Discovering Strings and Orchestra – Sample Lesson Plan

Science Grades 1-3 – Acoustics and Vibration

(contributed by Dr. Anne Clark, August 2007,
with permission granted to reproduce and adapt without request)

National Music Standards
Content Standard 8: Understanding relationships between music, the other arts, and disciplines outside the arts

Lesson Length
45 minutes or longer

Materials Needed
One violin, viola, cello, or bass, with its bow

Mutes for the instrument above: Tourte rubber, ebony wood, clear plastic/wire, wooden clothespin, plastic clothespin

A String Vibration Chart and pencil for each student

4-7 Clipboards with printed data sheets and pencils

A hand-held decibel meter (otherwise known as a sound meter) and optional frequency spectrum analyzer Eq: you can borrow from a recording studio, electronics repair shop, or science teacher; purchase from electronics or scientific equipment stores; or order online (such as typing in "Decibel Meter" or "Frequency Spectrum Analyzer: on eBay).

Chalkboard with chalk, or dry-erase board with marker

Optional: computer

Vocabulary to be Taught and Reviewed (as time permits)
Acoustics
Vibrate and Vibration
Decibel
Decibel Meter; Sound Meter

Optional: Frequency Spectrum Analyzer Eq
String
Bridge
Maple Wood
Resonance
Bass Bar
Instrument Top
Mute
Con Sordino and Senza Sordino
Ebony Wood
Tone Quality
Volume
Eardrum
Timpani
Hypothesis
Prediction
Baseline
Data

Resources and Sources for This Lesson
"String Instruments and Pitch" lesson plan created by Leslie Thomas and available on The Kennedy Center's ARTS EDGE website at http://artsedge.kennedy-center.org/content/3345

Clip art under the words Violin Bridge (or Violin Bridges)
http://images.search.yahoo.com/search/images?p=violin+bridge
The two images used in this lesson plan above were found on this site and were posted by:
1.(the practice mute) www.minehara.com
2. (the electronic pickup) www.schatlendesign.com

Glenn Axelton of Glenn's Music, Manhattan, KS
gmusic@glenns.kscoxmail.com

Radio Shack sells a new sound meter for approximately $45 which requires an additional 9 Volt battery and is child-friendly. It is analog; a digital one costs about $10 more
www.radioshack.com

Lesson Procedure
The volunteer clinician begins by asking students what makes the sound of the string instrument brought to the session. After various answers are offered by students, the volunteer clinician tells them to write or draw a picture on their distributed "**String Vibration Chart**" to remember the five steps.

l. A **string** is made to vibrate (quiver either clockwise or counterclockwise) by the musician's bow or plucking motion.

2. The string's vibration travels to the **bridge,** which also begins to vibrate because of the special type of wood, **maple**, from which it has been carved.

3. The vibrations travel down both of the bridge's feet to the **instrument top** and **bass bar** (underneath the top), which begin to vibrate.

4. The vibration of the instrument top causes the air near it to vibrate.

5. The vibration in the air reaches and vibrates the **eardrum**, a tiny "timpani" drum top made out of thin skin inside each our ears, which causes us to hear a sound.

String Vibration Chart

Your Name________________________________

What vibrates?

l.______________________

2. _________________________

3. _________________and_____________________

4. ______________________________

5.________________________________

After the charts are quickly checked for correct answers, and any errors are corrected, the volunteer clinician tells the students that today's meeting will explore the science of **acoustics** (sound), and the students are asked, "What do you think would happen if something blocked some of the vibrations of the string instrument at the bridge? We are going to do an experiment to find the answer to this question. First we must propose a **hypothesis**, or good guess, for the answer. I am going to help you start by noticing that there are ways to change the way the bridge vibrates by the use of **mutes** (hold them up for the first time). These are various types of mutes: black rubber, ebony wood, clear plastic with wire, heavy metal, and also some homemade mutes: clothespins of wood and plastic! Another way to talk about this is to say that the **resonance** (or how long the sound lasts) is changed by the mutes. When musicians see the words **"con sordino"** in their music, they put a mute on the instrument's bridge, and it produces a very different type of sound, or **tone quality**. When musicians see the words **"senza sordino"** later in their music they remove the mutes, and the tone quality returns to normal." (Demonstrate this as it is explained.)

Write the following hypothesis in big letters on a chalkboard or dry-erase board and say, "My **hypothesis** (or idea to explain this) is that when each mute keeps some the vibrations of the bridge from traveling to the instrument top and bass bar, the sound we hear will be different in its **volume** and **tone quality**. We can measure the volume change with a **decibel meter** or **sound meter**. A **decibel** is one unit we use to measure the difference in loudness or **volume.** (Optional: We can also measure the tone quality change with the **frequency spectrum analyzer Eq**, and even see a picture of how each mute sound looks.) So what we are finding out is if the sound's power and quality will change enough that we can measure it when we use the mutes on the bridge."

"You are going to be collecting scientific measurements for an experiment with the mutes, and I want each of your teams to make a **prediction**. Then after you measure the sound of your mute with the decibel meter, you will be able to test whether your prediction was correct. When all our teams have finished deciding about their predictions, we can as a group find out if the hypothesis was true or false."

Have the troop leader divide the students into teams so there are six different groups. (If not enough students are available, some teams of l can be used.) Have the youth group leader demonstrate how to take the initial readings to find the **baseline**; be sure the same string is played in the same way each time by the volunteer clinician. Pass out one different mute to each team and a clipboard with the blank **data** chart. Ask each team to state a prediction before those students come to the front of the group to take the measurement of its mute while the clinician plays. The clinician and troop leader should try to guide the teams to create original predictions <u>without giving any clues</u>. Here are sample predictions:

> <u>For grade l</u>, a simple prediction is: If the hypothesis is true, the muted instrument will measure differently than when the instrument plays without a mute.
> Another optional simple prediction: If the hypothesis is true, the mutes will also change the tone quality, measured by the frequency spectrum analyzer
>
> <u>For grades 3 and/or 2</u> more complex predictions could be encouraged, such as:
> If the hypothesis is false, the rubber mute will measure louder than the instrument without any mute on it.
>
> If the hypothesis is true, the practice mute will sound softer than all the other mutes (because it is the heaviest and stops most of the vibrations).
>
> If the hypothesis is false, the plastic and wooden clothespin mutes will have the same tone quality as the bridge without any mute on it.
>
> NOTE: You may find an unexpected result for the above predictions when you do your own measurements! Dr. Clark's experiment showed that the ebony mute was louder than the bridge without a mute on it. This would send us back to the "drawing board" for an explanation.

Explain that each measurement needs to be written in the **data** (or information) chart on the team clipboards, and that after all the data is collected, the whole troop will have to vote on whether or not they believe the data proves the hypothesis true or false.

Let each team come up to the front of the group, measure the bowed sound of the instrument played by the volunteer clinician with its assigned mute, and announce the decibel number (and optional frequency spectrum analyzer Eq number for all teams to record).

String Acoustics and Vibration Data Chart

Team Members____

____

____

	Decibel	**Frequency** (Optional)
Baseline: The Instrument **"Senza Sordino"**		

"Con sordino"

Team #1: Tourte Mute		
Team #2: Ebony Mute		
Team #3: Practice Mute		
Team #4: Wooden Clothespin		
Team #5: Plastic Clothespin		
Team #6: Clear Plastic Mute with Wire		

Tell the group to look at all the measurements on the data chart, and discuss in their teams whether the hypothesis has been shown to be true or false. Then ask each team to vote for either true or false. Tally the votes and announce the opinion of the entire group.

Informal Assessment

Have student volunteers say vocabulary terms and what they mean. Prompt them with the terms or point to the items (such as bridge and instrument top) to encourage this for about 4-5 minutes.

Extension

Explain that scientific data is often shared with other scientists and the public. If a computer is available, look up the project website www.astaweb.com/discoveringstringsnew.html and post the results where there is a spot for the science lesson results. Look to see if other people doing this lesson had similar or different results.

Allow individual students to measure other sounds in the meeting environment and compare them to the string decibel and optional frequency spectrum numbers.

Ask students to share with the group how they could invent a totally new mute design and material, to create a new tone quality for string instruments. Suggest that they make a prototype to bring to the next meeting, to try out on the string instrument.

Measure the results when someone's hands are placed on the instrument top.

Compare the measurement results when a laminated top instrument is compared with a solid carved wood top instrument.

Point out the picture of the pickup on the violin bridge below, and ask how students think this tiny microphone works, when it is attached right onto a bridge.

Conclusion
While waiting for snacks or parents to pick up children, ask for answers to questions such as these:
"Who in this troop would like to have a scientific job when they are older?
Do any of you think you might like to be an audiologist, or doctor who helps people hear more clearly? Have any of you ever injured your eardrum and been unable to hear clearly?"
"Who in this troop thinks they can see the mute being used by string players in an orchestra concert? What would you notice happening when the mute was put on or

taken off the instrument?" Have the volunteer clinician demonstrate the quick motions used by musicians with mutes. Tell the students that they will be taking a field trip to hear an orchestra concert, and may have the chance to hear how the mute changes the tone quality of an entire string section then. Otherwise, suggest they listen to some CD examples of muted string sounds in an orchestra, string ensemble, chamber group, or solo.

Notes for the String Clinician and Troop Leader