Collaborative Learning in Virtual Environments: Role-based Exploration of Causality in Ecosystems over Time and Scale

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Abstract: EcoMUVE is a middle school science curriculum that provides an immersive virtual eccosystem in which students learn about complex causality through collaborative inquiry activities. We describe case study research focused on EcoMUVE's supports for collaborative learning, including a jigsaw pedagogy and in-world supports such as chat and data sharing.

EcoMUVE, a research project funded by IES, has developed a curriculum for middle school students to learn about complex causal relationships in ecosystems using Multi-User Virtual Environments (MUVEs). This poster presents exploratory research on the multi-user aspects of EcoMUVE – supporting student collaborative learning in a model that blends face-to-face dialogue with interaction in immersive virtual environments.

EcoMUVE Forest is a two week, inquiry-based curriculum unit centered on an immersive virtual ecosystem that includes two forested islands. Students travel in time over five decades to see changes in populations and forest structure, and to figure out why fewer visitors are coming to one of the islands. The unit uses a jigsaw pedagogy in which a team can succeed only if each student contributes data for which they are responsible, and all team members collectively interpret that information. Students observe plants and animals, shrink to view microscopic organisms, collect data, and graph changes in the populations of different species. They work in 4-person teams, each choosing a role (e.g., botanist, bird watcher). Students work individually on computers on role-specific learning tasks and data collection, collaborating through online chat and data sharing, as well as face-to-face in team meetings. The unit culminates in each team creating and presenting to the class an evidence-based concept map that represents their hypotheses of the ecosystem interrelationships.

To look in depth at students' collaborative learning, we designed a case study around a science teacher and four classes of 7th grade students (N=91), ages 12-13, who used the Forest unit over two weeks. Data collected included pre- and post-surveys, chat logs, video, and team concept maps.

The key features we will highlight on the poster focus on the affordances of the technology for scaffolding collaboration, including student roles, data sharing, and in-world chat. We will describe how the concept maps that students create, as well their class presentations, demonstrate their collaborative learning.

Findings

In post-surveys, 95% of students said that they liked their role, and 91% said they learned from their teammates. Most students included descriptions of things they had learned from their teammates, for example, a birdwatcher said "I learned from the Botanist about the changes in suitable bird habitats on the islands." A pre-post survey of content learning found statistically significant ($t(82)=8.38$, $p<.0001$) mean score gains of 3.512 points, representing an effect size of 1.04 standard deviation units.

Students used on-line chat with teammates (Figure 1) to ask for help ("wait how do u go to a different island?", "what do small mammals eat?"), determine roles ("I call botanist"), share information ("red tailed hawks are eating the other birds" "omg really???"), share data ("Everybody make sure to add everybody else on data"), and plan their presentations ("maybe u can graph songbirds or other birds and show what they eat.").

Teams primarily collaborated on their concept map face-to-face at a shared computer, inputting all team member data and looking at the full dataset using multi-line graphs over time (Figure 2). Sample video transcript:

> E: What do the wolves eat? Do they just eat deer, or do they eat small mammals too?
> F: We should check that out.
> [E opens small mammals page of online field guide, while A watches. E reads out loud.]
> E: when a single wolf hunts alone it hunts and eats smaller prey such as rabbits and other small mammals
> [E switches to graph, they select deer, small mammals, and wolves to display over time]
> E: So small mammals and white tailed deer are affected by the wolves.
> F: [points] Yeah, when this starts going down this goes back up, when this starts rising this goes back down.

During team presentations, students projected their concept map using a document camera projector (Figure 3, left) and took turns explaining the parts of the map pertaining to their role (colored, Figure 3, right). Overlaps show related concepts that students learned collaboratively. For example, the population specialist (yellow) discovered that without wolves the deer population increased. She worked with the botanist (green) to identify the overpopulation of deer as the reason there were fewer shrubs. The birdwatcher (purple) then explained the impact of the lack of shrubs on birds who use the shrubs as habitat.

Figure 1. Example of chat in EcoMUVE.

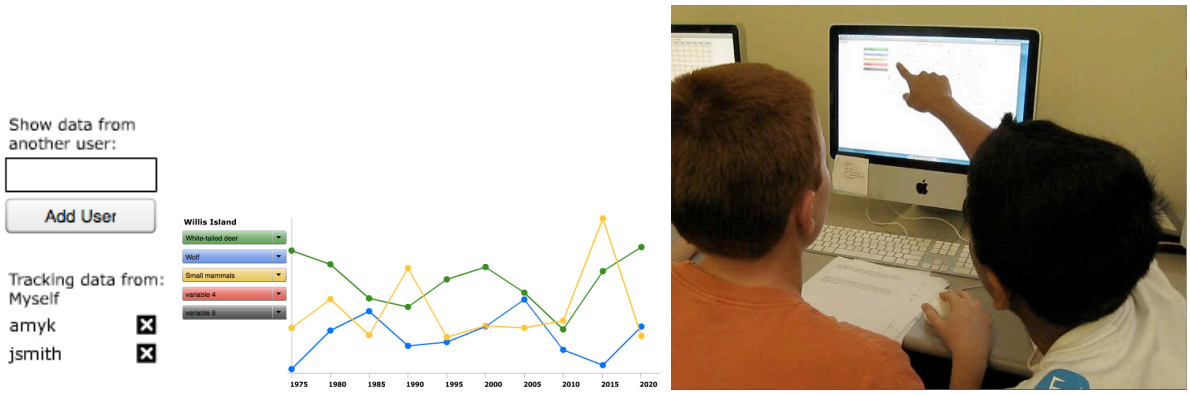

Figure 2. Sharing data interface (left), shared graph (center), student collaboration example from video (right).

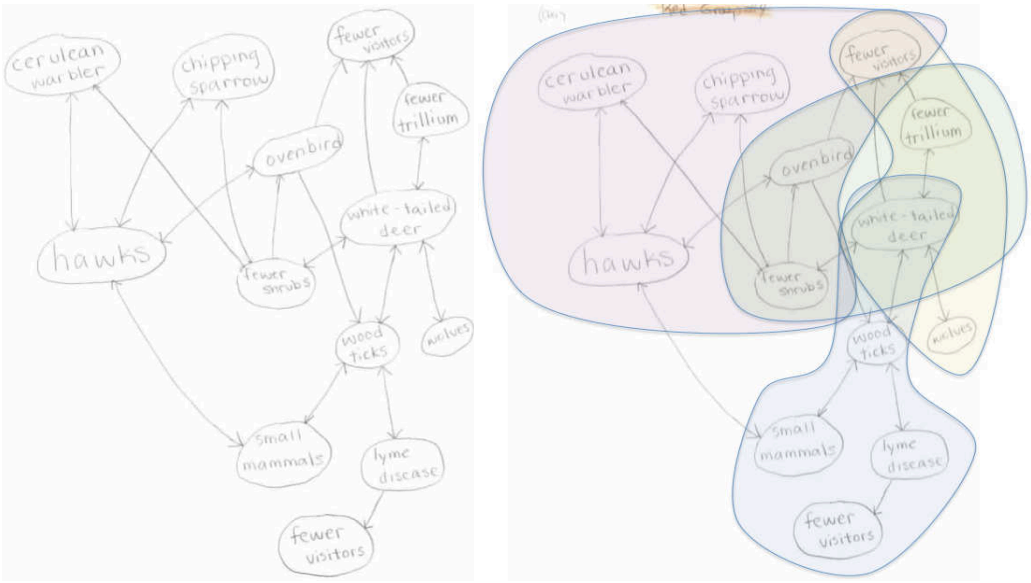

Figure 3. Example concept map, as drawn by students (left), colored to show overlapping roles (right).