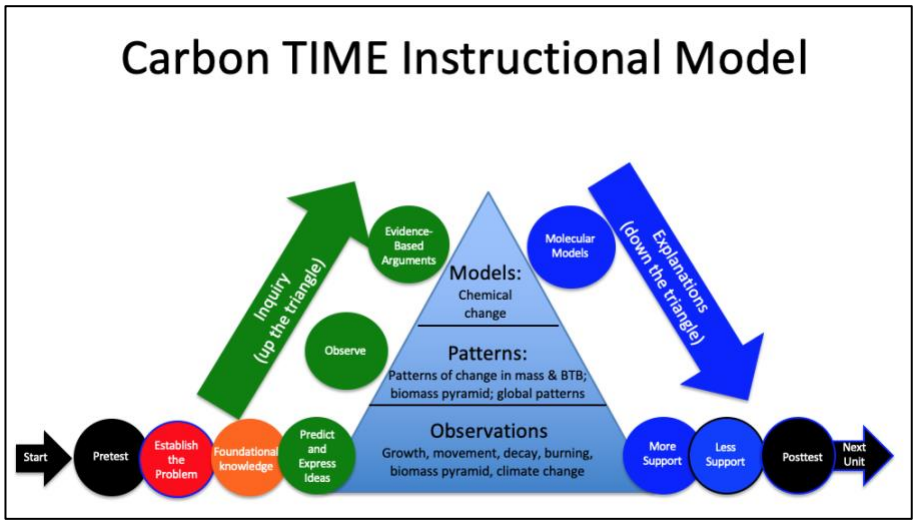
Teachers Make a Difference in *Carbon TIME*

Teachers make a difference in *Carbon TIME* classrooms; in fact, they are statistically more important than students' prior knowledge and school demographic factors in explaining variation in students' learning gains (see the Quantitative Analyses of Student Learning from *Carbon TIME* units for a two-page summary of our quantitative research, or the full 2021 Report, in the Research section of the *Carbon TIME* website).

So, what are teachers in classrooms with high student learning gains *actually doing*? This short document provides examples from some of the classrooms we studied, organized around the phases of the *Carbon TIME* Instructional Model.



Establishing the problem: Expressing Ideas and Questions

- They devote time: Teachers spend ~40+ minutes on Expressing Ideas lessons.
- They encourage students to share what they really think (not looking for "correct answers").

Foundational Knowledge & Practice

- They connect the activity to the phenomenon and driving question: "*Your initial ideas and questions focused on what ethanol is made up of that makes it burn, so we need to zoom in to a scale too small to be seen with a microscope*."
- They explicitly emphasize how the rules and facts (on the Three Questions) are important for answering students' questions about the phenomenon.

Inquiry: Predictions and Planning, Investigations & Evidence-Based Arguments

- They devote time: Teachers spend 20+ minutes on making and discussing predictions (especially for students to share their reasoning behind their predictions).
- They develop and discuss the investigation procedure as a class.
- They explicitly emphasize the role of empirical evidence in science.
- They discuss patterns in the data as a class and connect the data to the initial ideas and questions about the phenomenon.
- They emphasize the unanswered questions on the Evidence-Based Arguments Tool.

Using Models

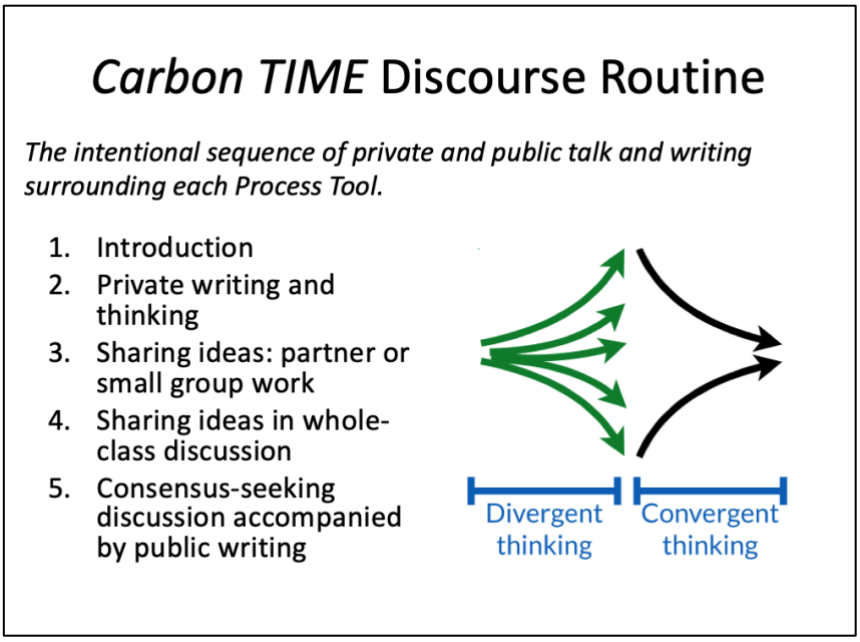
- They elevate the authority of models in science: "*Scientists do investigations to collect data, but they also use existing scientific models to make sense of what they see."*
- They use the models to specifically address the unanswered questions from the investigation: "*So, we know that CO_2 was produced when ethanol burns, but where do those carbon atoms come from?"*
- They emphasize the distinction between atoms and molecules.

Constructing Explanations

- They connect the explanation back to the driving question for the unit: "*We have all the pieces we need to explain what happens when ethanol burns, but now we need to put it together into a coherent explanation.*"
- They have students use their Evidence-Based Arguments Tools and modeling activity to work on the Explanations Tool.
- They provide students with the opportunity to discuss their explanation with others, and they also hold each student accountable for a final paragraph they write individually.

Throughout the Unit

- They connect to the unit driving question (ex: *What happens when ethanol burns?)* multiple times EVERY lesson.
- They return to students' initial ideas and questions throughout the unit.
- They use intentional "back pocket" questions to scaffold sensemaking as they work with small groups of students.
- They are explicit about scale: "*We saw that the BTB changed from blue to yellow, but what does that tell us about what is happening on the atomic molecular scale?*"
- They are explicit about the principles of matter and energy conservation: "*If energy cannot be created or destroyed, then the heat and light we saw released in the flame must have already been stored inside the ethanol*."
- They follow the *Carbon TIME* Classroom Discourse Routine around each Process Tool.



Adapted from Dr. Wendy Johnson, East Kentwood Public Schools