Equals in Partnership? Perceptions of Expertise in Teacher-Scientist Partnerships Built around Citizen Science Projects (Short Paper)

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מפגש בין שווים? תפיסת המומחיות בשותפויות של מורים ומדענים הנבנות סביב פרויקטים של מדע אזרחי (מאמר קצר)

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Abstract

Building upon the embedded potential for learning, growth, and empowerment, school-based citizen science engages K-12 students in authentic research activities. Such initiatives are commonly created as collaborations between scientists and schools, often with the support of educational specialists. The design and enactment of these multi-stakeholder environments call for the emergence of "trading zones", in which partners holding different worldviews and vocabularies negotiate difficulties as they work towards shared or congruent goals.

One of the factors that greatly impacts the resolution of these "trading zones" is the perception of expertise. The question of who holds what expertise has implications regarding the distribution of roles and affordances within the partnership. This study examines how scientists and teachers that collaborate in school-based citizen science projects perceive their own and each other's expertise in domains outside of their usual professional realm.

Findings show that teachers' scientific and interactional expertise was not highly valued by scientists. Scientists particularly considered teachers' scientific expertise to be low. Teachers, on the other hand, considered themselves to be competent contributors to research processes. Perceptions of scientists' pedagogical and interactional expertise was more complex, with both scientists and teachers showing mixed views of scientists' abilities in these domains.

Keywords: citizen science, school-based citizen science, teacher-scientist partnerships, expertise, trading zones.

Introduction

Citizen science encompasses a wide range of initiatives whose common characteristic is the participation of non-scientists in the practice of scientific research (Bonney et al., 2009). Citizens most commonly participate in data collection or processing of a scientist-led research, yet sometimes take responsibility for other research stages (Haklay, 2013; Shirk et al., 2012). Such projects can bring benefits both to research, such as enhanced data collection or locally-relevant studies (Mckinley et al., 2017), and to citizens, who gain knowledge, skills, enjoyment, the opportunity to contribute to science and society, and a voice in decision-making processes (Phillips et al., 2018, 2019).

Building upon the embedded potential for learning, growth, and empowerment, school-based citizen science engages K-12 students in citizen science initiatives and authentic research activities. Students are typically introduced to a scientist-led study and undergo a series of learning activities while participating in data collection and sometimes other research stages. When asking questions or analyzing data, students' work may ensue either in accordance or independently of the scientists' research process. While educational specialists are frequently involved, teachers often have significant roles in the design and enactment of the projects.

Such collaborations between scientists, teachers, and students are grounds for the emergence of "trading zones" (Galison, 1997), in which partners holding different worldviews and vocabularies negotiate difficulties as they work towards shared or congruent goals. This process may involve the establishment of boundary objects and a developing ability to communicate over disparate areas of expertise (Collins et al., 2007).

In the case of school-based citizen science, of particular interest are the relationships between scientists and teachers. Both bring their own professional expertise yet are faced with roles and tasks they are not accustomed to - teachers are not familiar with a particular scientific domain's body of knowledge and methodology, while scientists are not used to working with school systems and school children. Their capacity to navigate these untreaded waters, as well as their partners' evaluation of this capacity, are part of the delicate balance of considerations that directs negotiations within the "trading zone", ultimately determining the affordances provided by the partnership.

Research Goal

The goal of this study is to examine how scientists and teachers that collaborate in school-based citizen science projects perceive their own and each other's expertise in domains outside of their usual professional realms.

Methodology

The study examined 9 cases of citizen science projects that were active in schools for at least one school year. The projects were each led by different teacher-scientist teams, and in 7 cases included the involvement of an educational researcher. All teachers were experienced science teachers, except for one geography teacher that participated with her classroom in a geography-centered citizen science project. Within the leaders of each project, one scientist and one teacher were included as study participants.

Participants answered a questionnaire that encompassed several aspects of school-based citizen science projects and whose full results will be presented elsewhere (Atias et al., submitted). Among other questions, participants were asked to evaluate the efficacy of scientists and teachers for preforming different skills within the partnerships. Efficacy scores were given on a 7-point Likert-type scale ranging from *Very Low* to *Very High*. As the participants filled the questionnaire, they were instructed to *think-aloud* and voice their thoughts while working (Charters, 2003).

Participants' efficacy scores were graphically plotted to show descriptive statistics. To cross-reference scores and to uncover additional information on participants' perceptions of expertise, transcripts of the think-aloud statements were analyzed using a combined bottom-up and top-down thematic analysis (Boyatzis, 1998; Erlingsson & Brysiewicz, 2017). First, a bottom-up analysis identified three domains of expertise that participants referred to in their statements, as detailed in Table 1. Second, expertise-related statements in each of the three domains were coded to reflect one of four expertise levels, using coding definitions presented in Table 2.

Table 1. Domains of expertise identified in participants' think-aloud statements

Domain of Expertise	**Description**
Scientific	Related to scientific knowledge and skills
Pedagogical	Related to pedagogical knowledge and skills, especially, yet not exclusively, in science education.
Interactional [1]	Knowledge of the "language" and norms of both scientific and pedagogical domains, with the ability to operate and communicate at the intersection of both domains.

[1] This domain of expertise is closely associated with Collins and Evans' (2002) notion of Interactional Expertise.

Table 2. Definitions of levels of expertise used for coding of expertise-related statements

Level of Expertise	**Definition**
Unknowledgeable	Has no knowledge or ability within the domain.
Novice	Has little knowledge or low ability within the domain. Can learn and gain expertise.
Contributor	Has a sufficient level of knowledge or ability to make tangible contributions to the practice of the domain.
Expert	Has in-depth, "insider" knowledge and ability within the domain.

Results

Teachers' Scientific and Interactional Expertise

Participants' efficacy evaluations along a 1-to-7 scale (1 signifies *Very Low*, 7 signifies *Very High*) are presented in box-and-whiskers graphs (Figure 1). Within the boxes, a line signifies the median and *x* marks the average.

Findings show that teachers generally evaluate their own scientific and interactional skills higher than scientists do. Scientists gave particularly low scores to teachers' efficacy for scientific publication and research planning skills (determining research subject, goals, questions, methods and tools). Teachers' interactional skills were more readily supported by scientists, yet they provided somewhat restrained scores for one of the teachers' main roles – to guide students in performing research.

Figure 1. Participants' evaluations of teachers' efficacy in scientific and interactional skills within the school-based citizen science projects.

Examination of participants' expertise-related statements reveals further nuances in their perceptions. Findings are presented as a heatmap showing the levels of expertise reflected in participants statements, either in general or related to specific skills (Figure 2). These findings further demonstrate scientists' perception of teachers as unknowledgeable or novices in performing scientific research, especially regarding determination of research subject, goals and

questions. Also apparent is teachers' confidence in their own scientific and interactional abilities, with the exception of scientific publication and determination of research methods and tools.

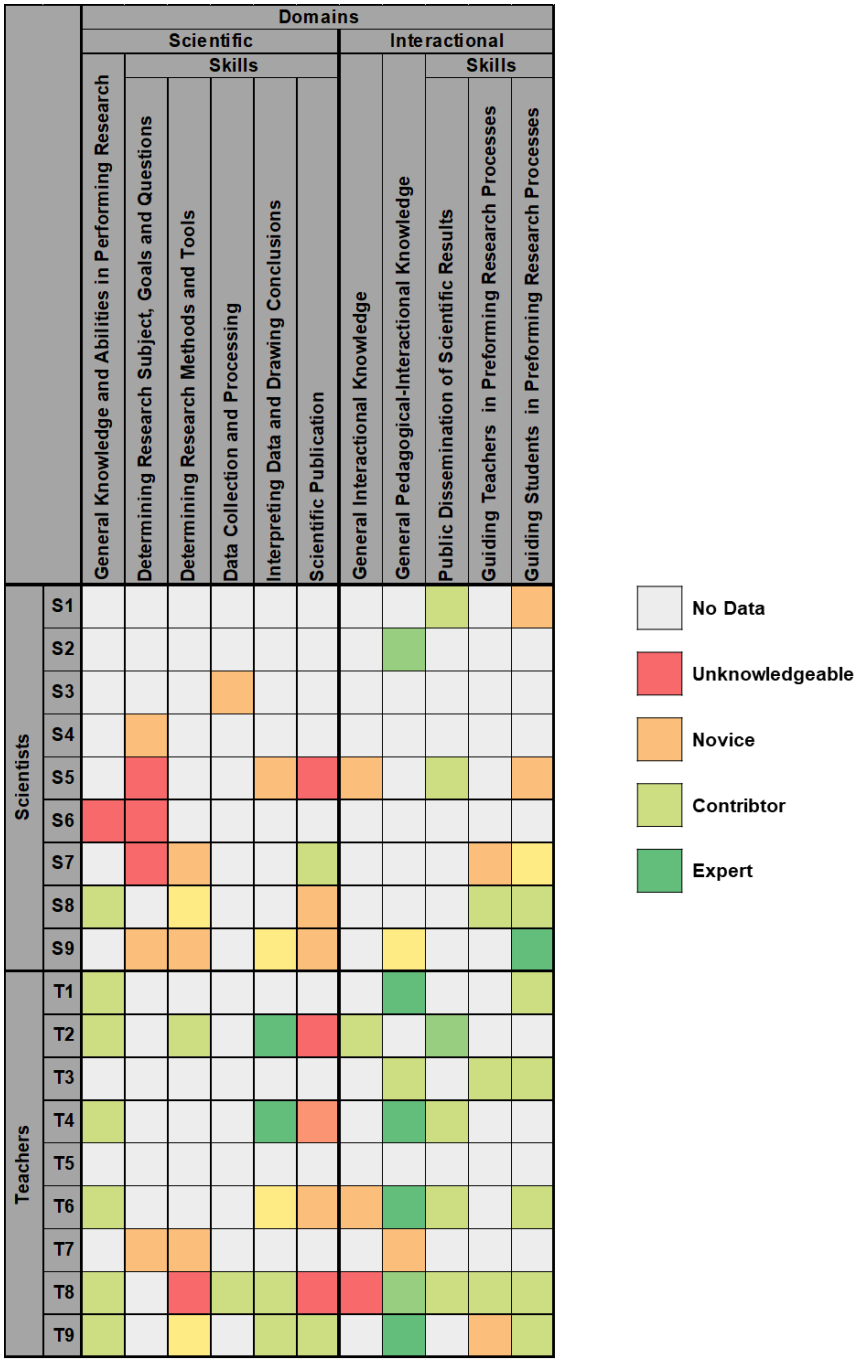

Figure 2. Participants' perceptions of the level of teachers' expertise in the scientific and interactional domains.

Scientists' Pedagogical and Interactional Expertise

Participants' evaluations of scientists' efficacy in the pedagogical and interactional domains show that both teachers and scientists generally consider these efficacies as medium-to-high (Figure 3). Scientists were less likely to value their own efficacy in developing learning resources and in guiding students in performing research.

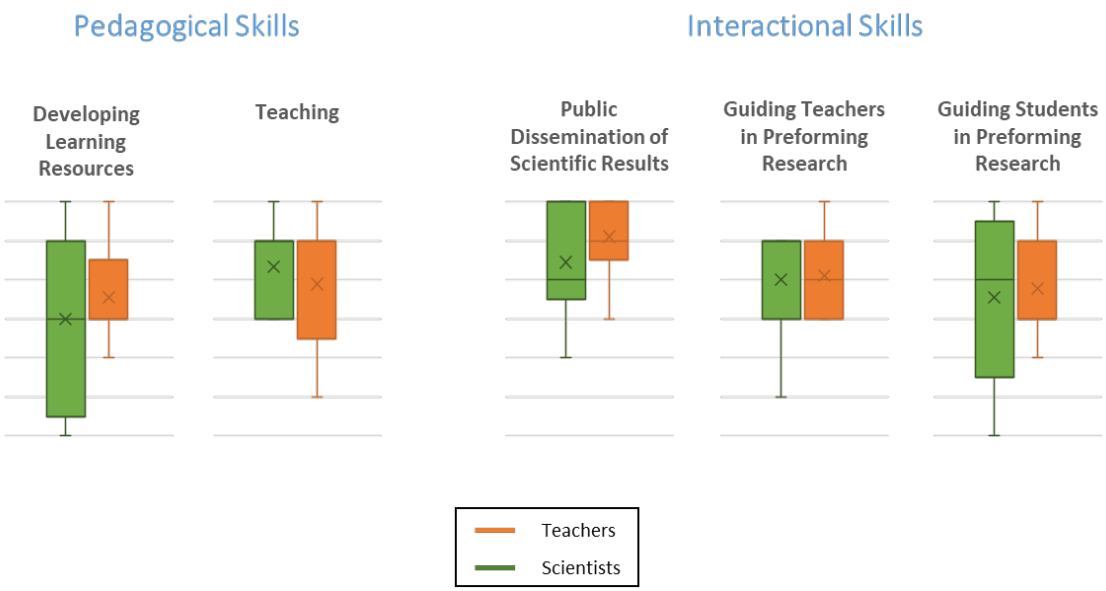

Figure 3. Participants' evaluations of scientists' efficacy in pedagogical and interactional skills within the school-based citizen science projects.

However, examination of participants' expertise-related statements reveals a different picture (Figure 4). Even though efficacy scores were generally medium-to-high, scientists have more-often-than-not referred to themselves as unknowledgeable or novices in the pedagogical and interactional domains. In several cases teachers expressed the same attitude, yet they were equally likely to refer to scientists as contributors or even experts within these domains.

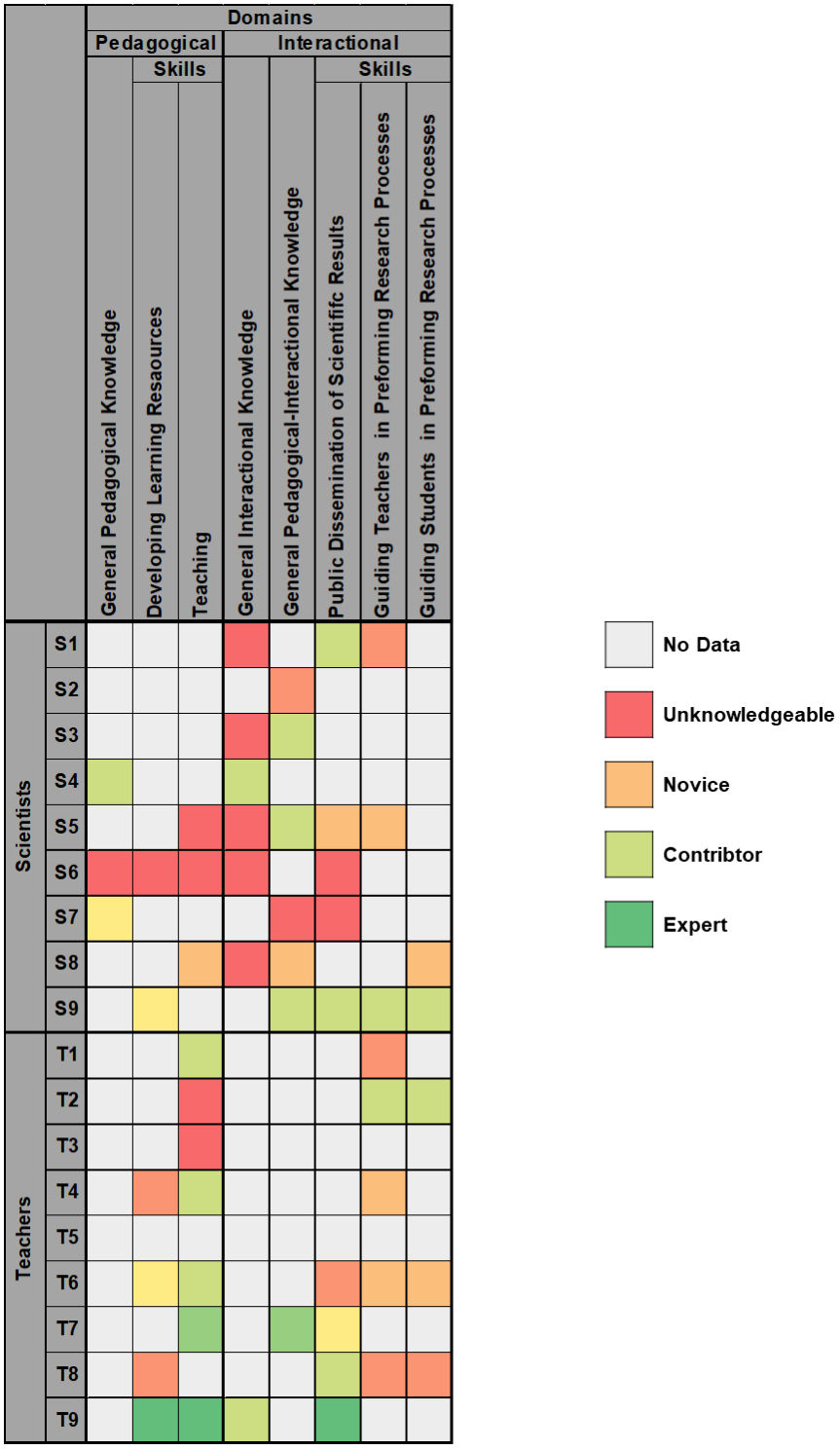

Figure 4. Participants' perceptions of the level of scientists' expertise in the pedagogical and interactional domains.

Discussion

Our findings demonstrate a well-known issue in academia-community partnerships, where scientists are often considered experts by default, while unique expertises of community members are not equally recognized (Bringle et al., 1999). This uneven perception of expertise leads to

unbalanced power relations and raises questions regarding the nature of the partnership – is it a mutual collaboration or do the goals and interests of one side take precedence over those of the other (Davis et al., 2017; Janke, 2013).

The disagreement between efficacy scores given to scientists' pedagogical and interactional abilities, and the way teachers and scientists *talk* about these abilities, may reflect this very issue. A careful reading of the think-aloud transcripts reveals cases in which participants at large and teachers in particular hedge their evaluation of scientists' expertise, as in "They [the scientists] can definitely teach students. They gave a very nice lesson. Yet not like we [teachers] do it." (T1). We interpret such remarks and the mismatched findings as echoing a complex and multi-layered perception of scientists' expertise and their role within the partnerships.

The same cannot be said regarding perceptions of teachers' expertise, of which scientists seem to possess a simplistic view that is similar to their view of students' expertise (data not shown). Teachers' and scientists' perceptions of teachers' expertise were not in agreement, as teachers demonstrated higher evaluations of their own abilities. This gap may lead to discrepancies in the "trading zone" negotiations both parties are engaged with as they co-lead the partnership.

This study takes a first step towards understanding perceptions of expertise in teacher-scientists partnerships built around school-based citizen science projects. Further examination of these issues can help clarify how these types of "trading zones" are created and navigated, and how can they be supported.

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