Traditional Transformations, Part 3

Rotations: Plains Star Quilts

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Grade Level	9th – 10th Grade	**Time Frame**	90-105 minutes
Subject	Mathematics	**Duration**	2-3 class periods
Course	Geometry		

Essential Question

How are transformations and symbolism used through indigenous cultures?

Summary

In this lesson, students will explore the culture of the Plains tribes and their Star Quilts. They will then use patterns to explore rotations and discover algebraic rules for common rotations. Students will apply what they learn to create their own quilt block and demonstrate their understanding of rotations and rotational symmetry. Prerequisite vocabulary knowledge for this lesson includes transformation, preimage, image, and rigid motion, which are all included in the Traditional Transformations, Part 1 lesson. This is the third lesson of five in the "Traditional Transformations" lesson series.

Snapshot

Engage

Students watch a video about the tradition of Plains Star Quilts.

Explore

Students make observations and discover patterns for rotations about the origin.

Explain

Students complete guided notes with the class and formalize their understanding of common and uncommon rotations.

Extend

Students apply what they have learned to identify different types of transformations and create their own quilt blocks using rotations.

Evaluate

Students demonstrate their understanding by rotating a point 180° about another point.

Standards

Oklahoma Academic Standards Mathematics (Geometry)

G.2D.1.11: Use numeric, graphic, and algebraic representations of transformations in two dimensions (e.g., reflections, translations, dilations, rotations about the origin by multiples of 90 °) to solve problems involving figures on a coordinate plane and identify types of symmetry.

Attachments

- Creating Qulit Blocks—Traditional Transformations, Part 3 - Spanish.docx
- Creating Qulit Blocks—Traditional Transformations, Part 3 - Spanish.pdf
- Creating Qulit Blocks—Traditional Transformations, Part 3.docx
- Creating Qulit Blocks—Traditional Transformations, Part 3.pdf
- Guided Notes (Teacher Guide and Model Notes)—Traditional Transformations, Part 3.docx
- Guided Notes (Teacher Guide and Model Notes)—Traditional Transformations, Part 3.pdf
- Guided Notes—Traditional Transformations, Part 3 - Spanish.docx
- Guided Notes—Traditional Transformations, Part 3 - Spanish.pdf
- Guided Notes—Traditional Transformations, Part 3.docx
- Guided Notes—Traditional Transformations, Part 3.pdf
- Lesson Slides—Traditional Transformations, Part 3.pptx
- Rotation Exit Ticket—Traditional Transformations, Part 3 - Spanish.docx
- Rotation Exit Ticket—Traditional Transformations, Part 3 - Spanish.pdf
- Rotation Exit Ticket—Traditional Transformations, Part 3.docx
- Rotation Exit Ticket—Traditional Transformations, Part 3.pdf
- Star Quilt Transformations—Traditional Transformations, Part 3 - Spanish.docx
- Star Quilt Transformations—Traditional Transformations, Part 3 - Spanish.pdf
- Star Quilt Transformations—Traditional Transformations, Part 3.docx
- Star Quilt Transformations—Traditional Transformations, Part 3.pdf
- Tribal Transformations—Traditional Transformations, Part 3 - Spanish.docx
- Tribal Transformations—Traditional Transformations, Part 3 - Spanish.pdf
- Tribal Transformations—Traditional Transformations, Part 3.docx
- Tribal Transformations—Traditional Transformations, Part 3.pdf

Materials

- Desmos account
- Guided Notes handout (attached; one per student; printed front/back)
- Guided Notes (Teacher Guide and Model Notes) document (attached; for teacher use)
- Star Quilt Transformations handout (attached; one per student; printed front only)
- Pencils
- Paper
- Graph paper
- Creating Quilt Blocks handout (optional; attached; one per student; printed front only)
- Compass (one per student)
- Protractor (one per student)
- Student devices with Internet access

15 minutes

Engage

Teacher's Note: Respecting Native Cultures

To provide a real-world example of geometric transformations, we are incorporating tribal culture from some of the 39 Tribes of Oklahoma. This allows students to gain an authentic and concrete understanding of Geometry standards while gaining insights into the indigenous culture of Oklahoma.

This lesson series is centered around the arts and crafts of various tribes of Oklahoma. Inform students about the Indian Arts and Crafts Act of 1990, which prohibits non-Native individuals from creating and selling tribal art as authentic tribal products. During these lessons, inform students that they will create their own artwork that is inspired by specific tribes' customs, but they are not creating the tribes' art in itself.

Teacher's Note: Desmos Classroom Activity Preparation

To access this Desmos Classroom activity, go to the "Traditional Transformations, Part 3" Desmos page.

Use the buttons on the page header to create an account or sign in. After signing in, the green "Assign" dropdown button will be active. Select the arrow next to the word "Assign," then select "Single Session Code." After making some setting selections, select "Create Invitation Code'' and provide the session code to students. For more information about previewing and assigning a Desmos Classroom activity, go to our Desmos Classroom page.

For more detailed information about Desmos features and how-to tips, go to our Desmos Resources page.

To set up the activity's pacing for students, select "View Dashboard" (next to the session code). In the upper-left corner of the screen, select the icon above the word "Pacing." Desmos Classroom should then prompt you to select the first and last screens that you want students to see. When prompted to set a range, select screens 1 and 4. To confirm your selection, select "Restrict to Screens 1–4". This allows students to access only screens 1–4 at this time. For more information about teacher pacing, go to our Pacing Activities page.

Provide students with your session code. Then, have students go to student.desmos.com and enter the session code.

Teacher's Note: Sign-in Options

If students sign in with their Google or Desmos accounts, their progress will be saved. They can then resume the activity or view their work later. If students continue without signing in, they can complete the activity, but they must do so in one sitting. It is strongly recommended that students sign in to avoid losing their work.

Introduce the lesson using **screens 1–2** of the Desmos Activity. Review the lesson series' essential question and learning objectives on **screens 1–2** to the extent you feel necessary.

Direct students' attention to **screen 3** and introduce the GramIt instructional strategy. Let students know that they are about to watch a video of Crystal Pewo Lightfoot, a member of the Apache Tribe of Oklahoma and a descendant of the Kiowa Tribe, sharing her knowledge of her tribal culture and how she uses rotations in her Star Quilt creations. Explain that, after watching the video, they will be asked to create two hashtags: one representing an aspect of the culture they learned about, and another representing a mathematical concept they learned.

Then, have students watch the "Plains Star Quilts and Rotations" video that is linked on the screen.

Embedded video
https://youtube.com/watch?v=YJxmt0dt3mw

After watching the video, direct students' attention to **screen 4** and ask them to enter their two hashtags, each representing a cultural and mathematical aspect they learned from the video.

If time allows, ask for volunteers to share their answers with the class.

15 minutes

Explore

On the Dashboard, press the orange plus sign to allow students to progress to **screen 5**. Give students a couple of minutes to familiarize themselves with the Desmos sketch tools if this is their first time using them.

On the dashboard, press the orange plus sign three times to allow students to progress to **screens 6–8**.

Share with students that, for this activity, they will work with an arrow symbol from a Plains-style quilt design. Direct students to use the sketch tools to label *image 2*, complete the table, then answer the prompts on their screen:

- Write the algebraic rule to describe the relationship between the *preimage* and *image 2*.
- How would you describe what happened visually when the preimage was transformed into *image 2*?

Teacher's Note: Guiding the Activity

At this time, ask more questions than you give answers. The purpose here is for students to find a pattern from the preimage to *image 2* and to notice that the transformation is a rotation.

Remember that this is not yet the point in the lesson to answer questions or worry about proper vocabulary. Some students may remember rotations from middle school while others do not, and that is okay.

Ask students to partner up or assign them their partners. Direct them to compare their work and responses from screen 6. If time allows, ask for a few volunteers to share their answers with the class.

Have pairs work together through screens 7–8 to find patterns between the preimage and rotated images. Then, have them attempt to write the algebraic rule.

To help students enter their coordinate rules, guide them to copy the mapping symbol from the “Type Math” button. If students see “\to” when they paste the mapping symbol, have them highlight that text, then press the “Type Math” button to convert that syntax into the symbol.

If time allows, ask for a few volunteers to share their responses with the class.

Teacher's Note: Guiding the Lesson

Students will refer back to their algebraic rules from the Traditional Transformations handout during the Explain portion of the lesson. During that part of the lesson, students will receive a confirmation of the accuracy of their rules.

20 minutes

Explain

Customizing Student Learning

The Guided Notes handout illustrates the vocabulary and provides students with three practice problems. The first two problems include polygons on the coordinate plane, while the third includes a polygon without a coordinate plane. The **Guided Notes (Teacher Guide and Model Notes)** document contains the answers for reference. If you only want students to work with rotations on coordinate planes, delete example 3 before printing the handout.

The activities on Extend and Evaluate are all on coordinate planes.

Give each student a copy of the attached **Guided Notes** handout, then press the orange plus sign on the Dashboard to allow students to progress to **screen 9**.

Introduce the vocabulary of *rotation* and *angle of rotation* to the class and guide them to write those vocabulary words on their handout. Remind students of the difference between *clockwise* and *counterclockwise* and let them know that all rotations are assumed to be counterclockwise unless otherwise stated. This is communicated both on screen 9 and on the handout. Then ask for a volunteer to answer, "Is a rotation an example of rigid motion?" Make sure to ask the student to provide their reasoning. Have students record the answer ("yes") with justification on their handout.

On the Dashboard, press the orange plus sign three times to allow students to progress to **screens 10–12**. Now, go through the algebraic rules of special rotations for rotations of 90°, 180°, and 270° about the origin. One special rotation is provided per screen. Consider having students take a moment to discuss with their partner what they think the rule should be.

Have students enter their responses into the Desmos Classroom activity, then bring the class together for a discussion on each rotation. To develop the rules, have students use the pictures on their Guided Notes or Desmos Classroom activity as well as their work from screens 6–8.

The activity on screens 10–12 will provide feedback on students' responses. Be sure to help students see that the rule is already started for them using (a, b). Help students see that a is the x-value and b is the y-value. Have students record the notation that makes sense to them on their handouts.

Teacher's Note: Guiding the Lesson

Ask guiding questions but try not to directly tell the students what the algebraic rules are. Students should be able to come up with these rules on their own or with some prompting questions. Consider the following questions if needed:

- What happens to the x-values of the ordered pairs when the figure is rotated ...°? Did you see those same values somewhere else on the points from the preimage?
- What happens to the y-values of the ordered pairs when the figure is rotated ...°? Did you see those same values somewhere else on the points from the preimage?

On the Dashboard, press the orange plus sign three times to allow students to progress to **screens 13–15**. Direct students' attention to the bottom of their handouts. Ask them to enter their answers to the following prompts on each screen:

- Rotating a figure 90° CCW is the same as rotating the figure …
- Rotating a figure 180° CCW is the same as rotating the figure …
- Rotating a figure 90° CW is the same as rotating the figure …

Then, ask them to record their answers on their handout:

Screens 13–15 will not provide feedback for incorrect selections but will let students know when they have selected the correct options (a "Well done!" text will appear). Use the Dashboard to assess students' answers. Make sure everyone has made the correct selections before proceeding.

Teacher's Note: Guiding the Lesson

Use the prompts above to help students see why counterclockwise is implied (counterclockwise is both the direction of positive angle measures and quadrant numbering). In other words, rotating a figure –90° about the origin would be the same as rotating clockwise +90°, while rotating a figure +90° about the origin is the same as rotating counterclockwise +90°.

Direct students' attention to the back of their handouts. Then press the orange plus sign on the Dashboard twice to allow students to progress to **screens 16–17**. Ask students to follow the directions on the screen and use the Desmos Classroom activity to complete examples 1–2 on their handouts. Here, students will see a "Rotate" button once they complete their table. Pressing the button shows the preimage rotate to where the image should be and provides students feedback.

Circulate the room or use the Dashboard to assess students' understanding. Consider bringing the class together after each example to answer questions.

Give each student a compass and protractor and ask them to set aside their devices. With example 3, guide the class through rotating a figure that is not on a coordinate plane.

Teacher's Note: Guiding the Lesson

Help students learn academic vocabulary by encouraging them to drop the middle-school language of "turn". Instead, ask them to use the high-school language "rotate" instead.

During this part of the lesson, answer questions and correct misunderstandings that students may have.

Have students add their completed Guided Notes to their math notebooks if it is a classroom norm.

35 minutes

Extend

Now it is time for students to apply what they have learned. On the Dashboard, click the orange "Stop" button. Students can now complete the Desmos activity at their own pace. Direct their attention to **screen 18** and remind students what *rotational symmetry* and *center of symmetry* mean.

Direct students' attention to **screen 19** and facilitate a whole-class discussion regarding the question, "Where else do you see rotational symmetry?"

Sample Student Responses:

Responses will likely vary.

- I see rotational symmetry in my ceiling fan at home.
- My #2 pencil has rotational symmetry because it is a hexagonal prism.
- Our table has rotational symmetry of 180° because it is a rectangle.

Teacher's Note: Copying Art

While we want to celebrate the important contributions of Native people and ensure students learn about these art forms, we must be mindful that copying tribal designs is considered disrespectful and is strongly discouraged because many of these designs hold historical and familial meaning. Please help students be aware of this historic theft from Native people and understand why it is important that such theft does not continue.

When students get to **screen 20**, have them set aside their Desmos Classroom activity. Give each student a copy of the attached **Star Quilt Transformations** handout and four coloring utensils that students can share. Have students work individually to color code their Star Quilt pattern: one color should be the preimage, and the other three colors should each indicate either a translation, reflection, or rotation. Let students know that not every rhombus needs to be fully colored by the end of this activity.

Encourage students to collaborate with a partner to help each other see the different transformations.

Teacher's Note: Guiding the Activity

Encourage students to fold or overlap their papers with one another to compare the rhombi with the preimage.

This activity will have multiple right answers; use the hidden **slide 13** for an idea of what to expect from students.

Students may observe that if they applied more than one transformation to their preimage, the multiple transformations would result in a certain rhombus. That is an accurate observation, so commend students who make that connection and let them know that multiple transformations will be discussed later in this lesson series (specifically during part 5). For now, they are challenged to consider only one transformation to the preimage as they color code their Star Quilt design.

Once students complete the activity, get them into groups of four and compare their results. As time allows, ask for volunteers to share any observations with the whole class.

Now give each student a piece of graph paper or the attached **Creating Quilt Blocks** handout. If students are using graph paper, ask them to draw the *x*- and *y*-axes in the center of the page.

Share the Pass the Problem strategy with the class. Explain that each group will work together to create four unique quilt blocks. Explain that each person will create their own preimage in Quadrant III, then pass the problem around to complete the quilt block design collaboratively. Tell students that their preimage creation can be a tessellation—like the Plains Star Quilt pattern—but is not required to be. Take a moment to introduce or remind students of the vocabulary *tessellations*, which is the repetition of one or more shapes such that the shapes cover a surface with no gaps or overlap.

Direct each student to create their own preimage in Quadrant III. Then instruct them to label at least four vertices.

After a few minutes, have everyone pass their paper to their right. On the paper they received, have them draw the image by rotating the preimage 270° about the origin, then have them label the corresponding vertices.

After a few minutes, have everyone pass their paper to their right. Ask them to check the work of the previous student, draw another image by rotating the preimage 180° about the origin, and label the corresponding vertices.

After a few minutes, and have everyone pass their paper to their right, check the previous student's work, draw the image by rotating the preimage 90° about the origin, and label the corresponding vertices. Encourage students to work together to adjust any points that need to be corrected.

After a few minutes, and have everyone pass their paper to their right. The paper should now return to the student who drew the preimage. Have them check the previous work and for rotational symmetry.

Consider having students display their quilt blocks on the wall to make a class quilt.

5 minutes

Evaluate

Use the Exit Ticket strategy to individually assess what students have learned from the lesson. Have students go back to their Desmos Classroom activity and direct their attention to **screen 21**. The screen will ask students to enter their responses to a practice question—only the teacher can see the feedback on students' answers.

Collect student responses and use them to determine if your students need additional practice or if they are ready for the next lesson. If students need additional practice, consider having students practice with more basic shapes, like rotating triangles or even just individual points about the origin 90°, 180°, or 270°.

The "Traditional Transformations, Part 4" lesson will discuss dilations and beadwork.

Teacher's Note: ACT Prep

Determining the new coordinates after a rotation of 90° and 180° are skills needed for the ACT exam. These questions often only ask students to rotate one point as opposed to a whole figure since it is a timed exam.

Cross-Curricular Opportunity

If you are interested in a cross-curricular lesson, share the lesson: https://learn.k20center.ou.edu/lesson/2936 with your art teacher, as it also celebrates the art of creating Star Quilts.

Resources

- K20 Center. (n.d.). Bell Ringers and Exit Tickets. Strategies. https://learn.k20center.ou.edu/strategy/125
- K20 Center. (n.d.). Desmos classroom. Tech Tools. https://learn.k20center.ou.edu/tech-tool/1081
- K20 Center. (n.d.). Gramit. Strategies. https://learn.k20center.ou.edu/strategy/2554
- K20 Center. (n.d.). Pass the Problem. Strategies. https://learn.k20center.ou.edu/strategy/2554
- K20 Center (2023, July 5). *Plains star quilts and rotations* [Video]. YouTube. https://youtu.be/YJxmt0dt3mw