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***Drawing Electric Music!***

**Combining Science, Visual Art, and Music to Explore Circuits and Create a Work of Art**

**Grade Level:**  5-8

**Time Estimate:** 1.5-2 hours

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| **WY Science Content and Performance Standards:****Current WY Science Content and Performance Standards:*** SC 8.1.12 Forms and Uses of Energy: Students investigate energy as a property of substances in a variety of forms with a range of uses.
* SC 8.2.2 Students use inquiry to conduct scientific investigations.
	+ Ask questions that lead to conducting an investigation.
	+ Collect, organize, and analyze and appropriately represent data.
	+ Draw conclusions based on evidence and make connections to applied scientific concepts.
	+ Clearly and accurately communicate the results of the investigations.
* SC8.2.4 Students recognize the relationships between science and technology in meeting human needs.
* SC8.3.2 Students explore how scientific information is used to make decisions.
	+ Interdisciplinary connections of the sciences and connections to other subject areas and careers in science or technical fields.

**Proposed 2016 WY Science Content and Performance Standards:*** MS-ETS1-4. Develop a model for a proposed object, tool or process and then use an iterative process to test the model, collect data, and generate modification ideas trending toward an optimal design.
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| **WY Fine and Performing Arts Content and Performance Standards:****Music:*** FPA8.4.M.2 Students describe ways in which other disciplines are interrelated with music
* FPA8.1.M.4 Students compose and arrange music within specified guidelines

**Visual Art:*** FPA8.1.A.4 Students collaborate with others in creative artistic processes
* FPA8.4.A.1 Students describe ways in which the principles and subject matter of other disciplines taught in the school are interrelated with the visual arts
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| **Materials/Tools:** blank paper/journals, pencil sharpeners, extra AAA batteries, extra pencils, erasers, notebooks, Drawdio (For this lesson, Drawdio should already be assembled by the teacher.) *Note: For older grades, kits can be purchased for students to build Drawdios.)* | **Vocabulary:** composition, design, conductor, electrical circuit*Note: Vocabulary should be displayed on word wall.*  |

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| **Objective:** Students will explore electrical circuits and conductors, using a Drawdio to create musical works of art. |

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| **Essential Questions:** * How does a Drawdio produce sound?
* How can I design a musical work of art for the Drawdio using my knowledge of circuits?
* How can I improve the design of my musical work of art to make it easy to use?
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| **Procedure:****Introduction/Background Discussion (15-20 minutes):** *Begin by introducing students to a theremin and synthesizer.* A theremin is the only instrument you play without touching. It is one of the very first electronic instruments, invented in Russia in 1919 by Lev Termen. It traditionally consists of a box with two antennas--one is a straight vertical rod which controls the pitch, the other is a horizontal loop shaped like a cane handle which controls the volume. The pitch and volume of the note are controlled by the distance of the hands from the antennas which generate an electromagnetic field. Any motion of the body or any solid object in the playing fields will affect the note. Later, sound synthesizers (an electronic musical instrument that generates electronic signals that are converted to sound through instrument amplifiers, loudspeakers or headphones) became popular and widely used in pop and dance music. Example of a traditional Theremin: * <https://www.youtube.com/watch?v=K6KbEnGnymk>

Samples of synthesizer music: * <https://www.youtube.com/watch?v=K5MpxSWEKSo>
* <https://www.youtube.com/watch?v=PRmksUshjPk&list=PL4gvIvW8V4oPAtnb7VxCMY2NBZuLs47jl&index=2>

Both of these devices use electricity to create sounds and music. Today, we are going to investigate a tool called a Drawdio that also uses electricity to create sounds and music. **Explore/Hypothesize (15-20 min):** * Teacher will first demonstrate or show video clip of Drawdio without providing any explanation of how the tool works. In groups of 2 or 3, students will study the Drawdio tool and come up with a hypothesis on how the Drawdio makes sound. Students will discuss their hypothesis as a group and then write it in their journals. *Note: During this time groups may look at the Drawdio tool, but may not touch it.*
* After recording their hypothesis, groups will begin using the Drawdio tool and producing sounds. When each group completes 5 minutes of exploration, groups should revisit their hypothesis. Were they correct? Students should record their observations draw a conclusion about how the Drawdio makes sound.
* Class will regroup and discuss the construction of the Drawdio and how it makes sounds. (A basic explanation is provided below that can be modified to fit the grade level of the class.)
* A Drawdio is powered by an AAA battery and uses an oscillator to create audio frequencies that can be heard using an amplifier. This design is similar to a stereo, but it is on a much smaller scale.
* An oscillator converts direct current from a battery into an alternating current signal that can carry sound.
* A Drawdio is able to create noise when the circuit is complete so the electric current can flow through the Drawdio. Copper is connected to graphite, so when a person touches both the copper tape on the pencil and the graphite on the paper from the drawing, the circuit is completed.

**Demonstrate Understanding (5 minutes):*** Teacher should demonstrate the Drawdio tool again. This time, make sure to show that the tool does not work when the circuit is not closed (when you are not touching the graphite). In their journals, ask students to explain in their own words how the Drawdio creates sound. When will the Drawdio not produce sound?

**Imagine/Plan/Create (30-45 minutes):*** In groups of 2 or 3 (or individually if supplies allow), students will draw or create a musical work of art that can be played using the Drawdio. Students must consider the musician that will be playing the instrument (ease of playing the instrument) as well as the aesthetic qualities (**composition/design**) of the instrument. Students will brainstorm and plan their first prototype before they begin designing the final product. After teacher check-in, students can create their musical work of art. *Note:**Depending on time, availability of materials, and depth of explanation of conductors/resistors, students can use other supplies than pencil and paper.*

**Improve (30 minutes):*** Groups or individual students will pair up with another group/student to share/play their creation and give/receive feedback for improvement. (10 minutes)
* After receiving feedback, students will re-group to make any changes or refine their design. (20 minutes)

**Reflect (20 minutes):*** In their journals, students will write a reflection that explains how their musical work of art is played. Students must include a brief explanation of how their work of art depends on a closed circuit. They should also discuss what modifications or improvements they made after meeting with their peers.

**Present (30 minutes):*** Groups/individuals will present their final instrument, talking about the design/composition, how to play the instrument, and any revisions they made to their original prototype. (15 min)
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| **Evaluation/Assessment:****Formative:** * Students will be observed throughout the project with the intention that each student will actively participate collaboratively and individually in discussion, drawing and exploratory processes.
* After instruments have been revised and refined, students will have the opportunity to present their final products, self-reflect, and provide feedback/critiques during presentations.
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| **Differentiation/Modifications:** * If a student is having difficulty using the materials, alternative materials or assistance may be provided.
* If project is taking longer than expected, the process can be simplified.
* Depending on the available time and classroom setting, the introduction to the theremin and synthesizer can be cut out of the lesson.
* If students finish work early, students can explore different conductors and resistors with the Drawdio, recording their findings in their journal.
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| **Variations/Extensions:** * If time and materials allow, prior to this lesson, students could build their own Drawdio.
* A more in-depth explanation and exploration of circuits can be added, depending on the time and setting of the lesson.
* An exploration of pitch can be added to this lesson, depending on the available time and setting.
* An exploration of different conductors and resistors can be added to the lesson. Students could draw and/or build a musical work of art using various materials.
* A more formal, written reflection of the hypothesis, process, revisions, and final product can be required.
* A more defined rubric/list of requirements for the musical work of art can be added to make the design process more challenging.
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**Background/Research/Additional Resources:**

* For inspiration on using the Drawdio in the classroom, please explore the following videos.
* <https://www.youtube.com/watch?v=KyOikJzMgOg>
* <https://www.youtube.com/watch?v=Qmp-Qi7-ltY>
* <https://www.youtube.com/watch?v=PV_w38ldZaE>
* <https://www.youtube.com/watch?v=oSnkz7UGEFk>