Over the past few decades, research in the informal science education field has been rapidly expanding. There are more doctoral programs that include a focus on learning in out-of-school settings. There are more informal science organizations or programs that are hiring full time research staff. Two volumes synthesizing research, much of it from the last 10-15 years, have recently been published by the National Academies of Sciences (NRC, 2009, 2015). Peer-reviewed educational research journals (e.g., Science Education, The Journal of the Learning Sciences) have dedicated special sections or have published special issues on informal learning.

While the growth of research-based knowledge about learning in informal environments is relatively new, the relationship between research and practice in informal science education can sometimes repeat patterns that are relatively old. Typically, the educational researcher holds most of the power in the relationship; for example, researchers usually control access to funds, have primary control over the data, and take the lead, sometimes sole, authorship of the publications or other representations of knowledge resulting from studies.

This pattern reflects our cultural models for the relationship between research and practice – i.e., what we envision, expect, and tend to enact when we imagine or begin a research and practice relationship. Encapsulated well by the common report headline What Research Says, our cultural model tends to position educational practitioners as having questions and educational researchers as having answers. One party is speaking and the other is meant to listen. Oftentimes, following this model, research seeks to reduce “the noise” of practice (though some might call noise “the lifeblood” of practice) in order to produce valid and replicable results. On this view, the daily realities of educators are sometimes seen as impediments to knowledge production rather than as resources or even primary sources for advancing
relevant and useful understanding to make change in the world.

A critique of this model is that it has led to the production of a large body of research that is more or less unmoored from practice. It therefore does not reflect the constraints, complexities, and needs of practice in ways that ensure that research can inform changes to practice that are widely usable and sustainable (Penuel, Fishman, Sabelli, & Cheng, 2011). A further critique is that because of a lack of connection with research, much of educational practice remains untheorized – that is, programs or approaches may work excellently, but because they are not explicitly connected to theories of learning or learning design, it is not clear how they can inform or be adapted into new contexts (Bevan, in press). The work lives locally, and thrives or declines based on the leadership and vision of individuals, missing the opportunity to substantively advance the field.

Research-Practice Partnerships: A More Equitable and Ethical Relationship

Research-Practice Partnerships (RPPs) have been proposed as a new cultural model for the relationship between research and practice that can produce more relevant results leading to more powerful and sustainable improvements in practice (Penuel, Bevan, Bell, Falk, & Buffington, in review).

Coburn, Penuel and Geil (2013) define RPPs as having five main characteristics: They are long-term, focused on problems of practice, committed to mutualism, use intentional strategies to foster partnership, and produce original analyses. Mutualism means that each party has shared vested interest and voice in the design, conduct, and outcomes of the research. It means that the principled search for insight and understanding about educational practices is a joint endeavor among educators and researchers.

Within this framework they describe three different approaches to RPPs in K-12 education:

(1) Research Alliances

Research Alliances are defined as long-term relationships between educational entities, such as school districts, and external research agencies, such as universities. In research alliances, partners co-determine what kinds of studies are needed to address pressing problems and inform and improve practice as well as outcomes. These may include original research studies, large-scale data analyses, or program evaluations. After agreeing on the key questions, educational practitioners remain responsible for oversight, design or implementation of programs, while researchers conduct data collection and analysis. In this sense roles are more traditional, while the context is deeply collaborative. Coburn et al. (2013) provide an example of the long-term relationship between the Chicago Public Schools and the University of Chicago who have worked together across a range of studies to understand theory and implementation of educational improvement. An example in the informal sector might be the long-term relationship between the lab of Professor Richard Lerner at Tufts University and the national 4-H program. Over a period of many years, Lerner has conducted multiple studies including longitudinal studies that have generated data for 4-H and a wide range of theory-building papers for the research community. Below we share a research alliance example from the Hive in NYC, where researchers and educators are working together to understand youth development.
learning pathways across time and settings, and how out-of-school organizations can innovate educational practices within a networked context.

(2) Design-Based Research Partnerships

Design-Based Research (DBR) partnerships involve researchers and practitioners collaborating to iteratively design, test, and refine educational improvements (e.g., a science unit, a workshop design, an assessment approach, etc.) to generate practice as well as theory and insight into learning. The example provided by Coburn et al. (2013) is a science curriculum adaptation project between the Seattle schools and the University of Washington. The partners are working over multiple years to design and study the implementation of the Next Generation Science Standards, beginning with adapting science kits to incorporate “scientific practices.” Both the district and the university share an interest in what it takes to implement the standards; thus, the project is mutually constructed to advance the interests of each, and additionally each partner needs the other to achieve their goals. Roles may be blurred, researchers may co-design professional development workshops along with district science supervisors; they may lead and teach activities together. Practitioners may be deeply involved in data collection and analysis activities. Below we share an example of a design-based research partnership located in Chicago that has developed a broadly inclusive DBR approach called “Community-Based Design.”

(3) Networked Improvement Communities

Networked Improvement Communities (NICs) are defined by Coburn et al. (2013) as networks of districts that collaborate to identify common questions, strategies, and solutions with regard to educational improvement. They work across multiple levels of multiple systems to identify key leverage points within systems that relate to the identified problem, question, or goal. NICs are often characterized by rapid design cycles where the improvement strategies are implemented, data is collected and reviewed, and improvement strategies are redesigned, reframed, and retested (Bryk, Gomez, Grunow, & LeMahieu, 2015). An example is a Carnegie Foundation for the Advancement of Teaching project aiming to support teacher retention in multiple school districts. One district is focused on improving feedback provided to new teachers by principals and others. Another supports a network of teachers to develop a common vision and tools for science teaching (Thompson, Hagenah, Lohwasser, & Laxton, 2015). The districts come together to share strategies and what is being learned, in an effort to begin to develop a holistic view of the problem space and solutions. Below we describe the California Tinkering Afterschool Network, which shares some features of NICs, including shared inquiry activities to frame questions and make meaning of results as well as an ethos of rapid prototyping.

Methods and Activities

There are some research questions – for example meta-analyses of studies, foundational research on learning, or even some forms of evaluation research that are for the benefit of policymakers or funders – that may not benefit from an RPP approach (although even then, we believe that if there are indirect implications for practice, practitioners ought to be on an advisory panel to ensure that the study takes practical realities into account). But research intended to directly inform practice can almost always benefit through RPPs.

RPPs are not restricted to particular research methods. For example, an RPP might decide that conducting a randomized controlled trial is the best method for particular questions they are equally vested in exploring together. Many of the RPPs we have encountered blend methodological approaches.
A Range of Research + Practice Relationships, Not All Are “Partnerships”

**COOPERATIVE RESEARCH**
Researchers and educators form an agreement for which one party provides a service to the other. For example, an informal organization or educator may agree to allow a researcher to collect data in their program or site. Or a researcher may agree to evaluate a program for the informal organization. In these cases, it may be that one party provides compensation to the other. These relationships are usually short term, and do not qualify as “partnerships.”

**COLLABORATIVE RESEARCH**
Partnerships between researchers and practitioners where there is a shared interest in a question or practice. There may be periodic check-ins on the study’s progress or results. There may be member checks in which informal educators review and respond to representations of the results. Representations of the research results are most likely authored by the researcher and part of the researchers’ long term professional agenda. These relationships and studies are probably not of a long duration, however when successful, the partnerships may continue with new studies in similar or new areas of inquiry.

**JOINTLY-NEGOTIATED RESEARCH**
Partnerships in which researchers and practitioners jointly identify the questions to be asked, collaboratively review data, and collaboratively analyze and produce written or visual representations of the results. This work is characterized as both long-term (over years) and mutually engaging and beneficial. Although respective roles in the research may be differentiated, the ownership of the questions, process, and results is fully shared and equally vested. Researchers and practitioners may come together over shared concerns at a systems or domain level, and then work together to determine their best way into understanding and clarifying solutions.

Research-practice partnerships typically involve either collaborative or jointly-negotiated research relationships.

In the Research + Practice Collaboratory we are using a Design-Based Implementation Research approach in our joint work because we believe that iterative co-design creates a particularly powerful context for the development of relationships, understanding, and mutualism (Penuel & Fishman, 2012).

The Collaboratory is conducting three studies, one in the informal sector. In the latter, we are co-designing professional development tools to support and advance equity-oriented facilitation strategies in afterschool program serving young people from economically and racially marginalized communities (see description below). The focus on equity-oriented facilitation and professional learning needs was jointly identified, as was the iterative design and refinement of tools to support it. At the same time, the roles of researchers and practitioners remain more or less distinct, drawing on their particular areas of expertise. For example, researchers are primarily responsible for collecting data, coding data, and presenting data summaries for joint consideration and analysis. Educators are primarily responsible for their programs in which the designs are being developed and researched. That said, researchers might help out in the facilitation of a given program while educators might engage in joint analysis of fieldnote or interview data alongside researchers.

It is a central tenet of our work in the Research + Practice Collaboratory that RPPs are fundamentally a more equitable and ultimately a more ethical way to conduct research for two reasons. First, because successful RPPs share power across both research and practice, and in the process fundamentally enrich
as well as illuminate the problem space in which research and practice will be developed. Second, while they are intended to develop both theory and method, they are first and foremost organized to begin with the needs and realities of the participating educators. Thus, they can develop knowledge and strategies that are valued and also practically feasible for educators (Bevan, Gutwill, Petrich, & Wilkinson, 2015). Thus practice is never simply a site for research or theory advancement; it is where we jointly seek to make change.

In the next section we highlight examples of RPPs in the informal sector. After reviewing their approaches and benefits, we surface design strategies and tensions that can guide future development of RPPs in informal science education.

**Informal RPPs: Three Examples**

**Research Alliance: Hive NYC Learning Network & Hive Research Lab**

*The idea for the Hive Research Lab sprang from the need among educators for research to inform the evolving learning network in New York City. Throughout the Research Lab’s history, our research focus, our findings, and even our methods are rooted in the needs and desires communicated by the local community.*  
– Kylie Peppler, Associate Professor, Indiana University

**Hive NYC Learning Network** links 81 informal learning organizations, including museums, libraries and other non-profit educational organizations with the goal of expanding and brokering interest-driven digital learning opportunities for youth. The network supports the development of new programs through organizational collaboration, coordinates activities among existing programs, and brokers opportunities for young people to access learning opportunities that develop their interests.

Since 2012, Hive NYC Learning Network has had a close research alliance with Hive Research Lab, led by scholars from Indiana University and New York University, two of whom were previously program members of the network. Together the research team, facilitators based at the Mozilla Foundation, and member organizations co-determine salient research questions and needs. As in policy-focused research alliances described by Coburn et al. (2013), some of this work has been oriented toward coordinating inter- and intra-organizational activities that better leverage existing institutional pathways and resources such as the city’s Summer Youth Employment Program, or defining ways in which a current mayoral initiative for community schools might establish connections to the informal learning sector. However, most of the work is oriented towards developing a collection of long-term and overlapping studies that can directly inform Network activities, aiming to simultaneously advance practice while developing theory about youth learning pathways and organizational learning networks.

For example, in studying the nature of youth interest-driven learning pathways within Hive NYC, researchers are examining how social support from a variety of contexts impacts youths’ educational, professional and civic opportunities/pathways across learning settings including Hive organizations. Early research revealed that student word-of-mouth and recommendations from trusted adults were key for youth taking up learning opportunities, and this in turn led the Hive members to create a series of youth meet-ups to expand and broker such opportunities. In other cases, impacts of the research come from conceptual uptake of the work, such as a school in the Bronx organizing its staff professional development around the concept of brokering future learning opportunities, or organizations who adopt language and findings generated through Hive research activities to advocate for the important role that informal learning opportunities play in supporting youth learning across time and setting.
Additionally, the partnership between Hive practitioners and researchers has led to the development of several new forms of knowledge production and representation. For example, Hive Research Lab designed a new programmatic model of community engagement activities with the goal of generating white papers on topics particularly pertinent to the Hive’s broad network and constituency, such as community-knowledge building (Santo, Ching, Peppler, & Hoadley, 2014) and youth learning pathways (Ching, Santo, Hoadley, & Peppler, 2015). Content for the white papers comes from interviews and program data, from reviews of scholarly literature, and from practitioner insights surfaced through structured engagement activities.

In the case of the community knowledge building paper, Hive program participants produced guidelines for how to instigate, organize, implement, and document contexts and formats for supporting community organizations to learn from one another. As the Hive Research Lab team notes, the ongoing feedback from practitioners, surfaced during the collaborative knowledge-production meetings, helps “to continually ‘tune’ the researchers to the ways that their collaborating practitioners think,” which in turn ensures that the paper can have greater utility, impact, and reach.

Design-Based Partnership: Building Relations in Chicago

The folks from the community that became Research Assistants started transforming protocol, transforming our methods ... For instance take some cognitive protocol that’s fairly normative. And the community would say ‘No don’t do it like this. Change the priming questions. Change the stimulus in these ways.’ It’s been pretty exciting and it’s actually forged new research ground that we often don’t think practitioners are interested in.

— Megan Bang, Professor, University of Washington

The Community Practice Research Collaboration is a partnership between Northwestern University (NU), the American Indian Center of Chicago (AIC), and local indigenous communities including individuals from the Menominee Reservation. Founded in 2002, the partnership’s goal has been to promote the development of sustained human capacity in the Chicago indigenous communities, especially in the realm of STEM awareness and proficiency, while privileging Native American epistemologies and experiences through providing STEM-rich afterschool programs. Project activities have focused on exploring, restoring, and coming to understand local ecologies.

The project takes a design-based research approach to creating, testing, and refining afterschool programs that effectively and inclusively blend Native American scientific epistemologies with Western scientific epistemologies in the exploration and understanding of local natural and social systems (Bang & Medin, 2019). Lesson plans are designed to weave the active presence of community members such as elder storytellers, indigenous STEM professionals and others into the programming. The foundations of this research agenda are deep collaborative relationships with community members, with careful attention paid to issues of power and representation. For example, a design team may include as many as 40 people. Teams are formed that balance gender as well as age, and those implementing generally involves one male, one female, one young person, and one elder. These decisions are all reflective of the design team’s efforts to theorize change in culturally based ways. Often this has meant taking the time to collectively reflect and analyze structures of power and cultural assumptions that are not aligned with the Native community and making deliberate design decisions to shift them.

Seeking to challenge traditional research/practice roles and support authentic collaboration, the project has developed various mechanisms for shared knowledge-construction and egalitarian teamwork. For example, since AIC is funded directly by the
National Science Foundation for this project, the RPP took the opportunity to have AIC serve as the employer of the project researchers (rather than contracting with the university). This means that the project researchers are required to participate in all facets of AIC staff life, including teaching, attending staff meetings, and planning events. Involvement and inclusion of the community has also directly shaped the design and implementation of the research. Nearly all of the individuals who are serving as project researchers – designing protocols, collecting data, participating in analysis and meaning-making -- have come from the Chicago Intertribal community, representing over 50 tribal nations. These researchers came to the project as individuals, not formally trained in research methods, to participate in the design research activities. Community members led these projects and fundamentally shaped the focus of the research. For example, the project was not originally focused on plant life, but because the community wanted to focus on plants, the research shifted. The project was initially interested in scientific reasoning and knowledge organization, but of greater interest to the community was a focus on things like making relationships through keen observation and paying attention to one’s surroundings. These shifts not only impacted how practices of attention and observation were taken up in the programs, but also how they formed new and powerful lines of developmental research.

Since the partnership started, the number of people from the native Chicago community earning degrees in higher education has quadrupled.

**Networked Improvement Community: California Tinkering Afterschool Network**

'It's this equal relationship where each one of us comes to the table and we have assets. We know girls, we know programs, the Exploratorium knows research.
— Linda Kekelis, Executive Director, Techbridge

The California Tinkering Afterschool Network (CTAN) is a partnership involving five informal science education organizations in California: Exploratorium (San Francisco), Discovery Cube (Santa Ana), Techbridge (Oakland), and the Community Science Workshops in Fresno and in Watsonville. Each of these organizations provides afterschool STEM programs to young people from economically and racially marginalized communities. Each organization has a shared interest in the potential of Making or Tinkering to serve as a powerful context for young people's STEM learning within a youth development frame.

Formed in 2012, CTAN consists of organizational leaders, front-line staff, and researchers. Initially the network was formed to explore how to expand tinkering into afterschool programs. Research questions focused on activity design, facilitation strategies, and how to integrate STEM-Rich Tinkering into existing afterschool programs. Over time, however, through joint discussion and collaboration, these questions began to drill into what was most pressing to these organizations, namely, how to support frontline staff to adopt equity-oriented strategies for facilitating student learning through STEM-rich tinkering.

At each site in the network, CTAN teams of researchers and practitioners are developing evidence-based descriptions of equity-oriented STEM-rich tinkering and facilitation along with
professional development tools and strategies that can scale and expand it. To support joint data analysis processes the network has focused on (1) Building trust across organizations and roles, (2) Developing shared understandings of teaching and learning related to STEM-rich tinkering, (3) Developing a common vocabulary for communicating ideas and theories, and (4) Designing methods for joint data analysis. Collaboration is maintained via monthly all-partner phone calls, weekly site-visits by RPP teams, the use of online communication tools, and face-to-face meetings approximately every quarter.

CTAN has several features of the Networked Improvement Community described by Coburn et al. (2013). For example, the entire network comes together periodically to explore the shared problem space, and identify a range of “drivers” related to the opportunities and problems the group is mutually invested in addressing. It was in such a meeting in 2013, that the network identified staff capacity to provide equity-oriented tinkering facilitation as a major driver affecting efforts to expand STEM-rich tinkering into afterschool programs serving youth from low-come communities. Similarly, these conversations led to a discussion of how tinkering can be used to reframe notions of “failure” for economically marginalized communities (Ryoo, Bulalacao, Kekelis, McLeod, & Henriquez, 2015).

CTAN also engages in the rapid co-design, prototyping and testing of resources and tools. For example, one site identified the need to support moments of reflective practice within daily schedules that did not allow time for extensive debriefs. The group is prototyping an iPhone app that can prompt and also collect (for later discussion) facilitators’ thoughts on how the day’s activities have advanced equitable engagement among the youth. The Network’s focus on building trust to support the development of shared vested interests has itself led to the creation of several professional development tools. In an early meeting, the network engaged in a Value Mapping exercise in which network participants articulated what was most important to them about their work, about tinkering and STEM, and about the collaborative research. This exercise began to illuminate the deep investment in equity-oriented facilitation. Network organizations then picked up the Value Mapping exercise and adapted it for their own purposes to support relationships and trust-building among their program staff. The productive nature of these experiences led the group to develop two partnership tools: A formalized, sharable, version of the Value Mapping exercise (Ryoo & Shea, in preparation) and a guide for creating and sustaining equitable RPPs (Ryoo, McLeod & Choi, 2015).

Conclusion

While the examples above have been organized to reflect the typology of RPPs presented by Coburn et al. (2013), in fact many of the informal RPPs blur and cross boundaries. For example, CTAN, which we describe as a NIC, employs design-based research in each of its five study sites. The Hive NYC research alliance involves a distributed network, and it has adopted rapid data collection methods, such as Plan-Do-Study-Act cycles, that are commonly associated with NICs. More research may be needed on the typologies and if and how they differ for informal learning contexts, or how they may blur and blend as more RPPs are developed across formal and informal contexts.
A review of the descriptions above reveals the following characteristics of research-practice partnerships (RPPs):

- RPPs are often formed by making personal connections and finding common shared concerns or interests. In other words, they start from genuine professional conversations rather than pressing project or proposal needs. For educational practitioners, this may mean picking up the phone and inviting a researcher to come to a program and meet afterwards to talk about it.

- RPPs pay particular attention to power dynamics within the partnerships, creating formalized structures, such as the leadership balance in the Community Collaboration in Chicago, or formalized processes such as the Value Mapping exercise in CTAN.

- RPPs can sometimes shift and blur roles, such as the American Indian Center hiring Northwestern University researchers as employees, or employing community members as researchers; or the Hive’s involvement of practitioners in the creation of white papers for the field.

- RPPs may redirect the actual focus of the research questions, as pressing interests or specific questions in practice take center stage or become clear pivot points for the larger effort.

- RPPs tend to change conditions on the ground, which leads to the emergence of new needs, such as a recognition of the power of reflective practice for supporting equity-oriented instruction, which in turn led to the need for rapid prototyping of particular solutions or tools, such as the reflection app for CTAN.

The RPPs described above suggest how a new cultural model for the relationship between research and practice can lead to new forms of knowledge and practice by virtue of the partnership itself. The partnership changes the conversation, the lens, and activity. In this new context, new questions emerge, new solutions are tested. At the Research + Practice Collaboratory we are documenting how participation in RPPs intellectually enriches the working lives of both researchers and practitioners, engaging each in practices that are demonstrably important for making immediate improvement in the lives of learners and for contributing to long-term theory.

Studies have found that typically the results of research improvement efforts drop off dramatically within a year of the research intervention (Yeager & Walton, 2011). We are exploring whether RPPs produce more timely, usable, and sustainable results than research developed without the close involvement of practitioners. We are also documenting the conditions that support productive RPPs, such as how to develop mutual trust, shared language, and common representations.

As research in the context of informal science learning further develops, there is a potentially powerful opportunity for this relatively new trajectory of knowledge development to orient towards pressing problems of practice. This may best be achieved through long-term partnerships that deeply engage both educators and researchers with new perspectives that can enrich their professional lives and lead to sustainable educational improvements.
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