

# Strategies for Sustaining Rigor and Responsiveness in *Carbon TIME*

*Carbon TIME* is designed as a “tool kit” to support rigorous and responsive teaching. The *Carbon TIME* units are the result of many years of research and development, as researchers and teachers have worked together to write and field test these units. The key features of *Carbon TIME* are the results of these efforts.

Rigorous and responsive teaching is difficult and complex; the most successful teachers achieve this goal by using the *Carbon TIME* tool kit flexibly. We have tried to include a variety of tools that enable this kind of flexible use. Many of these tools were originally developed by *Carbon TIME* teachers, then incorporated into the units as resources that all teachers can use.

We also describe strategies that we observed in the classrooms of case-study teachers—14 teachers who volunteered to work with *Carbon TIME* researchers making videos of their classrooms, interviewing teachers and students, and analyzing students’ work. We investigated differences between discourse in classrooms where students showed high learning gains and classrooms where learning gains were lower.

This educator resource describes several of the tools and strategies that *Carbon TIME* teachers have developed and shared. They did not always occur in the order below, but we found that they were common features of successful lessons. Here’s what we see as essential and optional about lessons or discourse routines that successfully facilitate three-dimensional learning:

- **Essential: Discourse routines include all five strategies.** It isn’t quite right to call the five items below “stages,” since sometimes the order varied. But in the successful lessons each of the strategies below was present in some form.
- **Essential: Each stage is both responsive and rigorous.** In successful classrooms, responsiveness and rigor were both present:
  - *Responsive* meaning that students’ ideas, questions, and practices are respected, carefully considered, and used.
  - *Rigorous* meaning that students accept and understand target performances for each activity and standards for successful performances.
- **Optional: Using *Carbon TIME* tools flexibly.** Each section below has a box listing *Carbon TIME* tools that support that feature. No teacher uses *all* those tools. Successful teachers choose the tools that work best to support responsive and rigorous teaching in their classrooms.

## ***Strategies and tools at different levels of organization***

Many lessons include discourse that occurs at three different levels of organization, each with its own processes and outcomes. The five strategies discussed in this resources include those three different levels of organization.

**Whole-class discussion.** The first level of organization is the whole class, where all students’ attention is directed toward a single discussion or presentation. These are the public events in the classroom.

Paul Cobb has written about “taken-as-shared” storylines in inquiry mathematics classrooms, describing a developing body of ideas, principles, and practices that have been collectively validated by the members of the class and used as the basis for the ongoing work of the class. In more successful lessons the whole-class episodes are contributing to the development of this take-as-shared (or consensus) storyline, with participation by many of the students.

In contrast, whole-class episodes in less successful lessons were more procedural in nature, with little evidence that the students were developing a consensus storyline or shared principles and practices. In some lessons those procedures were efficient, enabling students to successfully

complete their assigned work; the ideas that students expressed were brief “correct answers,” and their questions were often procedural. In the least successful lessons there was ambiguity or confusion about what students were expected to do; there was little or no uptake on students’ ideas and questions.

There are stages associated with whole-class discussion, which typically occur in temporal order during a lesson.

1. *Introduction:* Connecting to previous lessons and establishing the problem
2. *Public sharing of ideas and results:* Eliciting and discussing students’ ideas, questions, and/or data from investigations
3. *Consensus-seeking and conclusion:* Arriving at class consensus and connecting to future lessons.

**Small group work.** Individual and small group work is likely to occur at different times during different activities, when students are working in pairs or small groups for a common purpose. Small-group work episodes provide students with their primary opportunities to talk, share ideas, and get personalized feedback. (In a class of 25 students, each student can talk an average maximum of 4% of the time during whole-class episodes, 25% of the time working in groups of 4, or 50% of the time working in pairs.)

Elizabeth Cohen and her colleagues have written extensively about small-group work and its role in “complex instruction.” In the most successful small groups, all students had opportunities to talk, and their peers acted as “critical friends,” taking the ideas of other members seriously, providing critical feedback, and working to develop group products based on the contributions of all members.

In contrast, group work in some lessons was less equitable and less usefully critical. In some lessons groups completed their tasks successfully, but with higher-status members doing most of the work and lower-status members marginalized. In the least successful groups some members were visibly off task, and group products were incomplete or poorly done.

**Individual work.** The final strategy focuses on times when students are reading or writing individually, with an emphasis on individual products. There may be more or less student talk, but there is an expectation that each student will produce his or her own product.

Even in lessons where students were working in groups, the students in most successful lessons were individually accountable for doing quality work: groups helped each of their members be individually successful. Students individually created written products that showed successful engagement in the target performance, supported by effective scaffolding and rigorous criteria for success.

In contrast, the individual writing students in less successful lessons often failed to achieve the target-performance, either because scaffolding and accountability were insufficient or because students waited to copy the “correct answers.” In the least successful classrooms students did little individual writing and/or the writing that they did was not shared or evaluated.

# Descriptions of Successful Strategies

Each strategy is described below, including a general description and a box with *Carbon TIME* tools that are associated with that strategy.

## 1. Introductions (whole class): Connecting to ongoing storylines and establishing the problem for the lesson

Successful teachers use a variety of strategies to make sure that students see a purpose for each lesson beyond completing the task at hand. In particular, we see two qualities in successful introductions: connections to student learning storylines and establishing the problem for the target performance.

**Conceptual connections to student learning storylines.** The most effective lesson introductions connect the activity to the ongoing story of *students' learning in the unit*. The connections are not just procedural (e.g., “today we will be working on the Evidence-based Argument Tool); they don't just connect to the general unit storyline (e.g., yesterday we learned how digestion breaks large organic molecules into small organic molecules. Today we will learn how cells use the small organic molecules to grow.”). Instead, they review students' ideas and conclusions from previous lessons, how those ideas have changed, and how the upcoming lesson will address questions that students still haven't answered.

**Establishing the problem for the target performance.** The Teacher's Guides include a target performance for every activity—what students should be able to do by the end of the activity. Successful lesson introductions prepare students for active learning where they will be figuring out the target performance with support from the teacher and tools. In particular:

- Successful introductions help students to see how the target performance will be personally meaningful to them, answering questions that they are interested in.
- Successful introductions help students remember relevant ideas that they already have and tools that can help them achieve the target performance.

## 2. Sharing ideas and data through class discussions with public writing (whole class)

Individual and group work produces *private writing*—writing that is seen and shared by individual students or small groups. A key part of the *Carbon TIME* discourse routine involves sharing ideas, questions and results from that private writing, comparing and questioning ideas from different students or groups, and recording some of them as *public writing*.

### Tools for connecting to student learning storylines

*Carbon TIME* units include several tools that help to connect individual lessons to unit storylines and establish the problem for the lesson, including the following:

- The *Driving Question Board* reviews progress that the class has made and questions still to be addressed.
- The *Learning Tracking Tool* can be used to review conclusions and questions from the previous lesson
- The *Matter Tracing Tool* enables students to build a carbon-tracing story through different systems and processes in the *Animals, Plants, and Decomposers* units
- *Exit Tickets* from previous lessons will have students' ideas about conclusions and questions from those lessons
- *Saved student responses*: Many teachers have students save tools they completed early in the unit, such as the Expressing Ideas and Questions Tool, Big Ideas Probes, or the Predictions and Planning Tool, to see how the students' ideas are changing.
- *PowerPoint Slides*: Slide 2 of most presentations places the activity in the instructional model, and the following slides identify the problem for the day.

Whole-class discussions can and should be both *responsive and rigorous*. In the case of whole-class discussions this means responsive dialogue (discussed in this section) leading to rigorous conclusions (discussed below). In responsive dialogue students' ideas and results are *both respected and taken seriously*.

**Sharing and respecting students' ideas.** Sharing ideas is a logistical challenge; every student should have a voice, but there often isn't time to give every student an individual turn to speak. *Carbon TIME* teachers have addressed this challenge in many ways, some of which are incorporated into the tools for sharing ideas and data presented in the box. We note two kinds of strategies in particular:

- Sharing results of pair or group discussions: Students talk in pairs (Think-Pair-Share) or small groups, then had the pairs or groups share their ideas, with our without support from whiteboards and posters.
- Sharing through Post-it notes: Students can also use Post-it notes to display and organize ideas, as discussed in the box above.

Tools for sharing ideas and data
<p><i>Carbon TIME</i> units include several tools that help to share ideas or results and record them in public writing, including the following:</p> <ul style="list-style-type: none"><li>• <i>Post-it notes</i>: Big Ideas Probes include a strategy for using Post-it notes to vote for different explanations. Teachers also organize Post-it notes on Driving Question Board around key ideas or questions.</li><li>• <i>PowerPoint Slides</i>: Presentations for a number of activities include slides where teachers can type students' ideas. Some teachers also project the slides onto a white board and write on the white board.</li><li>• <i>Investigation results posters</i>: Investigations include class posters where individual groups can record their results.</li><li>• <i>Investigation results spreadsheets</i>: There are also spreadsheets for each investigation that classes can use to record results. The spreadsheets include functions such as calculating averages that students can use for pattern finding.</li></ul>

**Taking students' ideas seriously.** Taking students' ideas seriously requires more than encouraging them to talk or write. "It's fine to say whatever you are thinking of" conveys a different message from "Your ideas are important and we will discuss them seriously." Some teachers use talk moves such as those discussed in the [Talk Science Primer](#) that encouraged students to compare and organize ideas, looking for similarities and differences, using those differences to articulate unanswered questions.

Taking ideas seriously involves encouraging students to articulate them clearly and explain them fully, as opposed to accepting one-word answers or irrelevant comments. Teachers also encourage students to evaluate their ideas with respect to criteria such as those in the Three Questions or to evaluate anomalous data for possible mistakes.

*Public writing* also plays an important role in taking students' ideas seriously. Through public writing, such as writing on posters, PowerPoint slides, or the Driving Question Board, teachers select and preserve important ideas and questions that the class can return to later.

*Investigation results*: *Carbon TIME* investigations are organized around the idea that scientific investigations are designed to find *patterns in data*. This means that individual groups need to share their results and look for patterns. Sometimes this might involve questioning anomalous results (e.g., when groups have made procedural or measurement mistakes).

### 3. Lesson conclusions (whole class): Consensus-seeking discussions and writing; connections to future lessons

Class discussions need to be consensus-seeking as well as sharing ideas. The ideas that students initially share usually fall short of the target performances for the activities. It is hard to manage consensus-seeking (or convergent) discussions that are responsive and rigorous, but both qualities are essential. Rigorous discussions help students make progress toward target performances. Responsive discussions engage students in personal sense-making rather than leaving them as passive listeners.

#### **Rigorous conclusions: achieving target performances by using tools and principles.**

The Classroom Discourse Routine Educator Resource shows how the goals for consensus-seeking discussions change through the course of each unit:

- *Students as questioners:* At the beginning of each unit (including the Expressing Ideas and Questions Tool) the consensus-seeking goals focus on *questions* rather than ideas. Students can share or discuss their ideas about answers to the unit driving question without achieving consensus, but it is important for the class to agree on some key questions that they want to answer during the unit.
- *Students as investigators:* During investigations (including the Predictions and Planning Tool, data sharing and discussion activities, and the Evidence-based Arguments Tool) students need to reach consensus on (a) plans for the investigations, (b) patterns in their data, (c) conclusions based on patterns in data, and (d) unanswered questions that are not fully answered by the data.
- *Students as explainers:* When students are explaining processes, students need to reach consensus on explanations that answer the Three Questions, including the checklist on the Three Questions handout.

**Responsive conclusions: building on student data and ideas.** We have seen *Carbon TIME* teachers using two kinds of strategies to conduct consensus-seeking discussions in responsive and rigorous ways.

*Talk moves.* Teacher language is an important part of responsive and rigorous science discussions. During *Carbon TIME* discourse routines, we recommend:

- Using the Three Questions: Point out ways that student ideas are potential answers to the Three Questions or fall short of following the rules in the second and third columns.
- Comparing student contributions: Comment on students ideas and questions that are similar or potentially in conflict, identifying emerging consensus or issues to be resolved.
- Revoicing: Revoice student ideas and questions that help move the discussion toward consensus outcomes.

#### **Tools for consensus-seeking discussions and writing**

*Carbon TIME* units include several tools that help to connect individual lessons to unit storylines and establish the problem for the lesson, including the following:

- *Consensus about patterns in data:* The videos and PowerPoint presentations accompanying students' data collection and analysis activities include presentations of results from other classes that students can compare with their own to find the key patterns in data.
- *PowerPoint explanations:* Slides accompanying each Explanation Tool include example responses to the Three Questions and key points that need to be included in written explanations.
- *Tools for concluding lessons:* The Driving Question Board, Learning Tracking Tool, Model Building Tool, and Exit Tickets provide ways for students to record consensus conclusions and questions from each activity and return to them in future lessons.

The [Talk Science Primer](#) describes a variety of additional talk moves that teachers can use to support consensus-seeking discussions.

**Connecting to future lessons through public and private writing.** Successful consensus-seeking discussions are accompanied by public and private writing that (a) identifies the key questions or conclusions and (b) saves those conclusions so that the class can return to them later. All of the tools mentioned in the box for starting lessons above—the Driving Question Board, Exit Tickets, the Learning Tracking Tool, and the Matter Tracing Tool—are useful for this public and private writing. They are the tools that teachers use to connect lessons to one another, and to the ongoing student learning storyline.

*Investigation results* Successful teachers use tools such as the posters and spreadsheets to support consensus-seeking discussions about patterns in data. If the data are really bad, then the investigation videos and PowerPoint slides suggest patterns that other classes have found.

#### 4. Managing group work

Some of the most important times for student learning occur when students are working in small groups. This is when students can be active learners, personally figuring out how to engage in target performances. During successful group work, students are individual contributors and critical friends and teachers are actively monitoring and coaching students.

**Students are individual contributors and critical friends.** Students' participation in successful groups has three key qualities:

- *Equitable and meaningful participation:* All students participate in equitable ways (as opposed to some students doing work while others watch or copy), showing evidence that they find their work meaningful and worth their individual efforts. They take care to record their personal ideas and questions and to make use of the resources available. They share their ideas with partners and group members, rather than waiting to write down what someone else says. They consider others' ideas, sometimes editing what they have written in response.
- *Acting as critical friends:* Students in successful classrooms also serve as *critical friends* to others in their groups, listening to others' ideas, comparing them with their own, and analyzing differences. So they act as peer coaches and help groups to reach consensus about the best ideas and questions.
- *Progress toward target performance:* Finally, students in successful groups are focus their work and talk on the key questions or goals for the day, make effective use of tools, and other resources, and help one another make progress toward the target performance.

**Teachers are actively monitoring and coaching students.** Teachers in successful classrooms play active roles in setting up and monitoring students' individual and group work. In part,

##### Tools for managing group work

*Carbon TIME* units include several tools that teachers can use to help students be purposeful and on task. Many of these are prompts on PowerPoint slides or suggestions in Teacher's Guides:

- *Back pocket questions:* Some slides suggest questions that teachers can ask when they approach a group, providing a quick assessment of students' progress.
- *Reminders about resources:* Some slides also remind students of resources such as the Three Questions or results from prior work.
- *Comparing and checking ideas:* Students are sometimes prompted to compare their ideas or questions with partners or other group members.
- *Whiteboards and posters:* Some activities lead to sharing group results through posters. Some *Carbon TIME* teachers also use whiteboards as a quick way for pairs or groups of students to summarize consensus results.
- *Jigsaw activities:* Most units also include at least one jigsaw activity, where students develop specialized knowledge in expert groups, their share their knowledge in home groups.

they take care to establish the problem for the students' work, as discussed above. They make sure that the work is meaningful, and that procedures and expectations are clear.

Teachers in successful classrooms are also active while students are doing individual and group work, circulating around the classroom and working purposefully with different students and groups. Successful teachers generally have an agenda for their interactions with groups, with planned initial questions (back pocket questions) that provide ways of checking the group's progress quickly (e.g., looking at a drawing or a key conclusion). They provide active coaching for students or groups that are struggling while taking care to reach all the groups in a class.

**Accountability for group results.** Group work is also consequential in some way. Typically, groups share their results with the whole class, through contributions to class data for investigations, white boards, posters, etc. Jigsaw activities also make groups responsible for preparing all their members to become experts who can help members of other groups.

**Relevant evidence for group work variable.** We will probably find that the student-focused videos and examples of student work provide better evidence for the indicators below than the teacher-focused videos. We will definitely want to look at them for case study analyses. For quantitative analyses, we will need to consider the value added by looking at additional data sources and whether we have the time to do that.

## **5. Scaffolding, revisions, and accountability for individual student work**

If there is one quick way to identify the classrooms with the largest learning gains on the posttests, it is to look at samples of student work. In the most successful classrooms it is clear that students put sustained effort into completing and revising their written work, and that teachers held students accountable for what they wrote. Classroom videos and interviews with teachers and students show several strategies that teachers use to scaffold students' writing and hold them accountable, both during lessons and after the lessons are over.

### **Scaffolding, accountability, and revisions during lessons.**

Successful teachers find ways to scaffold and assess students' work that are both responsive and rigorous. They encourage students to write down their ideas and take them seriously. They help students to see how the work is meaningful and their ideas and experiences are relevant. At the same time, they remind students of criteria for successful performance such as those on the Three Questions checklist; they provide opportunities for students to assess their work; they

#### **Tools for scaffolding, revising, and assessing individual student work**

*Carbon TIME* units include several tools that teachers can use for assessment and revision of individual student work, including the following:

- *Assessing and grading tools:* Every test, process tool, and worksheet has an accompanying assessing or grading tool. Assessing tools are mostly early in the unit and focus on how to use students' response for formative assessment. Grading tools include rubrics for identifying correct answers and assigning points for partially correct answers.
- *Three Questions checklist:* The Three Questions Handout includes a detailed checklist that students and teachers can use to evaluate the quality of their explanations and improve or revise them.
- *PowerPoint explanations:* Presentations for activities where students are using Explanation Tools include slides that show correct drawings and words for the graphic organizer on the front of the tool and remind students of criteria for evaluating their paragraph explanations.
- *Example responses:* Some Explanation Tools are also accompanied by example "better and worse" responses that students can discuss and evaluate before they evaluate their own work.

sometimes provide model responses; they encourage revisions, sometimes in a different color pen from the students' original work.

**Accountability after lessons are over.** Accountability takes different forms at different times in the unit. In the initial parts of a unit (e.g., the Expressing Ideas and Questions Tool and the Predictions and Planning Tool) successful teachers do not formally grade students' ideas and questions. They do, however, discuss and critique them and save them to return to later in the unit—conveying that the work is significant even if it is not formally graded.

Later in the unit, especially for the Explanation Tools and posttests, successful teachers do formally grade students' work according to established criteria. Sometimes they engage students in evaluating and revising their own work or in acting as “critical friends,” critiquing the work of partners or group members and suggesting improvements. Successful teachers also sometimes collect students' work and assign formal grades, making the criteria for their grades clear. Again, they signal to students that their work is significant and that quality matters.

**Student motivation and accomplishment.** Successful students show a commitment to “figuring out” rather than just “learning about.” They work conscientiously throughout the lesson to put their ideas in writing and assess the quality of their own writing, rather than waiting to copy or follow the ideas of other students and the teacher. They also show commitment to “finishing the job,” taking advantage of opportunities to revise and improve their work, so that their final drafts are close to the target performance for the activity.