

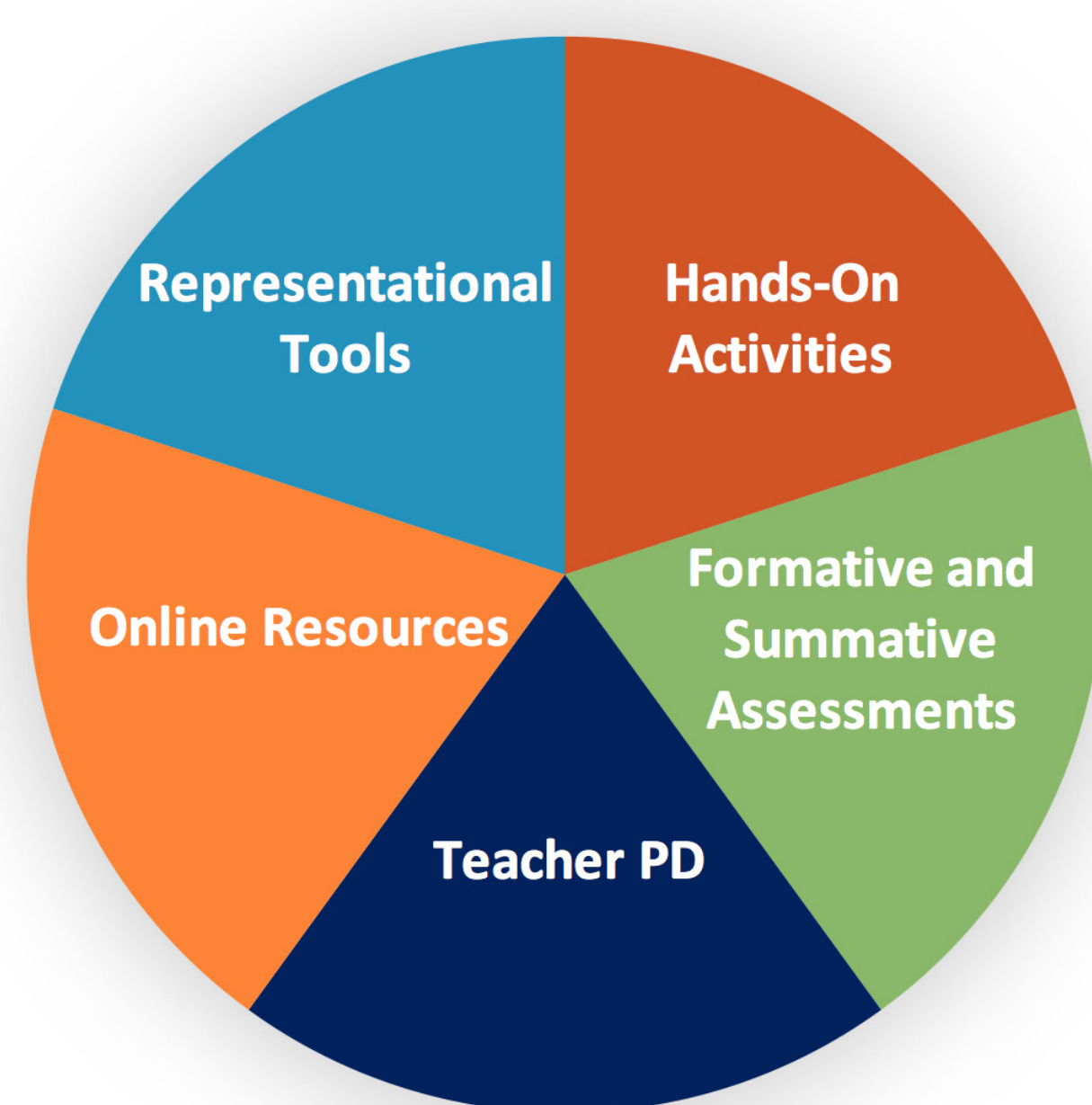
Preparing Elementary Teachers to Meet the NGSS Challenge

Sara J. Lacy(1), Roger G. Tobin(2), Sally Crissman(1), and Nick Haddad(1)

(1) TERC, Cambridge, MA 02140

(2) Department of Physics and Astronomy, Tufts University, Medford, MA 02155

Focus on Energy developed a coherent set of resources for introducing scientific ideas about energy to students and teachers in Grades 4 or 5.



The Energy Tracking Lens

A consistent conceptual framework for using energy ideas to think about any scenario:

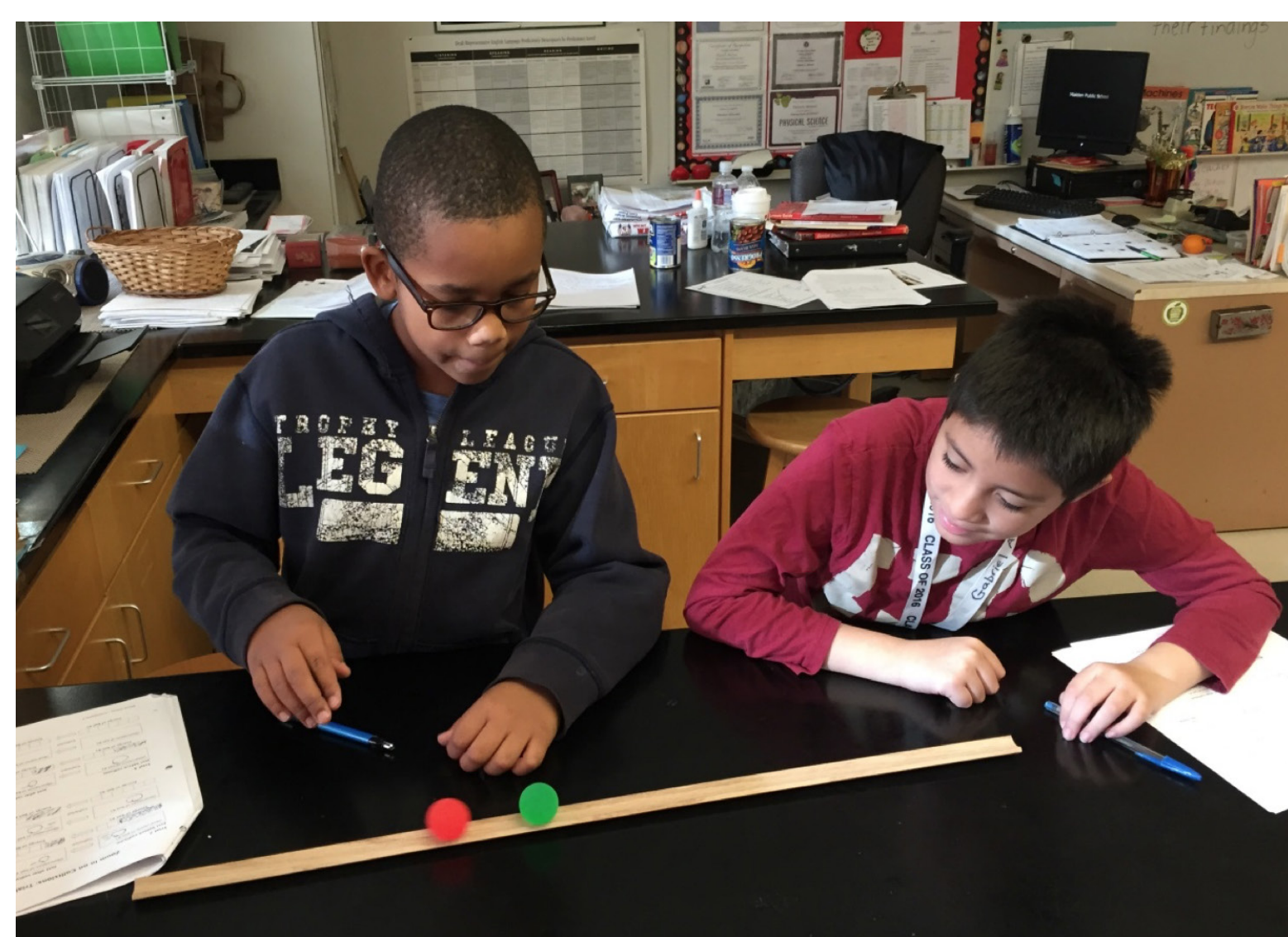
Part 1: Describe what you observe.

Part 2: Tell the energy story.

- System components?
- Form(s) of energy?
- Energy gains and losses?
- Energy transfers?
- Energy transformations?
- Where does the energy come from and where does the energy go?

Telling the Energy Story

Use observations to support your energy story.



What Should 5th Graders Know About Energy?

Energy as a MODEL for understanding the world (not disconnected facts or terminology)

Key Ideas:

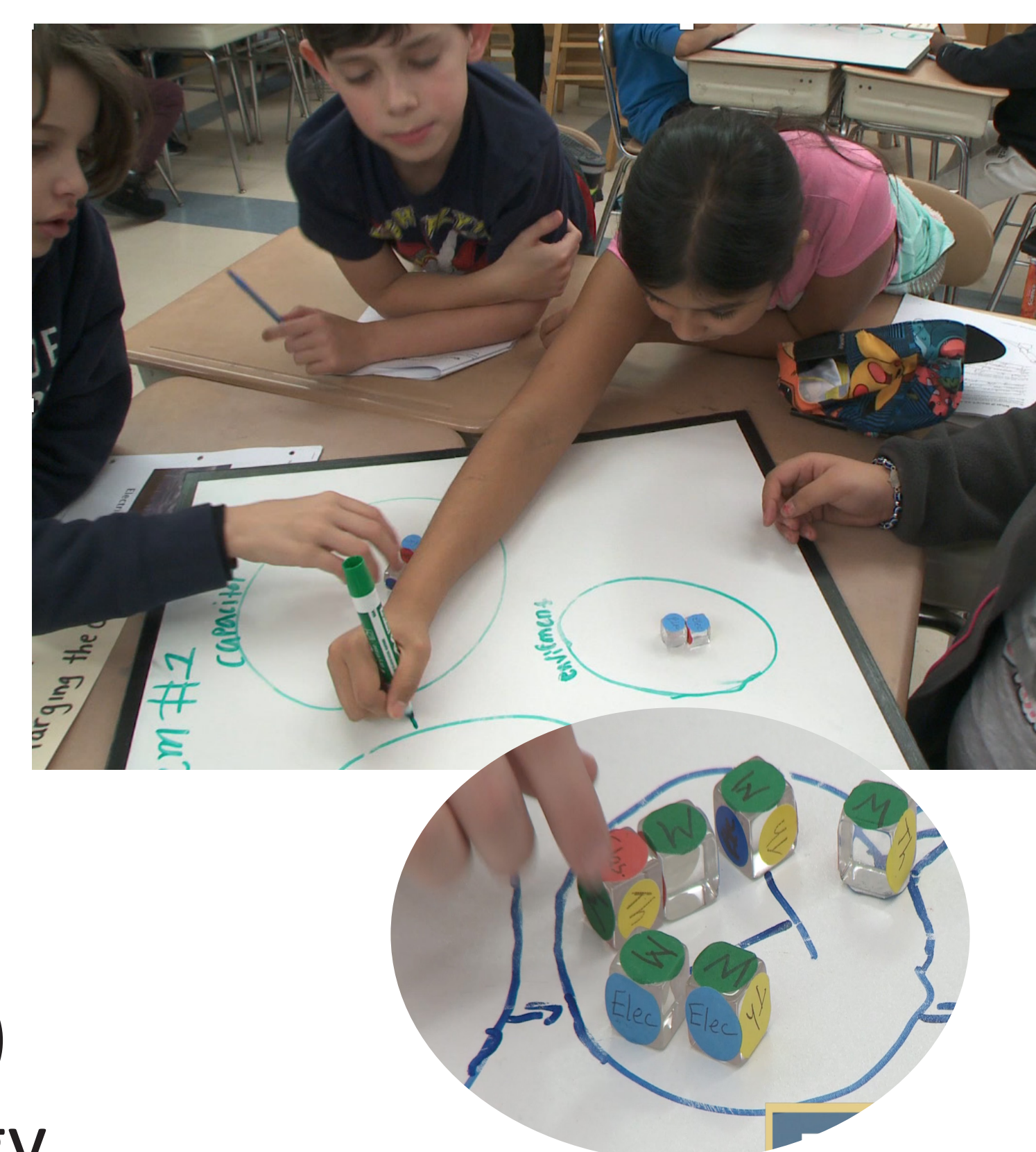
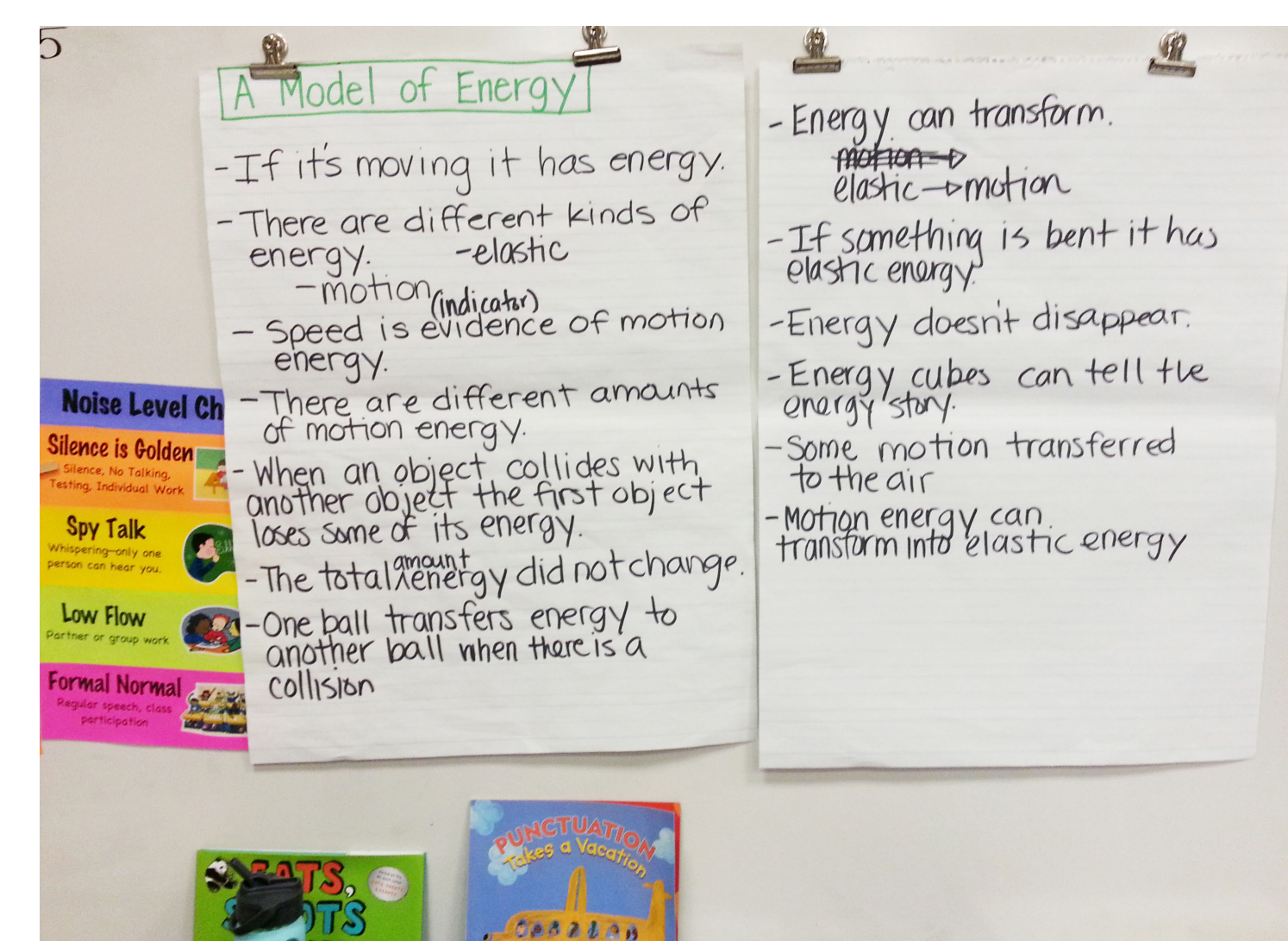
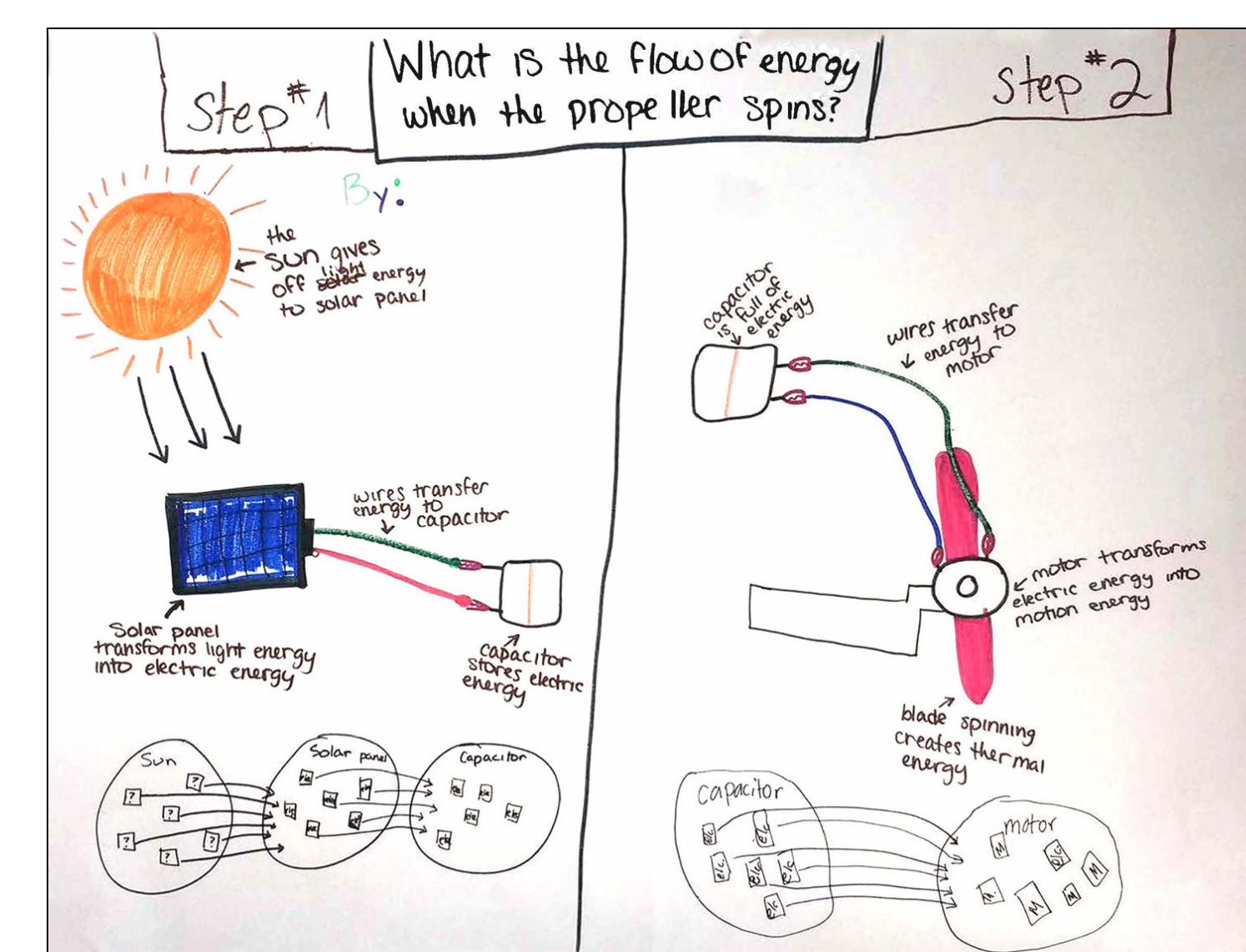
- Forms and their indicators (e.g., motion/speed)
- Transfer and transformation
- Dissipation
- Tracking energy gains & loss (precursor to conservation)
- Learning about energy means learning to use energy ideas to describe, explain and predict behavior

What Can Wait?

- Full understanding of conservation
- Indicators vs factors (e.g., thermal energy vs temp)
- Technical terms (kinetic, potential, fields)
- Degradation/entropy
- Microscopic (atomic/molecular) understanding
- Quantitative calculations (e.g., $\frac{1}{2}mv^2$)
- Gravity

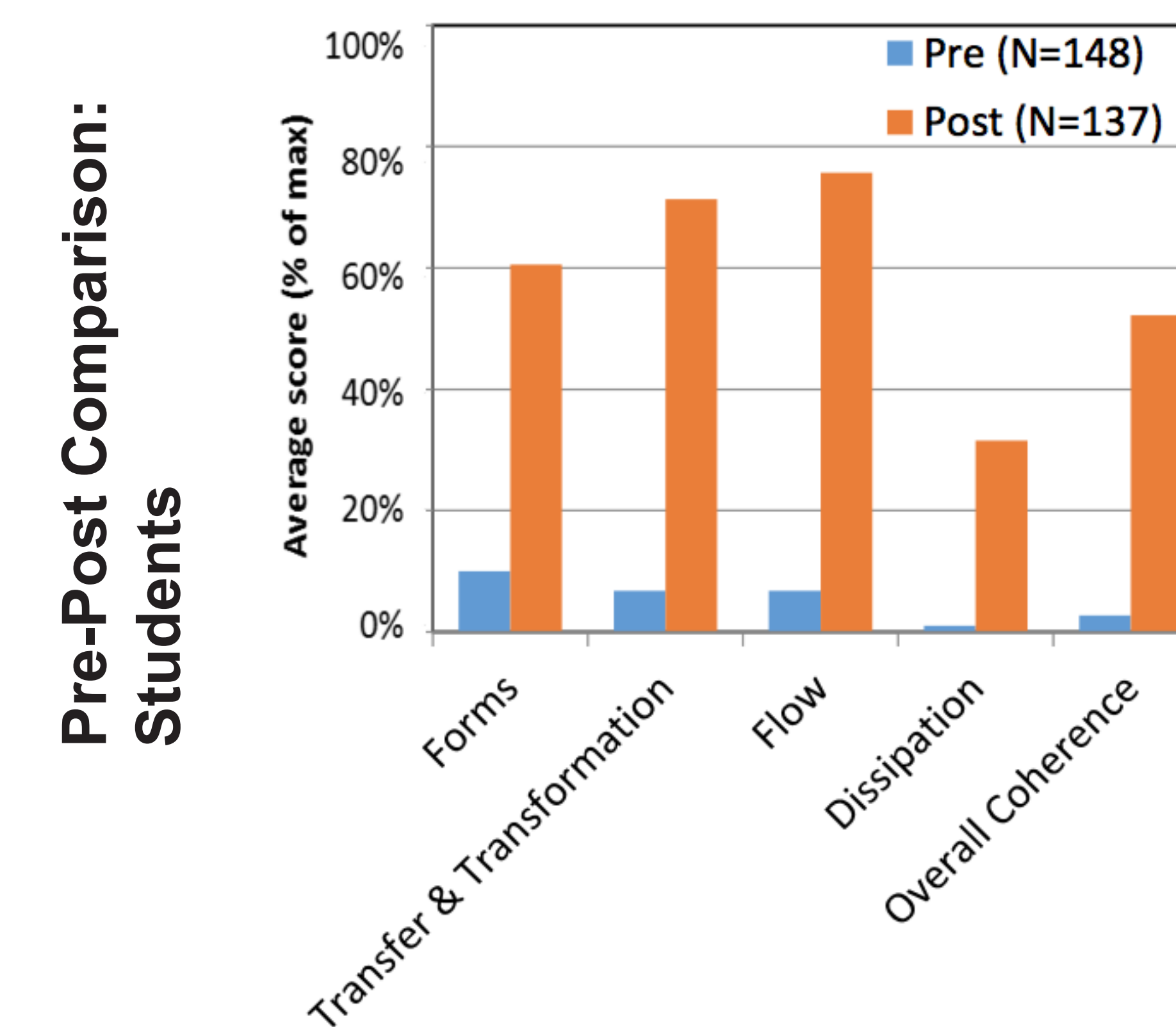
What Are Key Curriculum Features?

- 13-15 classes in three units: Motion/Elastic, Thermal, Electrical Energy
- Each lesson includes:
 - Investigation question
 - Guided hands-on investigation
 - Sense-making (individual, small-group, all-class)
- Class collectively builds and refines model of energy
- Age-appropriate, general, semi-quantitative representational tools (energy bars, energy cubes) for thinking and communicating the “energy story”



It works for elementary students:

- Preliminary data from 8 Grade 4 and 5 classrooms.
- No significant difference between low and high SES schools.
- 40% spontaneously (no prompt) included dissipation.

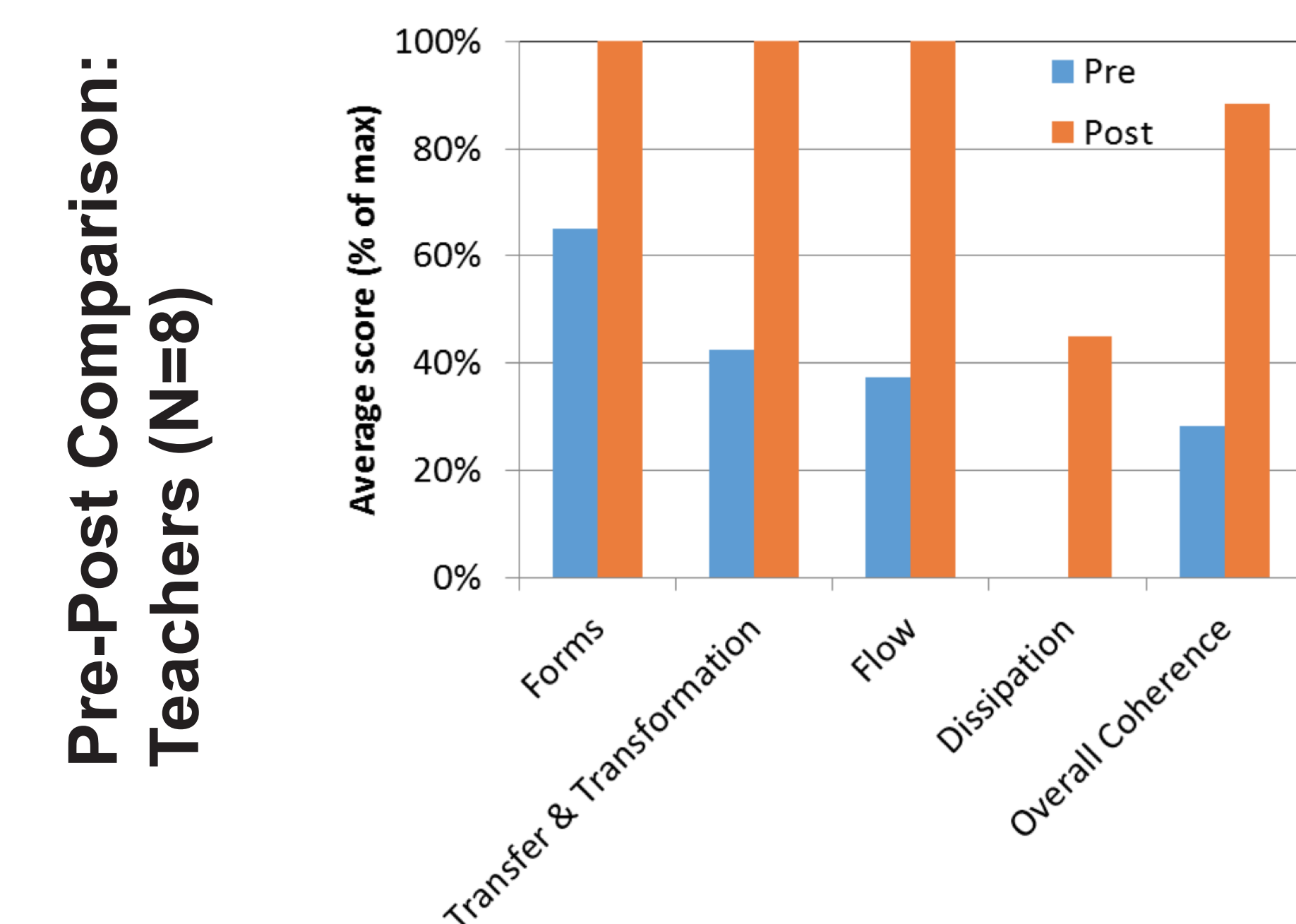


Other observations:

- Students exhibit authentic model-based science reasoning.
- Accessible to ESL and SPED students.

It also works for teachers:

- Teachers had intensive 1-week summer workshop.
- Experienced the same curriculum – activities, model-building, representations, sense-making discussions.
- Adults and children have many of the same conceptual challenges in understanding energy.
- Teachers also found curriculum engaging and showed large learning gains.



We thank our collaborators at Seattle Pacific University and Boston College. This material is based upon work supported by the National Science Foundation under Grant No. DRL-1418052. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

