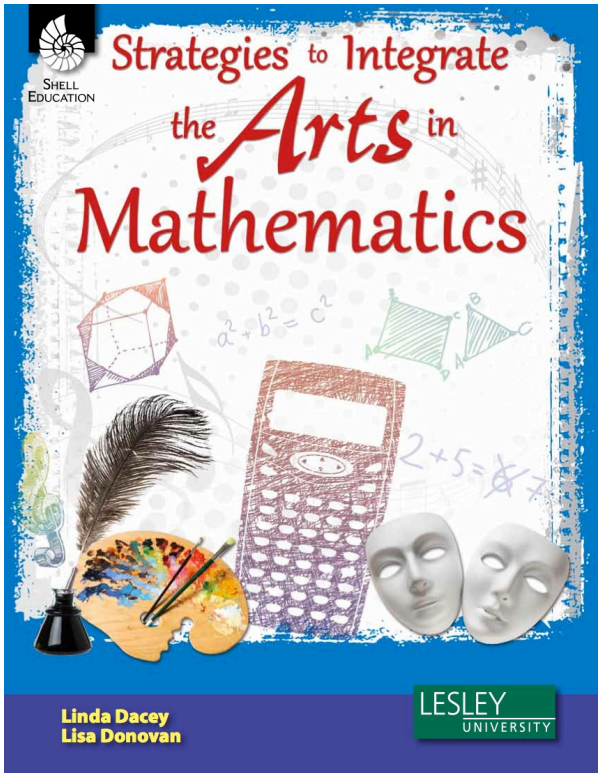
SHELL EDUCATION

Sample Pages from

Strategies to Integrate the Arts in Mathematics



The following sample pages are included in this download:

- Table of Contents
- Music Overview
- Sample model lesson

For correlations to Common Core and State Standards, please visit http://www.teachercreatedmaterials.com/correlations.

Shell Education

Strategies to Integrate the Arts in Mathematics

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Music

Understanding Music

Music has played a significant role in every culture since the beginning of time. Now with recent technology, our favorite tunes are readily available to us, and music has become even more prevalent in our lives. Dr. Howard Gardner has identified musical intelligence as one form of intelligence (2011). His theory of multiple intelligence suggests that students learn in different ways, and for some students, connecting with rhythm, beat, and melody provides access to learning. And as any adult who has introduced a cleanup song knows, music can motivate children and help them make transitions from one activity to another. Recently, attention has been given to the benefits of music in academic performance. It has been suggested that early music training develops language skills, spatial relations, and memory (Perret and Fox 2006).

Music and mathematics have long been linked. After all, it was the famous mathematician Pythagoras who first noted that the pitch of a string was directly related to its length. "Mathematics is also universal, crosses cultural, historical, and intellectual boundaries, and is reflected in music. The interconnectedness of math and music pulsates with a rhythm and harmony of its own" (Garland and Kahn 1995).

In the following strategies, students explore mathematical ideas alongside the basic elements of music. Students engage in singing, playing, and composing music as well as using everyday objects as nontraditional instruments. The focus is on deepening mathematical knowledge while experiencing the joy of creating music together in ways that all students can participate. Along the way, students develop a deeper understanding of and skills in creating music. No previous musical training is needed for you or your students.

Exploring mathematical ideas through music engages and motivates students. As students identify, apply, and generalize ideas to real-world situations, mathematics becomes meaningful and purposeful. Abstract ideas are connected to concrete models, and students' representational fluency deepens. The more avenues we provide for students to experience mathematics, the more likely we are to connect with the variable ways in which students learn.

Strategies for Music

Found Sounds

Sounds are all around us; they are found when we attend to them or manipulate them. Think about the sound of light rain or the squeals of delight you hear near a playground. There is rhythm in these sounds. Composer R. Murray Schafer thinks about the world as a musical composition. He notes, "In [music] we try to get people to use their senses to listen carefully, to look carefully" (quoted in New 2009). What makes a sound music rather than noise may depend on the listener, but it is also related to pitch (high or low) and rhythm. When students collect found sounds, they gain a new appreciation for what music is. They can also better understand the environment from which sounds come. Students can categorize these sounds, experiment with making them, and explore their dynamics (volume). Their findings can be represented in graphs.

Songwriting

When students sing, a deep connection is created with the melody, rhythm, and lyrics of a song. Further, creating and making music supports academic achievement (Deasy 2002). Though students have opportunities to sing in school, far less attention is given to their ability to create their own songs. This strategy invites students to become songwriters, and as they do, they become more familiar with the importance of tone, rhythm, and beat. Students can begin on an intuitive level or simplify the task, for example, by creating new lyrics for a song they already know. As songs can help us to remember things, these adaptations can help students to retain important mathematical information. Also, writing lyrics will prompt students to discuss, synthesize, and categorize curricular concepts. Students can explore rhythms on a drum or experiment with notes on a keyboard. As their musical knowledge expands, they can create original melodies as well as score their compositions.

Scoring

When music is composed, it needs to be scored so that others can perform it. Scoring is the communication of the sounds that are to be made and the timing of those sounds. The scoring can be done in nontraditional ways so that all learners are able to participate; for example, students can record a word in writing, such as *clap*, or draw a hand to indicate when such a sound is to be made. Such scoring techniques allow students to construct the symbols and their meaning. Traditional scoring can also be considered, allowing students to experiment with the common language of musicians. "Musical elements such as steady beat, rhythm, tempo, volume, melody, and harmony possess inherent mathematical concepts such as spatial properties, sequencing, counting, patterning, and one-to-one correspondence" (Geist and Geist 2008).

Call-and-Response

Used for centuries around the world, call-and-response is a musical pattern of phrases exchanged between musicians. There is a conversational pattern with the second musician (the "response") responding to the first musician (the "call"). This pattern has rich cultural roots in African, African American, Indian classical, and Cuban traditions among others. In the United States, such songs are most familiar as sea chanteys and maritime work songs.

The cadences and rhythmic patterns involve learners and support memory. This strategy supports full participation as students pose and answer questions in an engaging way to review information, reinforce skills, and expand ideas (Plessinger 2012).

Chants

Chants involve the rhythmic repetition of sounds or words. They can be sung or spoken. They can be a component of spiritual practices or heard on a football field. By combining different dynamics (ranging from soft to loud), pitch (variations from high to low), and different notes (length of duration), students can create engaging sound effects that help them learn and remember ideas. According to Sonja Dunn (1999), "A chant is a rhythmic group recitation." Chants can be used in a variety of ways. They can be created with catchy rhythms that make the associated words easy to learn and remember. When this form of chants is emphasized, students retain important mathematical information. Chants also can be constructed by layering phrases on top of another that are then spoken or sung simultaneously. In this format, the use of differing rhythms and pitch create interest and suggest relationships among the chosen phrases and thus the content being considered.

Found Sounds

Model Lesson: Categorization

Model Lesson Overview

Students listen closely to the sounds around them, think about the sounds that they can make with common objects, and categorize those sounds according to variations in loudness, or *dynamics*, and other properties of sound. Students bring in a "found sound" from home and consider the dynamics of these sounds as well as their other properties. They conduct a survey focused on one property, represent their findings in graphs, and summarize their findings.

Standards

K–2

- Collects and represents information about objects or events in simple graphs
- Knows standard symbols used to notate dynamics

3–5

- Organizes and displays data in simple bar graphs, pie charts, and line graphs
- Knows symbols and traditional terms referring to dynamics

6–8

- Organizes and displays data using tables, graphs, frequency distributions, and plots
- Understands the basic concepts of center and dispersion of data
- Knows standard notation symbols for dynamics

9–12

- Selects and uses the best method of representing and describing a set of data
- Uses the elements of music for expressive effects (e.g., pitch, rhythm, harmony, dynamics, timbre, texture, form)

Materials

- Various household items that produce sound (athletic shoes that squeak, utensils to rub together, etc.)
- *Characteristics of Sound* (page 113, characteristicssound.pdf)
- *Music Graph* (page 114, musicgraph.pdf)
- Copies of a class list (one per pair of students)

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Found Sounds *(cont.)*

Preparation

Tell students that they are to collect sounds for homework. Their job is to find objects that make interesting and different sounds and bring them to class the next day. Each student should bring one or two items. Provide examples of items they could find, such as an athletic shoe that squeaks, kitchen utensils that could be struck and rubbed against each other, or tinfoil to be crunched. You should also gather a couple of items to add variety to the collection or to give to students who may forget to bring one. Other ideas are provided in the Specific Grade Level Ideas.

Decide how you will display the Dynamics Chart (see Step 3 of Procedure) and prepare accordingly.

Procedure

1. Have students share their found sounds. Provide time for students to experiment with the "instruments" in small groups and explore different ways they can be used to make sounds. Encourage students to find more than one way to make a sound with each item. For example, they can blow on the top of a bottle, shake it with pennies or pebbles inside, or roll it. Provide time for students to share their discoveries about new ways to make sounds.

2. After each instrument is played, ask students to suggest adjectives to describe the sound it makes. If students are aware of the categorization of orchestral instruments, ask, "What instrument does this remind you of that you might hear in an orchestra or band? What type of instrument is this?" For example, a student might compare plucking an elastic band pulled taut around a piece of cardboard to playing a banjo or he or she might compare blowing on a bottle top to a wind instrument.

3. Introduce the word *dynamics* as the term musicians use to describe variations of loudness. Tell students that dynamics is one property of sound. Display the following chart that lists some Italian terms used to describe the loudness of western approaches to music.

Dynamics Chart

Word	Meaning	Symbol
Fortissimo	Very loud	*ff*
Forte	Loud	*f*
Mezzo forte	Moderately loud	*mf*
Mezzo piano	Moderately soft	*mp*
Piano	Soft	*p*
Pianissimo	Very soft	*pp*

Found Sounds *(cont.)*

4. Have students practice saying the Italian terms and explain that these words describe or identify the different volumes. Have a few volunteers play their instruments with different dynamics. Point out to students that these terms are relative. In other words, what is forte on one instrument may be softer than forte on another instrument. For example, a piano will sound louder than a violin even though both might be playing at a forte level. The same is true for twisting a cap and scrunching a plastic bag. Ask students to identify sounds with dynamics that do not change, such as an alarm clock ringing.

5. Have students work in small groups to categorize their instruments according to dynamics.

6. Distribute *Characteristics of Sound* (page 113) to students and point out that the property of dynamics has already been provided as an example of a property of sound. Have students brainstorm other properties of sound. These can include a wide range of possibilities, including material (plastic, natural, metal), pitch (high, low), duration (time the sound lasts, sustained or intermittent), and sound-production method (tapping, rolling, hitting, shaking, blowing air, or plucking). As students identify a property, record it for students to refer to throughout the lesson, and have them record it in the first column of the sheet.

7. Once students list a property, have them brainstorm words that describe or identify ways that property could vary. Have students record these words in the second column.

8. Tell students to choose one of the instruments they brought to class and identify the words in the chart that could describe the sounds it can make. Have students circle these terms on their recording sheet.

9. Have students find partners and distribute *Music Graph* (page 114) to each pair. Direct students to choose one of the properties listed, identify the descriptors they will use, and record this information on the sheet. Have students survey their classmates to determine which of their chosen descriptors students used to describe their instruments. Give students a copy of a class list to help them keep track of whom they have surveyed.

10. On the recording sheet, have students create a graph of their data and write their findings. Then, have students share their graphs. As they do so, ask follow-up questions. Use the Questions for Discussion to guide the conversation.

11. If time allows, have students experiment with ways to combine their sounds to create a musical composition.

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Found Sounds *(cont.)*

Questions for Discussion

- What descriptors did you choose? Are there others that could be considered?
- How many more of our instruments were (name a descriptor) than (name a different descriptor)?
- What graph should we look at to find the number of instruments that were made from metal?
- What types of sounds were most common?
- Which sounds do you prefer? Why?
- If you were to create a musical composition, what sounds would you pick to be played together?

Specific Grade Level Ideas

K–2

Focusing on the terms *forte* and *piano*, have students practice making loud and soft sounds. For their surveys, have students choose only two to four descriptors for the sound property they choose. Ask several questions that require them to look at the information on the graph and add or subtract to find the answer.

As a follow-up activity, take students outside to listen for sounds. The sound outing could be to the cafeteria, to a city street, or to a secluded area. After listening for a couple of minutes, have students talk about the sounds they heard and how they could be categorized. Students can also use found sounds to model addition facts.

3–5

Students can explore the activity as written. Students will similarly benefit from a sound outing as described in the K–2 Specific Grade Level Ideas. They may also be interested in finding out their classmates' favorite songs and classifying those songs by artist or type of music. Students can also use found sounds to model multiplication facts.

Found Sounds *(cont.)*

6–8

Encourage students to represent their data in circle graphs and report their findings in fractions and percents.

You can expand the terms used to describe dynamics by including *pianississimo*, which means extremely soft and is represented by *ppp*; *fortississimo*, which means extremely loud and is represented by *fff;* *sforzando*, which means with a strong and sudden accent and is represented by *sfz*; *crescendo*, which means a gradual increase in volume and is represented by <; and *decrescendo*, which means a gradual decrease in volume and is represented by >. Have students listen to a piece of music, note the dynamics, and relate them to these terms. Students can also play their sounds together to further explore dynamics within combinations of sounds.

As a follow-up activity, students can do research about popular music. For example, they can represent the age of popular artists in box plots. Ask questions to highlight measures of central tendency and variation.

Students can also use found sounds to model proportional relationships.

9–12

Have students collect sounds from found instruments, the Internet, and the environment. Then, have them categorize the changes in tempo or beats per minute (BPM). Students can then create a recording of sounds that includes a variety of changes in tempo (e.g., increasing at a constant rate, increasing at an increasing rate, or increasing at a decreasing rate). Have students play their recordings while listeners graph the change in tempo over time.

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Name _____ Date _____

Characteristics of Sound

Directions: In the first column, write properties of sound. In the second column, list words that can be used to describe or identify sounds for each property. An example has been done for you. Then, write the name of your instrument and circle each word that describes it.

My Instrument: _____

Property	**Words to Describe or Identify**
dynamics	pianissimo, piano, mezzo piano, mezzo forte, forte, fortissimo

Name _____ Date _____

Music Graph

Directions: Complete each task.

1. The property we chose is:

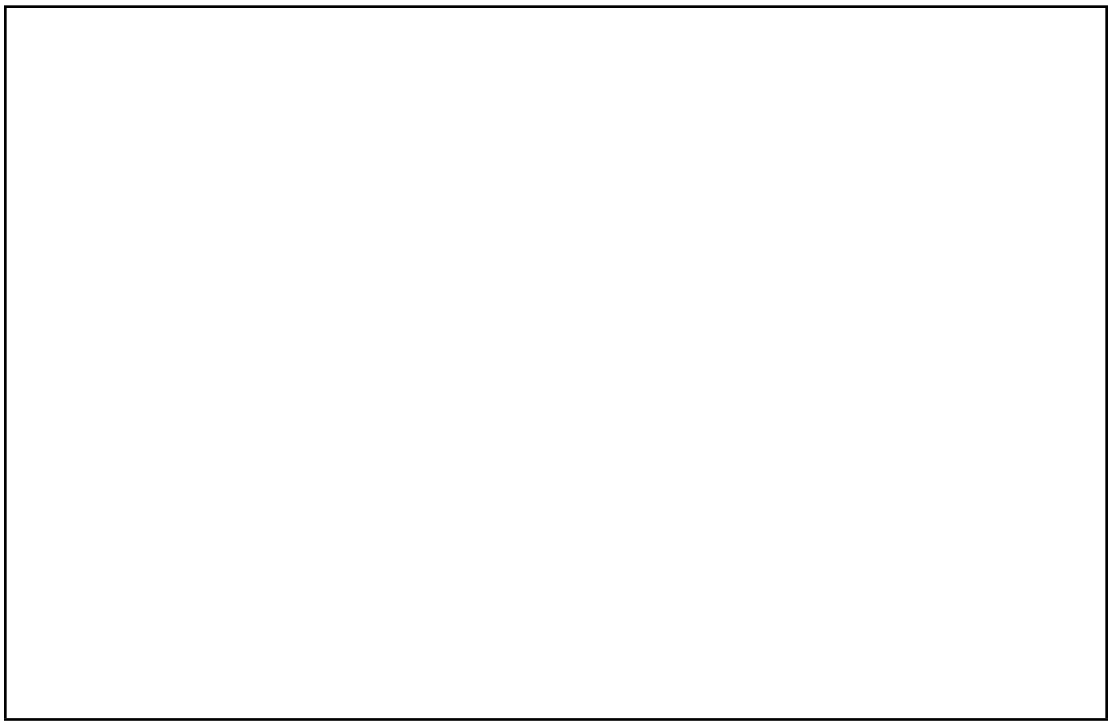
   _____

2. The words to describe or identify for this property we will include are:

   _____

   _____

3. Our graph:



4. Our findings:

   _____

   _____

   _____

   _____

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