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Exploring Self-Efficacy Shifts within an Informal STEM Program

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Abstract: Engaging in informal learning activities can support non-dominant learners' identity development, agency, and interest in STEM. In this paper, we build on the potential of community-based settings in engaging non-dominant learners (n=10) to explore learners' science self-efficacy. We find that overall self-efficacy improved, but not all students followed a similar learning trajectory. We explore these differences using examples from interviews and close by discussing methodological suggestions to address such emerging differences.

Introduction

In this poster, we build on previous work that demonstrates the potential for informal learning activities to create equity-oriented learning spaces and pedagogy that support non-dominant learners in STEM fields (e.g., Barton & Tan, 2010; Pinkard et al., 2017). Here, we attempt to identify methods for understanding shifts in science self-efficacy within the context of Palestinian learners' engagement in an out-of-school community-based program in Israel. Understanding learners' science self-efficacy within this context is important for both practical and theoretical reasons. Historically, Palestinians in Israel have been experiencing a systematic marginalization, rooted in settler-colonial citizenship dynamics within this political context (Rouhana & Sabbagh-Khoury, 2015). On a practical pedagogical level, cultivating self-efficacy is a major motivation of our collaborators at Al-Rowad for Science and Technology working with Palestinian Arab learners from their society in Israel. Understanding the role of context expands our methodological tools towards applied research with local communities and is a generative way of engaging with local communities (e.g., Medin & Bang, 2014). At a theoretical level, self-efficacy is defined as the belief that one is capable of taking part in an action or an activity at a designated level affecting learners' perceptions of their capability to complete a task (Bandura, 1997). Measuring self-efficacy towards science with careful attention to the context in which activities are situated can give an understanding of the complexity of such effects. Here we ask: Does science self-efficacy shift after engaging in an out-of-school, community-based program? If so, how?

Activities

This study is part of a larger project that aims to better understand the engagement and participation of learners within a community-based organization's transdisciplinary STEM learning program. This paper explores science self-efficacy shifts after students participated in the 4-day program (8 hours total). The program consisted of four major transdisciplinary hands-on activities designed by the organization: *Super Absorbent Polymer (SAP),* where learners were introduced to concepts and phenomena like colors and diffusion; *Newton's Disc,* which focused on light, color, and mechanical motion; *Illuminating Board,* where learners explore characteristics of light, dark, and illuminating materials in objects and animals; and *Oil & Water,* where students were exposed to volcanism, density, and reactions between substances. These activities were transdisciplinary by design. For example, each activity involved an artistic element, providing opportunities for transdisciplinary learning (Mawasi et al., 2021).

Methodology

Ten fifth- and sixth-grade learners (five girls, five boys) participated in the program. All participants are Arabic-speaking and attended all four days of the program. We used a pre-post learner questionnaire that included questions about learners' science interests, technology engagement in general, and science self-efficacy. The pre-post questionnaires were translated to Academic Arabic. After the program activities were completed, we conducted semi-structured interviews, where we asked them to elaborate on selected items from the questionnaires. Importantly, learners were not asked to explain why they chose the answer on the posttest. Instead, they were asked the question anew, encouraging them to answer based on how they were thinking at that moment.

Findings

Overall, we find a trend towards learners' science self-efficacy improving from pretest (M=3.2, SD=.36) to posttest (M=3.5, SD=.38), ($t(9)=-2.15$, $p=.06$). However, when looking at the items separately, we see that this trend is driven by a single item: "I can use science to solve problems in everyday life" (Pretest M=2.6 (SD=.97), Posttest M=3.6(SD=.52), ($t(9)=-3.0$, $p=.015$). We observed that learners' answers shifted between the posttest and

interview, with interview answers more closely aligning to responses given on the pretest. We use the qualitative data to explore how students are describe these concepts in order to better explain these findings. An inductive analysis (Thomas, 2006) allowed an understanding the ways of thinking that mediate learners' responses. Stances were interpreted and analyzed by the first author, who is from the local community (fluent in both Academic Arabic and Palestinian Arabic) and studying in the United States. The first author then created codes in English, and the stances that reflected codes were translated to English. Then the first author and second author (from the United States) discussed the codes. A major theme we identified is that there is neither internal nor external consistency in the way that students operationalize the term *science*. By external consistency, we mean that within an item, some students used the term to mean the school subject, whereas others took a more holistic approach. By lack of internal consistency, we mean that individual students changed the way they defined the term between questions (e.g., for the item "I can learn science easily," a student might have described doing well in science class, but for the item, "I can use science to solve problems in everyday life," a student might describe a scientific phenomenon that occurs at home). Results from the interviews reflect that learners demonstrated diverse ways of contextualizing science. For each item, the learners referred to either school, the program, everyday life, or general science, or a combination of these.

Discussion and implications

The findings reflect descriptive shifts in students' self-efficacy; however, these shifts were driven by a single item. Yet, the interviews show various ways of conceptualizing science across items. We explain these variations through the diverse ways students reflected on their engagement, including attending to knowledge they learned (procedural and declarative), describing how they used the activities at home, and perceived self-efficacy in relation to the physical artifacts they created. These results reflect that some learners' perceptions of what counts as science connects to their conception of doing well in school science. We also see that it is important to revisit the methodological tools applied within this local context. First, to be linguistically open, to expand ways for students to express their thinking and learning process (e.g., being prepared to use both Academic and spoken Palestinian Arabic, diverse use of dialects). Second, it is also important for the process of creating and iterating on assessments to understand learners' perceptions of learning and the teacher's role, as well as the various ways that learners perceive artifacts, and the social and political context mediating learning activities. Finally, it is important to be open to involve, share, and discuss results and design with community members throughout the process. We believe that collaborating with local community members to develop measurements, rather than relying solely on dominant scientific instruments that do not account for context, will deepen our understanding of learning.

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