Visualizations of Community Knowledge for Supporting Middle School Students to Model Phenomena in Scientific Inquiry

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Abstract: In a design-based research study, 85 middle school students participated in a model-construction inquiry activity, where they contributed claims about species relationships. The relationships were modeled with a food web visualization that captured the classroom community's understandings. In Year 1, the visualization and knowledge base of claims were independent technologies. In Year 2 the visualization was automatically constructed from the database of claims. We examine the design implications of the visualizations for supporting whole-class discussions.

WallCology

Researchers have used a variety of technology solutions to support learners in collecting and sharing their observations with peers. This poster examines community knowledge construction of food web models and whole-class discourse around the food web representation in two iterations of an 8-week WallCology unit. As part of the Embedded Phenomena framework, WallCology is a digital simulation that situates students in a complex virtual ecosystem mapped onto their classroom walls (Moher et al., 2008). Groups of two to four students observe the species through WallScope portals (i.e., computer monitors) and perform investigations on local ecosystems. Since local ecosystems are designed to inhabit only a subset of the species, students must work together as a community to discover the complete set of relationships in WallCology. The "master food web" (MFW) serves as a public display of the classroom community's knowledge and is the focus of teacher-led whole-class discussions. Cycles of group work (making and justifying digital claims) and whole-class discussions (reporting on findings) drive community progress. In Year 1, claims about each species were saved onto tablets located in specific places within the classroom (11 species & tablets). The information was aggregated locally and accessed on these tablets. The MFW was ***constructed as a class***, as informed by the students' local group work. In Year 2, claims were about ***relationships***, describing the producer-consumer or competition relationship between a pair of species. The MFW was ***automatically constructed*** in real-time from the database of claims.

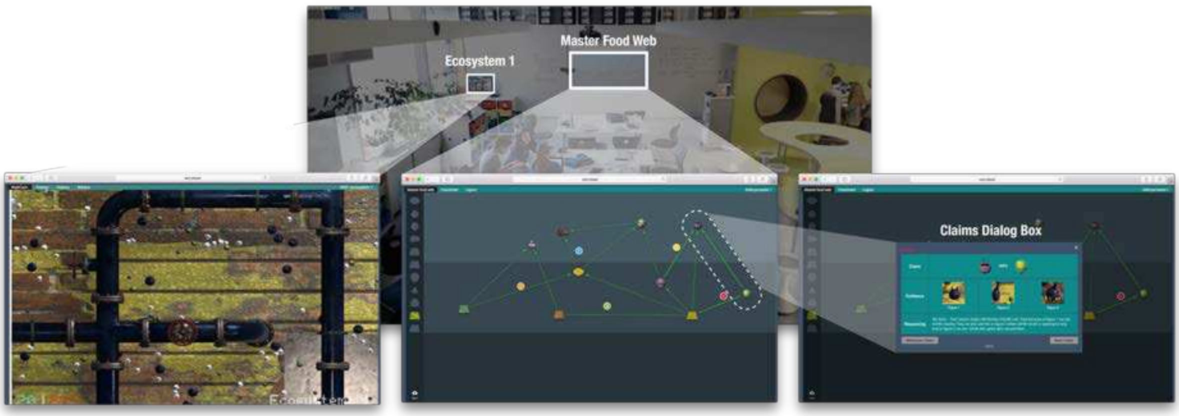

Figure 1. Y2 WallCology environment: WallScope (left), master food web (MFW; centre), claims dialog (right).

The design-based research study was implemented over two iterations with the same teacher participant. Three Grade 6 Science classes participated each year, with 44 students in Year 1 and 41 students in Year 2, aged 11-12. All sessions were video recorded and whole-class discussions reviewed.

Findings

Y1: Focus of whole-class discussions on procedural tasks in food web construction

In Year 1, whole-class discussions involving the MFW consisted of the teacher asking each group if they had anything to contribute to the representation (e.g., *"What do you have to add to our master food web?"*). Student groups took turns describing what they found, with minimal discussion. Below we present an illustrative example that characterized the discourse in Year 1. The case began with one group (of two students) reporting their findings after an investigation (e.g., manipulation to their ecosystem): *"We decreased the population of Muk (species #4) to see what would happen to the population of others and to see if Dr. Finklesheetz (species #6) ate anything...and what we found out was that Muk went down [in population] after Dr. Finklesheetz also went down [in population]. So we think Dr. Finklesheetz ate Muk and also the population of Mitch (species #9) went completely down. Meaning since Dr. Finklesheetz didn't have Muk to eat he was completely focusing on Mitch."* The students concluded that Dr. Finklesheetz ate Muk and Mitch. The teacher then asked *"...are the arrows correct? If the population of Mitch increases, does that have a positive effect on the population of Dr. Finklesheetz?"* Several students confirmed this. The teacher added the new food web arrows while asking students which direction the arrows should face, and then moved on to the next group once the arrows were created.

Y2: Focus of whole-class discussions on the *quality* of claims that formed the master food web

In Year 2, the MFW was automatically generated through the claims submission process, off-loading the construction task from the teacher. She focused whole-class discussions about group claims in greater depth and the classroom community's emergent understanding about the entire WallCology ecosystem, as represented by the master food web. Below we describe an illustrative example in Year 2 (at a comparable point in the unit as the previous case). The discussion began in a similar fashion, with the same teacher asking each group to discuss their claims and what they learned from their manipulations. With their claim displayed on the MFW, the group began with: *"We think Maushy (species #0) eats Phogqu (species #5). In Figure 1 you see we decreased Phogqu and that Maushy went down…Maushy eats Phogque. In Figure 2, you can clearly see Maushy went down…Last, in Figure 3, you may think you see lots of Phogqu. But actually, that whole top part was filled with Phogqu, showing Maushy probably eats it. Also, you see that there are a lot more Maushy's than Pansirty's (species #7) in the picture."* The teacher then asked the class *"What do you think?"* and five students raised their hands. When called upon, a student said *"I think this claim is good but it's not promising because the word 'probably' shouldn't be in a claim…it's just kind of like (shrugs shoulders). Also, in Figure 3 I think there should have been a 'before' picture because it's not that believable."* The discussion continued with the teacher describing the positive qualities of the claim (e.g., use of two clear population graphs that connects to the reasoning). She then asked if a different group could contribute another claim, which would strengthen the relationship on the MFW (as a thicker line). The discussion continued for a total of six minutes and included engaged verbal participation from at least six students (of 15 in the class) before moving on to the next group due to time constraints. The teacher also frequently gestured towards the MFW, particularly when addressing the class about community progress: *"We're not just trying to figure out ecosystem 5, we're trying to figure out the whole thing. That's the goal."*

Discussion

In both iterations, WallCology was framed around modeling species relationships as a community of learners. In Year 1, our design had students intentionally distilling community knowledge from the set of claims in constructing the MFW during whole-class discussions. At the time, we believed the deliberate transfer of knowledge from the claims database to the MFW was consequential and would elicit more thoughtful reflections. However, we found that the discussions did not progress past a superficial level of discourse. There was also limited engagement between groups during discussions. Our findings in Year 2 suggested that the MFW, as an aggregate visualization, created from real-time student-generated claims accurately reflected the state of community knowledge and was used as a meaningful object of community discourse. Whole-class discussions were organized in a guided exploration context, which allowed the topic of discussion to be focused on the quality of student claims. This in turn allowed the visualization to be used as a resource for identifying community effort and progress towards completion. Engaged patterns of participation was seen across groups illustrating the MFW as a context for argumentation, and adoption or rejection of candidate relationships present in the ecosystem.

Reference

Moher, T., Uphoff, B., Bhatt, D., Silva, B. L., & Malcolm, P. (2008). WallCology: Designing interaction affordances for learner engagement in authentic science inquiry. Presented at the *Proceeding of the 26th Annual ACM SIGCHI Conference on Human Factors in Computing Systems* (pp. 163-172).

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