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Physical Microcosms: Potentials for Enriching Classroom Investigations in Ecology

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Abstract: Ecologists construct physical microcosms that exemplify mechanisms and relations in ecosystems. This poster describes how a 7th-grade classroom complemented field study of an intertidal ecosystem with design of classroom microcosms. Initial designs appeared constrained by literal resemblance. As students' inquiry increasingly focused on interactions among organisms, they configured microcosms to facilitate observation of these interactions. Microcosms became sites for studying processes that could be inferred from field data but rarely observed directly.

Introduction

Physical microcosms are often employed by scientists to investigate more closely how components of a system interact (e.g., Strayer et al., 2006; Tyrrell et al., 2006). When scientists construct microcosms, they do not merely copy a system but instead deliberately select and arrange for conditions in the microcosm that make more salient relations and mechanisms of interest in a natural system. Designing and employing microcosms as investigative tools introduces students to crucial considerations about the status of models as approximations of the world, their utility as investigative tools, and their status as explanations of system structure and function (Lehrer et al., 2008). Because microcosms resemble the target system in some critical ways, they offer students an entrée to modeling, partly because the analogical distance between model and system is visible (Lehrer & Schauble, 2002). However, previous research indicates that for students to perceive the microcosm as a model, and not simply a copy, they must have agency in its construction, especially in decisions about what to amplify and what to suppress, and in articulation of how the microcosm will help answer one or more research questions (Lehrer & Schauble, 2012). Having a hand in some aspects of microcosm construction and use also helps students understand that modeling is performative, and not only a matter of representing objects and relations symbolically.

Research Design & Context

This work provides an account of one seventh grade classroom's use of physical microcosms to exemplify aspects of an intertidal ecosystem for the purpose of investigation. This work takes place within a larger, multi-year design-based research study investigating how students' conceptions of and practices for representing variability inform their construction and revision of models of ecosystems. The context of this work is a statewide middle school citizen science curriculum focused on understanding how the relative abundance and distribution of native and invasive species of crabs are changing due to climate-driven factors. In designing and investigating classroom microcosms, our goal was to consider how physical microcosms might enrich classroom investigations of the target system and to investigate learning opportunities as well as conceptual and material challenges students might encounter as they used microcosms to investigate intertidal ecology. Our design privileged giving students time to observe the microcosm; to "get-to-know" the organisms of the intertidal, and how they relate to each other and the larger system. As thinking progressed, we invited students to "stretch" the components of their microcosms into forms that lend themselves to quantification and investigation of relations among quantities (Lehrer & Schauble, 2006), a process still ongoing in our focal classroom.

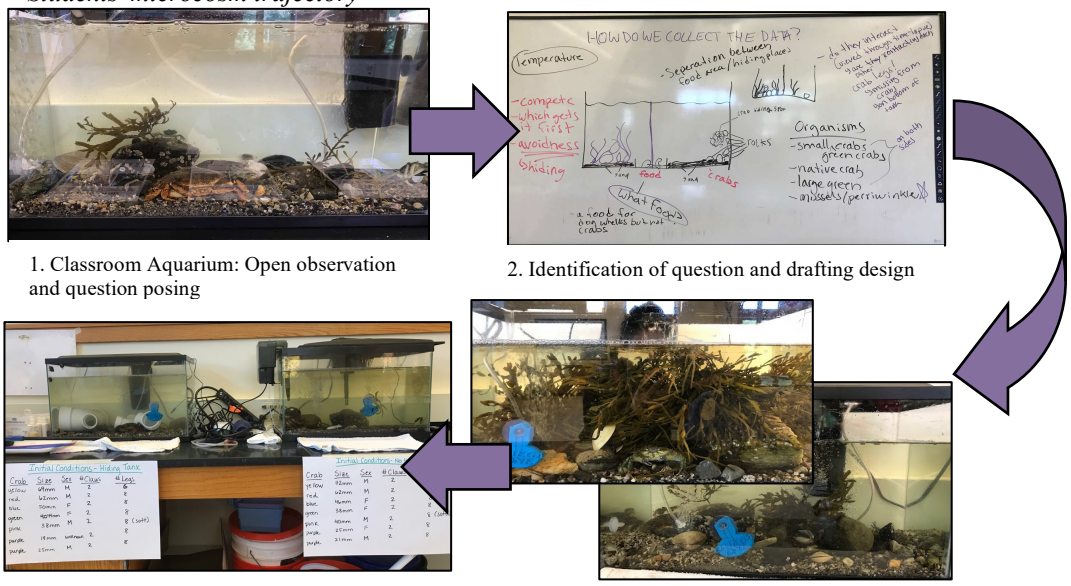
Findings & Implications

Although work on the project is still ongoing, consistent with previous work (e.g., Lehrer et al., 2000) we have found that although students initial microcosm designs privileged overt resemblance with the system, over time those commitments to resemblance created a material impasse which forced students to reconsider the purpose of the microcosm and its relation to the intertidal. Moving forward, they prioritized microcosm arrangements that facilitated observations of processes of interest—such as animals' refuge seeking—and that supported the collection of measures (Figure 1). After a period of open observation where students cultivated close looking, considered the purpose of microcosms in science, and posed questions, students completed two rearrangements of conditions to answer the question: *Do the amount of hiding spaces impact green crabs' behavior?* Students investigated this question by designing microcosms with two different hiding conditions: hiding and no-hiding.

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After a lively debate on whether the animals in the tank should be fed (one contingent of students insisted not feeding the animals would ensure "natural" behavior while another argued the environment was already artificial and therefore required providing food), the students settled on providing food in a central location ("hunger games style") to instigate foraging behavior and promote interactions between organisms. During this round of investigation students noted that their reliance on natural materials to create shelter for the animals prevented their own observations of behavior in the "hiding" tank. A second rearrangement of the microcosms using artificial materials was then undertaken to support seeing more of the processes and behaviors the students were interested in (e.g., "Maybe we should change it so that we can see them better."). With inquiry now stabilized, microcosms were now sites of study for processes, such as foraging and refuge-seeking strategies, that could be inferred but rarely directly observed in the field.

Figure 1:
Students' microcosm trajectory



1. Classroom Aquarium: Open observation and question posing

2. Identification of question and drafting design

3. First rearrangement: Hiding (top) and No-Hiding (bottom) Conditions using natural materials

4. Second rearrangement: Hiding (left) and No-Hiding (right) Conditions using artificial materials

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