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SCIENCE LEARNING IN EVERYDAY LIFE

Focus on ... Equity and Out of School Learning

Research–practice partnerships as a strategy for promoting equitable science teaching and learning through leveraging everyday science

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Equity is an enduring challenge in science education. Promoting equity requires a multifaceted approach that attends to power, teaching, and opportunities to learn (Hand, Penuel, & Gutiérrez, 2012). Although science education researchers in both formal and informal settings have helped design many powerful curricula, instructional strategies, and programs for youth with potential to promote equity, few of these are widely implemented (Fishman & Krajcik, 2003; Penuel & Fishman, 2012). Similarly, innovations have failed to "disrupt historically shaped inequities and cultivate transformative agency from within communities" (Bang, Faber, Gurneau, Marin, & Soto, 2016, p. 29). As noted in the recent National Research Council (2015b) report *Supporting Productive Science Learning in Out-of-School Settings*, a key strategy for promoting equity is to leverage everyday science learning. This means both engaging with science in the everyday and designed informal settings that young people traverse, and also connecting school science to the interests, experiences, and capacities young people develop through their everyday activities at home, in community, and via the media.

There have been powerful small-scale projects that seek to leverage everyday science knowledge. For example, GET City engages youth's social interests and concerns as jumping off points for engaging with science and scientific practices (Calabrese Barton & Tan, 2010). Cheche Konen engaged Haitian-heritage youth's linguistic practices to support math discourse in the classroom (Nasir, Rosebery, Warren, & Lee, 2014). And SciGirls has developed a fledgling network of programs designed to support gender equity among middle school girls (Luehmann). But to date, designed settings for science learning—whether museums, afterschool, or school environments—have not yet adopted this core equity practice at scale.

One conjecture for why research—even research focused on equity—has had little impact on practice is that there are few sustained partnerships between researchers and educators[1]. Yet across a range of fields, there is strong evidence that the uptake of ideas and findings from research depends on sustained interaction between researchers and practitioners (National Research Council, 2012b). Of course, promoting equity is not a simple matter of applying research to practice, but nor are sustained partnerships between researchers and practitioners simply a means to get practitioners to take up researchers' good ideas. Rather, partnerships are crucibles for reimagining how research and practice might relate in ways that promote the agency of educators and learners, and they present opportunities for collective efforts to challenge historically shaped inequities that many engaged in everyday science seek to address. They also more strongly position the knowledge, experience, and questions of educators as drivers of research, and as such represent a more equitable approach to advancing equity in education, whether in informal or formal settings (Bevan & Penuel, forthcoming).

In this essay, I explore four different kinds of "equity projects" (Bell & Wingert, 2017) leveraging everyday knowledge that are being developed through research–practice partnerships. Three of the projects investigate how out-of-school settings leverage students' everyday science practices, and one of them investigates how school settings can leverage out-of-school experiences. In describing the projects' aims and how partnerships are pursuing them, I highlight the ways that the arrangements between educators and researchers are helping to promote equity. As with many equity projects, the aspirations of these efforts reach into a just social future that does not yet exist. The goal of this chapter is to argue that considerations of equity with respect to everyday and informal science learning can benefit from the development and expansion of new approaches to research that put practitioners' deep knowledge of the communities they work with and the contexts they work within on equal footing with the methodological insights of researchers.

1 | WHAT MAKES A COLLABORATION A RESEARCH–PRACTICE PARTNERSHIP?

There are many ways that educators, community organizations, and researchers in science education work together, but only some can count as partnerships as I define them here. To be a research–practice partnership, the collaboration must meet the following characteristics as outlined by Coburn, Penuel, and Geil (2013):

1. Long-term: Partnerships are collaborative arrangements that develop over multiple years, and partners have an open-ended commitment to working together.
2. Focused on problems of practice: Partnerships are focused on addressing matters of concern to educator and community partners, rather than solely on developing theory and knowledge.
3. Mutualistic: Partnerships address the needs and goals of all partners.
4. Intentionally organized: Partnerships have established practices for making decisions together, designing innovations, and conducting research together.
5. Produce original analyses: Research to address questions of mutual interest to educators and researchers informs ongoing joint work of the partners.

Equity can be—but is not always—a focus of the work of research–practice partnerships. Yet, when it is, as with many partnerships located in urban communities where there are significant gaps in learning opportunities that are linked to historically persistent and systemic racism, classism, sexism, and heterosexism, mechanisms for directly addressing historical equities may also be an essential characteristics of research–practice partnerships (Barton & Bevan, 2016). Partnerships necessarily engage directly or indirectly with historical inequities and the related links among learning, power, and politics, but partners must seek to explicitly address underlying inequities, if the project is intended to be transformative and not reinforce the status quo (Renée, Welner, & Oakes, 2009). The partnerships described below engage in just such work.

2 | ADDRESSING HISTORICAL INEQUITY THROUGH INCLUSIVE DESIGN PRACTICES

One important type of equity project that partnerships can undertake is to address historical inequities through expanding who participates in designing policies and programs in science education. Historically, federal, state, and local policymakers decide the aims for education, and researchers play a role in supporting them through design and evaluation activities. Families, communities, teachers, and students have little say in the direction or strategies of education reforms. Partnerships, by design, seek to promote inclusion in multiple aspects of educational improvement,

including deciding on the problems to be solved and the aims of joint work (Penuel & Gallagher, 2017). But the scope of who is included varies from partnership to partnership, and even those with good intentions unwittingly limit participation of the very community members they are intended to support (O'Connor, Hanny, & Lewis, 2011).

A partnership among the American Indian Center of Chicago, Northwestern University, TERC, and different organizations on the Menominee reservation in Wisconsin is an example of a partnership that is engaged in this kind of equity project. The aims of this partnership are to expand Native American students' participation in science, a group that is not only underrepresented in science but whose communities have had their education controlled by outside agencies. With this historical context in mind, the team made a purposeful decision that indigenous people would fill the majority of leadership roles in the partnership. The group also committed to pursuing participatory research that involves community members (including elders), parents, youth, teachers, and researchers in all phases of research and development problem formulation, design and implementation, data collection, and analysis (Bang, Medin, Washinawatok, & Chapman, 2010). The resulting program, which involves learning in both community and classroom settings, proved successful in helping many young people begin to see themselves as scientists and to link their own cultural practices to science practices (Bang & Medin, 2010).

3 | EXPANSIVE NOTIONS OF STEM IN AFTERSCHOOL MAKING PROGRAMS

What counts as mastery in a domain of science is constantly evolving, and yet education standards and sometimes researchers represent science practices as static and generally constrained to those common to professional science being conducted in the lab or sometimes the field. Broadening participation in science is facilitated when we expand the entry points into science and trouble the sharp boundaries sometimes made between everyday experiences and scientific practice (Bell, Tzou, Bricker, & Baines, 2012; Calabrese Barton, 1998). Nowhere is this more evident than within contemporary efforts to develop "making" as a strategy for broadening participation in science and expanding what counts as science learning. In making, young people produce artifacts they develop based on their interests and experiences, often engaging in practices that can be easily connected to those emphasized in science education today (Bevan, 2017). Partnerships are a key strategy within efforts to promote equity through making, because careful work is needed to map connections among professional practices of making in science and engineering, youth initiative and activity, and learning (Bevan, Gutwill, Petrich, & Wilkinson, 2015; DiGiacomo & Gutiérrez, 2016).

The California Tinkering Afterschool Network is a partnership that illustrates this kind of project. A major focus of this effort is to support a group of afterschool programs that have developed studio spaces and programs focused on making and tinkering activities to promote equitable participation in these spaces and programs (Bevan, Ryoo, & Shea, in press). The research–practice partnership developed specific commitments to equity through a "value mapping" activity, where partners defined together what equity meant to them and how it manifested in their programmatic activities. These conversations shaped the research questions pursued, the coding schemes developed, and the joint analysis of the data. A key area of inquiry that emerged through this partnership work was a research focus on the role and meaning of working through "failure" for young people in making and tinkering spaces. This focus is important, because so many young people of color receive messages about persistence through failure that reinforce an individualistic, rather than collaborative, notion of what it means to succeed in science and engineering projects.

4 | ADDRESSING INEQUITABLE OPPORTUNITIES TO LEARN IN SCIENCE

Contemporary goals for science education are ambitious, and they include a commitment to all students achieving them. But many students do not have adequate opportunities to learn science: elementary students in schools under

high accountability pressures may receive little instructional time, and schools may lack the material resources needed to implement high-quality curriculum materials. Many of the schools where students do not have adequate opportunities to learn science are in communities with high concentrations of students living in poverty and students of color. Addressing inequities requires attending to the organizational processes that limit opportunity, something that is possible when researchers partner with district leaders committed to equity and with the authority to allocate resources to addressing inequity.

This is the focus of a partnerships organized using ecosystem strategies—where multiple agents and actors within a given community carefully collaborate to both diversify and enrich the learning ecosystem, and to intentionally broker learning opportunities across and within the ecosystem. Research–practice partnerships such as that of the HIVE NYC working with New York University and Indiana University are together exploring key research questions, surfaced through group network inquiries, that address questions critical to the sustenance of the learning ecosystem (Santo, Ching, Peppler, & Hoadley, 2017). For example, rather than research focusing on the qualities of learning designs or learning outcomes in a given program within the network, the research is focused on understanding where and how student learning is brokered (or not) across opportunities within the network. How are the everyday interests of young people intentionally pursued and supported across the day and over the years? The results of this research are informing the design of program activities at each network member to ensure that young people have the continuing opportunities to deepen, expand, and continue their developing interests in design and digital making programs.

5 | CONNECTING CURRICULUM TO STUDENTS' EVERYDAY INTERESTS AND EXPERIENCES

Afterschool spaces are not the only places where young people can make connections between their everyday experiences and science. It is possible to design curriculum experiences that explicitly draw on students' cultural experiences in ways that build both their understanding of science and identification with science (Tzou & Bell, 2010). Connecting curriculum to students' interests and experiences is an important equity strategy, because it helps students from different backgrounds see how science can be meaningful and relevant to their everyday lives (National Research Council, 2012a). Partnerships that include the voices of both teachers and students can enhance the likelihood that new curriculum will connect with students' interests and experiences.

The Inquiry Hub partnership among the Denver Public Schools, University of Colorado Boulder, and the University Corporation for Atmospheric Research has undertaken an equity project focused on this effort. The partnership is redesigning the district's biology curriculum, through a collaborative design process that brings together teachers, district leaders, and researchers (Severance, Penuel, Sumner, & Leary, 2016). Student voice in the design process enters in two ways to the process: first, in helping to select a "driving question" for the project-based units, and second, as feedback to the team on lesson coherence. Before developing a unit, researchers survey students of codesign teachers about their interest in a range of possible questions to investigate. Then, at regular intervals, students complete brief surveys about how relevant the lessons are to them, their class, and their community. The design team uses these data to inform ongoing revisions to units (Penuel, Van Horne, Severance, Quigley, & Sumner, 2016).

6 | NEW APPROACHES TO RESEARCH FOR EXPANDING EQUITY THROUGH LEVERAGING EVERYDAY SCIENCE

Research–practice partnerships are a promising—and maybe even necessary—strategy for implementing today's equity-oriented vision for science learning as reflected in documents such as the National Academies *Learning Science in Informal Environments* (2009) and *Identifying and Supporting Productive Science Learning in Out-of-School Settings* (2015),

as well as the Next Generation Science Standards. Science for all demands that education leaders and researchers "reach across the traditional boundaries of schools, districts, and states to share information and expertise" needed (National Research Council, 2015a, p. 6). But science for all demands more than just access to the same information and expertise; it requires specialized expertise about particular communities and students within them. As these examples illustrate, research–practice partnerships concerned with equity-oriented approaches to leveraging the everyday interests and skills of economically and racially marginalized young people can bring new voices to the focus and conduct of research. New questions are asked and new strategies are developed. By promoting equity within the research project itself, across the adults engaged in providing science to young people, such projects may be able to more directly identify and engage obstacles to achieving equity within the specific local contexts and audiences concerned. Science "for all" cannot be "one size fits all." As the out-of-school STEM learning sector seeks to deepen its engagement with equity, more research–practice partnerships that bridge everyday and designed learning contexts are needed to develop robust, relevant, and sustainable results that can scale.

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ENDNOTE

[1] Notable exceptions include the partnership between Maureen Callanan at UC Santa Cruz and Jenni Martin at the San Jose Children's Museum or that of Richard Lerner from Tufts and the 4-H program.

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