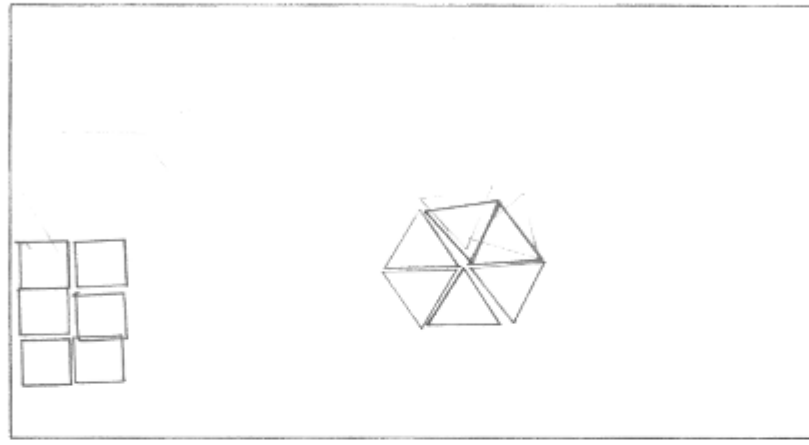
Name: _____
Every Day Math

Date: _____
Mr. Heer



Create Your Own Regular Tessellation

Directions: In the box below, draw a regular tessellation. You may use pattern blocks to help in drawing the shapes. Answer the question that follows as well.



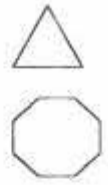
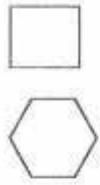
Write three reasons why the tessellation you drew is a regular tessellation.

1. No gaps

2. No overlap

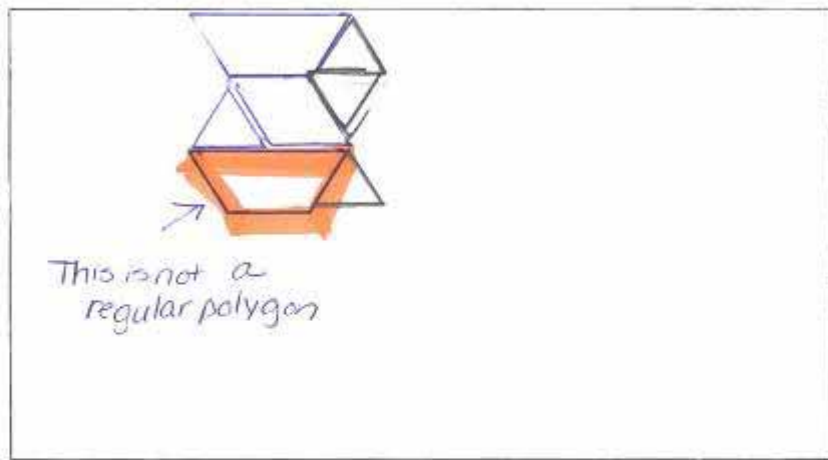
3. forms shapes
Be more specific

Name: Struggling Student Work Date: 11-3-04
Every Day Math Mr. Heer



Create Your Own Regular Tessellation

Directions: In the box below, draw a regular tessellation. You may use pattern blocks to help in drawing the shapes. Answer the question that follows as well.



Does this form a pattern?
 What is the pattern?
 ✓

Write three reasons why the tessellation you drew is a regular tessellation.

- * 1. It has no gaps.
- * 2. Nothing overlaps.
- * 3. It is a pattern.

Discussion of Student Learning

Through observation during this lesson and assessment after the lesson, it can be seen that most students achieved many of the objectives for the lesson. However, some students only understand some aspects of the lesson and need further instruction and modification to truly understand the entire concept presented.

All the students gained some knowledge about tessellations through this lesson. By looking at the prior knowledge checklist, it can be seen that all the students recognized patterns in the tessellations, but not all of the students noticed that there were no gaps or overlaps in the designs. Four students observed no overlapping and six students mentioned that there were no gaps. Six students had some idea about overlapping and four had some idea about no gaps, but these students did not explicitly state these ideas. Looking at the summative assessment sheets, however, four students did not explicitly mention patterns and five had difficulty drawing a pattern. All the students successfully identified the qualities of no gaps or overlaps in their statements. These results show that the students could identify some qualities of tessellations but some students need more work with applying patterns.

By observing students' computer generated tessellations, it can be seen that some students apply the ideas of no gapping and no overlapping and some need more work on these areas. Student M's tessellation (exemplary student work) reflects a pattern, no gaps, and no overlaps. Student B's tessellation (average student work) also reflects these qualities; however, if the student would have went further with the tessellation she would have seen that the pattern would not be the same at each vertex. To remedy this situation, I could have had students tile the entire surface. This would have shown the students the full pattern and not forced them to think abstractly until they developed the concept fully. One of student J's tessellations (struggling

student work) contains all the elements stated in the lesson, however, his second tessellation has gaps. The student tried to make a tessellation out of one shape, but he slanted the shape causing a problem. Again, I could have had the student tile the entire surface to better illustrate where the gaps occur. I could have had the student try to fit another shape in the gaps, and when this failed, asked him to try to turn his shapes to see if that would work.

Many students were trying to create elaborate designs, such as Student J, and a better direction would have been for students to “cover the entire square with one shape” and if they successfully achieved this, to “cover the entire square with two shapes.” To better identify what a pattern is, I could have had cutout sections of a tessellation and shown students that no matter what lines I cut on, the pattern would still be the same. While creating their tessellations, I could then have told students to imagine cutting out different sections and reminded them to make sure that each cutout would be similar.

The more complicated students made their tessellations, the more errors seemed to occur. In general, when students used only one shape, they were successful in creating tessellations. The more shapes students included, the more mistakes occurred. To remedy this, I could have given students a shape such as a hexagon to start with and had them first tile the surface with that shape. Then I could have given them another shape, then two shapes, and so forth until they could successfully complete each step.

Looking at journal pages eighty-six and eighty-seven, it can be seen that students had a general knowledge about tessellations after creating their own tessellations on the computer. Errors seem to occur more in dealing with the manipulatives rather than the actual identification of the tessellations. From the sample of an exemplary student, an average student, and a struggling student, it can be seen that all the students are able to successfully identify regular

polygons. Looking at the work of the entire class, only two students circled the other triangle as a regular polygon. To remedy this, I could have given the students protractors to determine the measure of the angles of this triangle to show that all the angles are not the same.

The journal pages also show that all students could identify whether or not triangles, squares, pentagons, and octagons could tessellate. The struggling student, however, incorrectly classified the hexagon. Looking at the student's paper, it can be seen that the drawing of the images caused difficulty. If the student had manipulated the pattern blocks or templates in a different rotation, he would have been able to see how the tessellation could form. To remedy this situation, students could have continued to use the web-site to discover the answers to these shapes. Instead of dealing with difficult manipulatives, students could have answered these questions using the web-site to tile the entire surface and printed their results. Furthermore, this student answered question three ("Which of the polygons can be used to create regular tessellations?") correctly, however his drawings do not support his answer. This student may have copied, may have overheard me saying this answer, or may have simply written the answer incorrectly. To improve this situation and test for true understanding, students should have answered question four. This student did not answer question four, however, leading to inconclusive results. Did the student just run out of time? Did the student not understand? To test the student's knowledge, students could have demonstrated and stated orally why these shapes were the only regular polygons to tessellate. Students should have been given more time to finish if needed as well.

The exemplary student and the average student all drew their tessellations and identified them correctly, however, the average student did not justify question four. Once again, the student may have run out of time or may not have understood the answer. Again, to fix this

problem, all students should have stated orally or in writing a reason for their answers. The exemplary student also identified the regular polygons, which some other students did not do. This shows that the directions given were not sufficient. I should have explicitly stated for students to write the names of the polygons on the lines as well as answer question four. Extra time should have been given for all students to answer all of the questions as well to truly find out if students understand the concept.

Interestingly, looking at the average student's work, it can be seen that higher-level thinking and problem solving were taking place. On the bottom of the student's paper, a solution to the octagon problem was sketched using triangles. This shows that the student was thinking of ways to make these shapes form tessellations. This would be a great extension activity to pose to students: "If you could add one other shape, could you make the octagons and pentagons tessellate?" This question could have led to higher order thinking for all students.

The summative assessment taken two days after the lesson showed interesting results. Nine students answered all the questions correctly. Ten students answered three out of four questions correctly. Of these ten students, five drew their tessellations incorrectly, and five explained their tessellations incorrectly. No students answered both sections incorrectly, showing that all students have some grasp on the information but only nine of the nineteen assessed achieved full success.

From these results, it can be seen that approximately half of the students fully understand the concept of tessellations. A quarter of the students do not understand how to draw a tessellation, and a quarter of the students do not fully understand the explanation of what a tessellation. Looking at the differences between the exemplary, average, and struggling student work, it can once again be seen that the more complex students make their tessellations, the more

errors occur. For instance, the exemplary student uses only one shape. The average student uses two shapes, and the struggling student uses three shapes. A way to modify this assignment to increase success is to tell the students to only use one shape. Also, the struggling student uses a trapezoid, a shape that is not a regular polygon.

For all students to achieve success, more scaffolding needs to take place. First, students could have been given the option of using only a triangle, a square, or a hexagon. They could have been instructed to tile the entire surface as well. Once students achieved success with this task, then they could have used two regular polygons. If students achieved success with this, then they should understand the concept of patterns and regular polygons, and then they could have been given the summative assessment which requires them to use all of these skills. By including ideas such as the cutout section and using only one shape, students should successfully create patterns and tessellations.

Based on the results of the prior knowledge checklist, the computer-generated tessellations, the journal pages, and the summative assessment worksheet, it can be seen that about half of the class grasps the concept of tessellations both verbally and through drawing. The other half however does not fully grasp the idea of patterns. Students may first need to identify the characteristics of patterns, identify patterns around them, and then practice creating patterns prior to this lesson. By having students practice patterns, modifying the lesson to only one shape, and teaching the idea of cutting out sections of tessellations, all students should be able to achieve the objectives with one-hundred percent accuracy.

[Table of Contents](#)

Lesson Reflection

Using assessment results to understand student learning, instruction, and future goals is an essential aspect of teaching. One must identify the strengths and weakness of a lesson based on the theoretical foundation, feedback from others, and above all, evidence of student learning. Looking at the assessment results of this lesson, it can be seen that overall, this lesson was effective because all of the students gained some conceptual understanding. The conceptual goals for this lesson include students understanding how to recognize a tessellation, understanding the qualities of tessellations, and being able to apply these understandings in their own tessellations. All students gained some understanding of what a tessellation is and how to identify and draw tessellations through the anticipatory set, the use of the pattern block web-site, and the tessellation song. To make this lesson effective for all students, modifications such as identifying patterns prior to the lesson, using only one shape, and tiling the entire surface should be applied.

Some strengths of this lesson include the anticipatory set, the use of the pattern block web-site, and the tessellation song. Based on the prior knowledge checklist, it can be seen that showing real tessellations helped all students identify patterns and some students identify that there were no gaps or overlaps. By showing the students real objects, Piaget's idea of manipulatives at the concrete operational stage is supported. These items prevented other errors from occurring since I referred students back to these items when their tessellations were incorrect. Furthermore, looking at the prior knowledge checklist, it is seen that students used one another's ideas to develop their own ideas about tessellations. When students identified that tessellations do not have gaps or overlaps, these statements usually occurred from groups sitting

by one another. These results support Vygotsky's ideas about social interaction, as students discovered each other's ideas and included them into their repertoires.

The use of the pattern block web-site was a definite strength of this lesson. Looking at the journal pages and the summative assessment sheet, it can be seen that students had difficulty manipulating their templates and pattern blocks to draw their own shapes. Many errors occurred simply because of a lack of fine motor skills. With the web-site, however, no overlapping occurred, and it was easy to see when students made gaps or did not establish patterns. These images could be modified easily, leading to correction and success. This aspect of the lesson supports Van de Walle's ideas since students were imposing their ideas on a model, were working with other students through cooperative learning, and using only one or two colors for tessellations.

The third strength of this lesson was the tessellation song. Not only did this song liven up the lesson, but it truly acted as a device for remembering characteristics of tessellations. Students sang this song as they created their own tessellations to help them remember the three main points. However, some students may have sung without truly understanding the concepts of the song. For instance, some students sang about patterns but did not apply this concept in their own tessellations. To improve this aspect of the lesson, students could be asked to create examples of each section of this song to better connect the concept with the language and create their own ideas of what tessellations are.

Half of the class fully grasped the entire concept of tessellations. For the other half, the lesson was only partially effective. The summative assessment results show that five students had difficulty identifying patterns verbally and five students had difficulty identifying patterns through drawings. Students should first be required to discuss the characteristics of patterns and

identify numerous patterns in the school, at home, and throughout the community. Since patterns can be a difficult concept to grasp especially when patterns are elaborate, this topic must be discussed prior to the lesson. Students could create their own patterns through drawings and manipulatives. The error occurred in the fact that I moved through Bloom's Taxonomy too quickly. I introduced knowledge and then almost immediately wanted students to use comprehension and application levels without first testing the knowledge level. First, I should have made sure that all the students could work on the knowledge level, and only then started to introduce higher levels of thinking.

To make this lesson effective for all students, additional scaffolding must also take place with explicit directions as supported by Vygotsky's zone of proximal development. Students should first be required to make tessellations out of one shape to make sure they understand the tiling of an entire surface. Then, once students master this skill, they can move on to more advanced tessellations. Students must also tile an entire surface. In doing so, they will be able to better see where errors occur in pattern formations.

Time constraints limited this lesson; however, for all students to be successful, the lesson should either be carried over to another day or extended to ensure student success, the ultimate goal. Students did not get the opportunity to explore higher-order thinking as shown by Bloom's Taxonomy or use whiteboards as shown by Henry, Henry, and Riddoch. The Cooperating Teacher mentioned that the lesson went well, but some students did not understand the directions for the journal pages. For this section, I explained the directions; however, I did not effectively model what I wanted the students to do. I should have walked students through the first problem as a class, walked them through the second problem in a more independent fashion, and then allowed them to work on their own. By giving clearer directions and modeling

these directions, less time may have been spent with the journal pages, and more time could have been spent with whiteboarding and inquiry.

This lesson was successful in the sense that many students achieved all of the stated objectives. However, success must be measured by *all* students mastering a topic; therefore, this lesson is halfway to complete success. The anticipatory set, the pattern block web-site, and the tessellation song all helped students gain greater understanding of tessellations as shown by assessment evidence. In the future, areas such as pattern knowledge, tiling the entire surface, using only one shape, providing additional scaffolding, and modeling directions should lead to increased student understanding and success.

[Table of Contents](#)