

Criteria for Creating and Categorizing Forms of Energy

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PROPOSAL:

Explicitly articulating the criteria used to identify forms of energy can empower teachers and students and help them to understand both the concept of energy and the nature of science.

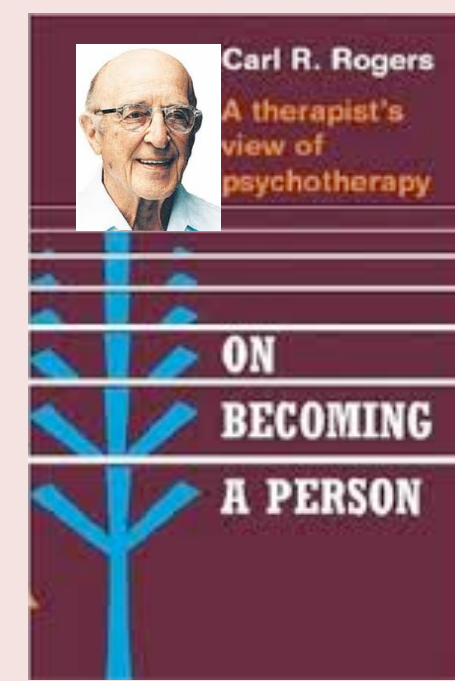
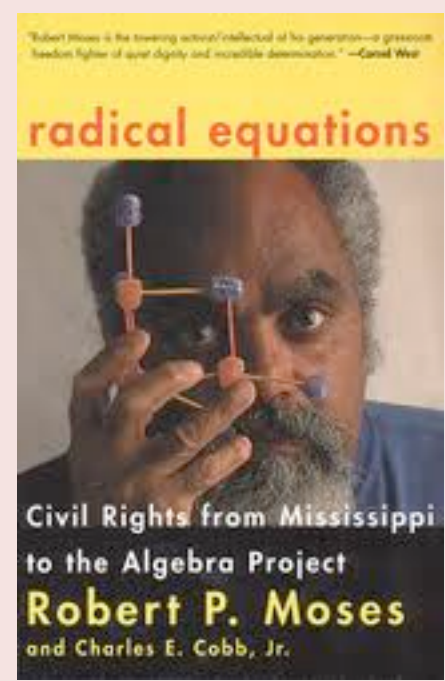
INSTRUCTIONAL CONTEXT:

Energy Project Professional Development Course for Elementary Teachers



SOURCES OF INSPIRATION:

1. Algebra Project (Moses)
2. Discourse Analysis (Rogers)



GOALS:

1. Help teachers to learn about energy
Inquiry-based with respect to **content**:
Participants construct understanding about energy by asking questions.
2. Help teachers to experience science as an area where they and their students are empowered to figure things out
Inquiry-based with respect to **method**:
Participants construction understanding about what it means to learn by developing their own standards of evidence.

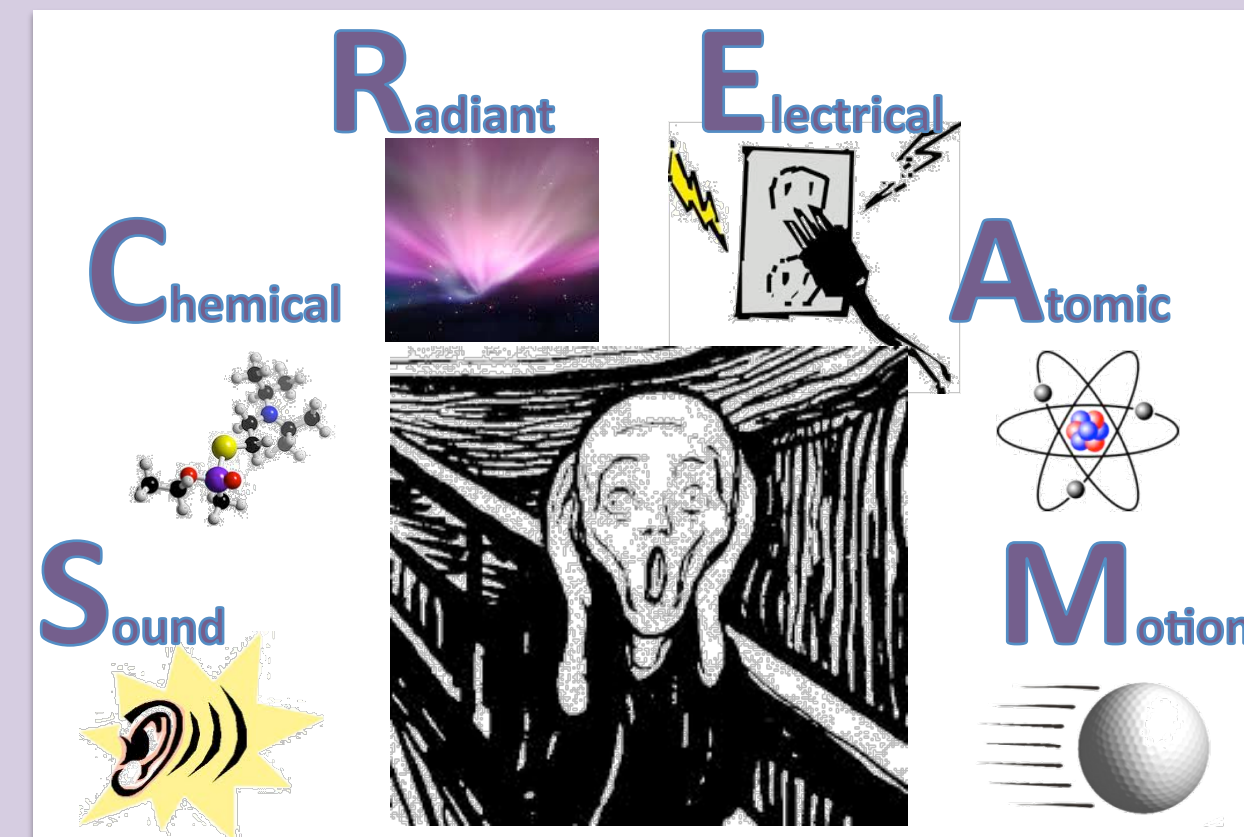
Participants ask & answer own questions by:

- Small group and whole class discussions
- Calling on the expertise of instructors
- Searching for answers on the internet
- Energy Theater – representing energy transfers and transformations in real-world scenarios with their own bodies.

DISSATISFACTION WITH FORMS:

Teachers express frustration with seemingly arbitrary lists of forms:

List from one school district (graphics by SBM):



List from *Benchmarks for Science Literacy*:

- Motion Energy
- Thermal Energy
- Gravitational Energy
- Elastic Energy
- Chemical Energy
- Electrical Energy
- Light Energy

Teachers want to know:

- Which list is correct?
- Which names should we use?
- Which forms should we teach our students?
- How do other forms fit into these lists?
- What exactly are these lists of?
- **How do we know what qualifies as a form of energy and how are forms categorized?**

CONCEPTUALIZING NEW FORMS OF ENERGY

After watching presentation where teachers in another class make up “phase energy”, a teacher asks:
Is it OK to make up a new form?

Marjorie: Phase energy. I know, we don't have any, we don't have understanding or, we'll make something up. We'll call it phase energy.
Instructor: Mmhhh. Is that okay? Is that what you're asking?
Marjorie: Yeah. I mean is it okay? Well, yeah, it.. you know, it accomplished I guess what they set out to accomplish, but is it real?

Responses from other teachers suggest understanding of provisional nature of science, but **NOT** empowerment to engage in the production of scientific ideas:

Brian: Isn't it all arbitrary anyway? ... I mean, you know, thermal energy – that's an idea. Like you could have called it pancake energy if you wanted to.
Anthony: So, in essence, it's kind of like what the experts which basically are the people that first like kinda first decided to think about it and create the benchmark or create the idea. It'd be the same thing if we called it Blue Bland. Once everybody agrees to that it's Blue Bland, as long as it conveys the understanding of what's happening to the best of our understanding, then basically it was okay. Is that kind of the... the thing?

Empowerment to produce scientific ideas may require:

1. explicit understanding of the criteria
- OR
2. engagement in real problem that is sufficiently complex as to require new forms of energy (e.g Energy Theater)

(two days later Marjorie makes up a new form in Energy Theater)

PROPOSED DEFINITION OF ENERGY FORMS:

Energy forms are categories of mechanism by which energy acts and/or evidence for the presence of energy.

PROPOSED CRITERIA FOR CREATING AND CATEGORIZING ENERGY FORMS:

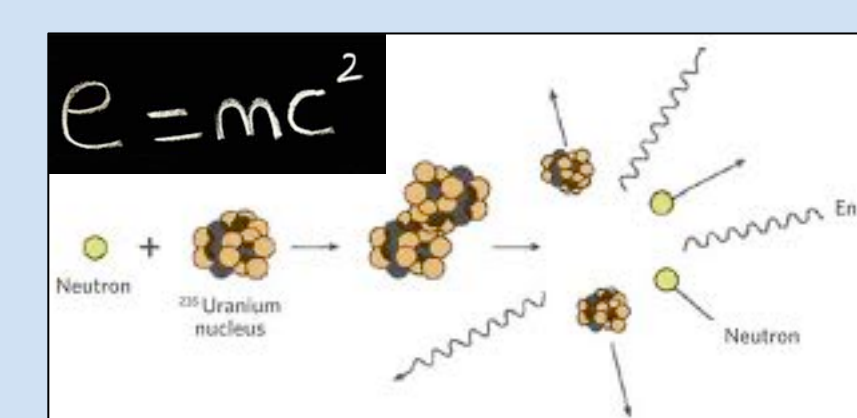
1. Accounting For All the Energy:

There should be enough forms to account for all the energy in the scenario being analyzed.

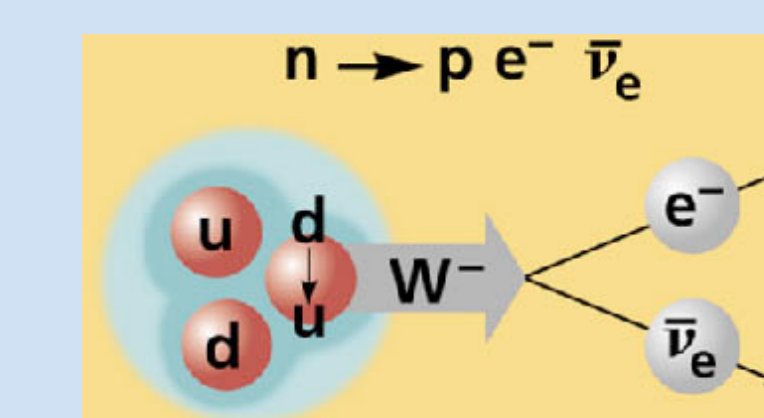
EVIDENCE: Creating new forms when known forms don't add up to satisfy Principle of Conservation of Energy

PHYSICIST DISCOURSE:

Mass Energy



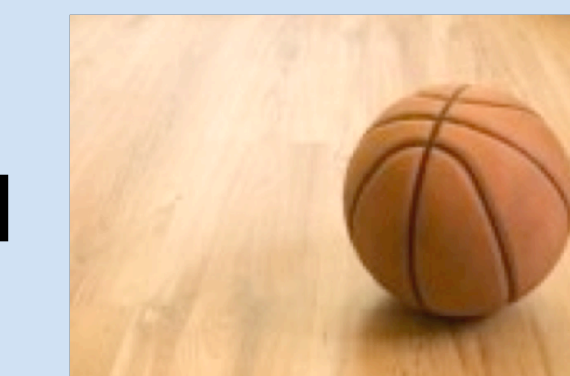
Neutrino Energy



Physicists postulated mass energy and neutrinos to account for apparent violations of conservation of energy.

TEACHER DISCOURSE:

Teachers frequently applied this criterion successfully:



During Energy Theater for a basketball rolling on the ground, teachers postulated the existence of thermal energy to account for lost kinetic energy, *even though they could not detect a temperature change.*

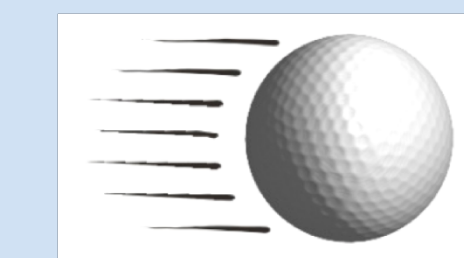
2. Distinguishing Features of Interest

The forms should be subdivided into enough categories to distinguish all the features of interest in the scenario.

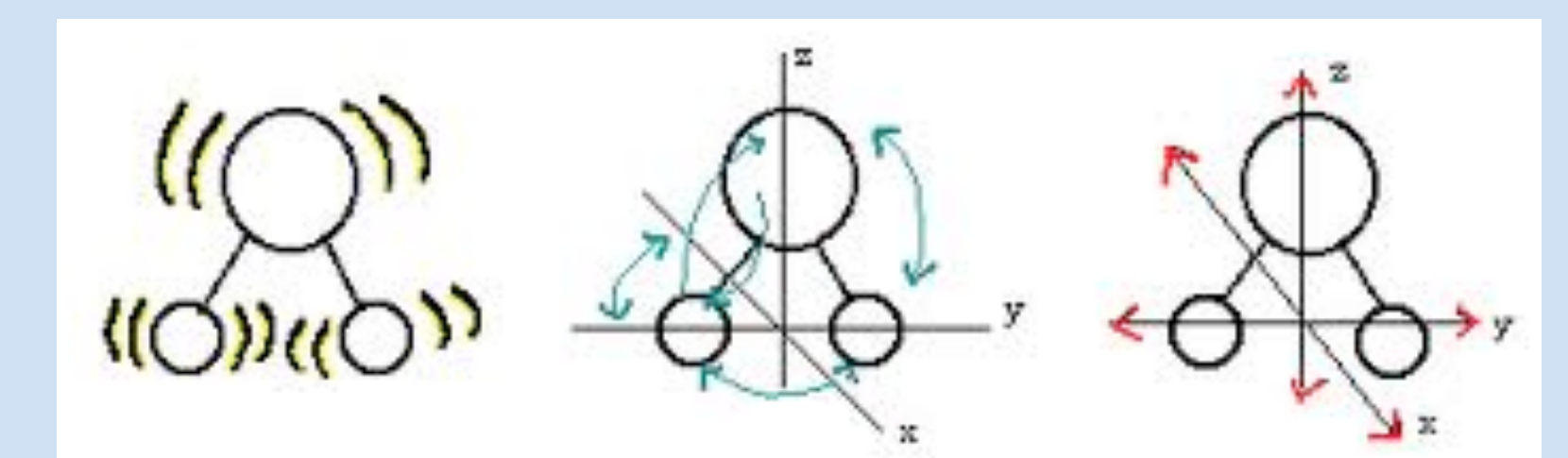
EVIDENCE: subdividing forms needed to explain something and lumping forms together when finer distinctions aren't useful

PHYSICIST DISCOURSE:

Kinetic Energy

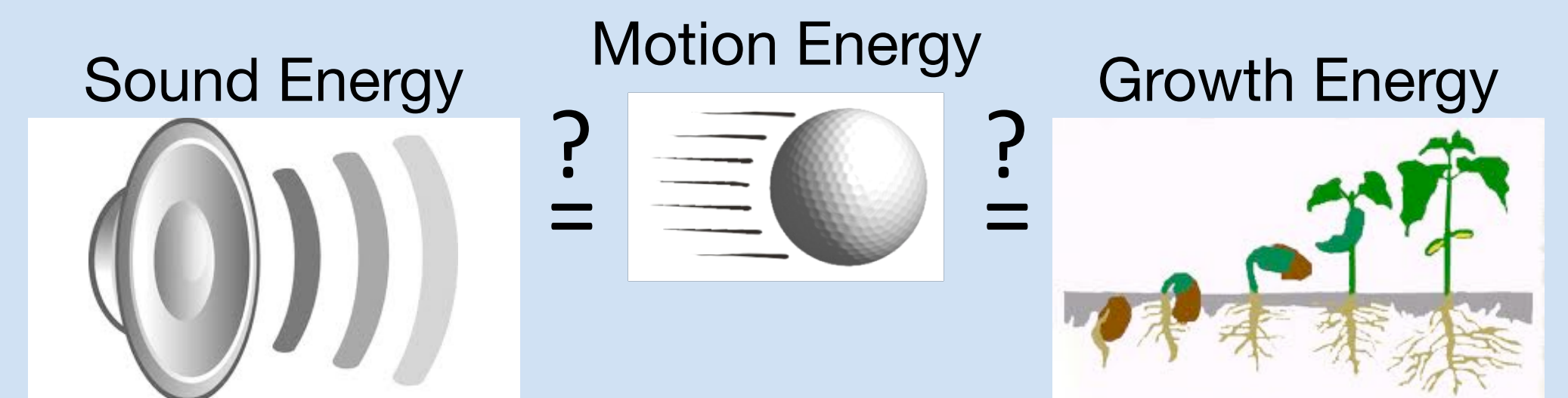


Rotational, Vibrational, and Translational...



TEACHER DISCOURSE:

Teachers struggled to apply this criterion:



They had the tools to distinguish many relevant features.

e.g. They were able to determine that:

- Sound does not exist independent of the motion of molecules.
- Sound involves vibrational motion rather than translational motion.
- Sound is a wave.
- Sound and motion are detected using different techniques.
- We care about sound for different reasons than we care about motion.
- Sound energy appears in the state standards for elementary science instruction.

Conclusion: Teachers likely could apply this criterion if it were articulated explicitly