Scratch Music Lesson Plan

Purpose: This lesson introduces Scratch programming by challenging students to teach Scratch to perform Beethoven's "Ode to Joy". It also helps students to understand the mathematical background of musical notation and develop skills in counting & cardinality, algebraic operations, temporal reasoning, abstract thinking, and mathematical modeling.

Materials: For this lesson students should have access to the Scratch programming environment. Three solid options for using Scratch exist (the third option, Snap!, does not have the MIDI-style note and rest blocks needed):

1) The current version (Scratch 2.0) is run from a web browser using Adobe Flash (works with PC, Macintosh, Linux, and Andriod platforms, but not iPads). It can be reached at: http://scratch.mit.edu/

2) A downloadable, stand-alone executable exists for the previous version (Scratch 1.4) with installers for Mac OS X, Windows (XP, Vista, 7, & 8), and Linux. It can be downloaded here: http://scratch.mit.edu/scratch_1.4/. This version lacks some functionality (Sprite cloning and custom blocks)

In addition, you should print out enough copies of the "Ode to Joy" sheet music, and the "Reading Music" handouts for each student to have their own copy.

The folder also contains a completed "Ode to Joy" Scratch project, for demonstration purposes as well as to familiarize yourself with the process. This should not be given to students, as they will be authoring the same project themselves.

Finally, headphones are a very, very, useful tool for this project. You can also use speakers, but it will be a cacophony.

Background: In this lesson, students will transcribe Beethoven's "Ode to Joy" from sheet music to a Scratch program. This project helps the students learn musical notation, practice ratios (a quarter note is ¼ the length of a measure, a half note is ½ a measure, and a whole note is the entire measure – hence the names), counting in regular intervals (counting and labeling measures) and irregular intervals (counting beats), and practice basic algebraic operations. Further, it will challenge them to attend to precision and structure in their program.

It also exposes opportunities to discuss the physics of waves in relation to a real-world application: music.

Finally, this exercise exposes aspects of the MIDI musical notation, which is a basis for most modern electronically generated music.

Objectives: This is a bulleted list of what they will do during the lesson and know or be able to do when they complete the lesson. Keep in mind, the procedure or directions will be in another section. If you are tying your lesson to K-12 Standards, add that here.

- Mathematics objectives

- o Model pleasing sound patterns (music) with mathematics (CCSS.Math.Practice.MP4)
  - o Use appropriate tools (Scratch) strategically (CCSS.Math.Practice.MP5)
  - o Solve problems that call for addition and multiplication (CCSS.Math.Content.OA.A)
  - o Attend to precision in synchronizing multiple scripts (CCSS.Math.Practice.MP6)
  - o Look for and make use of structure in musical notation (CCSS.Math.Practice.MP7)
  - o Look for and express regularity in repeated reasoning – for example, by copying blocks of identical or near-identical measures (CCSS.Math.Practice.MP8)
  - o Generate and Analyze Patterns (CCSS.Math.Content.OA.C)
  - o Identify and explain patterns in arithmetic (CCSS.Math.Content.OA.D)
  - o Develop understanding of Fractions as numbers (CCSS.Math.Content.NF.A)
  - o Understand decimal notation for fractions (CCSS.Math.Content.NF.C)
- Scratch objectives
  - o Use the Green Flag block
  - o Use the Set Temp block
  - o Use the Play Note block
  - o Use the Rest block
  - o Use the algebra operation blocks (addition & multiplication)

Discussion questions:

Are there patterns in this music? Can we take advantage of those patterns to write our Scratch scripts more quickly?
Using the "duplicate" command can quickly take advantage of these patterns. Repeat blocks are another tool that can be employed.

How does changing the tempo affect the mood of the music?
Encourage students to adjust the tempo.

What about other instruments?
You can change the instrument used with another block.

How can we represent sharps and flats?
While they don't appear in the drop-down menu, the sharps and flats are the in-between numbers that are missing from the drop-down. Just type them in.

Procedure:

Distribute the "Ode to Joy" sheet music and "Reading Music" handouts. You may also hand out the "Playing Ode to Joy in Scratch" handout.

You may either: 1) Lead the students through the process of writing the music using an overhead projector while they work on their own computers, or 2) have the students work through the handout independently while you assist and answer questions. A blend of the two approaches – introducing steps then letting the students work on them, is also highly effective.

Some helpful tips:

- Emphasize that students can use the "duplicate" operation to duplicate not just individual blocks, but all the blocks snapped to that block. Savvy students will realize that many of the measures are repeated in the music, and can capitalize on that.
- Stress the importance of organization, such as using comments to identify measures. As the program grows, it will become difficult to manage otherwise; frustrating students and hampering their progress.

Extension or Exploration: You can easily transcribe other music into Scratch, or even have students compose their own, original works. Writing music in Scratch continues to develop mathematical skills, especially as students begin challenging themselves to write more complex pieces.

Adapting works in different time signatures (3/4, 3/8, 5/4, etc.) can lead to a deeper exploration and eventual understanding of ratios.

There is also a rich opportunity to cross discipline borders, bringing a discussion of wave physics into how sound works, and into how musical notation has been organized around octaves (which are based on doubling frequencies).

Finally, this kind of project can lead to more advanced musical experimentation with more sophisticated tools, such as the open-source Audology sound-mixing software.