Learners' understanding of energy: Conservation of amount, decrease of value

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FACET INNOVATIONS

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Learning goals for energy instruction

Physicists want to teach:

- Conservation

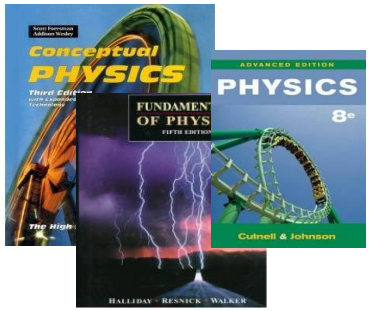
  $E_{initial}$

- Form

  Gravitational Potential, Thermal, Kinetic, etc.

- Efficiency

$$\frac{Work_{in}}{Work_{out}}$$



What do teachers think??

Students want to learn:

- Conserving (saving)

Wind, Nuclear, Solar, Geothermal, Coal, etc.

- Efficiency

Cheaper, faster, longer lasting, more useful for humans

Context for research

Energy Project Summer K-12 Professional Development

Energy Theater

Rules:

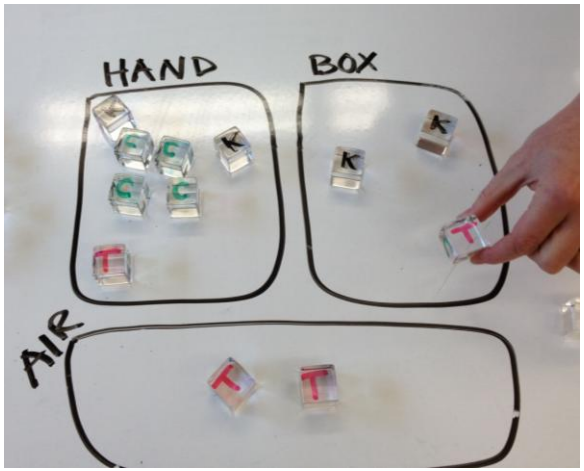
Each person (cube) is a ‘chunk’ of energy

Objects in the scenario correspond to locations on the floor (white board)

Energy forms are indicated with movements, hand signs, or letters

As energy transfers and transforms among objects, people (cubes) move and change label.

Energy Cubes



Energy Theater and Cubes emphasize what **physicists** want to teach: Conservation of energy through an entire process.

Teachers discuss the benefits and limitations of ET

Adding “usefulness” to representation

Energy loses value though the total amount is constant.

Spontaneous learner interest in "usefulness"

"Energy's value has decreased."

"The quality of the energy decreases as it dissipates."

"Energy is used up and becomes less available."

"When is energy useful?"

"Energy degrades into a less useful form."

Also seen in:

- Duit (1984)
- Kesidou & Duit (1993)
- Papadouris and Constantinou (2010)
- Pinto, Couso, & Gutierrez (2004)
- Solomon (1982, 1985, 1992)

Next: An Enhanced Model of Energy

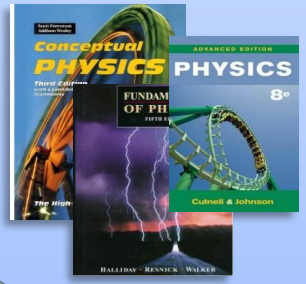
Entropy & 2nd Law of Thermodynamics

Conservation
Forms
Efficiency

Conserving
Sources
Efficiency

Socio-political

Coherent Energy Model



Future development

Develop a model for **energy usefulness** that:

- ✓ is responsible to advanced physics
- ✓ is accessible to elementary teachers
- ✓ creates a meaningful connection between energy that is conserved and energy that is used up

Example: Burning Coal