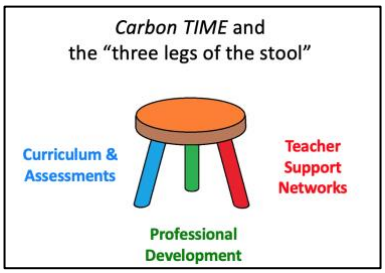
Carbon TIME Professional Development Course of Study

The *Carbon TIME* Program is built around "three legs of the stool" that are necessary to support successful teaching for students' three dimensional learning.



1. *Curriculum and assessments*, available through the website Units tab,
2. This *Professional Development Course of Study*, designed to prepare teachers to use *Carbon TIME* resources for the first time and learn from experience after they begin teaching *Carbon TIME* units.
3. *Professional Support Networks* that provide teachers with continuing engagement and opportunities to learn.

This Professional Development Course of Study is designed for district-level science coordinators, school-level science department leaders, and others in (or interested in) teacher-leader roles. It is designed to foster the kinds of teacher learning and engagement that will support students' three-dimensional classroom performances. See our coordinating *Carbon TIME* Professional Development Course of Study Goals, Modules, and Timing document for additional information.

Synchronous (in-person and/or virtual) professional development may also be available through Michigan State University; please contact us at envlit@msu.edu or MSU's CREATE for STEM Institute (https://create4stem.msu.edu) for more information.

PD Course of Study Introduction

The *Carbon TIME* Professional Development Course of Study includes four Modules designed to engage teachers in a total of 33 hours of synchronous professional development over more than one school year. Modules 1, 2, and 3 all are designed to help teachers prepare to teach *Carbon TIME* units for the first time. Module 4 brings teachers back together for analysis and additional learning after they have taught some *Carbon TIME* units.

As a part of your preparation to lead teachers who are learning to use the units, this introduction summarizes:

1. Goals and challenges for students and teachers
2. Essential features of *Carbon TIME* units
    a. The *Carbon TIME* instructional model and target performances
    b. *Carbon TIME* discourse routines and scaffolding tools
3. How Profesional Development Modules 1, 2, and 3 are designed to help teachers prepare
    a. Cognitive apprenticeship in essential features
    b. Preparation for future learning from the *Carbon TIME* website and from experience
4. How professional support networks and Professional Development Module 4 are designed to help teachers learn from experience and continue their professional growth

1. Goals and challenges for students and teachers

Carbon TIME is a based on research that analyzes goals and challenges for students, for teachers, and for Professional Development facilitators. These goals and challenges are briefly summarized below. We also urge you to read the Three-dimensional Learning in *Carbon TIME* educator resource, which discusses goals and challenges for students and teachers in greater depth.

Students: Environmental science literacy is the fundamental goal of the *Carbon TIME* project. We define Environmental Science Literacy as the capacity to participate in evidence-based discussions about socio-ecological issues and to make decisions that are informed by science. This involves two key elements:

1. *Three-dimensional science learning*, including mastery of NGSS performance expectations in the life, Earth, and physical sciences. These performance expectations focus on carbon cycling at multiple scales, from atomic-molecular to global.
2. *Preparation for future learning.* Students cannot learn all science they will need while in school; knowledge in science continues to grow and change; and we will face different environmental issues in the future.

Our learning progression research shows that achieving environmental science literacy is a major intellectual challenge for all students. These challenges are briefly summarized in Three-dimensional Learning in *Carbon TIME* and discussed in greater depth in publications in the Research portion of the *Carbon TIME* website. Students can achieve this goal only through continuing, carefully scaffolded engagement with phenomena. This, in turn, presents a core challenge for teachers.

Teachers: **assessing and scaffolding students' three-dimensional engagement with phenomena.** This is a new and difficult kind of science teaching for many teachers. *Carbon TIME* provides a tool kit to help teachers play this role successfully.

Learning about vs. figuring out and apprenticeship. Literature from NGSS and many current reform programs use "learning about vs. figuring out" to characterize the difference between traditional science teaching and teaching that achieves NGSS—and our—goals: assessing and scaffolding students' three-dimensional engagement with phenomena. This phrase captures the essential contrast between active and passive learning and the importance of students' agency in their own learning. We fully agree with these goals.

BUT our learning research shows that students cannot "figure out" all of the important concepts and practices necessary for environmental science literacy on their own. They need access to new information and substantial guidance from adults and tools. This is where apprenticeship comes in as a model of successful active learning guided by adults.

Cognitive apprenticeship is our term for a set of design principles that play a key role in both *Carbon TIME* units and Professional Development modules. Students—and teachers—can master new and difficult practices through a series of stages: *establishing the problem, modeling, coaching, and fading*. These stages involve a gradual transfer of responsibility from the instructor to the learners. (See the Cognitive Apprenticeship Educator Resource for more on cognitive apprenticeship.)

Professional development: preparing teachers for classroom teaching and future learning. The PD Course of study is organized around four goals for participating teachers:

1. Understanding Three-dimensional Learning and *Carbon TIME* Curriculum
2. Preparing to Teach *Carbon TIME* Units
3. Learning from Classroom Experiences and Student Work
4. Creating and Sustaining Supportive Professional Communities

These goals are built around two essential features of *Carbon TIME* units, discussed below.

2. Essential features of *Carbon TIME* units

Our research on student learning shows that achieving environmental science literacy is a difficult challenge for virtually all students—and that current middle- and high-school instructional materials are failing miserably at that challenge. The *Carbon TIME* units are the products of 10 years of development and revision, and we have strong evidence that they are effective; see the Quantitative Analyses of Student Learning from *Carbon TIME* units for a two-page summary of our quantitative research, and additional evidence in the Research section of the *Carbon TIME* website.

The units all share two essential features:

- An Instructional Model that organizes the unit as a whole.
- A discourse routine that organizes individual activities.

Overall unit organization: The *Carbon TIME* instructional model and target performances. We urge all PD leaders to read carefully Three-dimensional Learning in *Carbon TIME* AND to inspect carefully the parts of actual units that correspond to the stages in the instructional model. Each unit engages the students in science and engineering practices as they take on the roles of questioner, investigator, and explainer. It is important for you to understand how the sequence of activities supports students in those roles.

Each unit also has a list of *target performances* for each activity. The target performances are important because they link the overall plan of the instructional model and the overall unit goals with individual activities. We'll offer a guarantee: Students who are successful in the target performances for the activities will also be successful on the posttest, showing that they have achieved the unit goals.

Organization of individual activities: The *Carbon TIME* discourse routine and scaffolding tools. We also urge all PD leaders to read carefully the *Carbon TIME* Classroom Discourse Routine Educator Resource AND to inspect carefully the teacher's guide, PowerPoint presentation, and other materials for some individual activities. The target performances are difficult for students; most students will not be good at them when they begin an activity. The five steps in the discourse routine—*introduction, private thinking and writing, partner or small group work, sharing ideas in whole-class discussion, and consensus-seeking discussion accompanied by public writing*—are important for helping students to master the target performances. Teachers often vary their discourse routines, but the most successful teachers include all of these components.

Carbon TIME Classroom Discourse Routine Educator Resource also has brief introductions to the variety of *scaffolding tools* that we have developed to support teachers and students. We urge you to find examples of these tools on the website and study them. Additionally, Strategies for Sustaining Rigor and Responsiveness in *Carbon TIME* shares more about strategies successful teachers use to teach *Carbon TIME* in responsive and rigorous ways.

3. Modules 1, 2, and 3: Preparing to teach *Carbon TIME* units

The *Carbon TIME* units are kind of like a new car that comes with a thick owner's manual. Many teachers will be tempted to skip over the "owner's manual" and just start using the student-facing materials, figuring that "they already know how to drive." *This isn't gonna work.*

It won't work because the *Carbon TIME* units are not like the units that teachers have taught before; the units *have* to be different because traditional ways of teacher won't enable students to achieve environmental science literacy. So teachers need to understand both the essential features and some key details before they "pick up the keys and start driving."

Like the units, the *Carbon TIME* PD Modules are products of many years of working with teachers, observing *Carbon TIME* classrooms, and listening to teachers' recommendations (including the teachers who were also PD leaders). They are designed to accomplish two key goals:

- Help teachers master the essential features of *Carbon TIME* units through cognitive apprenticeship.
- Prepare teachers for learning from the *Carbon TIME* website and from experience.

Module 1: Introduction and Overview. This module focuses on the first stage in teachers' cognitive apprenticeship experience: establishing the problem.

- Teachers discuss the importance and the challenges of *Carbon TIME's* goals for student learning—environmental science literacy (including three-dimensional proficiency and preparation for future learning).
- They discuss the implications for classroom teaching—the importance of scaffolding and assessing students' three-dimensional engagement with phenomena.

- They are introduced to the resources on the *Carbon TIME* website and the essential features of *Carbon TIME* units—the Instructional Model and discourse routine.
- They see an overview of the PD Course of Study and its cognitive apprenticeship model.

Module 2: *Systems and Scale* preparation. This module includes three sessions that provide modeling and coaching for the essential features of the *Systems and Scale* Unit. Each session focuses on one of the three student roles (questioners, investigators, and explainers) in the Instructional Model. Each session includes four key features:

1. An introduction that locates the lessons in the Instructional Model and identifies target performances for students.
2. A "deep dive" into one key activity: Teachers experience the full discourse routine and discuss how to enact its features in their own classrooms. This deep dive provides modeling and coaching on *Carbon TIME's* discourse routine.
3. Exploring resources on the *Carbon TIME* website that support other activities in this part of the unit. These explorations provide modeling and coaching for *Carbon TIME's* Instructional Model and website organization.
4. Essential advance preparation: ordering materials and deciding which optional activities to do.

Module 3: Preparing to teach other units. This module provides brief introductions to the other *Carbon TIME* units: *Animals, Plants, Decomposers, Ecosystems,* and *Human Energy Systems.* The focus of the sessions in this module is primarily on how each unit enacts the key parts of the Instructional Model and on the tools and resources included in the unit, in addition to supporting advance planning around materials and instructional decisions that teachers make before starting the unit.

4. Professional support networks and Module 4: Learning from experience and continuing professional growth

The final portion of the PD course of study includes two components: support for teachers while they are teaching *Carbon TIME* units in their schools and Module 4, focusing on working with teachers to reflect on and learn from their teaching experience, as well as a dive into other *Carbon TIME* tools and resources.

Professional support networks are great opportunity for the coaching stage of teachers' cognitive apprenticeship, through classroom visits or teachers' participation in professional learning communities.

Module 4: Reflecting on teaching and digging deeper. This module includes four sessions, each exploring a particular aspect of *Carbon TIME* in greater depth: unit reflection, classroom discourse, studying student work, and three-dimensional assessment. Teachers use examples and data collected while they were teaching *Carbon TIME* units for additional coaching and reflection, as well as exploring other resources and options that they did not discuss in the first three modules.

About the Carbon TIME Project and Team

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All *Carbon TIME* materials are available online at http://carbontime.bscs.org/.