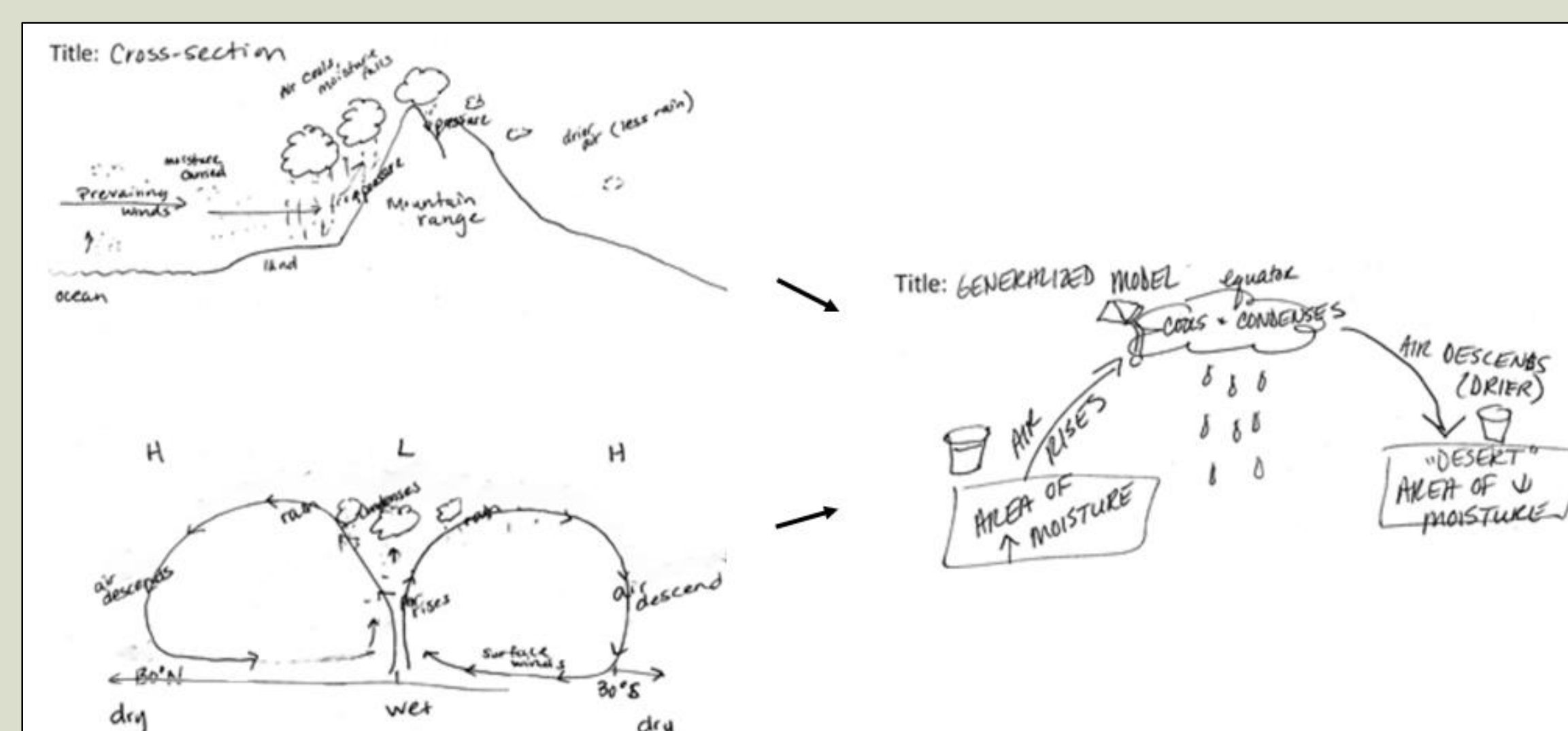




Models are organized units of representations that **abstract** the structure of their referents (Capps & Shemwell, in press; Nersessian, 2008)

Teaching that models are abstractions:

- Helps students learn the true nature of models
- Defines what students should learn that models are
- Helps keep modeling authentic



- Brings structure to science narratives

The Calvin Cycle
The Calvin cycle cannot take place without the ATP and NADPH from the light-dependent reactions. The chemical reactions of the Calvin cycle use carbon dioxide (CO₂) gas from the atmosphere and the energy carried by ATP and NADPH to make simple sugars. Because the light-independent reactions build sugar molecules, they are the *synthesis* part of photosynthesis. Only one molecule of CO₂ is actually added to the Calvin cycle at a time. The simplified cycle in **FIGURE 3.4** shows three CO₂ molecules added at once.

- Carbon dioxide added CO₂ molecules are added to five-carbon molecules already in the Calvin cycle. Six-carbon molecules are formed.
- Three-carbon molecules formed Energy-ATP and NADPH—from the light-dependent reactions—is used by enzymes to split the six-carbon molecules. Three-carbon molecules are formed and rearranged.
- Three-carbon molecules exit Most of the three-carbon molecules stay in the Calvin cycle, but one high-energy three-carbon molecule leaves the cycle. After two three-carbon molecules have left the cycle, they are bonded together to build a six-carbon sugar molecule such as glucose.
- Energy from ATP molecules is used into five-carbon molecules. T cycle. These molecules are

Hard to decide what to leave out

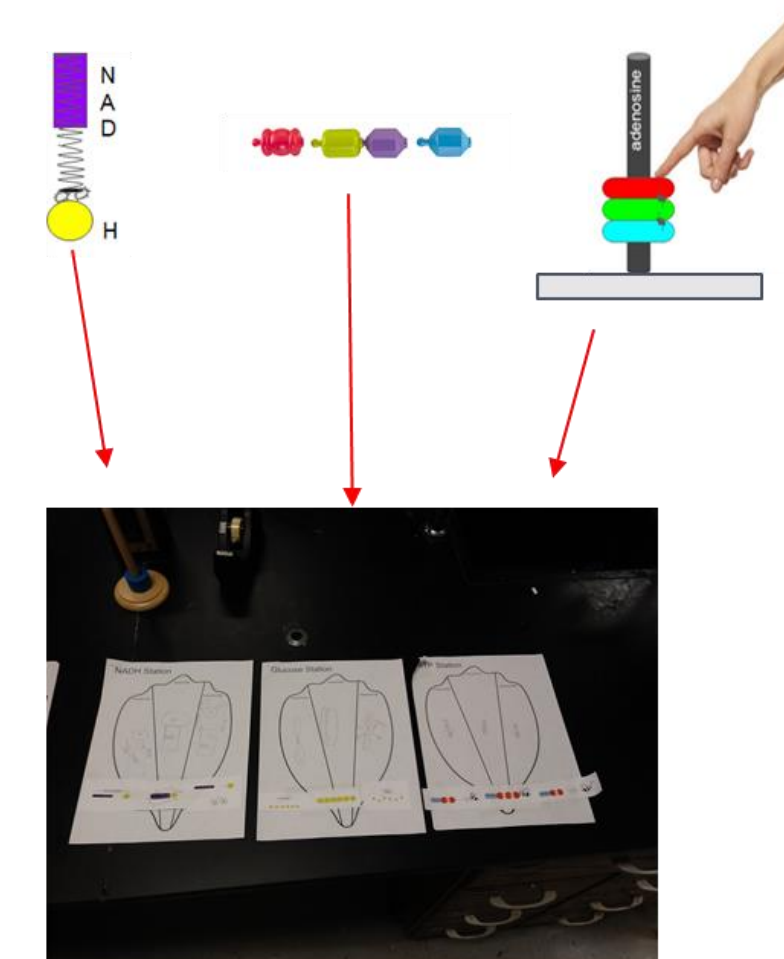
Vacancy of causation (not intrinsic to narrative)

Emphasis on time-ordered description of events

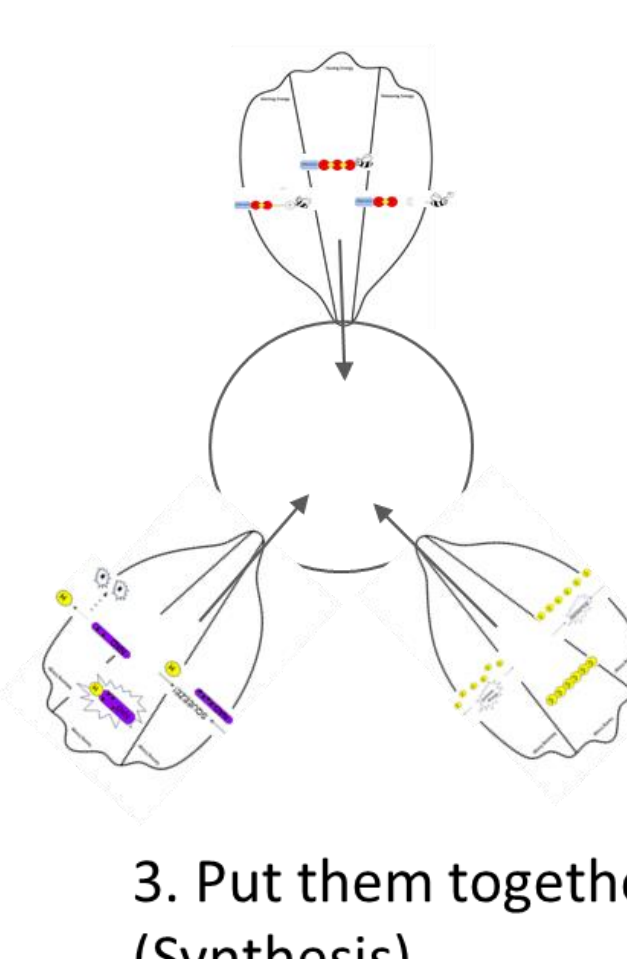
Project Goals:

- Understand the value of AiMS for learning the nature of models
 - Stronger evidence of AiMS impact on student learning
 - More complete conception of AiMS instruction; impact
 - Demands and affordances for teaching AiMS
 - How teaching/learning with AiMS differs across contexts
 - A conception of AiMS for broader audience
- Develop knowledge of how AiMS can bring structure to science narratives
 - Teacher benefits
 - Learner benefits

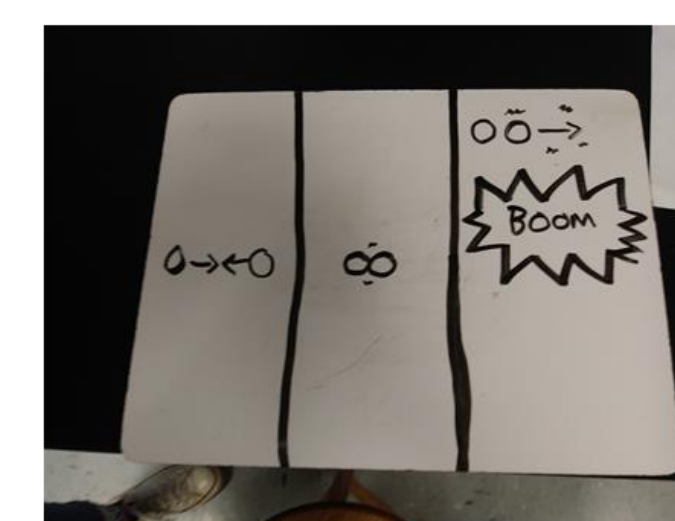
1. Three energy carrier analogs



2. Each can get, have, release energy



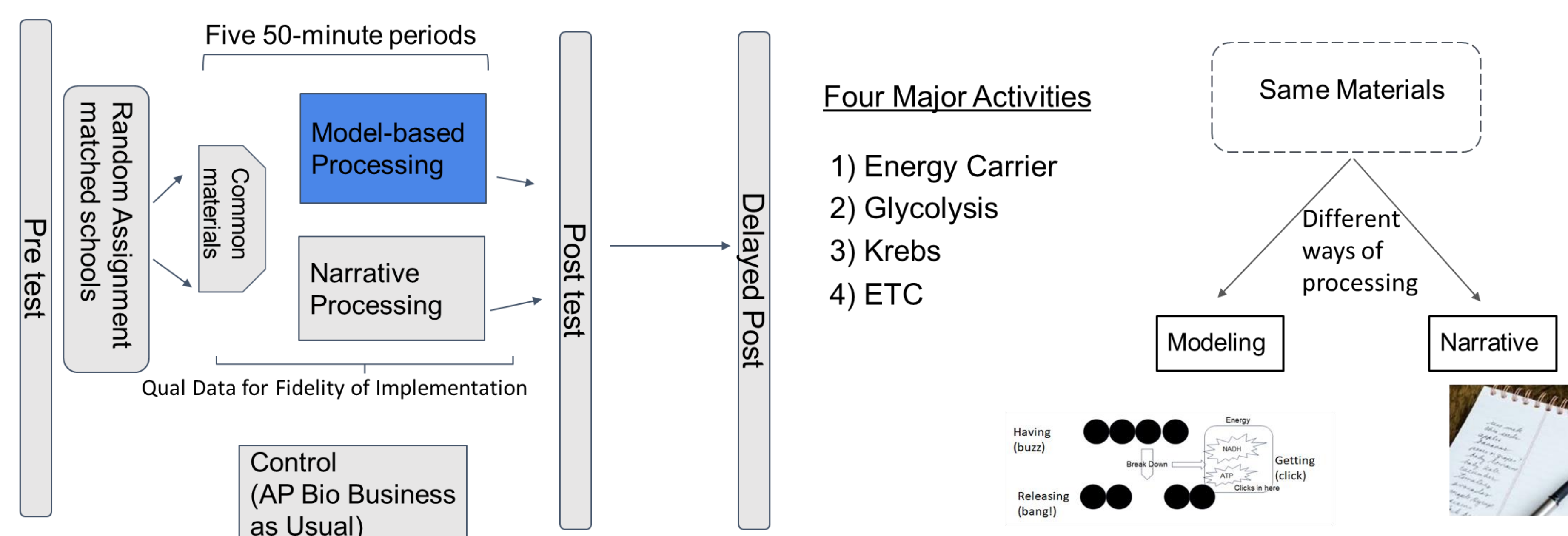
3. Put them together (Synthesis)



4. The Abstract Model

Research on Learning:

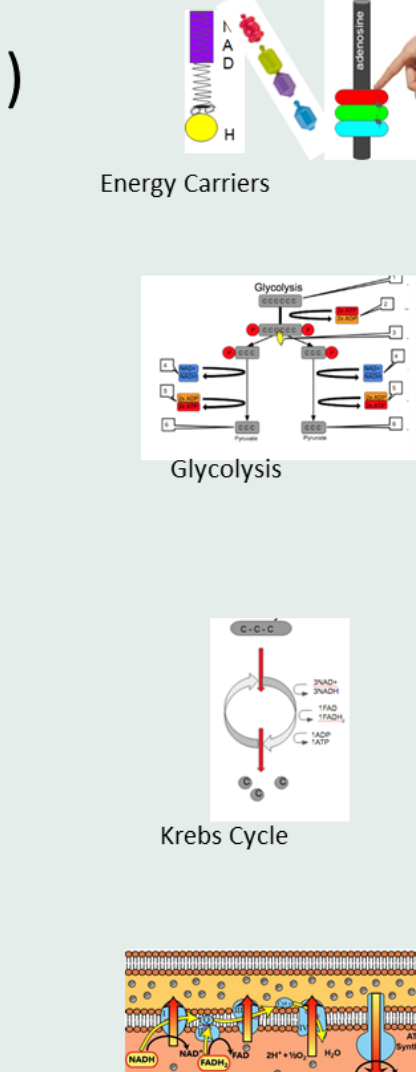
- Does synthesis help students learn the abstract nature of models?
- Does model-based instruction help learners bring structure to the narrative?
- Knowledge of underlying structure of the domain
 - Better comprehension
 - Longer retention
 - Transfer



Model-based Processing

- Build a General Energy Model (GEM)
- Instantiate GEM on Glycolysis Narrative
- Modify GEM to fit Glycolysis and Krebs
- Extend GEM to Explain ETC

Representation



Narrative Processing

- Make an argument for where each carrier fits in CR Narrative
- Sequence Glycolysis Narrative
- Extend the Narrative to Krebs + Argumentation Activity
- ETC play-by-play

Fidelity of Implementation

Purpose: Increase sensitivity of quantitative study

- Measure adherence to defined key elements of instruction
- Correlate adherence with test scores within treatment group
- Check strength of association: adherence with condition differences

Research on Teaching:

Purpose: Learn how teachers can develop the capacity to bring structure to science narratives

Analyze data (e.g., interviews, video of PD, and enactment video) for

- Degree to which prior instruction is driven by narrative
- Desire for structuring the narrative
- Receptiveness to structuring the narrative
- Capability to structure the narrative; variations in structuring

Before the Professional Development

Interview 20 of 32 teachers how they teach CR

Professional Development

Observe what ~30 teachers say and do as they learn about model-based teaching of CR

Post-PD

Curriculum implementation

Observe how the 6 model-based and 6 narrative teachers structure the CR narrative.

Post-implementation

Interview 6 model-based teachers

Project Timeline:

Summer 2017	Fall 2017	Spring 2018	Summer 2018	Fall 2018	Spring 2019-Spring 2020
Select content domain	IRB approval	Pilot instructional modules	Run PD institute	Run the research study	Data analysis
	Assemble instructional team	Recruit 30 teachers	Develop instruments		Prepare research manuscripts
	Develop instructional module	Interview teachers	Gear up for fall research		Prepare new AiMS module in new content area

Structuring science narratives (through modeling):

- Provides a centralized interpretative framework
- Aids comprehension
- Potentially transferable
- Accommodates non-narrative concepts
- Constrains against superfluous information

