

Lissajous: The Influence of Pi - Teacher's Guide

About the Dance

Lissajous is a dance choreographed and performed by the Bowen McCauley Dance Company and commissioned by Drexel University. The dance was created to explore the intersection of acceleration and choreography. During the development phase of the piece, students from Drexel University affixed sensors to the dancers so the choreographer could consider multiple forms of data, visual and computer-generated, in her work. The piece was set to an original music composition, *To Say Pi*, by composer Jordan Alexander Key.

The project provides a rich opportunity to explore science, technology, engineering, and math in relation to the arts – specifically dance.

The Lesson

The *Lissajous: The Influence of Pi* lesson is an exploration into the intersection of shapes and physics with dance and choreography. It highlights the influence of the STEM disciplines on the arts. The lesson focuses on circles and π (pi) and how patterns emerge from mathematical events.

The lesson was written to Virginia Standards of Learning for grades 6-8, but the essential question can be investigated in all grade levels. This guide includes suggestions for adapting the lesson components for grade bands K-5 and 9-12.

Essential Question

How do shapes and patterns appear in and influence art and, more specifically, dance?

Key Vocabulary

accelerometer, choreography, commission, frequency, lissajous, rotational motion, rotational symmetry, sensor, sinusoidal, symmetry

ADAPTATIONS FOR GRADES K-5

Activity Adaptations

Hook: Human Circle

This activity can be achieved in K-5 classrooms with one or more adjustments.

- Simply discuss the different sizes of the circles and how the students made them bigger and smaller.
- Focus the activity on learning the vocabulary: circle, circumference, diameter, radius.
- Give more explicit directions to students by telling them exactly how to form each of the three circles.
- Provide more supervision or direction for the taking of measurements.



Lesson Activity 1: Patterns in Movement

For grades K-5, focus the activity on the first two steps: watching the video and discussing the different roles: dancer, researcher, choreographer. Then, invite students to make up a short dance routine involving circles (of the arms, legs, hands, body, etc.) and teach it to a partner.

Lesson Activity 2: Creating Your Own Pattern Through Movement (The Spirograph)

This activity can be achieved in K-5 classrooms with one or more adjustments.

- Pre-cut the spirograph materials.
- Allow students to work in small teams.
- Use very large pieces of cardboard and crayons to make it easier to manipulate.
- Make one spirograph in advance and let each student take a turn with their own piece of paper; or, let all students take a turn on one whole class version.

Assessment

Students will complete a Venn diagram to compare and contrast two shapes. (Note: you may give students pictures of shapes, shaded in different/same colors and of different/same sizes, etc. to inspire comparison.) For older students, provide more complex shapes and require a specific and challenging number of items in each section of the diagram.

Discussion Questions

1. How did the choreographer use circles in the dance she made up?
2. What are some other shapes you could use when you make up a dance?
3. What are some other activities, besides dance, where you can see circles being used?

Cross-Curricular Suggestions

Language Arts

1. Read books that feature circles and/or shapes, such as *Lots of Dots*, by Craig Frazier, *A Star in My Orange: Looking for Nature's Shapes*, by Dana Meachen Rau, and *The Dot*, by Peter H. Reynolds.
2. Have students write a poem or a story about a circle using personification.

Social Studies

1. Study dances from around the world; coordinate by focusing on dances from the region or time period you are currently studying.
2. Look at landmarks from around the world and analyze the shapes that were used in their design and construction. Discuss the engineering or symbolism of each (e.g., how the pyramids are structured).
3. Look at famous works of art and find common shapes. For older students, introduce geometrical principles, such as the golden mean, and discuss their appearance in the paintings.

ADAPTATIONS FOR GRADES 9-12

Activity Adaptations

Hook: Human Circle

Students in grades 9-12 will likely be familiar with the concept of π (pi), so consider changing the hook in this lesson.

- Use the [Lissajous Doc.](#) video to spark interest in the project and focus your introduction on the curiosity and creativity of the graduate students. Ask your students what investigation they might like to launch with a professional dance company or other artistic organization.
- Maintain the activity of making shapes as a team, but make it a silent activity. Give one or two students a set of cards featuring simple and complex shapes and see how long it takes them to get their team into formation without using verbal instructions. Make it a competition between teams for either number of shapes created in a limited time or fastest team to create a specific shape.
- Play an improv game: Dance/Move Like a _____. Use shapes: *Dance like a hexagon, Move like a circle, Dance like a rhombus.*

Lesson Activity 1: Patterns in Movement

This activity can be replicated with no or minimal adaptation in grades 9-12.

Lesson Activity 2: Creating Your Own Pattern Through Movement (The Spirograph)

This activity can be replicated with no or minimal adaptation in grades 9-12.

- Add a predictive element to the spirograph activity: see if students can predict which hole will produce which pattern; see if students can replicate a pattern on the first try using predictive logic.
- Make the spirograph more elaborate by including an outer-gear-guide and introduce students to cycloids, hypocycloids, epicycloids, and hypotrochoid.

Assessment

The assessment can be replicated with no or minimal adaptation in grades 9-12.

Discussion Questions

1. How do you think the accelerometers changed the choreography for *Lissajous*?
2. What other data could be measured and used to drive creativity in dance or another art form?
3. What role did technology play in this project? Can you see a possibility for the use of A.I. in a project like this? How?
4. How would you feel about incorporating data into your own artistic endeavor?

Cross-Curricular Suggestions

Math and Science

1. Introduce planetary motion, orbits, and trajectories and the influence of mathematical concepts such as parametric equations.

Social Studies

1. Study dances from around the world; coordinate by focusing on dances from the region or time period you are currently studying.
2. Study the golden mean and look at famous paintings to determine its appearance and effect.

Performing Arts

1. Encourage students to choreograph their own dances inspired by a shape, natural phenomena, or pattern of movement.

The FREE curriculum materials are available at <https://www.bmdc.org/outreach/educational-curriculum>