Focus on Energy: Preparing Elementary Teachers to Meet the NGSS Challenge

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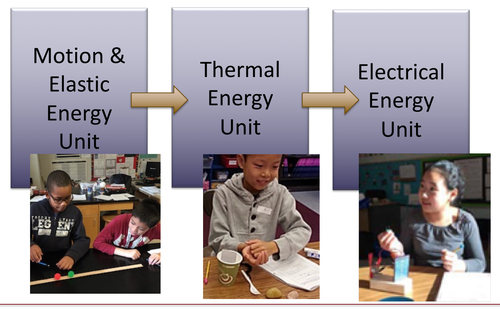
How do elementary students encounter and engage with apparent inconsistencies in their model of energy?

Focus on Energy Project Overview

- Iteratively developed a 13-session curriculum for grades 4 or 5,
- Each unit includes
  - Investigative question
  - First hand exploration
  - Multiple representations (including dynamic and static models)
  - Consensus building class discussions
  - Quick check formative assessments
  - Wrap up assessments
  - Horizon assessments
- Teachers are supported through
  - Online curriculum and assessment resources
  - Summer professional development workshops (week long)
  - Academic year professional learning community meetings (3 times per year)

Focus on Energy Curriculum



Motion & Elastic Energy Investigative Questions & Objectives

1. What can motion tell us about energy?
- Energy cannot be directly seen or measured.
- All moving objects have motion energy.
- Speed is the indicator of how much motion energy an object has

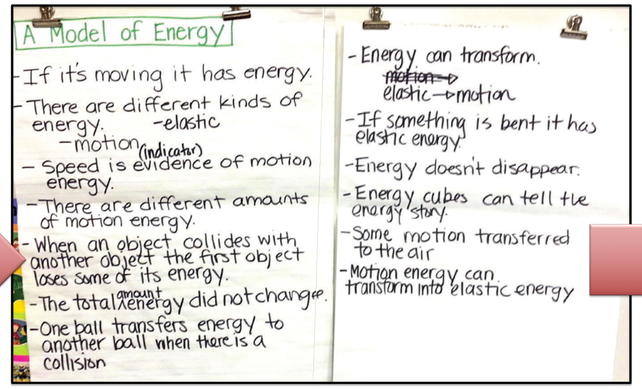
2. Can a ball cause another ball to move AND not lose any of its own energy?
- Energy can move from one object to another object
- Motion energy can be transferred between objects
- Whenever there is a loss of energy somewhere, there must be a gain in energy somewhere else (and vice versa).
- A drawing or representation (such as energy bars) can show changes in the amount of energy an object has.

3a. Can a paint paddle have energy?
- An elastic object is any object that returns to its original shape after being deformed
- Deformation of an elastic object is the indicator of the object's elastic energy
- Motion energy can be transformed into elastic energy (and vice versa).

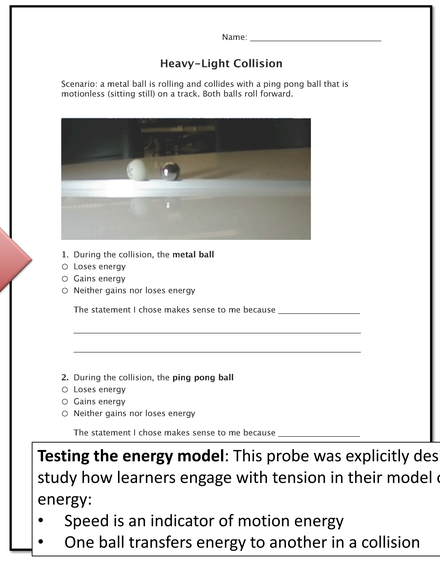
3b. What is the energy story of the paint paddle and pompom?
- Energy cubes can be used to reason about energy flows and forms.

4. What's the energy story of the propeller?
- The Energy Lens questions, "Where does the energy come from?" and, "Where does the energy go?" provide a useful way of thinking about energy flow in any scenario.
- Drawings and representations help reason about energy flow and transformation in a scenario.

Example of Class Model of Energy



Heavy-Light Collision: Horizon Probe



Name: _____

Heavy-Light Collision

Scenario: a metal ball is rolling and collides with a ping pong ball that is motionless (sitting still) on a track. Both balls roll forward.

1. During the collision, the **metal ball**
   - ○ Loses energy
   - ○ Gains energy
   - ○ Neither gains nor loses energy

   The statement I chose makes sense to me because _____

2. During the collision, the **ping pong ball**
   - ○ Loses energy
   - ○ Gains energy
   - ○ Neither gains nor loses energy

   The statement I chose makes sense to me because _____

Testing the energy model: This probe was explicitly designed to study how learners engage with tension in their model of energy:
- Speed is an indicator of motion energy
- One ball transfers energy to another in a collision

Methodology

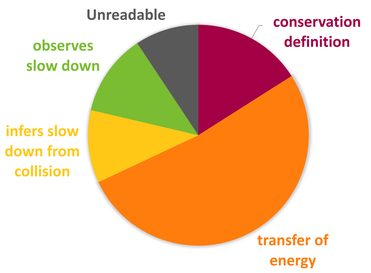
Data Collection

- Heavy-light collision probe was inspired by a classroom experience shared during the first year PLC.
- Probe developed and piloted with students from second year of project
- Teachers from third year gathered data from students following motion unit.
  - Seven classrooms
  - 107 student probes

Data Analysis

- Preliminary analysis
  - Responses analyzed for metal ball and ping-pong ball.
  - Explanations coded based on reason for change in energy.
- Future analysis
  - Responses grouped for metal ball and ping-pong ball.
  - Explanations coded based consistency, conservation, and evidence of transfer.

Metal Ball Loses Energy (70% of students)



transfer of energy (39)
"when the metal ball collides with the ping pong ball, the metal ball will lose energy because it will transfer energy"

conservation definition (12)
"when there is a gain somewhere, there is a loss"

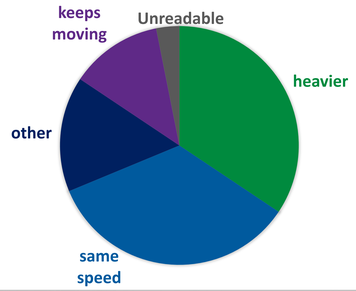
observes slow down (9)
"I think it loses energy because it keeps rolling but it slows down"

infers slow down from collision (8)
"the metal ball was moving and then it hit the ping pong ball and slows down"

exemplary energy reasoning w/o perceivable evidence
"…the metal ball hits the other ball and transfers some of its energy to the ping pong ball. But after that both balls move down the track, the metal ball doesn't visabley loose energy but I know it has.

"Then the metal ball hit the ping pong ball, gave some of its energy to the ping pong ball and then the metal ball started moving the tinyst bit slower.

Metal Ball Neither Gains nor Loses Energy (30% of students)



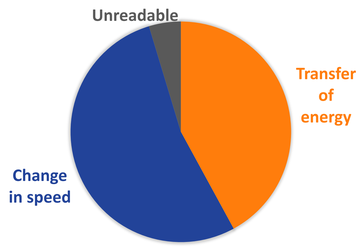
heavier (11)
"the ping-pong is so light that the metal ball is so heavy that it does not lose or gain motion energy"

same speed (11)
"It's speed didn't change when it hit the ping pong ball so I don't think it gained or lost energy"

keeps moving (4)
"when the collision happened it kept going after it was hit"

other (5)
"in the slow motion it looked like it had lots of energy"

Ping Pong Ball Gains Energy (100% of students)



change in speed (57)
"the ping pong got hit by the metal one and began to move"

transfer of energy (45)
"the metal ball gave it energy because it hit it"

Summary

Elementary students are capable of robust reasoning about energy, can reason well using their model of energy, and are ready to think about imperceptible energy changes

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