



# Can Using Systems Thinking Improve Student Success with Climate Change Education?

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## The Literature

The National Next Generation Science Standards are transitioning U.S. education from content-based standards to performance-based expectations.<sup>1</sup> Students should develop 21<sup>st</sup> century skills (i.e. problem solving, critical thinking, decision making, etc.) to **have the capacity to address impending environmental issues** on a global scale.<sup>2</sup>

The intent of systems thinking is to **consider the entire subject of interest** (i.e. ecosystem, environmental issue, etc.) and the interconnectedness of all of the various parts.<sup>3</sup> Natural systems include a **complex series of variables** that depend on each other and react in different ways. Systems thinking allows learners to **understand these relationships** and possible change. When students think on a systems scale, they focus on the stocks and pools of resources, feedback loops, time delays and boundaries.<sup>4</sup> One of the many benefits of systems thinking is its ability to help students think about complex environmental concepts and issues in a long term time scale. Studies have shown that students who were taught using systems thinking demonstrate a **higher level of understanding** of complex natural systems than those that were not.<sup>5</sup>

## New Climate Education Resource

A new resource that has been developed is the Project Learning Tree module, **Southeastern Forests & Climate Change**. The module contains 14 activities that focus on climate science in the context of southeastern forests and **addresses adaptation and mitigation strategies**. Five of the 14 activities focus on **systems thinking skills** as a means to addressing such a complex topic. In each activity there is a systems thinking focus or supplemental systems thinking enrichment activity to help teachers and students develop their skills to think in a large scale, interconnected manner.

The resource development team from the University of Florida coordinated the opportunity to pilot test two activities with local high school students to explore effective strategies for teaching systems thinking in the context of pine plantation management. Activities were field tested with students to learn how students respond to the concepts. In addition, the formative evaluation being conducted with

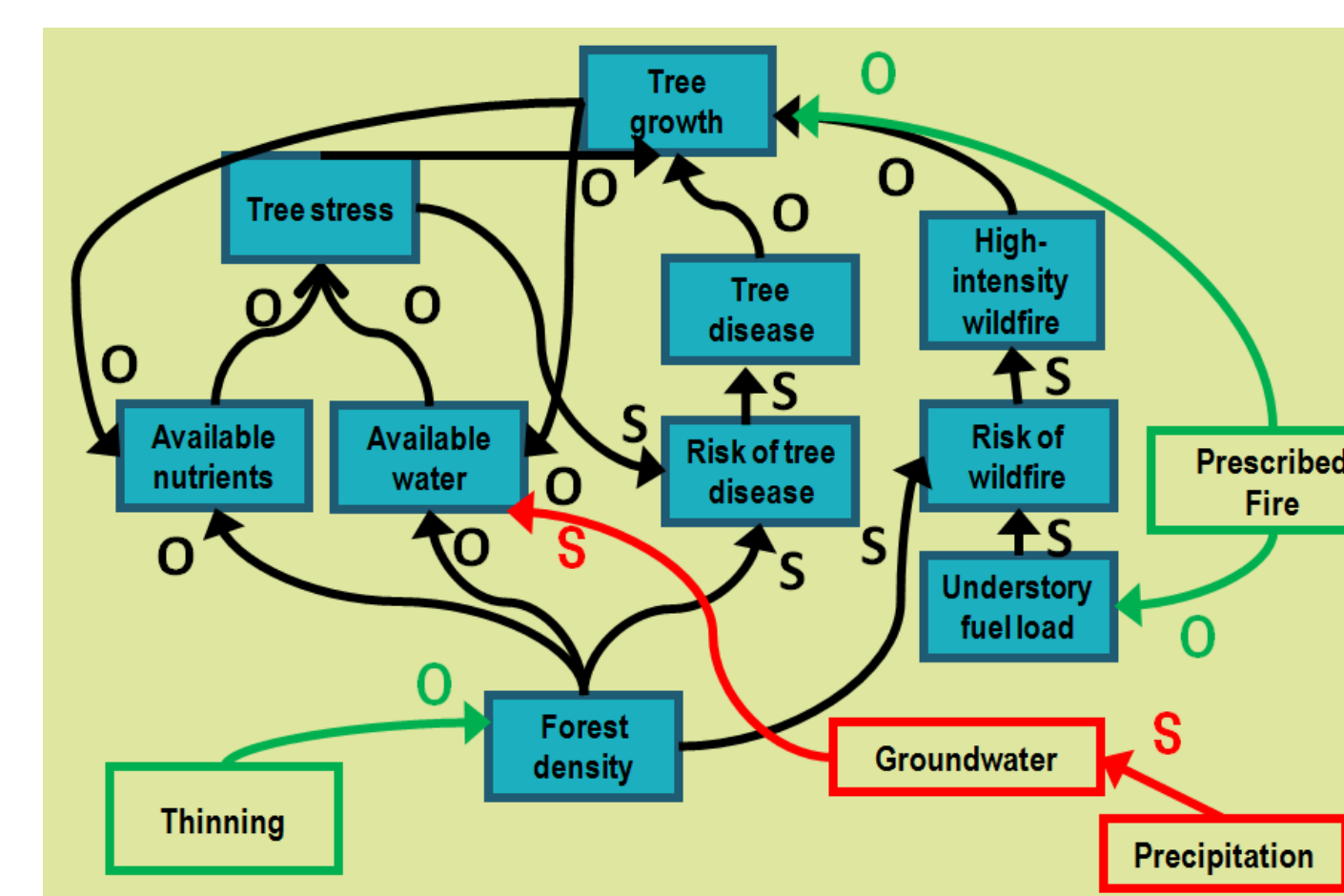
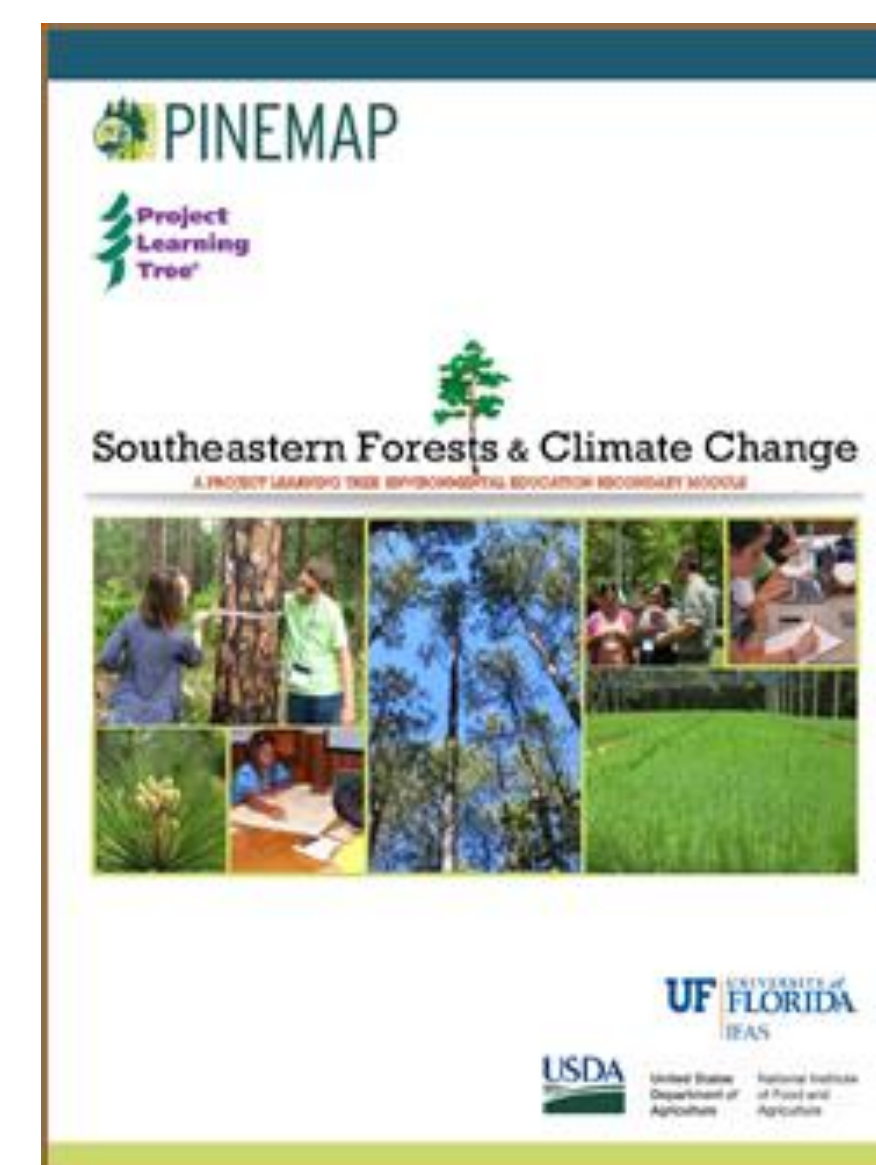
## Methods

### Santa Fe High School

- Two AgriScience Foundations classes at Santa Fe High School, Alachua, Florida
- Approximately 70 students in grades 9-12 with varying abilities
- Six 50-minute class periods to facilitate 2 module activities that focused on forest systems (**Figure 1**) and product life cycles
- Developed pre and post assessment questions and worksheets to obtain student feedback
- Analyzed qualitative responses to understand students' ideas
- Coded responses to discover themes

### Formative Evaluation

- 44 Teachers from 6 states across southeast (AR, FL, GA, KY, NC, VA)
- Approximately 1500 students in grades 6-12 with varying abilities
- Teachers each pilot tested 4 different activities
- Multiple choice pre and post assessment, 5 questions specifically about systems
- Conducted t-test to determine difference in means of pre and post assessment



**Figure 1:**  
Sample Forest System Diagram with Climate Scenario and Management Strategies

## Lessons Learned from Santa Fe High School

- ✓ **Systems vs. Cycles** -- Students were confused when differentiating between a system and a cycle. Students will need assistance to distinguish systems by highlighting feedback loops, the scale of the system, directional arrows that signify direct or indirect connections between forces and boundaries of the system.
- ✓ **Indirect vs. Direct Impacts** -- Students will make the jump to the ultimate conclusion with out considering the indirect impacts and variables influencing the system. Students will need assistance in identifying and understanding the intermediate steps in the system that lead to the final impact.
- ✓ **Absolute Language** -- Students tend to use the worst case scenarios, rather than focusing on gradual impacts over time. Students will need assistance to not jump to disaster conclusions and identify gradual changes over time.
- ✓ **Recency Effect** -- Students are easily influenced by recent events. These students' answers were significantly impacted by a recent cold snap. Teachers may need to identify current events that could skew students perceptions.

## Formative Evaluation Results

With the completion of the formative evaluation, several variables were identified that may account for why some students showed gain in system thinking skills and some did not. Success may be linked to:

- A.P. classes
- Age
- Assessment strategy
- Teacher variables (experience, education, knowledge of systems)
- Order of activities
- Number of systems explored

## Research Implications

This experience is helping to form research questions about incorporating systems thinking into climate change education curriculum:

- How to build systems thinking skills with students of varying abilities in the same class?
- How to teach teachers to effectively incorporate systems thinking into their science classes?
- Can systems thinking help improve student environmental literacy?
- Can all students learn systems thinking skills?
- How much reinforcement and repetition is needed?
- What can be learned in a two week unit?

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- Formative Evaluation teachers



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