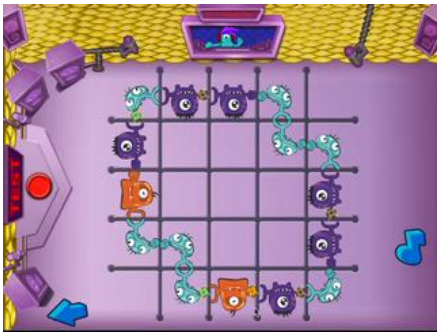
EXPLORING ELECTRICTY WITH MONSTER MUSIC

Monster Music

This game targets the difficulty students often have distinguishing between matter and energy. Basic concepts about electricity are commonly covered during sixth- or seventh-grade science, in the context of larger units of study about various types of energy. Students often learn about how electricity is generated, and build circuits to observe the "flow" of electricity through wires and switches. Descriptions of what is happening in circuits can be incomplete, and the often-used analogies, such as water flowing in pipes or freight trains on a circular track, can promote misconceptions. Problems also exist with the terminology used to describe electricity that lead to misunderstandings and confusion about electrical energy and electrical charge. We say that electricity "flows," it "runs low," we can turn it off and on, and sometimes it even "surges." But even though this language fits our practical, everyday experience of electricity, it reinforces the common misconception that electricity is a substance, rather than a type of energy.

Using Analogies

One strategy for engaging students in high-level reasoning is the use of analogy. Analogy helps students to connect familiar concepts and ideas to new learning. In the *Monster Music* game, the "source" analog is the alignment of the monsters to change noise into music. The "target" is how electrical energy travels between electrons to produce light, heat, sound, and so on.



The following instructional techniques **(A–F) are ones that researchers[1] have found are effective for mapping analogies during instruction.**

A: Use a familiar "source" analog (structures or processes students already understand) to connect students to the "target" being taught.

B: Present the "source" analog visually.

C: Keep the "source" analog visible to learners during the comparison to the target.

[1] Richland, L. E., Zur, O., & Holyoak, K. J. (2007). Cognitive supports for analogy in the mathematics classroom. *Science, 316*(5828), 1128–1129.

D: Use spatial cues to highlight the alignment between the corresponding elements (e.g., draw parallel diagrams, use a table that aligns the elements of the source and target concept).

E: Use hand or arm gestures to point to the source and then the target.

F: Use mental imagery or visualization by referring to a familiar mental image from the game or real life.

In addition to discussing the similarities between the game and the concept, it is important also to pay attention to the differences between the game and the concept, and where the analogy breaks down.

Below is an instructional sequence showing how to apply analogy mapping techniques to *Monster Music*. It includes analogical strategies to help students understand how the game they played is like or different from science concepts they are learning.

Because class times vary across schools, we have organized the sequence into a series of "steps" rather than lessons. This allows teachers to adapt the sequence to fit their particular schedule. For example, teachers with 45-minute class periods might do Step 1 (gameplay) and Step 2 (exit ticket) on the first day, Steps 3 and 4 on the second day, and so on.

Step 1 (*35–40 minutes*): Gameplay

Play the game for 35–40 minutes before you begin your unit on electricity.

Step 2 (*5 minutes*): Exit Ticket

At the end of the class, pass out the **Exit Ticket,** which asks students to rate the game and state what they think was the goal of the game. Review the Exit Tickets to help you with the discussion for the next session.

Step 3 (*20–30 minutes*): Game Debrief

The Purpose

The purpose of the debrief is to ensure students have a shared understanding of the basic mechanics and goals of the game. Our focus is on energy transfer in the context of electricity.

Throughout the Game Debrief Presentation

- **Make sure the animation is playing on each slide, not just a static image;**
- **Ask more than one student to respond to the questions;**

- **Have students come up to the whiteboard, point to the presentation animations, and describe what they did as they played the game;**
- **Encourage students to build on others' responses in the discussion; and**
- **Keep the PPT animations displayed throughout the entire lesson.**

The Process

Start the Game Debrief PPT.

Slide 1: What did you have to do to play the game?

Slide 2: What did you have to do to the monsters?

- **Important points to listen for:**
  - Players must click on the monsters' hands to get them to connect with each other.

Slide 1 of the Debrief PPT

Slide 3: How did you figure out how to make music?

- **Important points to listen for:**
  - When the monsters' hands are not connected, there is no flashing light between them, and there is noise but not music.
  - Monsters start out making sound, and that the sound is jumbled. The monsters must be properly connected in order for the music to be coherent.

Slide 4: What is happening when the monsters make music?

- **Important points to listen for:**
  - When the monsters make music, all of their hands are connected properly and light flashes between all the hands.

Slide 5: Why did you have to make the music?

- **Important points to listen for:**

- Players have to create music CDs to energize the people in Harmonia, who have lost their energy.

Slide 6: What are some strategies you figured out to win the game?
Have students describe the strategies they used to play the game.

Step 4 (*30–40 minutes*): Electricity Instruction: Lightning in Your Hand Activity

Have students do the Lightening in Your Hand activity that we provide.

Step 5 (*10–15 minutes*): Electricity Introduction

Present the five introductory slides at the beginning of the Electricity PPT that we provide, which focus on clarifying the difference between matter and energy.

Step 6 (*40 minutes*): Electricity Instruction: Human Circuit Activity, Charge and Flow

Have students do the Human Circuit activity that we provide.

Show slides 6 through 9 in the Electricity PPT that we provide, which introduce ideas related to electricity charge and flow. Slides 10 and 11 show that the movement of electric charges from one point to another is electrical current.

Step 7 (*15 minutes*): Revisit Game

Have students play the game again.

Step 8 (*30–40 minutes*): Analogy Mapping

Map the elements of the game that align to the content to build from students' knowledge of the game and help solidify their new knowledge.

Project the *Monster Music* mapping PPT. Each slide will have an animation from the game (the source) and images related to electricity (the target). For each discussion question there are two slides. One is a slide with a question to ask students, and the other slide provides the answer to the question. During the presentation

- **Make sure the animation is playing on each slide, not just a static image;**
- **When presenting both the question and answer slides, point between the game animation and the electricity-related image;**

- **Ask more than one student to respond to the questions;**
- **Have students come up and point to the presentation animations and describe what they did as they played the game;**
- **Encourage students to build on others' responses in the discussion; and**
- **Keep the PPT animations displayed throughout the entire lesson.**

POST ASSESSMENTS

If you would like to have students complete an electricity assessment after the unit, we recommend three resources. The American Association for the Advancement of Science Assessment website and the Misconceptions-Oriented Standards-Based Assessment Resources for Teachers website provide high-quality, multiple-choice assessment items that have been rigorously tested with students. You can find open-ended assessments in The Uncovering Student Ideas in Science series of formative assessment probes written by Page Keeley and published by NSTA Press.