K20 LEARN

Beyond the Slinky® (8th Grade)

Information Transmission Through Waves

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Grade Level	8th Grade	**Time Frame**	180 minutes
Subject	Science	**Duration**	3-4 class periods

Essential Question

How does the use of more complex wave patterns affect the communication of audiovisual messages?

Summary

In this lesson, students investigate how digital and analog waves carry information by developing models and relating these to information transmission. This lesson is Part 3 of the "Beyond the Slinky®" series on waves and their properties.

Snapshot

Engage

Students watch a video about the evolution of Super Mario since 1985 and analyze how video game graphics have improved over time.

Explore

Students use a snaky spring to develop models for sending analog and digital signals. They experiment with low-resolution image transmission through waves.

Explain

Students discuss their models and the differences in efficiency between digital and analog signals.

Extend

Students attempt to send higher-resolution images using their models and discuss the difficulties in transmitting complex information.

Evaluate

Using the Claim, Evidence, Reasoning (CER) strategy, students explain the improvement in video game graphics over time, comparing their explanations with their initial understanding from the lesson.

Standards

ACT College and Career Readiness Standards - Science (6-12)

IOD302: Understand basic scientific terminology
IOD403: Translate information into a table, graph, or diagram
SIN503: Determine the experimental conditions that would produce specified results
EMI404: Identify similarities and differences between models

Next Generation Science Standards (Grades 6, 7, 8)

MS-PS4-3: Integrate qualitative scientific and technical information to support the claim that digitized signals (sent as wave pulses) are a more reliable way to encode and transmit information.

Oklahoma Academic Standards (8th Grade)

8.PS4.3 : Integrate qualitative scientific and technical information to support the claim that digitized signals (sent as wave pulses) are a more reliable way to encode and transmit information.*

Attachments

- 3x3 Grids—Beyond the Slinky (8th Grade) - Spanish.docx
- 3x3 Grids—Beyond the Slinky (8th Grade) - Spanish.pdf
- 3x3 Grids—Beyond the Slinky (8th Grade).docx
- 3x3 Grids—Beyond the Slinky (8th Grade).pdf
- 5x5 Grids—Beyond the Slinky (8th Grade) - Spanish.docx
- 5x5 Grids—Beyond the Slinky (8th Grade) - Spanish.pdf
- 5x5 Grids—Beyond the Slinky (8th Grade).docx
- 5x5 Grids—Beyond the Slinky (8th Grade).pdf
- CER Content Assessment Guide—Beyond the Slinky (8th Grade).docx
- CER Content Assessment Guide—Beyond the Slinky (8th Grade).pdf
- Claim Evidence Reasoning CER—Beyond the Slinky (8th Grade) - Spanish.docx
- Claim Evidence Reasoning CER—Beyond the Slinky (8th Grade) - Spanish.pdf
- Claim Evidence Reasoning CER—Beyond the Slinky (8th Grade).docx
- Claim Evidence Reasoning CER—Beyond the Slinky (8th Grade).pdf
- Digital vs. Analog—Beyond the Slinky (8th Grade) - Spanish.docx
- Digital vs. Analog—Beyond the Slinky (8th Grade) - Spanish.pdf
- Digital vs. Analog—Beyond the Slinky (8th Grade).docx
- Digital vs. Analog—Beyond the Slinky (8th Grade).pdf
- I Notice I Wonder—Beyond the Slinky (8th Grade) - Spanish.docx
- I Notice I Wonder—Beyond the Slinky (8th Grade) - Spanish.pdf
- I Notice I Wonder—Beyond the Slinky (8th Grade).docx
- I Notice I Wonder—Beyond the Slinky (8th Grade).pdf
- Lesson Slides—Beyond the Slinky (8th Grade).pptx
- Spring Cards—Beyond the Slinky (8th Grade) - Spanish.docx
- Spring Cards—Beyond the Slinky (8th Grade) - Spanish.pdf
- Spring Cards—Beyond the Slinky (8th Grade).docx
- Spring Cards—Beyond the Slinky (8th Grade).pdf

Materials

- Lesson Slides (attached)
- I Notice, I Wonder handout (attached; one per student)
- Claim, Evidence, Reasoning (CER) handout (attached; one per student)
- Spring Cards (attached)
- Digital vs. Analog handout (attached; one per student)
- 3x3 Grids (attached; one half-sheet per group)

- 5x5 Grids (attached; one half-sheet per group)
- Content Assessment Guide (attached; for teacher use)
- Snaky springs (one per group)

Engage

Teacher's Note: Lesson Order

Follow this lesson in the order: Engage, Explore 1, Explain 1, Explore 2, Explain 2, Extend, Evaluate.

Introduce the lesson using the attached **Lesson Slides**. Display **slide 3** to share the essential question and go to **slide 4** to review the lesson objectives with students.

On **slide 5**, distribute the **I Notice, I Wonder** handout to each student. Show the video on Evolution of Super Mario using the SafeShare tech tool. Prompt students to use the I Notice, I Wonder strategy to note observations and questions about what they see in the video.

After the video, invite several students to share their observations and questions, facilitating a brief class discussion.

Sample Student Observations

Students should notice that video game resolution has improved drastically over time.

Next, distribute the **Claim, Evidence, Reasoning (CER)** handout. Ask students to write an initial explanation on the question, “Why do video game graphics improve over time?” Have students store their handouts safely, as they will revisit them in the lesson's Evaluate phase.

Move to **slide 6**. Explain that all electronic devices use electromagnetic (EM) waves to send and receive information, and that students will use a snaky spring model to explore how this process works.

Explore 1

Teacher's Note: Simulation Preparation

In this activity, students use **snaky springs** to model analog signals (Activity 1) and digital signals (Activity 2). Prepare the **Spring Cards** by printing and cutting them before class.

ACTIVITY 1

Display **slide 7**. Organize students into groups of four, assigning a unique role to each student. Consider modeling each role to set expectations. Display **slide 8** and distribute Spring Cards to the groups. Instruct students to cut out the cards and ensure each member has a different signal to transmit.

Explain that students will represent analog signals by generating continuous waves with their snaky springs, using different amplitudes to show blank vs. filled boxes. Each student should have a turn to send a signal and record someone else's signal.

Move to **slide 9**, facilitate a discussion on the strengths and weaknesses of transmitting signals continuously without pauses, focusing on how challenging it can be to distinguish between analog signals.

ACTIVITY 2

Display **slide 10**, introduce the idea of "discrete" waves, where there are pauses between each wave. As in Activity 1, students should use different amplitudes for blank vs. filled boxes and ensure each group member has the opportunity to send and record a signal.

Display **slide 11**. Ask students to discuss how using pauses affects the strengths and limitations of their signals. They should consider if they could tell if a pause represented a blank box, a missed signal, or a delay in transmission.

Explain 1

Display **slide 12** to prompt students to discuss the differences between analog signals from Activity 1 and digital signals from Activity 2. Use **slides 13 and 14** to define analog and digital signals, linking these definitions to the activities.

Teacher's Note: AM Radio vs. FM Radio

Explain that AM (amplitude modulation) uses analog signals, while FM (frequency modulation) uses digital signals. This makes FM broadcasts typically clearer, as FM signals are less prone to static.

Display **slide 15** to review key wave characteristics: amplitude, wavelength, and frequency. Invite students to share their understanding of these terms, then clarify as needed based on their responses.

Move to **slide 16**, ask students to identify which aspects of EM waves are most relevant to analog signals (amplitude) and which are most relevant to digital signals (frequency). Use **slide 17** to reinforce their responses, summarizing and elaborating as necessary.

Go to **slide 18** and pass out the attached **Digital vs. Analog** handout to each student. On the handout, ask students to answer the following prompt: "Why are digital signals a more reliable way to send information than analog signals? Use evidence from your investigation and class discussion to support your answer."

Allow students to draw models and diagrams to support their answer.

Teacher's Note: Content Assessment Guide

Refer to the **Content Assessment Guide** for ways to evaluate student responses to the following essential questions:

- Why are digital signals more reliable than analog signals?
- Why do video game graphics improve over time?

Explore 2

Teacher's Note: Sending Low-Resolution Images

In this activity, students use their digital signal models to send a low-resolution image represented on a 3x3 grid. This allows them to apply digital signal concepts to a practical example.

Display **slide 19** and explain that students will now transmit an image using digital signals. They will use a single wave pulse (1) or two wave pulses (0) to represent information. This allows them to transmit a simplified, low-resolution image.

On **slide 20**, distribute the **3x3 Grids** and prompt students to figure out an order for sending their signals. Typically, images are transmitted left to right and top to bottom, but encourage students to come up with alternate methods if they have other ideas.

Explain 2

Display **slide 21** and begin a class discussion on students' experiences with sending the low-resolution images. Encourage students to share their challenges, observations, and any new questions they might have about the process of sending information via wave signals.

Move to **slide 22**, introduce students to the concepts of "resolution" and "pixels." Explain that each square in the 3x3 grid represents a single pixel and that the number of pixels in an image determines its resolution. Help students make the connection that more pixels in an image allow for a higher resolution and clearer visuals.

Guide the discussion with questions such as: "How does increasing the number of pixels affect image quality?" and "What challenges might arise when sending images with higher resolutions?"

Extend

Display **slide 23**. Distribute the **5x5 Grids** and have students transmit a higher-resolution image using their snaky spring models. They may choose to create their own images or use a more detailed version of the letter image they previously transmitted.

Teacher's Note: Time

If time is a concern, consider these two alternatives to transmitting a 5x5 image:

1. Have students try to send as many recognizable 1s and 0s as possible in a short amount of time. This activity helps them understand how quickly computers and other devices must send large amounts of data to transmit complex images.
2. Alternatively, students can fill in both a 3x3 and a 5x5 grid for the same letter on paper, allowing them to see the difference in clarity between low and high-resolution images without using the snaky springs.

Display **slides 24 and 25** to guide a discussion comparing their experiences with transmitting 3x3 and 5x5 images. Through these questions, students should understand that sending more complex visuals requires a greater number of EM wave signals, which takes more time and is more challenging.

Move to **slide 26**, explain how modern electronic devices can transmit large amounts of data very quickly, enabling them to produce high-quality images and videos. To further the discussion, ask students to compare their experiences using older versus newer devices, emphasizing how technology has advanced to handle more complex data.

Evaluate

Display **slide 27** and replay the *Super Mario* evolution video shown at the start of the lesson. Prompt students to observe and reflect on how their understanding of image quality and transmission has evolved.

Move to **slide 28** and have students return to their **CER** handouts. Using the Claim, Evidence, Reasoning (CER) framework, ask students to develop a final explanation of how electromagnetic waves contribute to improvements in video game quality over time. Encourage students to draw models and diagrams to support their answers.

As before, allow students to draw models and diagrams to support their answers to the following questions:

- Why do video game graphics improve over time? Use evidence and scientific information from your investigations and discussions to support your answer.
- Look at your initial explanation from the start of the lesson. How has your thinking changed? What differences can you see between your initial and final answers?

Ask students to reflect on and compare their initial and final explanations, encouraging them to note any new insights or changes in their understanding.

Resources

- Atre, S. (2019, January 31). *Evolution of mario: A staple for Classic and modern graphics*. Medium. https://medium.com/@soniaatre/evolution-of-mario-a-staple-for-classic-and-modern-graphics-7acec3a6b914
- K20 Center. (n.d.). Claim, evidence, reasoning (CER). Strategies. https://learn.k20center.ou.edu/strategy/d9908066f654727934df7bf4f506fc09
- K20 Center. (n.d.). I notice, I wonder. Strategies. https://learn.k20center.ou.edu/strategy/d9908066f654727934df7bf4f507d1a7
- K20 Center. (n.d.). SafeShare. Tech Tools. https://learn.k20center.ou.edu/tech-tool/4269?rev=35624
- YouTube. (n.d.). *Evolution of Super Mario Game and Movie, LEGO (1985 ~ 2023)*. YouTube. https://www.youtube.com/watch?v=n9_nOA3Md_c