What is the question style?

Explain/Represent

Do you want to ask follow-up questions?

- No, I want to quickly get a sense of what's coming up for students → **Observation List**
- Yes, I want to know more details → **Non-fixing conversation**
- No, I want to quickly flag an idea so students can return to it later → **Idea parking lot**

Observation List

On a sticky note or piece of paper, students write three things that stand out (e.g., as exciting, interesting, sensible, or puzzling) about an observation, experiment (like one of the scenarios in an ACORN tutorial), then compare and discuss their lists. Instructors may add their own list.

Idea parking lot

Instructor or student write a student idea in the "parking lot" on a whiteboard or paper (this could be a space on the front page of the tutorial) to return to later.

Non-fixing conversation

One student speaks for 2-5 minutes about a question or scenario. Another student or the instructor asks follow-up questions to learn more about the other person's ideas. Do not ask questions to guide, critique, or challenge their thinking. Example questions include:

- How do you make sense of this?
- What experience is your thinking is drawing on?
- Can you give an example?
- Will you draw a diagram to illustrate your ideas?

Model

Is energy relevant?

- yes → **Energy story**
- no → **Energy story**

Energy story

Students collaboratively decide on and diagram or act out the "story" of various energy forms and the objects they are associated with and the energy transfers and transformations for a scenario they are thinking about.

Idea map

Instructor writes several student ideas on the whiteboard. Students add arrows to connect ideas and write how ideas relate and when they are useful.

Diagram diamond

Each student draws a diagram to model an experiment in each corner of the same paper, discuss the merits of their diagrams, and draw a consensus diagram in the middle.

Predict

Where are students in their completion process?

- They are working on models and want to check an idea. → **Thought experiment**
- They have clearly-articulated models to test → **Testing experiment**

Thought experiment

Instructor poses a new scenario or experiment and students explain what will happen. Use a thought experiment to:

- Affirm: an experiment where students' ideas/model gives a correct prediction.
- Extend: an experiment where the idea/model is fruitful, but not enough to predict or explain the outcome on its own.
- Define the limits of applicability: an experiment where the idea/model leads to an incorrect prediction.

Testing experiment

Instructor suggests several possible experiments, students decide which is best for testing a part of their model and construct alternative hypotheses.

This instructor resource is inspired by K. Wingert and A. Rhinehart, STEM teaching tools talk activities flowchart (2016);
Non-fixing conversation format is inspired by Hunter Close, and we acknowledge Carl Rogers for inspiring the non-fixing mindset.
Energy story inspired by Scherr et al, https://doi.org/10.1103/PhysRevSTPER.8.020115