Grade Level:

Grades 5, Adaptable for higher grades

Time:

Adaptable

Season:

All Year

Objectives:

Students will be able to...

-Understand how properties of waves can be used to predict light behavior

-Consider risks that windows and reflective buildings pose to local and migratory birds

-Create solutions to protect birds

Key Concepts:

-Patterns

-Cause and effect

-Energy and matter

Materials:

-Entry document, 1 copy per student

-CER Handout, 1 copy per student

-Multiple copies of a simple coloring page

Bird Window Strikes

Protecting Birds from Glass Collisions

Background & Summary

Students will understand that the properties of light make bird behavior predictable. This understanding will provide students with the necessary tools to understand window collision related threats to local and migratory birds due to reflection of light from windows and reflective materials used in building construction. Students will design windows, based on their understanding of light, to mitigate the dangers to birds.

Procedure

The following lesson is based on a problem-based learning model of instruction, with the question :
"How can we reduce the danger of window collision related threats to migratory birds?"

Introduction

Going off the prerequisite knowledge that light is a form of energy known as electromagnetic radiation and that it travels in waves, students will develop the following skills;

> Experience with writing an evidence-based response using the claim-evidence-reasoning model would help speed the process, though not required. If students are unfamiliar with this process, be sure to model expectations and utilize think-aloud strategies to support student success.

Activity
Project Checkpoint 1, *30 min*

Students will explore the problem of window collision threats to migratory and local birds and generate a list of need to knows.

Driving question: How can we protect birds in our community/school from window collisions?

1. Distribute the entry document handout to students.
2. Ask students if they have ever witness a bird crash into glass, if so what was their reaction? Proceed to show students the video and have them make a list of questions they have about the topic as they watch.
3. Tell them they will be designing and presenting a solution that will reduce the window collision threat to birds. Their goal will be to convince (the audience) that their solution should be implemented. With that in mind, they should have any additional questions answered needed to move forward.
4. Provide additional time(up to 5 min) for students to generate more questions, individually. Then in small groups, have students record their questions on a sheet of paper and eliminate any duplicates. They should do this without stopping to discuss or answer questions.
5. Have students sort their questions and categorize them with headings of their choosing, based on themes that emerge from the types of questions they wrote.
6. Provide an opportunity for revision and comparisons with other groups, as well as time to add additional questions.
7. As a team, they should prioritize the list of questions they need answered to proceed. Then call on groups to share one of their questions.
8. Have students create a list of 5 to choose from, this will allow for enough backup questions should another group have the same ones.
9. Continue to have groups take turns asking questions until, without duplication, all questions have been recorded on a class list.
10. Value all ideas by recording all questions, exactly as stated.

Activity
Project Checkpoint 2, *1-5;45 min blocks*

Students develop a conceptual understanding of light, waves, and reflective surfaces.

Become an Expert-Station Exploration and Discussion

1. Have students rotate through exploration stations as appropriate for grade level.
2. Depending on student level and ability, it may be best to have the stations and discussions over a 2-3 day period. Suggested topics for stations include:

- Station 1: Reflection of light
  - Part 1: Students compare images of reflection on a still body of water vs a wavy water surface and consider the reasons for the discrepancy
  - Part 2: Students investigate reflective surfaces:
    - Elementary- Compare reflection of light using various material, such as smooth aluminum foil, crumpled aluminum foil, clean mirror, mirror with oil and dust on the surface, smooth glass, etched glass.
    - Secondary- Compare reflection of light using plane, convex and concave mirrors to measure the angles of incident and reflected rays
    - Make thinking visible- draw a model to explain the differences between the two reflection images from part 1. In the model, be sure to identify the source of light, the path of light, and the reflection is upside down.

- Station 2: Bird Vision
  - Students color the same picture 2 ways- first how they would see the colors, then how they imagine a bird would see the colors(we aren't looking for reality or accuracy, it should simply be more vivid, sharp, maybe with extra details visible) Suggested resources:
    - https://www.youtube.com/watch?v=bG2y8dG2QIM
    - https://blog.nature.org/science/2015/08/17/field-guide-wrong-birds-eye-view-world-color-vision/
    - https://www.nature.com/scitable/blog/the-artful-brain/alternate_realities/
    - Compare binocular vision in humans to monocular vision in birds. Position a large manilla folder or other barrier in front of your nose to block your binocular view (the field of view where both of your eyes work together to make sense of your world) and simulate the monocular vision (being able to see different things with each eye) of some birds. Consider the advantages of having eyes on the side of your head vs at the front. Consider the disadvantage for perceiving the world in 3D and accurately perceiving depth and distance of objects in front of you. Suggested Resources:
    - American Woodcock monocular view
      - https://youtu.be/4Owj52XhoxI
      - https://theconversation.com/curious-kids-how-do-birds-see-where-theyre-going-101932
      - Compare pupil size of birds with other animals. What do you observe? How does the size of the pupil relate to vision?

Activity
Project Checkpoint 2, 3-5; *45 min blocks Contd.*

- Station 3: Windows, building design, and collisions
  - Provide students with several pictures of buildings with varying window designs and have them think about how window design may contribute to bird collisions. Several of the images should clearly show reflections of vegetation that would appeal to birds, and several images should show buildings with etched glass, vertical blinds, awnings, or other window obstructions. A web search of "bird friendly building design" will yield plenty of results.
  - Students should document the window design employed in their community/school and assess the threat to birds.
- Station 4: The Nature of Light
  - Redefining Light
    - Light is not just the opposite of dark, or sunshine, or colors of the rainbow. The term light refers to all of the electromagnetic radiation in the universe. The human eye can only detect some of these forms of light (the forms that you think of when you are describing light), but other animals can detect more (like ultraviolet and infrared). Scientists have special instruments they use to detect light.
    - Students research to understand that when we use the word "light" we are using it to understand our daily experiences with light and darkness, but the way scientists use the word "light" is to understand electromagnetic radiation and all of its forms. A reference document for these forms is the electromagnetic spectrum.
    - Secondary Only-add additional stations or readings to facilitate understanding of the dual nature of light.
- Station 5: Absorption, Reflection, and Transmission of Electromagnetic Radiation
  - Students shine light through various materials (water, felt, plastic wrap, wax paper, cardboard, white paper, black paper) and look for evidence of what happens to light when it interacts with the material. Students should document the appearance of a shadow (absorption), if the light bounces back to them (reflection), or if the light passes through the material (transmission).
  - Draw a model to explain the properties of materials that produced the different results.
  - Students research the use of materials to block electromagnetic radiation (sunglasses, spacecraft shielding, lead vests for x-rays, blackout fabric).

Students rotate through all stations with groups of 2-3 recommended. (Note: setting up each station twice, allows for smaller group sizes.) Teacher closes out the station rotation with a guided discussion to debrief the topics that were introduced. Revisit the "need to know" list and check off questions that have been answered. Additional notes, practice problems, and/or readings should be assigned to address and clarify any misunderstandings, meet grade-level learning standards, and answer additional questions on the need-to-know list.

Activity
Project Checkpoint 2, 3-5; *45 min blocks*
Contd.

Demonstrate mastery (45+min, depending on grade level and skill):

- All students take a quiz on general understanding that should have been obtained as a result of the station exploration and subsequent discussion.
    - Go over the results of the quiz and clarify misconceptions.
- Claim-Evidence-Reasoning Writing Prompt: *Why do so many birds crash into windows?*

Assign expert roles (45+min, depending on grade level and ability)

Give the group 5 minutes to meet and discuss which topic they are going to explore further. Each person in the group will pick/be assigned a different topic. Each student will dig deeper into tone of the topics and become an expert by reading and annotating a passage related to their topic, watching a tutorial video and taking notes, and/or working in a small group with the teacher to deepen understanding.

In secondary courses, it is recommended that readings and/or videos be completed outside of class as homework in order to provide additional time for teacher guided discussions and problem-solving practice.

Project Checkpoint 3, *45 min*

Students brainstorm and design several potential solutions to reduce window collision threats to birds.

Individual and Group Models

Individual Task, *10 min*

Students work individually to consider how the information they learned during checkpoint 2 will help solve the problem. Each student should design a model to demonstrate a potential solution to the window- collision problem, based on his/her/their area of expertise. For younger students, consider providing an instructional support, like this coloring page.

Group Task, *30 min*

Students reconvene with small group to share models and discuss how everyone's idea can be merged into one complete solution. As a group, students create a rough sketch of the model solution.

Individual Task, *5 min*

Each student writes a brief description of how the proposed model will help reduce window- collision threats to birds, based on his/her/their expert understanding of the problem.

Project Checkpoint 4, 45 min

Students refine their model and prepare a presentation to convince building architects of the value of incorporating bird friendly design in their plans

Presentation

Students work as a team to prepare for their presentation. The mode of presentation should be left to students, based on what they determine will be most effective. Some suggested products are a poster presentation, building a prototype and demonstrating how it would work, making a commercial, writing a letter, or creating an informational graphic.

Bird Window Strikes- Entry Document

Window Collisions Threaten Birds

One to three million birds collide with windows and other reflective surfaces on buildings and manmade structures every day in the U.S, which equates to a billion bird crashes every year. It is estimated that most result in the death of the bird.

As you view the film, make a list of things you will need to know in order to develop a way to protect birds from windows.

C-E-R Writing

QUESTION	*Why do so many birds crash into windows? In your explanation, be sure to include the role that light plays in bird window collisions.*
Claim A clear, concise statement that answers the question, without elaboration.	
Evidence Provides facts, figures, numerical data, and descriptive data to support the claim. Ask your teacher if you need to cite your resources.	
Reasoning Discuss the significance of the evidence you presented, explain the meaning of the evidence and how it supports your claim. This is your opportunity to show that you really know what you're talking about.	

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Vocabulary to Know

Elementary

Energy: power derived from the utilization of physical or chemical resources, especially to provide light and heat or energy to work machines

Light: the natural agent that stimulates sight and makes things visible

Reflect: (of a surface or body) throw back (heat, light, or sound) without absorbing it

Secondary

Absorption: the process or action by which one thing absorbs or is absorbed by another

Acoustic: relating to sound or the sense of hearing

Amplitude: the maximum extent of a vibration or oscillation, measured form the position of equilibrium

Boundary: a limit of a subject or sphere of activity

Constructive Interference: occurs when the phase difference between the waves is an even multiple of 180 degrees

Crest: point on a wave with the greatest positive value or upward displacement in a cycle

Diffraction: the interference or bending of waves around the corners of an obstacle or through an aperture into the region of geometrical shadow of the obstacle/aperture.

Doppler effect: an increase(or decrease) in the frequency of sound, light, or other waves as the source and observer move toward(or away from) each other.

Energy: power derived from the utilization of physical or chemical resources, especially to provide light and heat or energy to work machines

Hertz: the rate at which a vibration occurs that constitutes a wave, either in a material(as in sound waves), or in an electromagnetic field(as in radio waves and light). Usually measure per second

Interference: the combination of two or more electromagnetic waveforms to form a resultant wave in which the displacement is either reinforced or canceled

Light: the natural agent that stimulates sight and makes things visible

Lambda: wavelength

Medium: the intervening substance through which impressions are conveyed to the senses or a force acts on objects at a distance

Node: a point at which lines or pathways intersect or branch; a central or connecting point

Opaque: not able to be seen through; not transparent

Refract: (of water, air, or glass) make (a ray of light) change direction when it enters at an angle

Resonance: the reinforcement or prolongation of sound by reflection from a surface or by the synchronous vibration of a neighboring object

Transparent: (of a material or article) allowing light to pass through so that object behind can be distinctly seen

Period: the interval of time between successive occurrences of the same state in an oscillatory or cyclic phenomenon, such as a mechanical vibration, an alternating current, a variable star, or an electromagnetic wave

Phase: a distinct period or stage in a series of events or a process of change or development

Velocity: the speed of something in a given direction

Wave: a disturbance in a medium that carries energy without a net movement of particles

Wavelength: the distance between successive crests of a wave, especially points in a sound wave or electromagnetic wave

Background Information for Educators

Problem-based learning is a framework for understanding content with built-in authenticity. Students are presented with a problem and tasked with designing a solution. To accomplish this task, students will necessarily acquire an understanding of relevant scientific principles through investigations, collaborative studies, and analysis. Problem-based learning works best when students are provided clear expectations and feedback in the form of rubrics, modeling, and formative checks.

In this lesson, the problem that student will explore is bird collisions into windows. Every year nearly one billion birds collide with glass in the U.S., and most of those fatalities happen at homes and buildings shorter than four stories tall. Even glass walkways and bus stop shelters cause bird collisions.

Birds do not perceive glass as a barrier and do not learn to avoid it in the way that humans are able to use context clues (such as door and window frames, locations, and EXIT signs) to recognize the location of a glass barrier. Birds most often collide with glass when they see natural reflections (clouds, sky, or trees) in the glass, when they see plants through windows, and when they are attracted to landscaping or interior lights. Many birds that seem fine following window collisions die later from sustained injuries.

Understanding the role of light in creating window reflections can help students consider ways to solve the problem of bird window collisions.

References & Resources

"Buildings & Glass." U.S. Fish & Wildlife Service, June 2021, https://www.fws.gov/birds/bird-enthusiasts/threats-to-birds/collisions/buildings-and-glass.php.

"Bird-Safe Design: Conservation: Houston Audubon." Houston Audubon Society, houstonaudubon.org/conservation/bird-friendly-communities/bird-safe-design.html.

Birkhead, Tim. "What Makes Bird Vision So Cool." Audubon, May-Jun. 2014, https://www.audubon.org/magazine/may-june-2013/what-makes-bird-vision-so-cool.

Powell, Hugh. "Why Birds Hit Windows-and How You Can Help Prevent It." All About Birds, 11 Sept. 2020, www.allaboutbirds.org/news/why-birds-hit-windows-and-how-you-can-help-prevent-it/.

TEXAS TEKS

Science

5.6 (C): Demonstrate that light travels in a straight line until it strikes an object and is reflected or travels through one medium to another and is refracted.

Integrated Physics and Chemistry.5(G): explore the characteristics and behaviors of energy transferred by waves, including acoustic, seismic, light, and waves on water, as they reflect, refract, diffract, interfere with one another, and are absorbed by materials

Physics.7 (D): investigate behaviors of waves, including reflection, refraction, diffraction, interference, resonance, and the Doppler effect