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 construct 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.

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 of, or we’ll make something up. We’ll call it phase energy.

Instructor: Mr. T. Is that okay? Is that what you’re asking?

Marjorie: Yeah. I mean is it okay? Well, yeah, if you know, it accomplished 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 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 benchmarks or create the ideas. It’ll be the same thing if we call it Blue Bland. Once everybody agrees to that it’s Blue Bland, so 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 thing ... 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)

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

PROPOSED DEFINITION OF ENERGY FORMS:

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

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.

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 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.

PROPOSED CRITERIA FOR CREATING AND CATEGORIZING ENERGY FORMS:

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