Overview

EcoMOD: Integrating Computational Thinking into Ecosystems Science Education via Modeling in Immersive Virtual Worlds

Under Track 1 Design and Development of the STEM+C program, the EcoLearn group at Harvard University will develop and study ecosystems science curricula that introduce modeling concepts and processes to third graders, based on computational thinking and programming. Research has revealed that even young students can demonstrate sophisticated reasoning and understandings related to complex causal patterns and features, and can engage in computer programming activities. The *EcoMOD* (Model/Modify, Observe, Design) project will build on and extend our prior EcoMUVE curriculum for middle school, using a design-based research approach to combine an immersive virtual environment with hands-on interactive modeling through a scaffolded computational interface. EcoMOD will offer links between multiple forms of representation to help connect visual models to dynamic representations of ecosystem interactions in a simulated forest setting. The curriculum will provide a highly supported, object-oriented programming environment similar to Scratch or StarLogo NOVA with a simple, scaffolded block interface, customized to focus on ecosystems modeling and designed specifically for younger children. EcoMOD's learning goals in habitats and food webs are taught using a systems perspective, shifting the instructional focus from comprehension of static representations to consequential student interaction with dynamic computational models.

EcoMOD will explore these research questions:

RQ1 - Using a design-based research methodology, which approaches to abstraction and representation offer the best scaffolding to students? Given this scaffolding, to what extent are students able to construct, modify, and interpret computational models that represent ecological concepts in EcoMOD?

RQ2 - To what extent do students show gains in understanding causal dynamics in, ecosystem science content knowledge and affective measures after using EcoMOD?

RQ3 - How does teachers' use of the curricula unfold in practice? What types of supports are necessary prior to and during the implementation?

RQ4 - To what extent do teachers see usage of the EcoMOD curriculum in typical school settings as desirable and as feasible from a practical perspective?

EcoMOD will develop measures and methods for assessing the outcomes of this third grade curriculum on students and teachers. The resultant proof of concept, case-based data can inform future research on controlled comparison studies.

Intellectual Merit

The EcoMOD curriculum will scaffold student understanding of computational modeling as a core practice used to explore and understand ecosystem interactions, and will include other representations to reinforce students' learning about food webs and habitats at different levels of abstraction. Integrating modeling into the elementary science curriculum offers the potential to meet important 21st century learning goals, including understanding causal relationships in complex systems and infusing computational thinking into disciplinary contexts. This work can reveal aspects of children's understanding that researchers and designers can leverage to create deeper and earlier understanding of these complex causal concepts. Studies of immersive environments coupled with computational modeling tools can help to elucidate their strengths and limits for improving young students' motivation and educational outcomes, as well as enabling powerful research methods for collecting and analyzing detailed data on

experiential learning. Overall, this can enable a rich integration among STEM content and activities, inquiry and modeling processes, and computational thinking.

Broader Impacts

Developing more advanced scientific and computational knowledge in later grades depends on creating a strong foundation in the elementary school, which curricula like EcoMOD can enable. This work can: 1) result in changes in how researchers and designers think about modeling and computational thinking related to ecosystem science in the elementary curriculum; 2) offer rich and robust means for helping students and teachers learn about modeling and computational thinking in ecosystem science; and 3) lead to deeper student understanding of the causal dynamics within ecosystems, possibly enabling making topics taught later in the elementary curriculum accessible to students at earlier developmental levels .