Energy Theater

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Agenda

1. Energy Theater Rules
2. Energy Theater
3. How to use and assess Energy Theater in the classroom
    a. Advantages and limitations of the “energy as a substance” metaphor
    b. Learning goals (NGSS)
    c. Classroom management
    d. Assessment: Energy Tracking Diagrams
    e. ET Scenarios you could use in your classroom

Scenario 1

Use Energy Theater to represent a salmon swimming upstream steadily.

- Groups of 8-10 are ideal (today 6-8 people)
- You must follow the rules!
- There are many levels on which you can be "correct", but the goal is for your Theater to match your understanding.

Energy Theater Rules

1) Each person is a unit of energy in the scenario.
2) Regions on the floor correspond to objects in the scenario.
3) Each person has one form of energy at a time.
4) Each person indicates his or her form of energy in some way, often with a hand sign (such as a letter) or an iconic movement (such as fanning).
5) People move from one region to another as energy is transferred, and change hand sign as energy changes form.
6) The number of people in a region or making a hand sign corresponds to the quantity of energy in an object or of a particular form, respectively.

Debrief #1 (For learners)

Discuss:

a) What were some similarities about the performances?

b) What was different about the performances?

Debrief #1 (For learners)

Discuss:

a) What changes (if any) would you make now that you've seen the other group's presentation? Why?

b) What questions do you still have about the energy in the scenario?

Debrief # 2 (For instructors)

Think & write individually:

What are advantages or limitations
in using Energy Theater
as a classroom learning activity?

With respect to…

- Achieving learning goals in your curriculum
- Classroom management
- Assessing your students' ideas about energy

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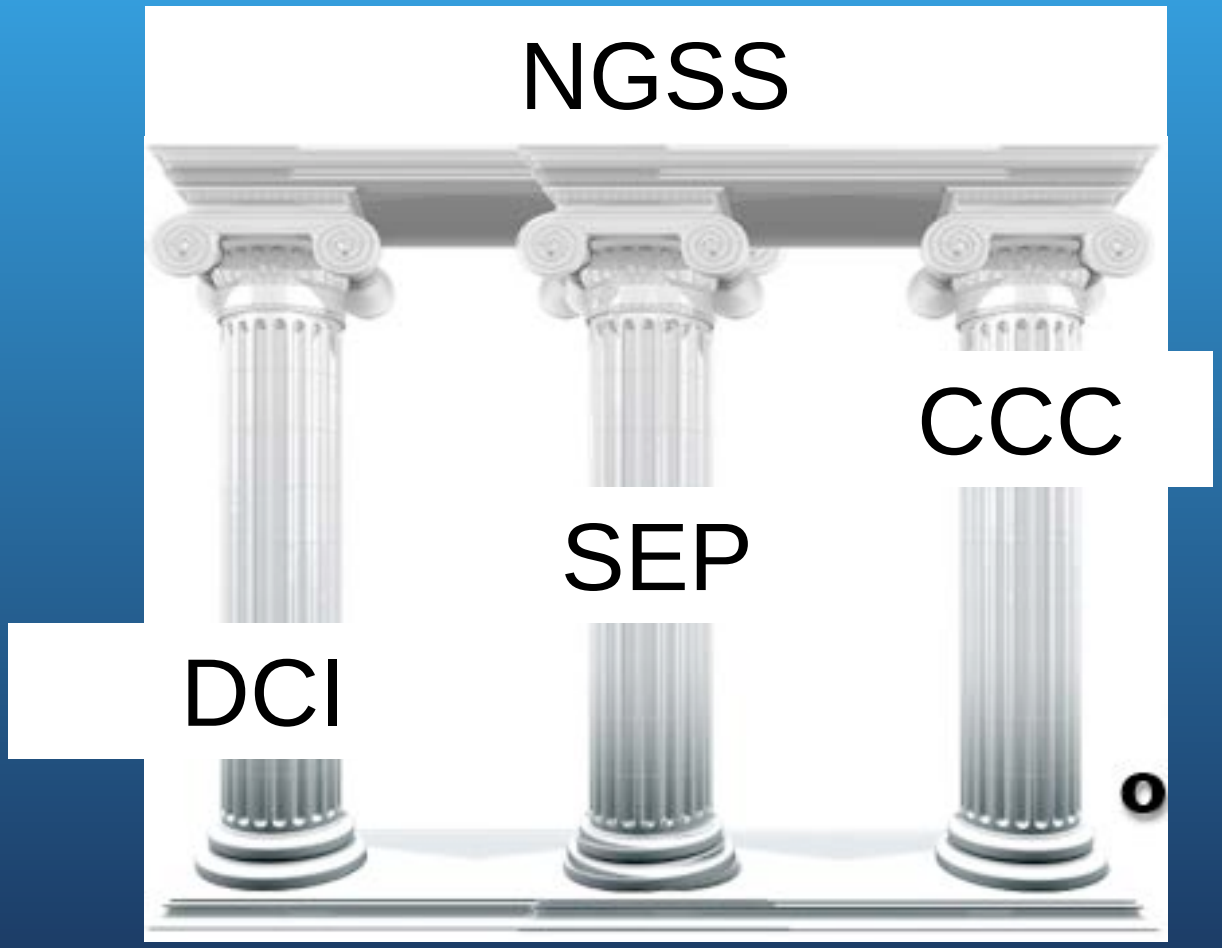
   a. Learning goals (NGSS)
      *“Energy as a substance” metaphor
   b. Classroom management
   c. Assessment: Energy Tracking Diagrams
   d. ET Scenarios you could use in your classroom

Energy Theater Learning Goals

for middle/high school students



Energy Theater Learning Goals

Disciplinary Core Ideas:

Students should be able to accurately and consistently use a substance metaphor to represent what energy *is* and what it *does:*

1. Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems.
2. Changes of energy in a system can be described in terms of energy flows into, out of, and within that system.
3. At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy.

“Energy as a Substance” Metaphor

Advantages:

+ Energy is conserved
+ Energy is localized
+ Energy is located in objects and can be transferred among objects
+ Energy can change form

“Energy as a Substance” Metaphor

Limitations:

- Energy is *not* a material substance, it is a mathematical construct. It's not pushable, frictional, consumable, inertial, or gravity sensitive.
- Energy can be located in a "field" rather than an object.
- Negative energy values are inappropriate for this model.

Energy Theater Learning Goals

NGSS:
Scientific and Engineering Practices:

1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models *(and revising)*
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

Energy Theater Learning Goals

Crosscutting Concepts:

Students are expected to infer **energy** transfer & transformation from evidence of changes happening in the physical world – in all subjects!

Students are expected to predict **cause and effect** relationships for complex natural and human-designed systems by examining what is known about smaller scale mechanisms within the system.

Classroom Management

1. *Think & write individually:*

What does a teacher look like/sound like
who enables student ownership
of the scientific process
while doing Energy Theater?

2. Take _____ minutes to add your thoughts to the chalk talk posters.

What does a teacher look like / sound like who enables student ownership of the scientific process while doing Energy Theater?

Looks like

- lksjdf

Sounds like

- lskdjf

What does a teacher look like / sound like who enables student ownership of the scientific process while doing Energy Theater?

Looks like

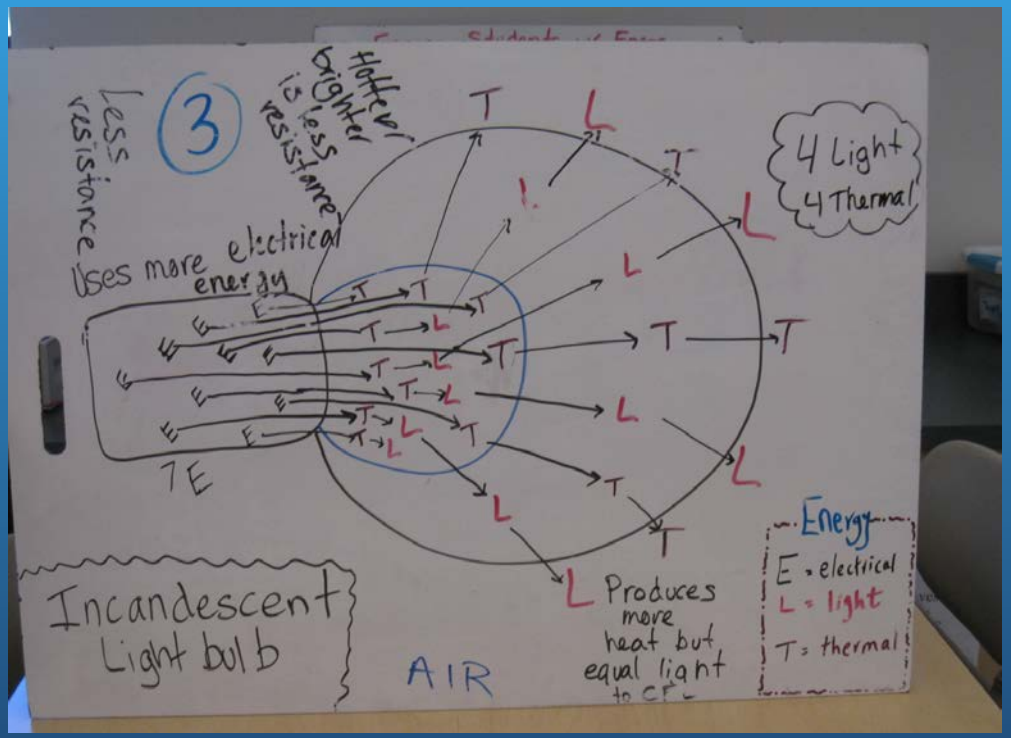
- Hold their distance from the groups
- Come to the group only when asked
- Sit on same physical level with students
- Gives group roles: casting director, director, producer, actors, stage manager
- Steps in when groups have disagreements.
- Gives sentence starters for deeper thinking: Another way we could do this is…. The weakest part of our representation/understanding is…

Sounds like

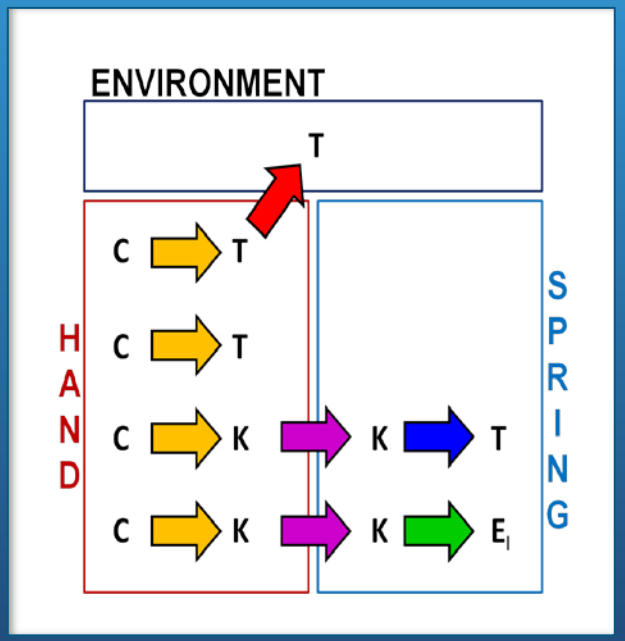
- Have you all agreed where the energy in this step comes from?
- What evidence or physical changes might justify your choice of energy here?
- If you couldn't do it this way, what's an alternate way to do it?
- There is no correct answer, but you must justify what you put into the theatre.
- How and when will you and your group decide to make a change?
- How do you know when you're "done"?
- How could you make this clearer to sixth graders?
- Are there any other observations about the system that might give you some further clues?

Assessment: Energy Tracking Diagrams

Light bulb:



A hand compressing a spring:



What differences / similarities do you notice in the "rules" for this representation vs. Energy Theater?

Assessment...your thoughts?

Discuss at your table (choose one)

1. What would you look for in students' diagrams to determine whether they've met your learning goals?
2. When discussing the diagrams or theater with students, what features might you emphasize?
3. Can you assess individual learning from the group activity? If so, how? If not, what next?

Sample Energy Scenarios: Biology

- A seed growing
- Food chains (energy flow through the different levels in an ecosystem)
- A leaf producing food (photosynthesis)
- A person eating (cellular respiration)
- Exercising ("burning" fat / calories)
- Storage/release of energy as ATP/ADP (might need to introduce chemical energy as like spring energy for different parts of the molecule that are twisted/bent)

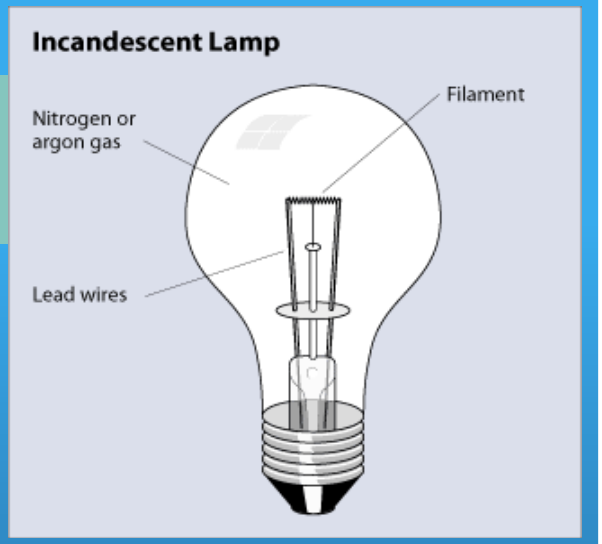
Sample Energy Scenarios: Chemistry

- Lighting a match (activation energy in a chemical reaction)
- A lit match is used to explode a hydrogen balloon
- Ice melting into a cold river (phase changes)
- A balloon/bike tire explodes in the sun (gas laws / kinetic molecular theory of matter)
- Endothermic/exothermic reactions of your choice:
  - Potassium chlorate + a gummy bear
  - Vinegar + baking soda
  - Sulfuric acid + sugar

Sample Energy Scenarios: Physics

- Lowering a bowling ball at constant speed.
- A mousetrap car is let go, and coasts to a stop
- A blender is turned on (or any household appliance)
- A bouncing tennis ball eventually comes to a stop.
- Electricity generation
  - nuclear power plant
  - hydroelectric power plant
- A moving piston in a gasoline engine (adiabatic / isothermal gas processes)
- A light bulb, battery, or simple circuit

Scenario 2



Use Energy Theater to represent an incandescent light bulb burning steadily.

- Groups of 8-10 are ideal (today 6-8 people)
- You must follow the rules!
- There are many levels on which you can be "correct", but the goal is for your Theater to match your understanding.

RESOURCES

- Link to Seattle Pacific University's Energy Project Website with more sample scenarios & info.
- Research justifying/explaining Energy Theater
  - Energy Theater
  - Energy Tracking Diagrams
- Our contact information
  - Abigail Daane – abigail.daane@gmail.com
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