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HOW DO YOU STAGE A HOLOGRAPHIC CONCERT?

Read the article about the science of holographic illusions:

https://education.australiascience.tv/how-do-you-stage-a-holographic-concert

A Step-By-Step Guide to Creating Holograms in your Classroom.

Background Science.

Abstract

In this lesson, students will use gain an understanding of ray optics, including how light is reflected and refracted to produce an image that appears like a hologram. They will explain the behaviour of light and how ray optics are used in image formation from lenses and mirrors.

In this activity, students use a sheet of acetate to make a transparent, four-sided pyramid. The pyramid's sides act as four mirrors, situated at 45° angles on a smartphone or tablet screen, and create a hologram-like projector. When used with a holographic animation video, moving 3D images (holograms) appear inside the pyramid.

The activity is an ideal way to explore the reflection of light, specifically specular reflection – when light reflects at the same angle as it hits a surface.

Students will also learn how scientists look to CGI and AI production techniques to help stage virtual performances.

Objectives.

What students know upon completion of this lesson:

- Describe the locations of the real image, virtual image and reflection of light occurring in this activity. Produce a ray diagram to demonstrate understanding of the science behind optical illusions.
- Compare this optical illusion to the light physics of an actual hologram.

What should the students be able to do upon completion of this lesson?

- Make observations and develop questions for further exploration.
- Students will conduct and evaluate an experiment to explore the behaviour of light, (specifically refraction and reflection of light) and viewing angles.
  In the elaboration activity (**Want More?**), student will develop research and scientific literacy skills by conducting research of topics related to optical illusions and the behaviour of light.

Apparatus.

- Examples of various kinds of holograms/illusions to display in the opener (see **Engagement**).

For each Student or Group:

- Pyramid Projection template (Haunted 'Hologram' template)
  https://www.ontariosciencecentre.ca/media/2326/hauntedholotemplate.jpg
- A flat, hard (but flexible) piece of clear plastic, such as recycled packaging or overhead projector transparency (acetate) sheet.
- Scissors or a utility/craft knife (adult supervision required for junior students)
- A washable marker
- Clear sticky tape
- A smartphone/tablet with access to YouTube, and compatible videos such as: Pepper's Ghost video. Create Your Own Pepper's Ghost Illusion: https://youtu.be/OdA77IVRbm0

Lesson Plan.

Engagement

1. Display a series of optical illusions and holograms using your Interactive board. The following site has some examples. https://www.optics4kids.org/optical-illusions

Inform students those Optical illusions fool our brains. Watch the video: *How Do Optical Illusions Work?* https://youtu.be/VYIr40D7wNw This provides a clear explanation of the theory behind optical illusions.

2. Link the above video back to an everyday, real life example students can easily relate. Use the following scenarios:

    a. How many of you are carrying money in your pocket? If you have bank notes in your pocket, you also have a hologram in your pocket! Holograms are shiny, metallic patterns with ghostly images that appear to be floating inside them. Holograms are difficult to reproduce so stop people printing counterfeit copies of banknotes. Holograms are also found on credit cards, driver's licences, and ID cards to name but a few.

    Click on the image to show students a short video detailing the use of holograms on Australian bank notes. This forms an interesting discussion point and emphasises the relevance of holograms to everyday life.

    b. Ask students if they have ever been to Disneyland? Did you visit the Haunted Mansion or The Twilight Zone Tower of Terror? If the answer if yes, then you have already experienced the Peppers Ghost optical illusion firsthand! At the time you may be wondering how exactly the effect works to make the ghosts appear and disappear before your eyes. Explain the following to students: The basics of the effect involve placing a large piece of glass at an angle between a brightly lit "stage" room into which viewers look straight ahead and a hidden room. The glass reflects the hidden room, kept dark, that holds a "ghostly" scene. This in fact creates an optical illusion and not a true hologram. This is discussed in more detail later (see **Want More?** in **Student Activity**) and the **Plenary** section below.

Introduction (taken from the Student Activity).

This article explained the science of using light to create a holographic illusion.

In this lesson you will explore the reflection of light, specifically specular reflection – when light reflects at the same angle as it hits a surface.

In this activity, you will construct a “3D” illusion of a pyramid that creates a reflected image from a digital screen display, your mobile phone! This activity is a modern take on an illusion first described in 1584 by Neapolitan scientist Giambattista della Porta and popularised for theatrical use by John Henry Pepper in the 1860s, hence its modern nickname “Pepper’s Ghost”.

Additional info to discuss with students:

- In a Pepper’s Ghost Illusion, when a real or recorded image is reflected in a transparent screen at a 45-degree angle, viewers see a reflected virtual image that seems to have depth and appear out of nowhere…Spooky!
- The following link contains further background knowledge. Read the article and discuss some of the science mentioned with you students.

https://www.explainthatstuff.com/holograms.html

Assessment.

Checkpoint 1: Monitor students’ answers to your questions to be sure everyone understands the concept of the lesson. Before proceeding, be sure that students understand the principles of reflection and refraction.

Exploration.

To start this lesson, your students will need to create pyramid projectors. These are the clear, pyramid-shaped containers that will help reflect and refract the light.

Print out a copy of the template from: https://www.ontariosciencecentre.ca/media/2326/hauntedholotemplate.jpg

This step might sound complicated, but in the simplest method, all you need to do is run a transparency through the copy machine. **NB Check to make sure your copy machine can handle transparencies!**

If it can't, you can carefully trace the template onto a transparency with a thin permanent marker. Use a ruler to make sure the lines are precise.

Laminating pouches can also be used. Run the laminate pouch through the laminator, trace the template. Then cut, fold, and secure the pyramid following steps 2 and 3 in the method (see **Student Activity**).

Demonstrate how to construct the projector and place it on the screen correctly.
Check out this simple How-to Video: https://youtu.be/VRljGNLyMYY

Prior to the experiment, note/discuss the following points:

- This Pepper's Ghost activity, while not a true hologram, takes much less technology and is a good exploration of light and viewing angles. As they carry out the experiment, encourage students to think of reasons why the illusion technique is not considered (in science terms) a true hologram? This concept is discussed further in the **Want More?** section of the **Student Activity**.

Experiment – Instruct students to create their pyramid projectors, following the **method** provided in the **Student Activity**.

- Students can now use their pyramid projectors to view the hologram video in the link below. On your phone or tablet, open YouTube and visit the following site: https://youtu.be/OdA77IVRbm0

Video links are provided in the **Student Activity** (the following links also include suggested age suitability, topic, and length of video clip).

Butterfly (students Years 4-12) Colour changing butterfly - 01:03 min
https://www.youtube.com/watch?v=vTufphdowOw

Space (students Years 4-12) Planets, stars, galaxies - 01:14 min
https://www.youtube.com/watch?v=kUERqqY3pdk

Happy Birthday (students Years 4-7) Birthday cake, candles and present - 00:33min
https://www.youtube.com/watch?v=Tn20jpkNInI

Mario (students Years 8-12) Mario character walking /running - 01:48min
https://www.youtube.com/watch?v=QPHUnK6bzRo

Various (students Years 4-7) Minions, SpongeBob, Frozen - 05:56 min
https://www.youtube.com/watch?v=e5W0GLGd1hc

Various (students Years 4-7) Santa, Space, fireworks, soccer ball - 01:58 min
https://www.youtube.com/watch?v=tfBUFCHMcDk

Following the experiment:

- Assist students to construct a ray diagram (see What did you observe? in Student Activity)
- Would the size of the projector pyramid need to change if the size of the screen used to view the video is increased / decreased? This can be explored further in the Want More? section of the Student Activity. Additional resources for this can be found here: https://www.bealsscience.com/post/2016/02/15/3d-hologram-projector-for-you-phone-or-tablet

In addition to exploring fundamentals of light, the activity is ideal for cross-curricular learning. If you are eager to try a project that implements basic technology while integrating, science, engineering, art, and maths principles then you need look no further! Your students will be actively engaged in the process and learn to create some fantastic portable projectors and hologram images.

1. If you want to push this project further and incorporate math, you could have your students create their own templates using graph paper and rulers. Check out the link below for more information: https://www.wikihow.com/Make-a-Holographic-Illusion-Pyramid
2. If you want to push this project further and incorporate art, you could have your students create their own images to be projected. These can be created digitally or traditionally. Students can either create in a graphics program (such as Photoshop or Adobe Draw) or create with traditional media, snap a photo, and upload it to the device. Check out the link below for more information: https://theartofeducation.edu/2018/05/25/a-step-by-step-guide-to-creating-holograms-in-your-classroom/

Explanation.

Have students report their findings using the **Evaluation** questions (see **Student Activity**) to assess their understanding of the scientific principles involved.

In the discussion of the findings, explain that they **only** tested the theory of the illusion focusing on one **variable**, the size of the pyramid projector. To elaborate on this idea, ask students to suggest another variable they could alter. Do they think this will affect the appearance of the image? (See **Want More?** Section in **Student Activity** for suggested variables)

Explain that there are many uses of the technique (see **Engagement** above and **The Theory** in **Student Activity**). Ask students how they might design their your own illusion using the Pepper's Ghost concept. (See **Want More?** Section in **Student Activity**)

Assessment.

Checkpoint 2: Have students explain the physics behind how the Peppers Ghost illusion works. Have students construct a ray diagram (see **What did you observe?** in **Student Activity**)

Plenary.

Discuss the applications of illusions:

Peppers ghost illusions are commonly used theatres, amusement parks and museums. Can they think of an example of where they have seen then being utilised?

Link back to the magazine article, discuss to use of this technique in the future. How would the technology differ? What other factors would scientists and stage designers need to consider? Do you think this is an effective method of staging a performance/concert? Would you pay to view a performance using this technology? Why/why not?

Other Considerations.

- Highlight potential hazard warning for cutting the projector template with younger students. The edges of the acetate can become quite sharp.
- Preview hologram video content, prior to use to ensure suitability for age of students carrying out the activity.

Pacing/Suggested Time: Students could be given pre prepared templates and instruction/ to accommodate a shorter experiment. Students could spend several lessons researching and designing their own shape of projector and investigating any difference observed.

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SCIENCE UNDERSTANDING TOPICS				
YEAR	BIOLOGICAL SCIENCES	CHEMICAL SCIENCES	EARTH AND SPACE SCIENCES	PHYSICAL SCIENCES
R				
1				
2				
3				
4				
5				ACSSU080
6				
7				
8				
9				ACSSU182
10				

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YEAR	LINKED TO SCIENCE AS A HUMAN ENDEAVOUR	CURRICULUM CODE
Yr 5	**Nature and development of science**	
	1. Science involves testing predictions by gathering data and using evidence to develop explanations of events and phenomena and reflects historical and cultural contributions. **b.** *developing an understanding of the behaviour of light by making observations of its effects*	ACSHE081
	Use and influence of science	
	1. Scientific knowledge is used to solve problems and inform personal and community decisions. **i.** *exploring objects and devices that include parts that involve the reflection, absorption or refraction of light such as mirrors, sunglasses and prisms.*	ACSHE083
Yr 9	**Nature and development of science**	
	1. Advances in scientific understanding often rely on developments in technology and technological advances are often linked to scientific discoveries.	ACSHE158
	Use and influence of science	
	1. People use scientific knowledge to evaluate whether they accept claims, explanations or predictions, and advances in science can affect people's lives, including generating new career opportunities.	ACSHE160