

# Representing energy transfers and transformations

---

Rachel E. Scherr,  
Hunter G. Close, Lane Seeley, and Sam McKagan  
AAPT Winter Meeting – Ontario, CA  
February 7, 2012



Seattle Pacific  
UNIVERSITY



Supported in part by  
NSF grant DRL0822342

# Energy Project



*Professional development program*  
for K-12 teachers  
on the learning of **energy** and  
practices of **formative assessment**

*Research program on:*

- teaching and learning of energy
- relating “school energy” to sociopolitical concerns
- learning theory development
- assessment of teacher learning

# Energy Project team and collaborators



Stamatis Vokos  
Lane Seeley  
Lezlie DeWater  
Rachel Scherr  
Sam McKagan  
Amy Robertson  
Abigail Daane  
Julie Glavic



Hunter Close



Eleanor Close



Jim Minstrell



Benedikt Harrer



Brian Frank



Michael Wittmann



Leslie Atkins



# Goals for energy learning

## SUBSTANCE METAPHOR

Energy is a kind of stuff (invisible, massless, etc.); objects are containers that can have such stuff in them.

- ✓ Conservation
- ✓ Transfer
- ✓ Flow



## ENERGY DYNAMICS

Detailed tracking of energy transfers and transformations in real-world processes



# Population-specific learning goals

Our learners are **inservice K-12 teachers**.

- They need foundational conceptual understanding.



- They want responsible connections to urgent sociopolitical issues.



- They teach in a wide range of situations.

*To leverage sound conceptual understanding into changes in their classroom, they have to be prepared to be creative.*



# Theoretical perspective

Learning is anchored in **representations.**

*Culturally-produced artifacts  
that speak with the voice of  
the culture that produced them*

## **GUIDING QUESTIONS:**

What do specific representations “say” about energy?

What questions do specific representations “ask”?

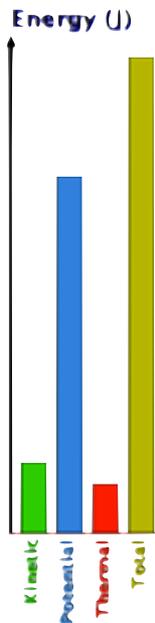
What representations support our learning goals?

# Familiar representations of energy



"There is a total amount of energy.  
That whole amount is divided into parts."

"What proportion of the energy  
is in each form?"



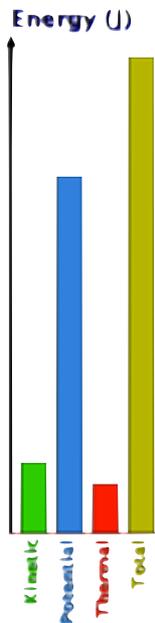
"There are different categories of energy."

"Which form has the most energy in it?"

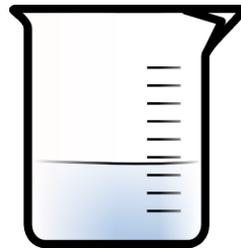
# Do they support our learning goals?



Energy is a kind of stuff  
(invisible, massless, etc.);  
**forms** (or **systems**)  
are containers that can have  
such stuff in them.



**MAYBE?**



**NOT SO MUCH**



# Novel representations of energy



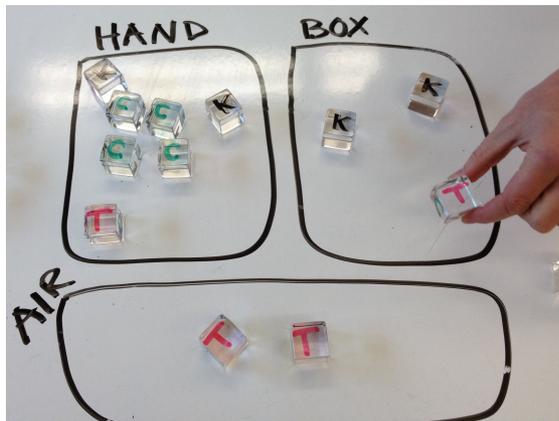
## Energy Theater

You are a unit of energy.

Objects in scenario correspond to areas on the floor.

You indicate your form in some way.

As energy is transferred among objects, you move to different locations on the floor.

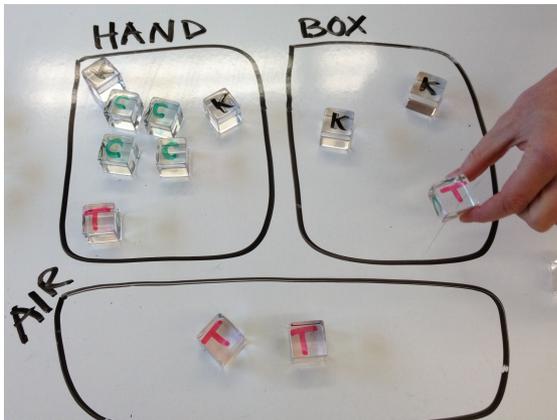


## Energy Cubes

Blocks are units of energy.

Objects correspond to areas on whiteboard.

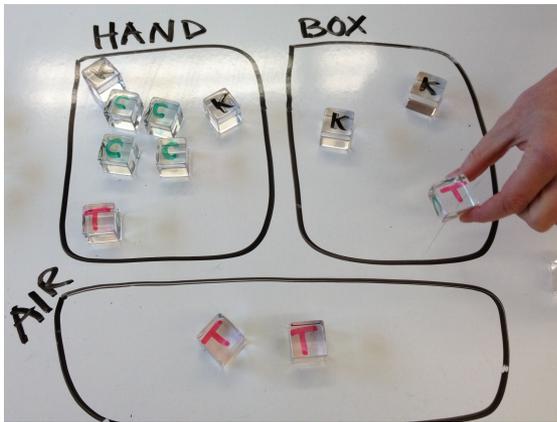
# Novel representations of energy



"Energy is located in objects. Every unit of energy has a form. Energy moves among objects and transforms."

"Where does the energy start? Where does it go after that? What form is each unit of energy in at each moment?"

# These support our learning goals



**EMBODY**



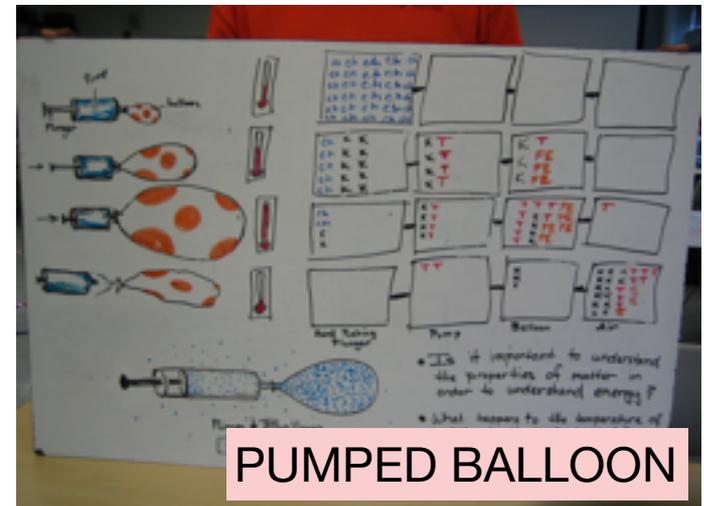
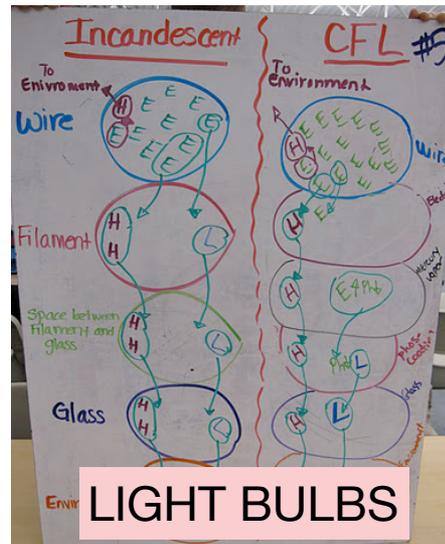
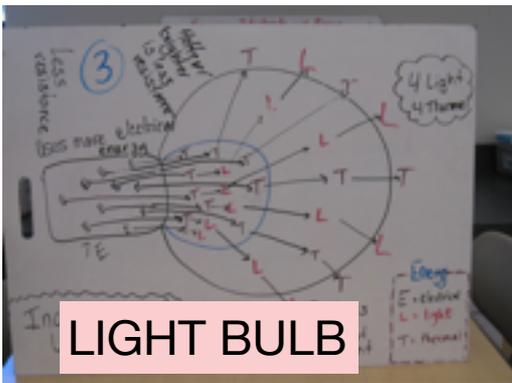
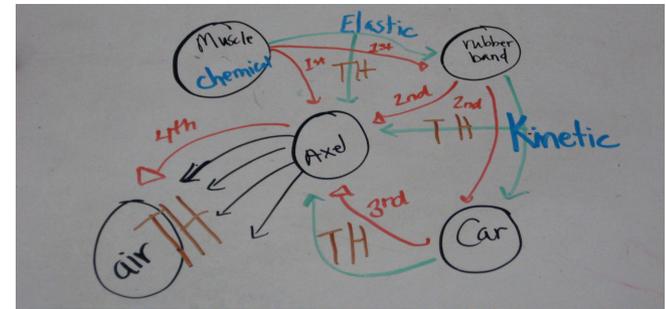
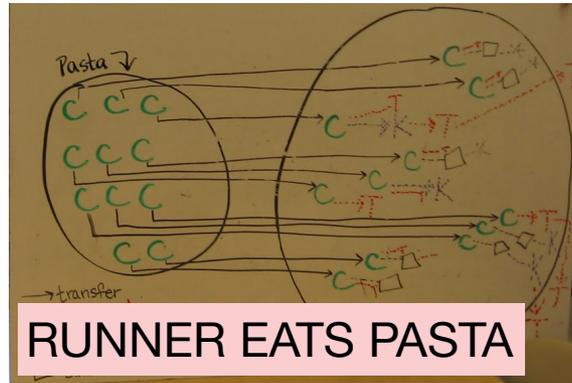
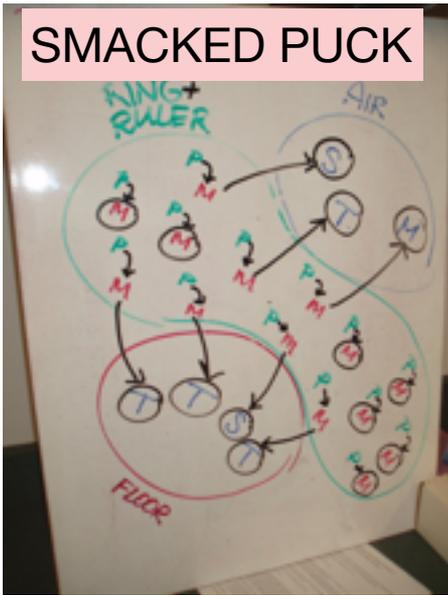
**ASK FOR**



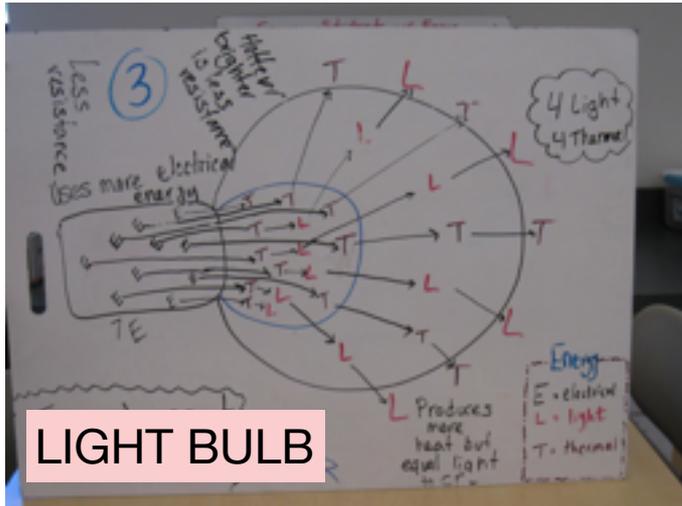
# Assessment of energy learning

“After acting out the Energy Theater, draw and label one or more diagrams that show what your group did.”

# Learner-invented representations

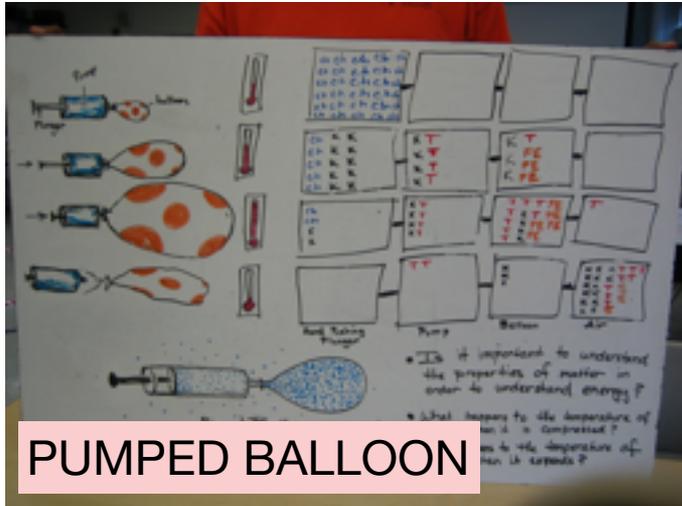


# Learner-invented representations



LIGHT BULB

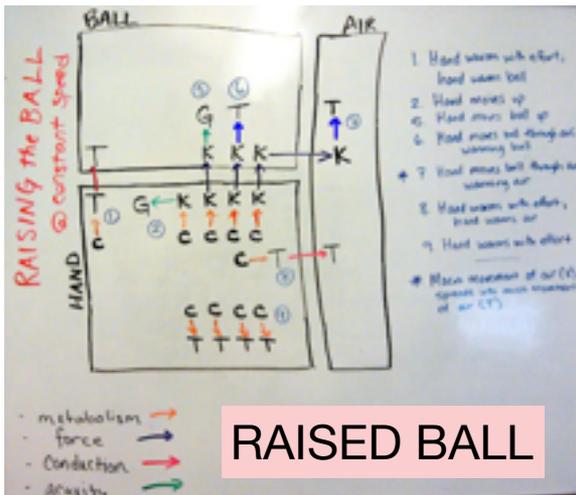
Each energy unit is a letter that traces a path through the system; when form changes, letter changes



PUMPED BALLOON

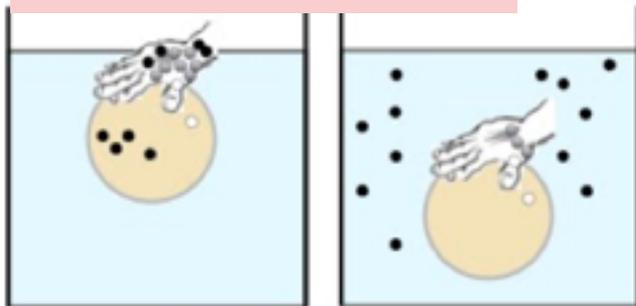
Energy units are colored letters; objects are schematic areas; time sequence is diagram sequence; *coordinated with observable state of system (volume, temperature)*

# Expert-refined representations



Each energy unit is a letter that traces a path through the system; when form changes, letter changes; *arrow color indicates mechanism*

## SUBMERGED B-BALL



*Leslie Atkins*

*Energy movie* in which energy units are dots; when form changes, color changes

# Progress toward learning goals

