Overview
We use design-based implementation research and a social network frame to develop sustained implementation networks for an environmental literacy learning progression-based system. We highlight how network designs maximize dimensions shown to be important to scale and sustain innovations in education (Coburn, Russell, Kaufman, & Stein, 2012): expertise (the presence of people in the network who have mastered essential knowledge and practices), strength of ties (members of networks need strong personal and professional ties), and depth of interactions (teachers need to focus on core practices in their work together).

Network structure & activities
We are currently establishing 6 networks across 3 states. Each network is led by a team spanning organizational boundaries, with a researcher, an LEA administrator, and a teacher leader.

Sites
Washington
• Seattle region
• Statewide Educational Service Districts
Washington
• K-12 data
• Seattle Public Schools
Colorado
• Denver region
• TED-Ed
Michigan
• Kellogg Biological Station
• Michigan Education Association
Michigan
• Network A (Seattle)
• Network B (Denver)

Development of one implementation network in an urban district
The figure below represents development of an implementation network in one urban school district, highlighting important network features. The nodes (circles and squares) represent the Biology teacher in the school district, with clusters of nodes indicating schools. Prior to 2013-14, no district-supported collaborative structures existed for Biology teachers; in 2013, a PD model with periodic collaborative release days and a curricular resource web page was established. Lines connecting nodes to the center indicate teachers’ participation in the district-sponsored collaborations. Encouraging informal use of Carbon TIME resources in the network, which includes formal Carbon TIME participants, legitimizes peripheral participation with the learning progression system. The network structure provides teachers with access to Carbon TIME expertise, and the activities of the district network focus on deep interactions. Synchronizing Carbon TIME activities with district network activities supports sustained growth of the professional network over time.

Design-Based Implementation Research within the network

Initial Process Tool design
- Research staff wanted to scaffold student practices for conservation of matter and energy; scaffold teaching practices for formative assessment
- Teacher thought tool unnecessary and redundant; wanted scaffold for high-stakes state assessment prompts
- Students directly expressed appreciation for and desire to use process tool
- Research staff and LEA leader in weekly meetings examine question of what features cause students, but not teacher, to value the process tool

Joint redesign of Process Tool (#1)
- Writing prompt aligned with state assessment criteria added
- Guiding questions refined
- New format piloted with students; data analyzed by teacher, LEA leader, and research staff

Joint redesign of Process Tool (#2)
- Diagram added to support tracing of matter and energy
- Attention given to meaning of arrows as conceptual support
- Guiding questions refined
- Teacher shared new version with network teachers, expressing value: teachers adopted use of process tool in their own classrooms

Network research plans
Aims
1. We will use both quantitative modeling and qualitative research methods to study teachers’ patterns of participation in these networks and the effects of their participation on teachers’ knowledge and practice and student learning.
2. We will also study the “boundary work” necessary as teachers, researchers, and administrators negotiate their differing priorities and interpretations.

Broad approach
• Mixed method approach
• Rely on existing instruments: Assessments of students and teachers; interviews with teachers
• Develop new instruments: Focus on network interactions, implementation, teachers’ planning and instructional practices
• Annual points of feedback for informing cohort/network support iterations
• Initially work within a “cross-case” analysis frame (small N), move to quantitative/modeling approach

Sample survey constructs

Category
Social network
Planning and teaching practices
Implementation barriers and supports
Background & expertise
Sample constructs
• Closest professional colleagues
• Help received from colleagues
• Focus and frequency of collaborative interactions in network
• Vision of NGSS
• Planning instruction
• Use of educative elements of teaching materials
• Engaging students in science & engineering practices
• Making connections to crosscutting concepts
• Perception of implementation supports and hindrances
• Science PD in past 2 years
• PD related to Carbon TIME
• Experience
• Changes to job conditions
• Past exposure to Carbon TIME
• Goals for participating in Carbon TIME

This research is supported by grants from the National Science Foundation: A Learning Progression-based System for Promoting Understanding of Carbon-transforming Processes (DRL-1020187), and Sustaining Responsive and Rigorous Teaching Based on Carbon TIME (NSF-1408886). Additional support comes from the Great Lakes Bioenergy Research Center, funded by the United States Department of Energy, from Phase-based Opportunities for Sustaining Outcomes and High-hopes, funded by the United States Department of Agriculture. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation, the United States Department of Energy, or the United States Department of Agriculture.