



Sound Shapes

Hearing Geometry As Function and Metaphor

TRACKS
1-10

Sound Shapes explores various elements of music that embody geometric principles. The introductory reading discusses how the study of mathematics can influence our lives beyond its direct utilitarian applications by enhancing analytic thinking and enriching communication through metaphor. This activity presents music as an example of the use of mathematical terms as metaphors to communicate nonmathematical ideas. Students review a list of geometric terms and

refine and agree on their meanings. They then listen to ten music examples, each of which illustrates a geometric concept in its musical structure. Students analyze the music and match it with the geometric term that denotes a relationship between geometric elements analogous to the relationship they hear in the notes or rhythm. Sound Shapes does not require students to do mathematical calculations. It uses indirect learning pathways to enhance understanding of geometric terms.

Mathematics topics

Geometry vocabulary, mathematics as metaphor, symbolic representation, the use of mathematics in daily life. *Prerequisites:* An understanding of the meaning of geometric terms.

Music topics

Ear training, melodic voice leading, melodic shape. *No prerequisites.*

Use with the primary curriculum

- As enrichment when you are introducing definitions of mathematical terms
Use Sound Shapes when you are introducing new terminology. It need not be confined to geometry class, because the message of the activity reaches beyond the specific content of the terms.
- As a special interest activity at any juncture in your curriculum
Sound Shapes can provide a thought-provoking segue between units in any course.

Objectives

- To enhance understanding and retention of geometric concepts
The unique application of geometric terms in Sound Shapes requires students to fully understand the underlying ideas.
- To inspire students to study mathematics
Sound Shapes shows how the study of mathematics can be used to provide metaphors for nonmathematical concepts. The activity can inspire new ways of perceiving the value of mathematics and the scope of its applications.
- To teach abstraction and metaphor
Sound Shapes stimulates higher-order thinking. Developing students' abilities to think abstractly and to use metaphor can prepare them for advanced mathematics.
- To provide access for auditory learners
Sound Shapes allows auditory learners to shine, while usually strong students may struggle. This can be a healthy shift in classroom culture, with benefits that can last throughout the school year.
- To stimulate students by providing pedagogical variety
Sound Shapes provides a refreshing change of instructional pace that can stimulate students and carry over to activities that students find less engaging.

Student handouts

- The Hidden Life of Geometry (reading; one per student)
- Help, Hints, and Geometric Terms (resource page; one per group)
- The Geometry/Music Connection (worksheet; one per student)

Materials

- CD tracks 1–10

Instructional time

50 minutes

Instructional format

Students work in groups of up to four. Since most classes demonstrate a large diversity of student ability to think in the abstract ways that Sound Shapes requires, make the groups as heterogeneous as possible in all respects, including musical background, mathematical strength, gender, ethnicity, language proficiency, personality type, and learning style. You may be surprised by which students are able to make the abstract connections.

Following the reading, you can either lead the initial discussion or assign a student to facilitate it. Your role during most of the activity will be to play the CD tracks, coach students as they work in groups, and lead discussions. For each of the ten examples, the activity focus moves from independent work groups to whole-class discussion. The structure of the activity is quite simple. The complexity lies in developing a level of comfort with its abstract nature and effectively coaching students.

Student preparation

Have students read *The Hidden Life of Geometry* the night before or the day of the activity. If it is the norm for your class to engage deeply in group discussions, you might present the reading the day before and have an opening discussion at that time. The activity itself will take 30–40 minutes.

ACTIVITY SCRIPT**STEP 1 Discuss the topics of the reading**

This is a good opportunity to have an open discussion on a variety of issues in mathematics education.

Sound Shapes

Ask students:

Why is it so important to study mathematics in school?

In what ways does mathematics prepare us for life?

How can knowing mathematics help us communicate more effectively about nonmathematical things?

What is a metaphor?

What are *parallel lives* and what does *circular reasoning* mean?

What do you think the reading was talking about when it said that mathematics can help us with our romantic life? Is this idea far-fetched? [Mathematics develops skill in logical/rational thinking and systematic problem solving. If we need to make decisions when we are emotionally distracted by love or tragedy, training in rational thinking can be a skill to fall back on and can help us find clarity.]

Give students an overview of the activity and direct them to refer to the resource page Help, Hints, and Geometric Terms.

STEP 2 Review the definitions of the geometric terms

Systematically go over the geometric terms on the resource page to reach clear mathematical definitions that use exact language. This important step will help students make the musical connections. For example, we might first describe the term *intersection* as “two lines crossing,” then refine this definition to “the point at which two lines cross.” To use the idea of intersection in a broader context, such as the description of a musical event, we can then define it as “the set of elements common to two sets.” In the first music example, two instruments are playing melodies. These two melodies each comprise a set of notes. At one point the two instruments play the same note, creating a common element for the two sets. This note represents the intersection of the two melodies.

As you coach students to make the connections between geometric terms and music examples, revisit and rearticulate the meanings of the terms.

STEP 3 Discuss how to listen to the examples

Before beginning the listening exercises, direct students’ attention to the resource page for guidelines for listening to the music. Be sure they understand the idea that melodies have a shape that can be thought of as a graph. (See Functional Composer [both movements] for specific applications of this concept.)

STEP 4 Work through each music example, matching geometric terms

Use the teacher notes in the Answer key to coach students and verify responses as they work through the examples. Play each example as many times as necessary. For each example, have groups discuss among themselves to arrive at

