Planning for Scaling and Sustaining Afterschool STEM Programs

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Abstract: This paper develops a sustainability framework for afterschool STEM programs. The framework draws primarily from research on supports needed to scale and sustain innovative programs in schools. It also addresses challenges to and strategies for promoting sustainability unique to the afterschool context. The framework highlights that, to achieve implementation depth and program evolution, programs must be designed with usability in mind. Designers must consider up front the capacity of the organizations that will be implementing the program. We present illustrations of five successful strategies afterschool STEM programs have used to achieve scale and sustain themselves: (1) achieving depth through co-design; (2) achieving spread through partnerships; (3) developing ownership from the beginning rather than transferring ownership; (4) sustaining programs through professional development infrastructure; and (5) developing and aligning frames to allow programs to evolve. This paper concludes with a call for developing credible plans for sustainability in program proposals and for more research on scaling and sustaining afterschool programs.

Most STEM afterschool programs begin with innovation plans and funds for a single project. That project supports development, implementation, and sometimes a limited amount of dissemination. At some point, all projects face the question of how to grow and sustain the program. After school programs where projects are implemented often have limited capacity to sustain programs on their own given high turn over in staff and the costs of continuing the program. This lack of capacity may be intensified if staff lacks STEM knowledge needed to understand concepts, discern important learning goals, and effectively enact curricula. As a consequence, many high-quality projects in informal science education do not last beyond the grants that fund their development.

Education research has articulated the features for scaling and sustaining innovations in schools (Coburn, 2003; Schneider, 2007; St. John, 2003), even focusing on the sustainability of science programs in school (Fishman & Krajcik, 2003; Blumenfeld *et al*, 2000). Missing from the informal science research field are models for how programs in the innovation phase of a first project can plan and prepare for scaling and sustainability. Just as the absence of a clear plan for implementation and scaling hampers efforts to scale STEM innovations in schools (Confrey, Lemke, Marshall, & Sabelli, 2002; McLaughlin & Mitra, 2001), so too does the absence of such plans for afterschool programs.

A key idea we present here is that developers should imagine the innovation as unfolding in multiple stages that anticipate and prepare for the challenges of becoming a scalable, sustained program. Rather than leaving thinking about sustainability and dissemination plans until after a program design has been articulated, scale and sustainability plans should be integral to the conception of the innovation. Policymakers and funders can encourage these plans for the sustainability and scalability of these innovations in order to help build a strong infrastructure for STEM afterschool programs.

Establishing a Sustainability Framework

Frameworks for scaling and sustaining school-based innovations provide insights for developers of afterschool STEM programs as they plan the stages of their innovation through sustainability and scaling. Coburn (2003) outlined four interrelated dimensions for scaling and sustaining education innovations--depth, spread, shift, and sustainability--and Dede (2007) added a fifth dimension to Coburn's framework: evolution. Together, these five dimensions highlight specific areas that can be thought of sequentially by developers as well as collectively as they can reinforce one another. *Depth* refers to the impact of the innovation on youth learning and educators' practice. Coburn (2003) states: "reform must effect deep and consequential change." *Spread* is the traditional notion of scale: the spread of a reform to a greater number of afterschool sites. *Shift* in innovation ownership requires that practitioners responsible for the implementation, not developers of the innovation, have full authority for the innovation, including ongoing support, professional development and future implementations. *Sustainability* means maintaining the depth of the program (and allowing for acceptable adaptations) over time under less than ideal conditions. *Evolution* of the innovation for sustainability involves three types of innovators: developers, researchers and practitioners. Practitioners' implementation influences future research and development. Evaluations and assessment tools that informed the original innovation for all three types of innovators can help practitioners to adapt and evolve the innovation as well as provide data for seeking funding for the sustained program. Evaluation plays multiple roles in the scaling process (Harvard Family Research Project, 2010).

Cutting across all five of these dimensions, researchers at the University of Michigan (Blumenfeld et al., 2000; Fishman & Krajcik, 2003) developing science curricula have identified usability of the innovation—by teachers, students, and administrators—as key to the sustainability of an innovation in schools:

> If an innovation is "usable," this means three things: (1) that the innovation is adaptable to the organization's context, (2) that the organization is able to enact the innovation successfully, and (3) that the organization is able to sustain the innovation. (Fishman & Krajcik, 2003, p. 565)

These researchers note that the innovation is more than the curriculum materials; part of the innovation is the understanding, building, and planning for ongoing support of the capacity of the organization to implement effective science curricula. The curriculum materials must be usable by the audience, but often the capacity of the organization needs to be increased in order to use the program. Other researchers of in-school science learning have noted the importance and interplay of both the usability of the curriculum and the building of the organization's capacity to offer the curriculum (St. John, 2003; Cohen & Ball, 1999). This capacity refers not only to the capabilities of the educators but alignment with the organization's culture and policy and management's initiatives (Blumenfeld et al., 2000; Fishman & Krajcik, 2003).

In this paper, we construct a sustainability framework that draws upon research on the sustainability of in-school science curriculum innovations but that also addresses challenges to and strategies for promoting sustainability unique to the afterschool context. These examples from the field of afterschool science learning include lessons learned from several afterschool programs and from our own work on Build IT, a collaboration between SRI and Girls Inc., a national organization that reaches more than 800,000 girls in K-12 each year. Build IT is supported with funding from NSF's ITEST and the Noyce Foundation and is an after school and summer youth-based curriculum for middle school girls to develop IT fluency, increase their interest in taking mathematics and computer science courses, and encourage their pursuit of IT careers. Evaluation data from the Build IT program's development, implementation, and scaling successes and challenges over the past five years in the Girls Inc. network of affiliates indicates a process for achieving scale and sustainability of informal science learning programs in afterschool settings (Koch *et al*, 2010).

Achieving Depth through Co-Design

To achieve 'deep and consequential change' in afterschool STEM learning, our experience and research point to a co-design process in which developers from the learning sciences and youth development collaborate to develop a learning science-rich curriculum that fits well in a youth development environment. At first glance, engaging in co-design as a means to achieve sustainability may seem counter-intuitive:

collaborating with practitioners takes time, agreement on curricular goals and how to achieve them, and a structured process for iterating. Yet co-design, in which developers lead a highly-facilitated, team-based process with practitioners to design and implement prototypes of the innovation, can help develop greater ownership over designs, strengthen STEM content, and make it more likely that designs will be usable in real settings (Penuel, Roschelle, & Schectman, 2007).

An example of a project that is employing co-design to develop powerful STEM afterschool programming is the NSF-funded Science Learning through Science Journalism (SciJourn) Project. This project aims to apprentice students to the practice of science journalism. The project's strategies are being developed by a partnership among education researchers, science journalists, teachers, and youth development staff at a local science museum. The perspectives and expertise of researchers, science journalists, and educators is incorporated into the program. In particular, the museum youth development staff's expertise in the museum space for learning and the needs of the participants helped to strengthen engagement in the STEM content and fit with the museum's program offerings.

In Build IT, SRI's and GIAC's philosophies and pedagogical approaches from the learning sciences and youth development, respectively, met in the development of a constructivist, problem-based curriculum that provides youth with hands-on experiences that are not solely computer based but enable youth to use their bodies, creativity energy, and visual representations to act out computational approaches to solving problems and designing the world around them. Build IT incorporated two main processes for developing a robust curriculum: identification of learning goals and how to achieve them using *Understanding by Design* (Wiggins & McTighe, 1998) approach and an iterative co-design process between SRI (learning sciences) and Girls Inc. (youth development). The co-design process allowed constant checking of the program's usability for youth and youth development leaders. These processes enable curriculum features, such as embedded assessments and Eccles' Expectancy Value Model (Eccles, 2009) for STEM workforce learning and interest, to have compatible qualities of both the learning sciences and youth development that encourage sustainability in the youth development environment: the youth development approach is visible and learning goals, assessments, and activities are articulated in a language consistent with youth development.

Using a co-design approach for both the curriculum and professional development has provided a systematic way to approach usability and capacity building in Build IT. In our scaling experience, the curriculum first appeared daunting to many of the affiliates. The professional development structure and ongoing supports were critical to getting over this hump. The evaluation of the scale up also showed some consistency in what each affiliate struggled with the first year of implementation: the mathematics and securing IT professional visits. Most sites were able to overcome these hurdles by the second year with the curricular and professional development supports provided by the Girls Inc. national office.

Achieving Spread through Building Partnerships

For spread or scaling of an innovation to occur, the innovation must influence the norms and principles, such as policies, curricula enactment, and professional development within the organization (Coburn, 2003). The proven impact of the innovation, ease of use, and fit with the organization are critical factors in achieving scale. Partnerships can support and reinforce these factors with the organization implementing the innovation.

For example, The John W. Gardner Center for Youth and their Communities at Stanford University partners with communities to improve youth development programming at a systemic, organizational, and individual level. Its partnership with the community of Redwood City, California, now spans over 10 years and multiple projects that evidence a shared commitment to working together to improve the lives of young people in that community beyond the life of a single grant. What sustains the work, which spans projects in schools, community-based organizations, and local government agencies, is a shared commitment to the partnership, its goals, and recognition that the work of community change takes time. The role of the researchers in the partnerships has been to provide data and analytic support that can inform community members' questions about how best to improve youth outcomes across the multiple institutions of the community.

A report on the sustainability of 21st Century Community Learning Centers (21CCLC) by The Finance Project (2006) also highlights the importance of partnerships. Grantees emphasized that partnerships are essential for long-term sustainability, specifically partners that have shared goals, clear roles in program development and refinement, and credibility with funders. Partnerships also have the potential to expand the capacity of programs to coordinate educational and social services many young children living in poverty need, so that afterschool programming can be as effective as possible (de Kanter, Adair, Chung, & Stonehill, 2003).

The importance of partnerships for the scaling of a program is also evident in Techbridge, a program that has encouraged more than 2500 middle and high school girls in science, technology, and engineering learning and career exploration over the past 10 years. Techbridge, developed out of the Chabot Space & Science Center in Oakland, CA, has cultivated ongoing partnerships with schools, parents, teachers, STEM organizations, and afterschool programs. The partners provide feedback and research data to Techbridge in order to continue to improve the program and refine its fit with these organizations.

For Build IT, the work began with key partnerships among SRI International, bringing expertise in information technology and the learning sciences, Girls Incorporated of Alameda County, CA, a Girls Inc. affiliate that brought expertise in youth development and a strong youth development program in which to develop the innovation, and Girls Inc., the national office for the more than 150 Girls Inc. affiliates nationwide that could provide professional development and scaling support for its network of affiliates. As part of the Build IT curriculum, girls meet and engage in hands-on activities with women STEM professionals in order to encourage their interest in STEM learning and careers. Embedded in the Build IT program is guidance for youth development organizations on how to foster ongoing relationships with these STEM professionals and their organizations. This strategy for establishing ongoing partnerships with the local STEM community, as well learning scientists and STEM experts, has the potential to keep the program current with STEM changes, rather than insular to the one organization implementing it, and attract new funding opportunities.

Developing Ownership from the Beginning Rather than Transferring Ownership

During the initial stages of design, typically curriculum developers and researchers drive improvements to designs. External grant funding typically supports the work to revise initial designs to reflect what developers are learning from testing them in programs. When the grant ends, however, there may be no additional revisions to designs, since follow-through depended on funding the time of developers and researchers. To sustain the ongoing revisions needed to keep designs fresh and responsive to learners' interests and needs, projects need to transfer ownership to practitioners for revision before the grant ends.

One way to shift ownership for continuous improvement is to build processes for revising learning activities into designs themselves. Japanese lesson study (Lewis, Perry, & Hurd, 2004; Lewis, Perry, & Murata, 2006) is an example of such a design that targets instructional improvement in schools. The design is itself structured as a process of continuous improvement: teachers develop a lesson targeting specific knowledge and skills, teach it in front of colleagues who are part of the lesson study team, and then revise the lesson on the basis of feedback from the whole team. It offers what has been called a "local route" to scaling (Lewis, et al., 2006), since the model requires every local team to engage in lesson design and revision, in ways that reflect local goals for student learning. The process of engaging in lesson study, while intensive, often builds a level of ownership necessary for improving designs.

A related strategy is to build mechanisms of assessment into learning activities that provide learners with feedback that they can use to guide their own learning, and give program leaders evaluation tools to see and make modifications to the curriculum as needed. Many arts-based after-school programming organize opportunities for youth to plan and manage collaborative activities and to modify their performances or products on the basis of external review and critique (Heath, 2001; Heath & Roach, 2000; Soep, 1996). Feedback from professional artists and from older youth creates an atmosphere of challenge and collaborative critique in which young artists learn to question their own work (Heath & Roach, 2000). The practice of critique is also characteristic of the work of professional software engineers in their design activities, a practice that has been adapted and modified in the Build IT program with much success. In Build IT, youth have frequent opportunities to give each other feedback on their designs as well as show themselves, their peers, youth program leaders, families, and their communities what they know and can do.

Sustaining Programs through Professional Development Infrastructure

Professional development supports play a key role in sustaining a program. As programs move towards sustainability, resources for professional development and other assistance to facilitate implementation often dissipate, especially for programs attempting to achieve scale as well as sustainability (Coburn, 2003). In youth organizations, turnover is high.

Organizations may train staff to implement a program one year, only to lose those staff the next year. That organization may not have the capacity to implement the program anymore, unless it has a process for inducting new staff to support specific programs and providing opportunities for ongoing professional learning.

A strategy some programs have employed is to share professional development responsibilities with sites from the beginning. In the Build IT project, a program manager, who supervised the staff implementing the program, worked side-by-side with the Principal Investigator and her staff from SRI to design and deliver professional development. With the first implementation of a Build IT unit, SRI led the professional development; the second implementation, SRI and Girls Inc. co-led the professional development. By the third implementation, Girls Inc. led the professional development, inducting staff new to the organization into the program.

The Build IT program is successful in part because ongoing professional development is part of the Girls, Inc. infrastructure – at each affiliate and nationwide. Like many other youth-serving organizations, affiliates experience frequent turnover in program staff but also have a relatively stable core of program managers who supervise these program staff. At the national level, Girls Inc. provides affiliates with professional development on many of their programs, including Girls Inc.'s Operation SMART™ (Science Math and Relevant Technology) Girls Inc. is comfortable providing professional development for STEM programming and includes Build IT in its suite of Operation SMART™ programs. Girls, Inc.'s ability to provide professional development through its own staff, as well as its national infrastructure for curricular innovation and implementation, make it a youth-serving organization with strong capacity to sustain innovations that fit within its mission and rely on this infrastructure.

Developing and Aligning Frames That Allow a Program to Evolve

A single project that initiates a cycle of program development typically presents a single "frame" to a potential funder, in order to win support for the project. The term frame draws from the writings of Goffman (1974) and from social movement theory (Snow & Benford, 1988); it refers to a specific definition of a problem to be solved, a path to its solution, and a rationale that makes the solution a compelling one to the audience. The need for a youth program related to science and technology program, for example, might be defined in terms of the need for more widely accessible pathways into STEM careers for youth of color, or in terms of the need for a more compelling entry point into engineering careers for women. The solution proposed is typically a curriculum, a program, or a design for professional development, and the rationales include appeals to past work and expertise that make the developers the right team.

A proposal frame is rarely enough to sustain a program across multiple projects or to convince new groups to fund new development related to the program or to implement it in new settings. A key task for sustainability is to develop multiple frames that establish congruence among the frames for defining problems that funders and implementers may bring. This activity of aligning frames cannot be simply "chasing the money," but rather must be a genuine bridging or extension of activity in ways that allow for the program to be shaped, grow, and even transform, as it moves to a new context.

A strategy that selected institutions and teams often use to develop an understanding of a problem across multiple projects is to conceptualize a "program of research and development" that guides their activity. Two successive projects involving a partnership between the Santa Fe Institute (SFI) and Santa Fe area schools focused on exploring how modeling and participatory simulation tools can help students learn about complex systems. The first project involved a partnership with software developers and researchers at the Massachusetts Institute of Technology; it built capacity of staff at SFI in educational outreach and among local teachers to help students build models of complex systems. With this solid foundation, the local team, led by SFI, pursued a second grant that did not include the MIT researchers and that shifted the focus to after school programming. Because of the enduring involvement of local schools in the partnership, the second project was able to offer unique opportunities to students, such as receiving school credit for participating in afterschool programs.

For Build IT at scale, the frame for funding varies according to the affiliate and its surrounding community's needs and resources. Build IT has shown to be a fundable program in many locations, even acting as a marketing tool to fund programs in addition to Build IT. At the national Girls Inc., national funding frames are used. Evaluation data captured at the local and national levels through evaluation and assessment tools developed in the project support the evolution of the program for learning as well as providing important data for future funding.

Directions for Research for Improving Sustainability

Designing for sustainability requires that we anticipate from the earliest stages of innovation development and beyond initial funding the following: the contexts of use and usability of the innovation in that context, the organization's capacity to support implementation in those contexts, and the types of future contexts.

The process can begin with careful attention to developing plans for dissemination and sustainability. Such plans require more than plans for sharing what is learned with relevant communities of practice and more than a strong institutional partner that makes a promise to sustain the program on its own. It requires a well-specified theory of implementation that delineates roles and responsibilities for implementation and a plan to conduct research on implementation that identifies the strengths and weaknesses of the program as well as the frequently invisible work required to sustain programs. The work of supporting programs is ongoing; making visible the scope and nature of that work during the life of the program can help programs better plan for sustainability. Programs need to consider business models for continuing to sustain an innovation's ongoing implementation, and when appropriate, plans for building research programs to support the innovation's evolution in ways that carry across multiple projects.

Research on implementation activities and sustainability can contribute toward a "science of broader impacts," that is, a knowledge base for how programs can achieve broad reach, especially among underrepresented communities. At present, many programs consider the heart of their contribution to science in terms of the teaching and learning growth that can be accomplished under conditions of high support from researchers. We hope that programs will begin to consider the science of sustainability as an equally worthy goal for knowledge building in the field.

Discussion Questions

1. How must these frameworks developed for innovations in schools (i.e. Coburn and Dede's *Scaling Framework* (depth, spread, shift, sustainability, evolution); University of Michigan researchers' sustainable science curriculum innovations through usability and capacity building) be adapted for afterschool programs? Is there something missing in these views for the afterschool?

2. What do afterschool science programs that do last have in common?

3. Based on this whitepaper, what advice do we have for policymakers in developing an infrastructure that supports the maturation of innovations into sustainable programs?

    2a. What advice do we have for implementers? (informal learning organizations)

    2b. What advice do we have for researchers of these environments?

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