21. PINEMAP's Teacher Module Integrates Research and Education

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The development of a new teaching resource is directly tied to PINEMAP's education-focused outcome of developing an engaged and literate public with the capacity to make informed, practical decisions related to climate, forest ecosystems, and forest management. By implementing the module activities in classrooms, teachers and students will learn about concepts that PINEMAP researchers are currently exploring. In addition, the module has provided an opportunity to connect PINEMAP collaborators and graduate students with educators and other stakeholders.

Educational resources for middle and high school science teachers are important PINEMAP deliverables. This resource, *Southeastern Forests and Climate Change,* has evolved into a module containing 14 activities that teachers can use in biology, environmental science, or agriculture courses to teach students about southeastern forests and climate adaptations. This module is a platform to support integration among PINEMAP researchers and stakeholders and is also a context for graduate student research.

Figure 21.1. PINEMAP graduate student Jianxing Zhang shared information about his research in a short video that is available as a teaching resource for educators.

Sharing Research with Science Educators

The overall goal of PINEMAP is to advance biological research on southern pine and to use those findings to improve forest management decisions. In the long term, introducing the public to the science that underpins this goal encourages understanding of management decisions aimed at making forests resilient and sustainable under variable climates. By building our teaching module to parallel the PINEMAP research agenda (see Table 21.1, page 47), we gained several key advantages: (1) researchers assisted in the development and review of the activities, ensuring accuracy in the material; (2) the process of research and research findings have been made available to educators and students as supplementary videos; and (3) faculty and graduate students have been engaged in teacher workshops to help educators understand and use the material.

The education team worked closely with the PINEMAP management team to brainstorm activity ideas that relate to the research agenda and involved researchers and graduate students in pilot tests and activity revisions. A set of creative, appropriate, and engaging activities evolved from this interaction between research scientists and the education team.

Meeting Stakeholder Needs

A partnership with Project Learning Tree® (PLT), a national environmental education program that has coordinators and facilitators in most states, established a recognizable home and distribution network for the new module. Using PLT's program development framework, we created the PINEMAP Education Advisory Committee that met bimonthly to review activity ideas, provide feedback and additional resources, and discuss potential concerns. Members of this committee have also been instrumental in offering presentations to introduce the materials and in considering how the southeastern-focused materials can be adapted for use in other regions of the country—significantly expanding PINEMAP efforts. We conducted a needs assessment after drafting the conceptual framework and asked teachers specific questions about activity format and usability. These results helped focus several activities on data analysis, systems thinking, and problem solving (Monroe et al. 2013). An evaluation of this draft document was conducted in fall 2013 (see Chapter 22, page 48), and this teacher feedback will be instrumental in making additional revisions to the materials.

Teacher feedback also guided the development of complementary module materials, such as slide presentations and short videos (Figure 21.1). These resources are available online to help teachers introduce basic concepts and current research activities. Student worksheets and slide presentations are available in an electronic format that educators can modify to best meet their needs. The module website also includes interactive activity descriptions, tests of knowledge, and a variety of web links for additional information (http://sfrc.ufl.edu/extension/ee/climate).

Teachers participating in a Climate Change Symposium in Gainesville, Florida learn how to measure a tree to calculate stored carbon. Photo by Jessica Ireland.

The opportunity to share PINEMAP's research findings with educators has engaged research faculty and graduate students in the process of developing education materials and interacting with teachers and students.

Research Findings Enhance Climate Education

Graduate students on the education team are using the module development process to answer a number of interesting research questions that will help create a more effective product. For example, when developing activities about the carbon cycle and carbon sequestration, we did not know if introducing the carbon cycle in the context of climate change would enhance or deter student interest. An experiment with high school students attending two summer science camps enabled us to determine that students who explored the carbon cycle and carbon sequestration in the context of climate change gained significantly more knowledge about these topics than students who explored them in isolation (Hall 2013). Additional work is underway to assess students' feelings of hopefulness regarding climate solutions and to explore teaching climate change within a systems thinking framework. While these findings will be incorporated into the PINEMAP module, they are also useful to the broader field of environmental education.

Summary

The opportunity to share PINEMAP's research findings with educators has engaged research faculty and graduate students in the process of developing education materials and interacting with teachers and students. Bringing the research process to the classroom makes science education tangible, local, and practical for both teachers and students. Giving PINEMAP graduate students opportunities to interact with teachers allows students to crystalize their research findings and reminds them that many audiences care about the applications of their work. Seeking partnerships with existing environmental education programs and practitioners has established a ready audience for distributing and using the new materials. Finally, engaging graduate students in social science research has improved the materials and led to new insights into climate education.

Research Concept	Teaching Objective	Activity
Changes in temperature and precipitation will influence forest habitats.	Climate affects forests.	A web-based exploration of the USDA Forest Service Climate Atlas enables students to learn about climate models and projected effects of tree habitat ranges (Activity 3).
Tree growth and yield responds to changes in soil fertilization and tree density.	Management strategies can increase forest resilience given climate variability.	After creating a systems model of a tree plantation, students use management and climate cards to draw additional relationships and predict outcomes from their model (Activity 5).
Trees can reduce levels of atmospheric carbon.	Trees sequester carbon as they grow.	Students measure carbon stored in a tree and extrapolate that to annual carbon sequestration in a forest, and then compare an estimate of their state's carbon emissions to their state's sequestration rate given current land use (Activity 8).
Tree breeding to select genetic traits that will enable trees to thrive in a changing climate.	Loblolly pine has a variety of traits enabling trees to survive in different climates.	Students graph data from test plots with six families to reveal two distinct populations (Activity 6).
Life cycle assessment can reveal opportunities to reduce atmospheric carbon.	Life cycle assessment provides important information about externalities and opportunities for consumer decisions. Consumers have the ability to select products based on contributions to atmospheric carbon.	Students "shop" for products and identify criteria that could be reflected in the product's price (Activity 9). Students use a life cycle assessment to determine the outdoor dining furniture with the lowest emission of greenhouse gases (Activity 10). Students debate parallel items and reflect on the criteria they could use to make purchasing decisions (Activity 11).
Wood substitution is an effective strategy to reduce atmospheric carbon.	Three forest carbon pools remove carbon or prevent it from going into the atmosphere.	A cooperative learning strategy helps students solve the puzzle of atmospheric carbon in the forest, long-lived wood products, and in the parallel products not used (concrete and steel) (Activity 12).

Table 21.1. Research concepts form the foundation of module activities.