Using Animal Sounds and Videos to Teach Physics: a Collaborative Curriculum Development Effort

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Cornell Lab of Ornithology

“Interpreting and conserving the earth’s biodiversity through research, education, and citizen science focused on birds”

Macaulay Library

The world’s largest archive of animal sounds and associated video.
A Digital Rich Media Archive of Animal Behavior

PI: Jack Bradbury

DUE-332872
Facilitating K-12 Selection

Pilot whales
Long-finned pilot whales, also known as blackfish, are highly social and vocal animals. In this recording, clicks, whistles, and several other vocalization types may be heard.
Catalog #110808 (3 minutes, 54 seconds) Paul J. Perkins

Weddel seal
Weddel seals make over 30 types of calls. Many of these sounds are used by adult males during the breeding season to defend breathing holes in the ice, presumably allowing them greater access to females.
Catalog #123436 (43 minutes, 30 seconds) Jeanette A. Thomas

Killer whales
These killer whales are feeding on herring by concentrating the school into a tight ball and then stunning the fish with a blow from their strong tails. Communication between the animals as well as the impact of their tails on the balls of herring may be heard.
Catalog #123122 (4 minutes, 3 seconds) Sofie Van Parijs

Harp seal
This harp seal pup is only a few days old; his mother will leave him on his own after about 12 days. Many pinniped mothers may use these calls to identify their own pup after being separated.
Catalog #123701 (1 minute, 16 seconds) Iba C. Van Opzeeland

Marine animals
In this recording, many animals can be heard under the ice of Arctic waters. The long falling calls in this recording are adult male bearded seals attempting to attract a mate. Also heard are bowhead whales and beluga.
Catalog #112595 (14 minutes, 29 seconds) Donald K. Ljungblad

NSDL
THE NATIONAL SCIENCE DIGITAL LIBRARY
DUE-0532786
Purpose: Demonstrate meaningful uses of rich media

- Elementary
- Middle
- High School
Approach: Strategic Partnerships

- Science content specialists
- Education and outreach specialists
- Teachers
- Students
Many of our teachers have asked us, “Isn’t there some way to combine biology and physics?”

Monica Plisch
Assistant Director of Education
American Physical Society
Why study animal behavior?
Partnership with CIPT

- Lending libraries
- Downloadable lessons
- Workshops for teachers and students
- 700 Teachers
- 10 states and Singapore

CNS Institute for Physics Teachers

Cornell University
CIPT Lab Development Process

Spring Year 1:
• Idea Meeting
• Refine Proposals
• Form Teacher-Scientist teams

Summer Year 1:
• Show and Tell with prototypes
CIPT Lab Development Process

Fall Year 1 - Spring Year 2:
• Piloting in classrooms

Summer Year 2:
• Public debut at summer institute
• Available through lending library
Partnership with WFL BOCES

- 25 component school districts in four counties in central New York
- Support services, science kit distribution, professional development
WFL BOCES Methods

• Recruit active or retired teachers with complimentary interests to work in teams and develop lessons
• Advised by science content specialist and education specialist
• Pilot lessons in own classrooms first
• Available on loan from science resource center; training/orientation offered as needed
Guiding Principles

• Start with compelling questions about animals, the physics will follow!

• 5 E’s instructional model
  – Engage
  – Explore
  – Explain
  – Elaborate
  – Evaluate
Elementary examples: What are birds’ physical adaptations and how does form relate to function?
Wing shapes and flight styles
Beaks as simple machines
Middle school example: How do animals convey information through variations in their sounds?
<table>
<thead>
<tr>
<th></th>
<th>Frequency, duration, amplitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angry</td>
<td>Warning</td>
</tr>
<tr>
<td>Sad</td>
<td>Nervous</td>
</tr>
</tbody>
</table>

The table illustrates different emotions conveyed through frequency, duration, and amplitude in bird sounds.
High school example: How are animals like speakers?
Body size and wavelength

![Graph showing the relationship between maximum wavelength and body length. The graph includes actual data points and two prediction lines for different wavelengths.](image)
Body size and wavelength
High school example:
How are feather colors formed?
Light Waves and Feather Color

Examples of Interference in Nature

Peacock Feather
Abalone Shell
Iridescent Opal

Figure 9
Light Waves and Feather Color
“I like this lab because it combined chemistry, biology, physics, and math. Just like the real world.”

11th grade student
Benefits

- Teachers involved in content creation: so actually lessons they need and want
- Tied tightly to standards: so could actually be adopted during year
- Lasting partnerships with much revision and testing
- Flexible and low-cost or free: adopt one lesson or whole unit
Benefits

• Emphasizes connections among disciplines
• Cutting-edge and authentic science content
• Conceptual introduction to math and graphical representations
• Use of technology and rich media supports visual mental models
Challenges

• Knowing where to start
• Striking the right balance of physics and biology
• Distance and ability to meet/check-in
• Keeping current on cutting-edge science
• Accurately representing complex, real-world situations with physical models
• Massive amount of equipment, prep, construction, storage
Challenges

- Many roles for science content and education experts--also two bosses
- Teachers often wedded to how they “normally” teach (abstract concepts and equations before concrete examples)
- “I already have a lab on this.”
- “If it’s not in the standards I won’t do it.”
- Inconsistent writing styles/abilities
- Planning for technology hurdles or snafus
Lessons Learned and Recommendations

- Tap into existing outreach groups (lending libraries, teacher professional development programs)
- Find the *right* partners (grade level, location, quality standards, similar goals)
- Evaluate teachers carefully—have them submit sample lessons
- Present united front and talk among science and education partners often
Lessons Learned and Recommendations

- Be careful about timing—use school breaks
- Schedule regular check-ins
- Milestone deadlines and payment at intervals
- Expectations for feedback/turn-around time
- Use wiki/website to organize versions and share ideas or comment on drafts
Lessons Learned and Recommendations

• Budget appropriately, and don’t buy equipment in bulk until you’ve extensively tested it
• Allow plenty of time for initial research, idea generation, revisions
• Clear expectations about lesson format
• Expect/hire editors to get drafts in desired style and format
• Recruit help with construction of prototypes and equipment
Thanks!

birds.cornell.edu/macaulaylibrary
Panel Discussion

• Your Questions????
Panel Discussion

• Which technologies and media show the best promise for teacher adoption and classroom integration?
Panel Discussion

• How did technical limitations such as available computer equipment and platforms affect your decisions?

• How were partners trained to use the digital tools? Was there resistance, and if so, how was it overcome?

• What design challenges did you face in creating learning environments with digital library resources, and how did you address them?