Citizen Science in Schools: Supporting Implementation of Innovative Learning Environments Using Design-Centric Research-Practice Partnerships

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Abstract: Citizen Science can be used in schools to enhance science learning, bringing people from distinct cultural communities to a joint endeavor. This research examines how this unique setting can be turned into a mutually-beneficial learning ecology. To do so, a Design-Centric Research-Practice Partnership (DC-RPP) approach was applied in an elementary school, while examining what mechanisms of intervention can serve to support the development of the learning ecology.

Introduction

Citizen Science (CS) projects, in which non-scientists (citizens) take part in various stages of the scientific process (Shirk et al., 2012), aim for advancement of science, along with other goals such as outreach, public engagement and policy-making. Engaging in CS may promote different aspects of scientific literacy (Bonney, Phillips, Enck, Shirk, & Trautmann, 2015) as participants take part in authentic inquiry. Thus, CS has the potential to become a unique learning environment for school-based science education (National Academies of Sciences, Engineering, and Medicine, 2018).

CS-based learning environments bring together multiple forms and levels of expertise, including students, scientists, school educational staff and educational researchers. This joint endeavor can provide context for potential learning for each of the participants. Such an environment can be perceived as a learning ecology (Barron, 2006), as illustrated in Figure 1a. Nonetheless, fostering mutual learning in such a diverse setting, comprised of distinct cultural communities, can be challenging (Penuel, Allen, Coburn, & Farrell, 2015). We believe that Design-Centric Research-Practice Partnerships (DC-RPPs: Kali, Eylon, McKenney, & Kidron, 2018) can address this challenge. DC-RPPs are long-term partnerships that aim to co-design and implement innovative solutions to practical challenges in schools in a mutually beneficial way. Two theoretical lenses can serve in establishing productive DC-RPPs: (1) Boundary Crossing - a sociocultural theory that describes how boundaries can facilitate learning between communities (Akkerman & Bakker, 2011; Akkerman & Bruining, 2016) and (2) Organizational Learning – a theory that concerns with becoming a learning organization (Senge, 1990), as detailed in Figure 1b. We contend that using mechanisms of intervention based on these theories can promote learning in a CS-based learning ecology. Hence, this research aims to explore: (1) What type of learning outcomes can be achieved in such a unique ecology for each of the participants, and (2) What mechanisms of intervention can serve to support its development, particularly in relation to the interaction between the school educational staff and educational researchers.

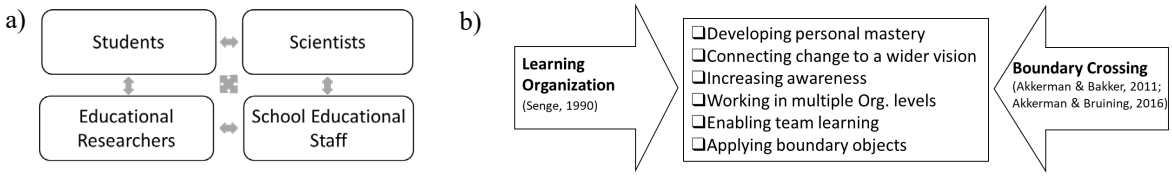

Figure 1. A CS-based learning ecology in school, and mechanisms of intervention to foster its development.

Intervention and methods

A CS-based learning ecology was established in an elementary school around a CS project that aims to collect the public's observations of jellyfish. The ecology included students from the 4th and 5th grades, marine ecologists, school educational staff, and educational researchers (present authors). A 3-year intervention program was designed based on mechanisms of intervention detailed in Figure 1b. Here we report initial findings from the first two years of the intervention. Data was collected from 20 students (out of 60), two scientists, nine educational practitioners (the principal and eight teachers), and three educational researchers. At

the end of each year, interviews and focus groups were conducted with the research participants. Students and teachers each filled their own questionnaire regarding learning experiences. In addition, ongoing correspondence between participants, reflections and researchers' journals were used as data sources. Initial content analysis was conducted to address both research questions using our theoretical frameworks.

Preliminary results

Regarding types of learning outcomes in the CS-based ecology, findings show that some progress was made for all participants, but learning was more prominent for particular groups. Examples are highlighted in Table 1.

Table 1: Examples of types of learning outcomes in the CS-based learning ecology examined in this research

Participant Group	Examples for Types of Learning Outcomes (Initial Findings)	Sample Quote
School Educational Staff	Expansion of assumptions about learning and teaching	"I realized that scientific research is feasible also for elementary school kids, not just for MA students."
Educational Researchers	Adoption of new attitudes and practices to meet school's needs	"It was a great learning experience, an unexpected path with recalculations as needed…."
Students	Realizing how science works	"I used to think these things aren't getting verified."
Scientists	Insights on communicating science to children	"To pass on a message to younger children, we are missing an understanding of how they see things."

To reveal the mechanisms of intervention that supported learning, we focus on the DC-RPP between the educational researchers and school educational staff. Findings show commonalities as well as differences in how various functionaries perceived which mechanisms contributed to learning. An example of a repeated mechanism is the added value of a "broker" role (individuals that bridge between communities), consistent with Akkerman and Bruining's conceptualization (2016). An example of a differing one is the perceived contribution of on-going communication. While the teachers gave little attention to this mechanism, the researchers felt that lack of communication impaired the partnership. In addition, we observed an interesting development of mechanisms along the course of the partnership. For example, using confrontation as a direct mechanism to promote learning, was feasible only towards the middle of the second year, probably thanks to maturation in the relationships between the communities. In addition, we observed how maturation in the relationships between the communities allowed the employment of different mechanisms along the course of intervention. For example, utilizing confrontation between the researchers and school principal to promote learning, was feasible only towards the middle of the second year.

Conclusions

The described research demonstrates how DC-RPP can be highly instrumental in successfully promoting mutually-beneficial learning ecologies of CS in schools.

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