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Learning about Ecosystems in a Computer Supported Collaborative Learning Environment

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Abstract: This paper explores how a group of students collaborated in understanding ecosystem processes in a technology intense learning environment. The technology (hypermedia, NetLogo simulations and ACT toolkit) provided opportunities for students to engage with complex phenomena and understand the dynamic nature of the ecosystems.

It is difficult for learners to understand ecosystems as they have not had the opportunity to observe and engage the multidimensional processes of the ecosystem. Computer-supported collaborative learning environments can provide opportunities for students to understand ways of organizing ecosystem understanding, interact with simulations that provide a context for collaborative discussion and engagement, and use modeling tools that provide a focus for negotiation understanding. In this paper we present results from a CSCL learning environment created to help students understand aquatic ecosystem processes. The environment was designed to help middle school students develop a deep understanding of ecosystem processes using a structure behavior and function approach (Goel et al 1996). The SBF approach was applied to an ecosystem model by using the following guidelines: Structure refers to components of an ecosystem that have form. Structures can be macro (e.g Fish, plants) or micro (e.g bacteria, fungi) in nature. Behavior represents system mechanisms and processes. Finally, functions are roles the structures play in an ecosystem. The premise of using the SBF approach is that this gives students a framework to gain a deeper understanding about ecosystem processes. Research has shown that students can easily identify structures but it is difficult for them to identify behaviors and functions (Hmelo, Holton, & Kolodner, 2000; Hmelo-Silver, Marathe, & Liu, 2007). Thus in this paper we look at how students move from talking about structures to talking about behavior and functions during the course of the intervention.

Methods

To help students understand complex ecosystems processes, we designed a two week intervention in a public middle school in New Jersey. The unit used aquarium as a model ecosystem and was designed by a team of learning scientists, middle school classroom teachers, and ecologists. The aquarium was set up in the classroom prior to the beginning of the unit. The technology was an integral part of the intervention and consisted of: a function oriented hypermedia, simulations of macro-micro level processes and the aquarium construction tookit (ACT; Vattam et al. 2011). Throughout the curriculum unit, students worked in small teams of four to five.

The science teacher introduced the unit by asking students their ideas about functions involved in ecosystem processes. The teacher then assigned the students to groups and asked them to use the ACT tool to map their ideas about ecosystems as structures behaviors and functions. The students used the hypermedia to refine their knowledge about ecosystem functions. The students then explored two NetLogo simulations (Eberbach & Hmelo-Silver, 2010). They were then asked to refine their ecosystem models in their groups and finally present to the entire classroom.

Fifty four seventh grade students participated in the activity. However for the purposes of this study we report on talk from one group of four students that were video recorded. They collaborated around one computer, which had the hypermedia, the NetLogo and the ACT. The hypermedia was used to sharpen the student ideas about ecosystems and in the NetLogo simulations students manipulated various ecosystem components (number of fish, amount of food, etc) in order to maintain a healthy ecosystem. We coded each utterance as structure, behavior or function. The data was coded from the first time the students started to use the ACT tool to organize their thoughts as a group in SBF terms, to the time they made their final presentations in the classroom. The students used the NetLogo simulations during this time. An utterance was coded as a structure if any student in the group said a sentence that involved a single ecosystem component. For example an utterance got coded as a structure if the students said " Lets put in fish" or " hey where are the plants". An utterance was coded as a behavior if the students had more than one component in their talk and they made a linear connection (how) between those two components. An example for an utterance that got coded as a behavior would be " Plants produce oxygen". Finally an utterance was coded as a function if the students gave an explanation for the process itself (how did the structures do what they did). An example of a function-oriented utterance would be “Fish eat food to get energy”.

Results and Discussion

Initially (day 1) the students started with identifying more behaviors than function. This is because prior to using the ACT tool the teacher had discussed a few ecosystem processes with the students. The teacher had not discussed these processes in details and thus the students identified more behaviors than functions. As observed in figure 1 - earlier (day 1 and day 2) the students have identified many more structures and behaviors than functions. The structures have gone up in numbers on day 3 and day 5. This is because on day 3 and 5 the students engaged with the NetLogo simulations (model nitrification and carrying capacity). Also day 3 and day 5 have many more functions when compared to day 1 and day 2. This is because the NetLogo simulations help the students understand the mechanisms between the structures that cause a certain ecological phenomena.

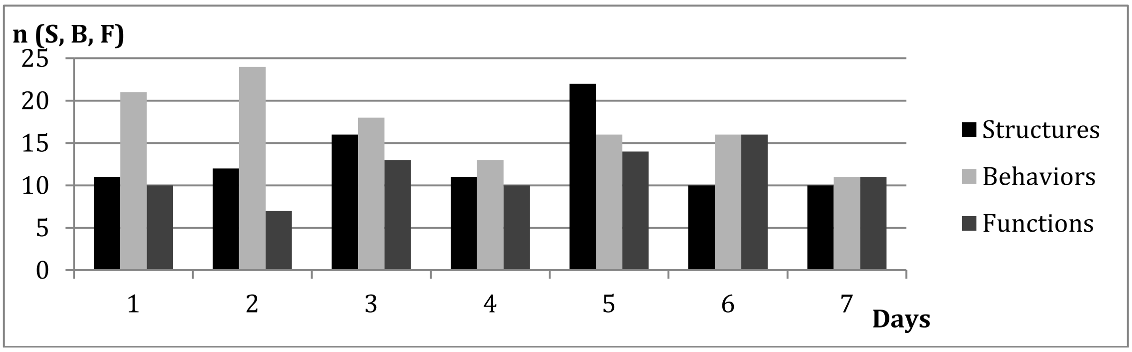

Figure 1: student progress (daywise) in terms of identifying structures behaviors and functions

Prior studies have noted that when experts/scientists discuss science they often present their ideas as behaviors and functions (Hmelo-Silver, Marathe & Liu, 2007). As observed in figure 1 the students engage more in function and behavior talk than in structure talk as they move toward the end of the unit. Day 6 and Day 7 are also the days the students refine their models. These are the days after which the students have engaged in all of the activities (NetLogo simulations, hypermedia and ACT tookit) and now are in a position to finalize their models. Data from day 6 and 7 show that for every structure there are more behaviors and functions. Toward the end of the unit the students are engaging in complex discussions with regard to ecosystem processes. For example while revising their final models the students were having conversations like the one below:

Student1: Fish eat food and create waste – that's how ammonia gets into the water
Student 2: You mean waste is generating ammonia?
Student 1: Bacteria breaks down ammonia and plants use it to grow

In the above example we can observe that the students are talking about a few structures (fish, plants, bacteria) but then they are also simultaneously engaging in behavior and function talk (e.g bacteria breaks down ammonia and plants use it to grow)

Therefore our findings suggest that a combination of using structure, behavior, and function approach along with a set of carefully designed CSCL tools can support and guide the students toward understanding the complexity of ecosystem processes.

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