Common Boundary between Different Worlds: Collaboration between Researchers and School Teachers in NLC KB Project in Singapore

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Abstract: This interactive session showcases three models of nature learning camp-knowledge building (NLC-KB) program in Singapore - knowledge. They are the result of productive work of different stakeholders in this design research around boundary objects – knowledge building and environmental science. The goal of this session is thus to present boundary object as a methodological concept to understand how the different stakeholders work together to create a different KB-NLC program for their school, yet with resemblance of the KB-NLC community. The interactive session will include presentations of the three models by three different schools.

Description of Project

The aim of this design research project is to develop a collaborative elementary science program that fosters deep understanding of the nature of science (NOS) and environmental science knowledge through a knowledge building approach. The NOS covers the epistemology of science, science as a way of knowing and the values and beliefs inherent in scientific knowledge (Lederman, 2007) whereas environmental science fosters opportunities to acquire knowledge, values, attitudes, commitment and skills to protect and improve the natural environment (Hart, 2007). Both NOS and environmental science have inherently attitudinal and affective components that are reportedly best developed through the inquiry approach. The latter is modeled after the scientific process of theory building (Schwarz, Lederman & Crawford, 2004) which has many parallels with knowledge building principles in the learning sciences.

This research dovetails onto an existing annual nature learning program for primary school students, called the Nature Learning Camp (NLC). Started some 10 years ago by a group of environment enthusiasts comprising an environment researcher, a group of primary school teachers from different local schools in Singapore and personnel from National Parks Board, the one-day event incorporated short-science inquiry activities to help primary school students learn about the local ecosystems, in particular the freshwater and rainforest reserves in Singapore. However, due to the brevity of time spent on the activities, these science activities might not make much lasting impact to the students, which really requires sustained tapping into attitudes and affect. The intention of this design research is therefore to extend the original one-day NLC program into a year-long program to engage students in collaborative theory building activities. The goal is to expand students' understanding and appreciation of the natural world and to enrich what they would learn in school. Knowledge Building (Scardamalia & Bereiter, 2003) approach is adopted to encourage students across schools to work more extensively with scientific data collected and to advance the collective knowledge of the NLC community. To mediate the knowledge building process among students, Knowledge Forum, a computer-supported collaborative learning system is used. With an emphasis on environmental science and NOS in the local primary science curriculum, this study aims to generate insights and exemplars for science educators on boundary crossings between formal learning in the classroom and out-of-school contexts. In short, the study aims to achieve the following objectives:

a. To create and refine a collaborative knowledge building learning model mediated by Knowledge Forum (KF), a computer-supported collaborative learning (CSCL) system, for primary science classrooms in Singapore;
b. To deepen students' understanding of NOS, particularly the role of theories in experimentation and scientific knowledge creation during inquiry activities; and

c. To advance students' knowledge and affect towards environmental science.

This study involves three main groups of stakeholders – primary school science teachers, environment enthusiasts including the environment researcher and a few primary science teachers, and principal investigators of this project. A total of four primary schools participated in this study. As a multi-disciplinary team, the study is an integration of different interest/research areas of science education and learning sciences – knowledge building, environmental issues and school science. With each stakeholder working towards different goals in the program, the concept of boundary object is used to understand how different stakeholders work to develop a KB-NLC program in their own school while maintaining a common object that binds the members of intersecting social worlds together in this research project. In achieving the goal of the research study, each school has developed their own KB-NLC program, each with different learning outcomes yet recognizable in the motive that drives the activity.

Theme of the Interactive Session

The session showcases three examples of KB-NLC programs implemented in different schools that exemplify the productive work of different stakeholders in this design research around boundary objects (Star & Griesemer, 1989). Boundary objects, according to them, are the intersecting objects of different social worlds/communities which are "plastic" to meet the needs of different communities yet "robust" at the same time to be "recognizable" across different worlds (p. 393). Using the concept of *boundary object* (Star & Griesemer, 1989), we examine how different stakeholders and the principal investigators work together around their differences to implement Knowledge Building in their NLC activities while keeping to the fidelity of a common object that bound the community. Figure 1 shows the intersecting worlds of the three groups of stakeholders in this design research to create a boundary recognizable by its common motive, processes and environmental themes that KB activities are based on. All three case examples in this presentation emphasized on revision and refinement of students' scientific ideas through iterative cycles of show-and-tell, collaborative (online discussion) and experimentation. All these KB activities were conducted around themes related to environmental science.

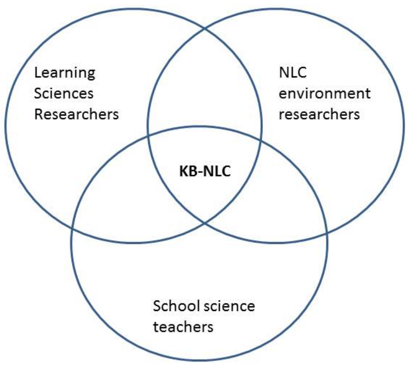

Figure 1. Intersecting Social Worlds.

While the plasticity of the boundary objects characterizes each case example as part of the KB-NLC community, the flexibility of boundary objects distinguishes each one as they differ in terms of their learning outcome, space and time. One KB-NLC case example was conducted as part of the school's science curriculum while others were conducted as an after-school enrichment or co-curricular activity. In terms of learning outcome, one school focuses on science process skills; another focuses on scientific knowledge and the third focuses on environmental issues.

In this interactive session, the goal is thus to present boundary object as a methodological concept to understand how the different stakeholders work together to create a different KB-NLC program in their school, yet with resemblance of the KB-NLC community. In doing so, we also present three case studies of KB-NLC as exemplars of the productive negotiation among us.

Description of the Three Orientations of KB-NLC Program

Three orientations of KB-NLC emerged from the design research project – knowledge orientation, process-orientation and affective-orientation. The following sections provide a brief description of each of the orientations.

(1) Knowledge-oriented Approach

A knowledge-oriented approach was observed to arise from two of the participating schools. In this approach, the trigger that began their knowledge building tends to be an everyday process that students were familiar with. Examples include decomposition of meat and germination of seeds. Students working in this orientation would be focusing on advancing knowledge-based ideas such as cause-effect (e.g., "small seeds germinate faster than big seeds") and reasoning (e.g., "maggots are produced by the process of abiogenesis"). The students working in this mode then conducted experiments to test their hypothesis. For example, students used a large number of seeds of varying sizes and compared their rates of germination to find out if small seeds germinate faster than big seeds. They then proposed reasons to support this hypothesis and compared their ideas with those found in the Internet and through interviews with their family members, for instance. The result of this knowledge-oriented approach was a set of generalized knowledge about the phenomena studied. For example, the group of students working on the decomposition of meat came up with a set of generalized characteristics of decomposition after they extended their investigations to test the ideas about decomposition of meat to other organic matter such as dead plants and other animals.

(2) Process-oriented Approach

While the knowledge-oriented approach focused on constructing new understanding about a phenomenon, a process-oriented approach focused on constructing new understanding of the science inquiry process, even though both might have been initially triggered by puzzlement over some phenomena. However, the talk in this approach tended to be focused on how to improve the science experimentation process so that evidences generated could be improved. Some process-based ideas include the concept of fair test and control. The rise above of the knowledge building endeavor included improved experimental design and processes.

(3) Affective-oriented Approach

The affective-oriented approach might look similar to a problem-based approach in the sense that students often work on trying to solve a more practical problem (e.g., reason for fishes' death in the tank kept in the classroom). The knowledge building component emerged from the need to find reasons for the problem (e.g., what led to the fishes' death in the fish tank). The students would propose possible causes and reasons (e.g., too much food in the fish tank could lead the fishes' death as the food caused a change in the pH level of water). Investigations were carried out to test their hypotheses (e.g., using a pH sensor to track the changes in pH level over a period of time with tanks of different amount of fish food). Following the establishment of the cause of the problem would be to extend it to the problem context in which this knowledge building arose. The result could be an improved understanding of the effects of one's action on the environment or in society.

Format of the Interactive Session

The activities of the interactive session will include an introduction of the CSCL project and boundary object as a methodological concept, followed by a series of short presentations by partnering schools of their KB_NLC program.

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