Symmetric Designs

Reflections and Osage Ribbonwork

Michell Eike, Rachelle Johnson
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Grade Level	6th – 7th Grade	**Time Frame**	100–110 minutes
Subject	Mathematics	**Duration**	2–3 class periods
Course	Middle School Mathematics		

Essential Question

How are reflections and symbolism used within indigenous cultures?

Summary

In this lesson, students will explore the culture of the Osage tribe and their ribbonwork. Students will apply what they have learned about math and indigenous cultures to create their own ribbonwork design and demonstrate their understanding of reflections. Prerequisite knowledge for this lesson includes the following vocabulary: transformation, preimage, and image.

Snapshot

Engage

Students watch a video about the tradition of Osage ribbonwork.

Explore

Students make observations about and discover patterns of reflections over the axes.

Explain

Students complete guided notes with the class and formalize their understanding of reflections.

Extend

Students watch a video about a fashion designer, then apply what they have learned to create their own ribbonwork design.

Evaluate

Students demonstrate their understanding by reflecting a point over an axis.

Standards

Oklahoma Academic Standards Mathematics (7th Grade)

7.GM.4.3: Graph and describe translations (with directional and algebraic instructions), reflections across the x- and y-axes, and rotations in 90 degree increments about the origin of figures on a coordinate plane, and determine the coordinates of the vertices of a figure after a transformation.

Attachments

- Exploring Ribbonwork (Part A)—Symmetric Designs - Spanish.docx
- Exploring Ribbonwork (Part A)—Symmetric Designs - Spanish.pdf
- Exploring Ribbonwork (Part A)—Symmetric Designs.docx
- Exploring Ribbonwork (Part A)—Symmetric Designs.pdf
- Exploring Ribbonwork (Part B)—Symmetric Designs - Spanish.docx
- Exploring Ribbonwork (Part B)—Symmetric Designs - Spanish.pdf
- Exploring Ribbonwork (Part B)—Symmetric Designs.docx
- Exploring Ribbonwork (Part B)—Symmetric Designs.pdf
- Guided Notes (Model Notes)—Symmetric Designs.docx
- Guided Notes (Model Notes)—Symmetric Designs.pdf
- Guided Notes—Symmetric Designs - Spanish.docx
- Guided Notes—Symmetric Designs - Spanish.pdf
- Guided Notes—Symmetric Designs.docx
- Guided Notes—Symmetric Designs.pdf
- Lesson Slides—Symmetric Designs.pptx
- Notecatcher—Symmetric Designs - Spanish.docx
- Notecatcher—Symmetric Designs - Spanish.pdf
- Notecatcher—Symmetric Designs.docx
- Notecatcher—Symmetric Designs.pdf
- Over the Line—Symmetric Designs - Spanish.docx
- Over the Line—Symmetric Designs - Spanish.pdf
- Over the Line—Symmetric Designs.docx
- Over the Line—Symmetric Designs.pdf
- Perfecting Patterns—Symmetric Designs - Spanish.docx
- Perfecting Patterns—Symmetric Designs - Spanish.pdf
- Perfecting Patterns—Symmetric Designs.docx
- Perfecting Patterns—Symmetric Designs.pdf
- Transformation Vocabulary—Symmetric Designs - Spanish.docx
- Transformation Vocabulary—Symmetric Designs - Spanish.pdf
- Transformation Vocabulary—Symmetric Designs.docx
- Transformation Vocabulary—Symmetric Designs.pdf

Materials

Preparation

At the end of the Explore phase of this lesson, students will use a Desmos Classroom activity to check their work and observe animated reflections over each axis.

To prepare for this Desmos Classroom activity, go to Desmos Classroom: Symmetric Designs. Create an account or sign in under the “Activity Sessions'' heading. Select the “Assign” dropdown button, then select “Single Session Code.” Adjust the settings as desired, then select “Create Invitation Code.” Prepare this session invitation code to distribute to students during the lesson. For more information about previewing and assigning a Desmos Classroom activity, go to External Apps Tutorials: Desmos Classroom.

For more detailed information about Desmos features and how-to tips, go to External Apps Tutorials: Desmos Resources.

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. Students will be able to make real-world connections and learn more about a few of the indigenous tribes of Oklahoma in order to learn about geometric transformations in a more authentic and concrete way.

This lesson is centered around arts and crafts of various tribes of Oklahoma. Tell students about the Indian Arts and Crafts Act of 1990, which says that no non-Native person is to create tribal art and sell it as tribally made. During this lesson, inform students that they are creating their own artwork inspired by specific tribes' customs, but they are not creating the tribes' art.

Introduce the lesson using the attached **Lesson Slides**. Display the lesson's essential question on **slide 3**, and then move to **slide 4** to identify the lesson's learning objectives. Review each of these with your class to the extent you feel necessary.

Display **slide 5** and let students know that they are about to watch a video of Dana Daylight sharing her knowledge of her tribe and how she uses reflections in her Osage ribbonwork creations. Introduce the I Notice, I Wonder strategy to the class. Explain that after watching the video, they will be asked to share something they noticed and something they wonder.

Show **slide 6** and play the *Osage Ribbonwork and Reflections* video on the slide.

Embedded video
https://youtube.com/watch?v=CCU7hBirn9c

Transition to **slide 7**. As time allows, ask for volunteers to share what they noticed and/or wonder.

Optional: Vocabulary

Many introduce transformations in the following sequence: translations, reflections, rotations, and dilations. However, this order is not required for understanding. If you are choosing to teach this lesson first, then students will be missing some key vocabulary. Use the attached **Transformation Vocabulary** handout to help meet your students' needs.

25 minutes

Explore

Show **slide 8** and pass out a copy of the attached **Exploring Ribbonwork (Part A)** handout to each student. Share with students that during this activity, they will be working with an arrow pattern from Osage ribbonwork.

Have students work individually to complete the pattern in Quadrant III, then ask them to answer the following prompts on the handout:

- How did you complete the pattern?
- Describe how the preimage transformed into *image 2*.
- Describe how the preimage transformed into *image 4*.

Teacher's Note: Guiding the Activity

Ask more questions than you give answers. The purpose here is for students to reflect either *image 2* or *image 4* over the *x*-axis or *y*-axis respectively. Some students may see rotational symmetry from *image 1*. Challenge those students to resist using *image 1* to create *image 3*—prompt them to instead consider if there is something other than rotations (turns) or translations (slides) that might help them complete the pattern.

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

Have students find partners or put students into pairs yourself. Direct them to compare their work and responses. If time allows, ask for a few volunteers to share with the whole class.

Transition to **slide 9** and distribute a copy of the attached **Exploring Ribbonwork (Part B)** handout to each student. Direct their attention to the *Reflect Over the y-Axis* section at the top of the page. Let students know that they still need their Part A handout available to use as reference. Instruct pairs to complete the table and answer the following questions:

- Does the description of your pattern hold true when *image 4* is reflected over the *y*-axis to get *image 3*?
- Does the description of your pattern hold true when *image 2* is reflected over the *x*-axis to get *image 3*?

Here, students should be looking for patterns to describe a reflection over the *y*-axis. If time allows, ask for a few volunteers to share their responses with the whole class.

Direct their attention to the *Reflect Over the x-Axis* section back of the page. Instruct pairs to complete the table and answer the following questions:

- Does your description apply to the other pair of reflections over the *x*-axis?
- What else do you think we could reflect a figure over?

Here, students should be looking for patterns to describe a reflection over the *x*-axis and considering reflections over something other than an axis. If time allows, ask for a few volunteers to share their responses with the whole class.

Teacher's Note: Guiding the Lesson

Students will refer back to their algebraic rules from the Exploring Ribbonwork handout in the next phase of the lesson. This will be when students check the accuracy of their rules. Be sure students keep track of their handouts.

Provide students with the session invitation code you prepared. Have students go to student.desmos.com to enter the session code.

Teacher's Note: Sign-in Options

Students should see the option to sign in to Desmos via their Google account or through Desmos itself. Note that signing in is not required for this activity. However, if students sign in with their Google or Desmos accounts, their progress is saved, and they can 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 or risk losing their work.

This activity should take no more than one class period, but you may consider having students log in to complete longer activities in the future.

Direct students' attention to **screen 1** of the Desmos Classroom activity. Have students check their work by entering the coordinates for the vertices of *image 2*. Remind them that these are the ordered pairs recorded on the front side of their Part B handout. After completing the table, a "Reflect" button will appear. (If students do not enter something into each row of the table, the button will not appear.) Instruct students to select the "Reflect" button and watch the animated reflection to check their work.

Have students navigate to **screen 2** by selecting "Next" in the top-right corner of their screen. Have students either use the graph from their Part A handout or their second table from their Part B handout to enter the coordinates of the vertices of *image 4*. Here students also check their work by selecting the "Reflect" button that appears once they have completed the table.

20 minutes

Explain

Display **slide 10** and pass out a copy of the attached **Guided Notes** handout to each student.

Introduce the vocabulary word *reflection* to the class. Guide them to write this vocabulary word on their handout. Then ask for a few volunteers to share examples of where they see reflections in the real world.

Go through the algebraic rules for reflections over the *x*-axis and the *y*-axis. Have students use the pictures on their Guided Notes as well as their work from the Explore portion of the lesson to develop these rules.

Teacher's Note: Guiding the Lesson

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. Consider the following questions, if needed.

- What happens to the *x*-values of the ordered pairs when the figure is reflected over [a given axis]?
- What happens to the *y*-values of the ordered pairs when the figure is reflected over [a given axis]?

For students who may still be unsure with the pattern, consider reviewing the patterns of the coordinates of each quadrant. Specifically, draw the *x*- and *y*-axes. Have students remind you which quadrant is which and label each quadrant (I, II, III, and IV counterclockwise). Then write plus and minus symbols as coordinates to represent the *x*- and *y*-values within each quadrant. For example, write (– , +) in Quadrant II because the *x*-values are negative and the *y*-values are positive within that quadrant. Use this labeled drawing to help students see patterns.

Direct students' attention to the back of their handout and complete the first example as a class. Ask guiding questions to have students explain how to interpret the given algebraic rule and reflect the preimage over the *y*-axis. Use the graphs on **slide 11** as needed. Then have students try to independently complete the second example.

As students work through the second example, circulate the room to monitor progress. Then bring the class back together and display **slide 12**. Ask for a volunteer to share how they completed this example. This is the time in the lesson to correct any misunderstandings and directly answer questions. Use the attached **Guided Notes (Model Notes)** document as needed.

Optional: Additional Scaffolding With Patty Paper

For the Explain and Extend portions of this lesson, consider using patty paper. Patty paper—usually small pre-cut squares of parchment paper—is a great supply to use to help students who struggle with seeing transformations. If patty paper is not available, consider using parchment paper, wax paper, tracing paper, or sticky notes instead. Give each student a piece of patty paper to help take the preimage and reflect it with the following steps:

1. Trace the preimage (or at least the vertices) and the reflection line with a pencil.
2. Label the vertices.
3. Flip the paper over.
4. Line up the traced reflection line with the given reflection line.
5. Use the see-through property of the paper to trace the figure or the vertices on the patty paper such that the pencil lead transfers from the patty paper to the handout.
6. Label the new vertices on the handout. Consider just lifting part of the patty paper at a time to keep track of the original vertices.
7. Lift the patty paper and use a straightedge to connect the vertices, if needed.

Optional: Reflective Device

The plastic tool used to allow students to see the reflection, like a mirror, and be able to reach around it to sketch the reflection is often called a GeoMirror, Mira, GeoReflector Mirror, etc. This tool is an alternative to using patty paper.

Go to MathBitsNotebook to check out how to use this tool.

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

35 minutes

Extend

Optional: Alternative to Video

The following activity involves showing students a video interview. If time is a concern, you can instead facilitate a brief discussion with students about what career(s) they think might make use of reflections.

Now it is time for students to see how they could use their knowledge of reflections in a career.

Give each student a copy of the attached **Notecatcher** handout and display **slide 13**. Explain to students that each quadrant has a different prompt within the given image. Direct students to use the empty space beside the image to write each response as they watch an interview with Leslie Deer.

- **Quadrant I:** What did you find interesting?
- **Quadrant II:** What does Leslie Deer do for a living?
- **Quadrant III:** How does this information relate to you?
- **Quadrant IV:** What question(s) do you have?

Show **slide 14** and play for students the *Apparel Designing and Culture* video on the slide. This video is an interview with Leslie Deer, who shares her knowledge of her tribe and how her culture influences her work in her career as a fashion designer.

Embedded video

https://youtube.com/watch?v=nKjKx2iDJnM

Teacher's Note: Copying Art

While the goal of this real-world connection is to celebrate the important contributions of Native people and ensure students learn about these art forms, keep in mind that copying tribal designs is considered disrespectful and is strongly discouraged. 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.

Show **slide 15** and give each student a copy of the attached **Perfecting Patterns** handout. Instruct students to get into groups of 3–4 or assign groups. Then share with the class the Pass the Problem strategy.

Direct students to follow the directions for "Student A." Acting as Student A, each student should write their name at the top of the upper-left box. Instruct everyone to think about the ribbonwork designs that they have learned about and then create their own polygon design (preimage) in Quadrant II. For the sake of time, recommend that students create a preimage using five vertices at most. The more complex the design, the more time this activity will take. As needed, reference the image on the slide—which has more than five vertices—to explain this.

Move to **slide 16** and have everyone pass their paper to the person on their right within their group. With their groupmate's paper, have students now act as Student B. Each student should write their name at the top of the upper-right box. Direct everyone to label the vertices of Student A's design. Remind students that the letters should go in alphabetical order but can go clockwise or counterclockwise.

Direct the class to use the space in their handout to create a table of the corresponding points if the preimage was reflected over the *x*-axis. In other words, students should use what they have learned during this lesson to write the new ordered pairs for the corresponding vertices of the image without drawing the reflection.

Teacher's Note: Guiding the Activity

Challenge students to not draw the reflected image, but to think about their algebraic rules. Remind the class that their tables should have corresponding points clearly labeled. For example, if Student A's design has a vertex at $H(2, 3)$, then Student B's table should include $H'(2, -3)$.

Move to **slide 17** and have everyone pass their paper to the person on their right within their group. Have students now act as Student C and to write their name at the top of the lower-left box. Direct everyone to check Student B's table. Allow time for students to check, talk through, and correct any mistakes.

Direct the class to use the space in their handout to create a table of the corresponding points if the preimage (from Student A) was reflected over the *y*-axis. In other words, students should use what they have learned during this lesson to write the new ordered pairs for the corresponding vertices of the image without drawing the reflection.

Show **slide 18** and have everyone pass their paper back to Student A. Give each student a piece of graph paper.

Instruct everyone to copy their preimage to their graph paper and then plot the points from Student B's table and Student C's table. Once students have done so, have them work together to adjust any points that need to be corrected.

Display **slide 19** and direct students to complete the ribbonwork design by completing the pattern in Quadrant IV.

Have students use four colors to color their design. Remind the class to use contrasting light and dark colors like the Osage tribe does. Consider giving students the challenge of using more than four colors while keeping the symmetry.

Optional: Alternative to Coloring

Instead of coloring the design, consider having students cut fabric and sew their ribbonwork design.

Begin by asking students how challenging they believe their design would be to sew. If needed, allow students time to adjust their design as needed to meet their level of sewing experience. Be sure that students add approximately one half inch around their design for seam allowance. Then have students use their design as a template and cut their design out of fabric.

Once their design is cut, have students pin their design and use seam/hem gauges to measure their desired seam. Have students use a sewing machine to sew their designs.

Note that this approach takes additional time and preparation, but it represents a true real-world connection. Students can further extend this and apply their knowledge of reflections to create and embroider designs.

5 minutes

Evaluate

Display **slide 20** and use the Exit Ticket strategy to individually assess what students have learned from the lesson. Give each student either a quarter sheet of the attached **Over the Line** handout or a sticky note, an index card, etc. for them to write their response. Reference the hidden **slide 21** as a sample response.

Optional: Sample Response and Scaffolding

Depending on your classroom norms, you might choose to unhide and display slide 21 for students to check their own work. You can also unhide and display the graph on **slide 22** to support students who need further scaffolding.

Collect student responses and use them to determine if your students need additional practice or are ready for the next lesson. If students need additional practice, consider having them practice with more basic shapes like reflecting triangles or simply individual points over each axis.

Teacher's Note: ACT Prep

Identifying lines of symmetry and determining the new coordinates after a reflection are skills needed for the ACT exam. These questions often only ask students to reflect one point as opposed to a whole figure since it is a timed exam.

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.). I notice, I wonder. Strategies. https://learn.k20center.ou.edu/strategy/180
- K20 Center. (n.d.). Pass the problem. Strategies. https://learn.k20center.ou.edu/strategy/151
- K20 Center. (2023, July 5). *K20 ICAP - Apparel designing and culture* [Video]. YouTube. https://www.youtube.com/watch?v=nKjKx2iDJnM
- K20 Center. (2023, July 5). *Osage ribbonwork and reflections* [Video]. YouTube. https://www.youtube.com/watch?v=CCU7hBirn9c